Preliminary Technical Proposal for Jessica JaimePaulin Fully Functional Extraction Machine (50L Level)

1、Project objectives and positioning

target

Build a modular and scalable laboratory pilot plant extraction platform, complete 50L small-scale validation, output essential oil/flower water and solvent extracts (polyphenols, flavonoids, etc.), establish a GC-MS component fingerprint library, and lay the foundation for subsequent scaling up and commercialization.

positioning

Targeting small and medium-sized plant extraction and small batch customized production, with a focus on "modularity, multi process, and scalability", it adapts to the low threshold pilot needs of farmers, small and medium-sized enterprises, and scientific research institutions.

2、Core modules and equipment specifications

Main specifications and core functions of key equipment in the module
Steam distillation module 50L distillation kettle+steam distributor made of AISI-316 material, basket type loading, steam flow rate 20-25kg/h for essential oil and flower water extraction
Pre processing module ultrasonic wall breaker 500W adjustable, suitable for 20-50L tank raw material wall breaking, improving extraction efficiency
Solvent extraction module 20-50L closed-circuit extraction tank with reflux condensation recovery system, solvent recovery rate≥95% for extracting polyphenols, flavonoids and other components
Concentrating module small vacuum evaporator 1-5L/h concentration capacity for extract and flower water concentration
Control and monitoring module PLC+touch screen+sensor real-time monitoring of temperature and pressure flow, automatic recording of batch data, process control and traceability
Residue processing module tray oven 75kg/batch processing capacity residue drying for fertilizer or biochar production

3、Typical process flow

Raw material sorting→ drying (moisture content 10-15%)→ ultrasonic pretreatment (10-20 min, 300-500W)→steam distillation (90-120 min, 1 bar)→oil-water separation (collecting essential oils/flower water)→ residue solvent extraction (1-3 times)→ concentration and refining→ formulation (nanoemulsion/microcapsule)→ residue resource utilization.

4、Quality Control and Safety Compliance

quality control

-Raw material standard: Record the harvesting date, place of origin, variety, and moisture content, and chop the particles with a diameter of 1-1.5cm.
-Testing requirements: Each batch of essential oils should undergo GC-MS component fingerprint analysis to compare the content of major components (such as 1,8-cineole).
-Data traceability: PLC automatically records batch data and stores it for 3 years.

safety measures

-Steam system: equipped with safety valves, liquid level protection, and overpressure alarm; Solvent system: Closed loop recovery, anti-static grounding, explosion-proof electrical.
-Personal protection: equipped with protective goggles, heat-resistant/solvent resistant gloves, and ventilation facilities.

Regulatory compliance

-Agricultural products: complete toxicology, field testing, and registration; Cosmetics/food ingredients: comply with corresponding safety and labeling regulations.
-Environmental requirements: Wastewater treatment meets standards, and residue disposal complies with local regulations.

5、Development Plan and Budget

Milestones (6 months)

1. 0-6 weeks: Confirm requirements, complete equipment procurement and installation debugging;
7-10 weeks: Complete 3 batches of small-scale experiments and GC-MS analysis, record the yield and composition;
3. Weeks 11-16: Optimize process parameters and develop one formula product;
4. Weeks 17-24: Pilot scale-up verification and completion of economic sensitivity analysis.

Budget Estimation (MVP)

-Equipment and installation: 12000-30000 USD;

-Analysis and Testing: 300-900 USD (3 batches of GC-MS outsourcing);
-Material consumption: 500-1500 USD;
-Total start-up budget: 15000-35000 USD.

6、Core deliverables

1. Equipment list and procurement specification sheet;
2. Trial SOP document and batch record template;
3. Three batches of GC-MS reports and yield statistics;
4. Suggestions for process optimization and preliminary economic evaluation report.

The strategy has been preliminarily determined, and now we will start with tactics, that is, technology.

Detailed process parameter table, covering every process from raw material entry to final release in the form of a table: objectives, key parameters (numerical range), control points and monitoring items, sampling frequency and retention requirements, release standards, equipment/interfaces and notes. The table content can be directly implemented as the core entry of the small-scale SOP and used for operation, recording, and verification.

Detailed Process Parameter Table

Process	Objective	Key Parameters (Numerical Range)	Control Points and Monitoring	Sampling Frequency and Sample Retention
Raw material incoming inspection	Confirm that the raw material meets the process and safety requirements	Moisture content 10-15%; Particle size 1.0-1.5 cm; foreign matter rate 0%	Raw material batch number, place of origin, harvest date, pesticide residue, microorganisms, ash content	Take 3 samples from each batch and merge them into a sample of ≥ 500 g, keep the sample for 12 months
Raw material pretreatment and shredding	Achieving uniform particle size for mass transfer	Chopped particle size 1.0-1.5 cm; loading rate ≤ 70%	Detection of chopper speed, cutting blade gap, and particle size distribution	Take one sample after each batch of shredding and record the particle size distribution
Drying	Reduce moisture content to target, prevent mold growth	Temperature 40-60 ° C (thermal sensitive material ≤ 50 ° C); Wind speed/load according to equipment instructions	inlet and outlet temperature, relative humidity, moisture content curve	3 moisture content points are taken at the end of each batch of drying, with an average of ≤ 15% for release; Leave a sample of 500g
Ultrasonic pretreatment of UAE	Wall breaking, enhancing soluble component transfer	Power 300-500 W; Frequency 20-40 kHz; time		

Detailed Equipment Specifications and Interface List (50L Level) ", including technical parameters, materials, flange/interface dimensions, instrument list, power and utility requirements, installation/acceptance document list for each core equipment, can be directly used for inquiry and on-site layout.

Overall Equipment Requirements

-Material: AISI-316L (or equivalent) for all liquid receiving parts; Sealing components PTFE/EPDM (solvent compatible).

-Surface treatment: Inner surface Ra ≤ 0.8 μ m; The outer surface is mirrored or sandblasted.

-Document delivery: Factory certificate of conformity, material certificate (3.1/EN10204), welding records, pressure vessel certificate, electrical wiring diagram

P& ID、 Installation dimension diagram and IQ/OQ document.

Core equipment item by item specifications

1. 50L distillation kettle (basket type)

-Capacity: 50 L (working volume 35-40 L); Jacket heating; Flange opening DN300/DN400; Steam interface G1 half/DN25; Steam flow design 20-25 kg/h; Safety valve, level gauge, bottom valve DN25.

2. Condenser group

-Condensation area ≥ 1.0 m^2; Interface DN50/DN80; Cooling water inlet and outlet flange DN25; Design a cooling water temperature difference of 5-10 ° C.

3. Ultrasonic Wall Breaker (Canned Type)

-Adjustable power of 500 W; Frequency 20-40 kHz; Can capacity 20-50 L; jacket or external cooling interface; Power supply 220/380 V, explosion-proof option.

4. Closed loop solvent extraction tank (20-50 L)

-Equipped with reflux condensation and solvent recovery circuit; Recycling condenser DN50; The solvent recovery rate is designed to be ≥ 95%; Solvent interface with quick release connector (leak proof).

5. Small vacuum evaporator/recycling system

-Evaporation capacity 1-5 L/h; Vacuum pump interface KF25/DN25; Condensation recycling bottle with cold trap; Solvent purity testing port.

6. PLC control cabinet

-PLC+7 "touch screen; The I/O list includes temperature, pressure, flow rate, liquid level, vacuum, and leakage alarms; Export data to CSV/FTP.

7. Residue oven

-Tray type, processing capacity of 75 kg/batch; Temperature adjustable from 40-200 ° C; Exhaust and solvent recovery interface.

Instruments and interfaces

-Temperature: PT100 × 6 (kettle, jacket, condenser, extraction tank, recovery)

-Pressure: Pressure gauge/transmitter 0-2 bar x 3

-Flow rate: steam mass flowmeter; Cooling water flow meter

-Liquid level: Magnetic flap or radar level gauge

-Safety: solvent leak detector, combustible gas detector, explosion-proof grounding terminal

Requirements for Public Works and Installation

-Steam: stable source at 0.8-1.5 bar; Interface DN25; Condensed water recovery pipeline.

-Cooling water: ≥ 0.5 m^3/h, inlet ≤ 25 ° C.

-Electricity: 3 × 380 V, 50 Hz, reserved 10-15 kW according to the total power of the equipment.

-Ventilation: Local exhaust 6-12 times/hour, explosion-proof level in solvent area.

(Procurement Package)

-Equipment specification sheet (per unit); P& ID and installation dimension diagram; Instrument list (model/range); Electrical wiring diagram; IQ/OQ template; Spare parts list (first-year consumables).

This is the "50L Distillation Kettle (Basket) Complete Inquiry Specification Table" that can be directly used for inquiries, including key dimensions and interfaces, materials and surfaces, instrument lists, utility requirements, acceptance and delivery documents. It can be copied to procurement emails or bidding documents for use.

This specification is for laboratory pilot level 50L basket type steam distillation kettle, used for essential oil/flower water extraction. The designed steam flow rate is 20-25 kg/h, the working volume is 35-40 L, the liquid receiving material is AISI-316L, and the inner surface roughness Ra is≤0.8μm (reference for similar commercially available equipment)

Inquiry Specification Table

Project	Specifications and Requirements
Volume	50 L nominal; Working volume 35-40 L
Material	Liquid receiving parts AISI-316L; Sealed PTFE/EPDM
Surface	Inner surface Ra ≤ 0.8 μ m; External surface mirror or sandblasting
Heating method	Jacket steam heating, steam interface DN25/G1 half
Steam design	Design steam flow rate of 20-25 kg/h; Working pressure ≤ 1.5 bar
Flanges and interfaces	Boiler top manhole flange DN300; Bottom valve DN25; Condensation reflux port DN50
Safety device	Safety valve, liquid level protection, overpressure alarm, reserved bursting disc
Instrument	PT100 × 3; Pressure transmitter 0-2 bar x 1; Steam mass flow meter x 1
Control	PLC interface; Export data to CSV format; Touchscreen 7 "
Cleaning	CIP interface and spray ball; CIP design pressure 2 bar
Electrical	Explosion proof level options; Grounding terminal; Power supply 3 × 380 V
File	Factory Material Certificate 3.1; P& ID; Welding record; IQ/OQ Template

Instrumentation and installation points

Temperature/pressure/flow all require independent transmitters and calibration certificates; Flanges shall comply with ANSI/DIN standards and indicate the surface type and number of bolt holes. Suggest the supplier to provide on-site installation dimension drawings and P& ID for arrangement.

acceptance
Delivery includes: equipment, instruments P& ID、Material certificates, factory test reports, IQ/OQ documents, and spare parts lists; Acceptance shall be verified through pressure testing, functional testing (steam stability, condensation efficiency), and three batches of trial operation

I have converted the first engineering blueprint into a reproducible Python script, which will generate a vector graphic (SVG) containing front, side, top, vertical, interface details, and support diagrams when run. Please run in an environment with Python and matplotlib, where the script has adjustable parameters for easy reuse.

The following is the script description (important parameters can be directly modified): kettle diameter Dmm, overall height Hmm, working volume annotation, flange size flange-d n, canvas scale, and output file name. The script uses matplotlib to draw multi view engineering drawings and adds dimension annotations, interface numbers, and material annotations (AISI-316L, Ra≤0.8μm) on the drawings. If you need to generate or adjust the scale in bulk, simply modify the top parameter.

`python

50Lbasketstill_blueprint.py

```
Pre run installation dependency: pip install matplotlib numpy
import matplotlib.pyplot as plt
import matplotlib.patches as mpatches
import numpy as np

==========Adjustable parameters==========
D_mm=420 # kettle outer diameter mm
H_mm=1200 # total height mm
Workvoltext="Working volume 35-40 L"
flange_dn = {"top":"DN300","steam":"DN25","cond":"DN50","drain":"DN25"}
outputsvg = "outputblueprint.svg"

==============================

Unit Conversion and Scale (1 unit=scale mm in the figure)
Scale=1.5 # Scale factor, adjust the size of the drawing
```

```
W = 420scale3
H = 297scale3

Fig=plt. figure (figsize=(11.69,8.27)) # A4 horizontal approximation, can actually be enlarged
ax = fig.add_axes([0,0,1,1])
ax.setxlim(0,W);    ax.setylim(0,H)
ax.axis('off')
```

Auxiliary function: Draw cylinder (front view)

```
def drawcylinderfront(x,y,diam,height,ax,facecolor='none',lw=1):
r = diameter/2
# 釜体矩形表示
rect = mpatches. FancyBboxPatch((x-r,y),diam,height,boxstyle="round,pad=0.02",linewidth=lw,fill=False)
ax.add_patch(rect)
#Schematic diagram of jacket
jacket = mpatches. FancyBboxPatch((x-r-10,y-5),diam+20,height+10,boxstyle="round,pad=0.02",linewidth=0.8,fill=False,linestyle='--')
ax.add_patch(jacket)
```

Draw a front view

```
x0 = 120scale;    y0 = 60scale
drawcylinderfront(x0 + Dmmscale/2, y0, Dmmscale, H_mmscale0.6, ax)
Ax.text (x0+Dimscale/2, y0+Hmscale * 0.6+20, "Front View", ha='center ', fontsize=10)
```

Annotate the overall height and diameter

```
ax.annotate("", xy=(x0-60, y0), xytext=(x0-60, y0+H_mmscale0.6), arrowprops=dict(arrowstyle="&lt;-&gt;"))
ax.text(x0-80, y0+Hmmscale0.3, f"H={Hmm} mm", rotation=90, va='center')
ax.annotate("", xy=(x0, y0-30), xytext=(x0+D_mm*scale, y0-30), arrowprops=dict(arrowstyle="&lt;-&gt;"))
ax.text(x0+Dmm*scale/2, y0-50, f"D={Dmm} mm", ha='center')
```

Annotated interface (schematic)

```
ax.plot([x0+Dmmscale0.75, x0+Dmmscale0.95],[y0+Hmmscale0.45,y0+Hmmscale0.45], color='k')
ax.text(x0+Dmmscale1.0, y0+Hmmscale0.45, f"蒸 汽 入 口 {flange_dn['steam']}", fontsize=8)

ax.plot([x0-Dmmscale0.05, x0-Dmmscale0.25],[y0+Hmmscale0.2,y0+Hmmscale0.2], color='k')
```

ax.text(x0-Dmmscale0.35, y0+Hmmscale0.2, f"冷 凝 回 流 {flange_dn['cond']}", fontsize=8, ha='right')

Side profile (simplified)
x1 = 420scale; y1 = 60scale
ax.addpatch(mpatches.Rectangle((x1, y1), Dmmscale, H_mmscale*0.6, fill=False))
Ax.text (x1+Dmmscale/2, y1+Hmmscale * 0.6+20, "side profile", ha='center ', fontsize=10)

Internal basket and spray ball diagram
for i in range(3):
ax.addpatch(mpatches.Rectangle((x1+20, y1+50+ i80), Dmmscale-40, 20, fill=False, linestyle=':'))
ax.plot([x1+ D_mmscale/2], [y1+60+i80], marker='o', color='k')
Ax.text (x1+Dimscale+30, y1+Hmscale * 0.3, "Basket and Spray Ball", fontsize=8)

Top view (simplified)
x2 = 120scale; y2 = 60scale + H_mmscale0.65
circle = mpatches. Circle((x2 + Dmmscale/2, y2 + Dmmscale/2), D_mm*scale/2, fill=False)
ax.add_patch(circle)
Ax.text (x2+Dmmscale/2, y2+Dmmscale+20, "Top View", ha='center ', fontsize=10)

Schematic diagram of flange hole ring
r = D_mm*scale/2 - 20
theta = np.linspace(0,2*np.pi,9)[:-1]
for t in theta:
px = x2 + D_mmscale/2 + rnp.cos(t)
py = y2 + D_mmscale/2 + rnp.sin(t)
ax.add_patch(mpatches.Circle((px,py),3,fill=True))

Interface detail drawing (enlarged)
x3 = 420scale; y3 = 60scale + H_mmscale0.65
ax.add_patch(mpatches.Rectangle((x3, y3), 220, 160, fill=False))
Ax.text (x3+110, y3+170, "Interface Detail (Enlarged)", ha='center ')
Ax.text (x3+10, y3+140, f "PT100 position: kettle/jacket/reflux", fontsize=8)
Ax.text (x3+10, y3+120, f "flange: RF, bolt holes according to {flamed_dn ['top ']}", fontsize=8)

Supporting and lifting diagram
x4 = 700scale; y4 = 60scale
ax.addpatch(mpatches.Rectangle((x4, y4), Dmmscale0.8, H_mmscale0.4, fill=False))
Ax.text (x4+Dmmscale0.4, y4+Hmmscale0.4+20, "Supporting and Lifting Diagram", ha='center ')

ax.plot([x4+20, x4+ Dmmscale0.8 -20],[y4+Hmmscale0.4, y4+H_mmscale0.4], color='k')
ax.text(x4+10, y4+H_mmscale0.4+5, "地脚孔 M16 x4", fontsize=8)

Title bar and material notes
Ax.text (W0.02, H0.95, "Drawing Number: 01 Name: 50L Basket Distillation Kettle Scale: 1:10/Detail 1:5", fontsize=9)
Ax.text (W0.02, H0.91, "Material: AISI-316L liquid receiving part, inner surface Ra≤ 0.8μm, weld seam according to ASME IX", fontsize=8)
Ax.text (W0.02, H0.87, f "Common interface: Steam {flamedn ['steam ']} (≤1.5 bar), Condensation {flamedn ['cond']}, CIP {flamed_dn ['drain ']}", font size=8)
ax.text(W0.6, H0.91, workvoltext, fontsize=9)

Save output
plt.savefig(outputsvg, dpi=300, bboxinches='tight')
Print ("Generated project blueprint file:", outputted as svg)
Print ("Adjustable parameters: Dmm, Hmm, flamedn, scale, output svg")
`

Drawing No. 01-50L Basket Steam Distillation Kettle Front and Section Engineering Description

Purpose and scope of drawings
Purpose: To provide engineering information for the manufacturing, installation, and acceptance of a 50L basket steam distillation kettle, serving as the first drawing for equipment manufacturing and on-site installation.
Scope: Includes front view, side profile, top layout, detailed drawings of key interfaces, support and lifting requirements, materials and surface treatment, weld and groove specifications, main dimensions and tolerances, inspection and testing requirements.

Composition of Drawings and View List
View List:
-Front view: kettle body shape, jacket outline, top manhole position, basket loading basket schematic, liquid level sight glass, bottom valve position, support legs and lifting ears.
-Side profile (longitudinal profile): basket structure inside the kettle, jacket channel, steam flow arrow, internal spray ball arrangement, liquid level measurement point, and sewage outlet profile.
-Top view: Position of top manhole and manhole flange, direction of condensate reflux pipeline, flange hole position and bolt ring diameter, layout of basket inlet and

outlet.
-Enlarged interface details: steam inlet DN25 flange, condensation reflux DN50 flange, CIP spray ball interface, bottom valve DN25 detail, PT100 and level gauge installation flange detail.
-Support and installation diagram: base size, anchor bolt hole position, lifting ear position, equipment center of gravity marking and lifting diagram.
-Flange and Sealing Table: Interface Number, Flange Standard, Face Type, Number of Bolt Holes, Gasket Material.
-Material List and Surface Treatment Notes: Liquid receiving parts material, inner and outer surface roughness, passivation and cleaning requirements.
-Inspection and testing items: factory test, pressure test, functional test, and delivery document list.

Key dimensions and tolerances (example values, manufacturing drawings are based on annotations)
-Nominal volume: 50 L; recommended working volume: 35-40 L.
-Outer diameter of the kettle: ϕ 420 mm ± 2 mm (as shown in the diagram, subject to detailed annotations).
-Overall height (including support legs and lifting ears): approximately 1200 mm ± 5 mm.
-Top manhole flange: DN300, the distance from the flange surface to the center of the kettle top is marked.
-Steam inlet flange: DN25 (G1 half), with flange outer diameter and bolt hole corresponding tolerances according to ANSI/DIN standards.
-Condensation reflux flange: DN50, flange hole diameter and bolt hole position detailed drawing annotation.
-Wall thickness of jacket: 3-6 mm (depending on the manufacturer's structural design), wall thickness of kettle body: 4-8 mm, tolerance ± 0.5 mm.
-Loading height: The distance between the top surface of the basket and the bottom of the kettle is marked to ensure the working volume range.
-The installation center height of the liquid level sight glass is 120-300 mm from the bottom of the kettle (as indicated in the detailed drawing).

Materials and Surface Treatment
-Liquid receiving material: AISI-316L (or equivalent stainless steel), provide EN10204 3.1 material certificate.
-Sealing element: PTFE or solvent resistant EPDM, selected according to the interface purpose and listed in the flange table.
-Inner surface roughness: Ra ≤ 0.8 μ m; Smooth the weld seam and perform passivation treatment.
-External surface treatment: mirror or matte sandblasting, anti-corrosion coating will be quoted separately according to on-site requirements.

Welding, beveling, and non-destructive testing

-Groove form: Refer to the diagram for V-shaped or U-shaped grooves, and the groove angle and root gap shall be in accordance with ASME or equivalent standards.
-Weld seam requirements: The liquid welding seam should be fully melted, polished to be flush with the base metal after welding, and the surface Ra of the weld seam should be ≤ 1.6 μ m.
-Non destructive testing: Key welds are subjected to radiographic or ultrasonic testing (RT/UT) and a testing report is provided.

Instrument installation and location instructions
-PT100 temperature probe: at least three installation positions: liquid phase inside the kettle, jacket outlet, and condensation reflux port; Detail annotation of probe depth and flange type.
-Pressure transmitter: installed on the steam inlet side, with a range of 0-2 bar, equipped with a diaphragm valve and a drain outlet.
-Level gauge: The installation flange of the magnetic flap or radar level gauge is located on the side of the kettle, and the level sight glass is arranged in parallel as a mechanical indicator.
-CIP spray ball: detailed diagram of the position and coverage angle of the top spray ball, CIP inlet flange DN25, designed circulating pressure 2 bar.

Support, lifting and foundation requirements
-Supporting structure: Four point support feet or circular base, with anchor bolt holes (M16 × 4 or as shown in the detailed drawing) on the base.
-Lifting ears: The position and strength of the lifting ears on both sides should be marked. When lifting, the center of gravity must be balanced, and the equipment center of gravity coordinates should be marked in the diagram.
-Basic reserved holes: detailed drawings of the center distance, aperture, and embedded part size of the anchor holes, and the recommended concrete grade for the foundation is C25.

Public works interface and working conditions
-Steam interface: DN25 (G1 half), designed steam flow rate of 20-25 kg/h, working pressure ≤ 1.5 bar, maximum allowable temperature according to steam parameters.
-Cooling water interface: inlet and outlet DN25, inlet temperature ≤ 25 ° C, recommended flow rate ≥ 0.5 m^3/h.
-CIP interface: DN25, designed for a circulating pressure of 2 bar.
-Bottom valve/drain outlet: DN25 ball valve or butterfly valve with quick connect for easy drainage and sampling.

Testing and acceptance requirements
-Factory test: appearance inspection, size verification, material certificate verification, non-destructive testing report of welds.
-Pressure test: Conduct water pressure test or air pressure test according to the contract, record the test pressure and duration.

-Functional test: Run for 2-3 hours under no-load steam supply, record steam pressure, condensation temperature, and no leakage.
-Material trial operation: It is recommended to conduct one batch of material trial operation on site to verify the yield and process stability (as agreed in the contract).
-Delivery documents: Material certificate, welding records, non-destructive testing report, instrument calibration certificate P& ID、 Installation dimension diagram, IQ/OQ template, operation and maintenance manual.

Title bar and revision records
-Drawing information: Drawing number 01; Title: Front view and section of 50L basket distillation kettle; Scale 1:10 (front/side view), sectional view can be enlarged with 1:5 detailed drawing.
-Revision column: List the version number, revision date, summary of revision content, and signature column for review and approval.
-Signature column: The designer, proofreader, reviewer, approver, and client confirm the signature location.

Special precautions and manufacturing tips
-Loading rate control: During manufacturing, ensure that the gap between the basket and the kettle meets the requirement of a loading rate of ≤ 70% to avoid overfilling and affecting steam circulation.
-Maintainability: Manholes, flanges, and instruments should be easy to disassemble and maintain on site, with reserved inspection space for electrical and instrument wiring.
-Explosion proof and grounding: If the equipment is used for solvent extraction linkage, all electrical components must be selected according to the explosion-proof level and reliable grounding terminals must be provided.

Drawing No. 02- Condenser and Reflux System Engineering Description

Purpose and Scope
Purpose: To provide engineering information for the manufacturing, installation, and acceptance of condenser groups and reflux pipelines for a 50L steam distillation kettle, supporting condensation efficiency verification, cooling water and condensation circuit layout, flange and valve interface positioning.
Scope: Includes condenser front view and section, detailed drawings of cooling water inlet and outlet, overhead layout of reflux pipeline, condenser support and installation, flange and sealing details, instrument installation location, testing and acceptance requirements.

View List and Key Points of Content

1. Front view and sectional view - condenser shell shape, schematic diagram of tube bundle, cooling water inlet and outlet flanges, condensate collection tank, reflux outlet and overflow outlet, insulation layer outline, and position of drain outlet.
2. Top view layout diagram - the direction of the reflux pipeline between the condenser and the distillation kettle, valve positions, flange docking relationships, inlet and outlet directions of the cooling water pipeline, and valve layout.
3. Interface details (enlarged) - Details of DN25 flange for cooling water inlet and outlet, DN50 flange for condensation reflux, installation flange for temperature/pressure sensor, detailed drawings of condensate sampling port and drain valve.
4. Support and Foundation Diagram - Dimensions of Condenser Support, Position of Anchor Bolt Holes, Lifting Ears and Lifting Diagram, Center of Gravity Marking and Foundation Reserve Holes.
5. Instrument installation diagram - installation position and bypass valve layout of condenser temperature probe (inlet/outlet), pressure gauge, flow meter, cooling water flow meter and bypass valve.
6. Flange and Sealing Table - Interface Number, Flange Standard, Face Type, Number of Bolt Holes, Gasket Material, and Sealing Grade.

Key parameters and material requirements

-Condenser type: shell and tube or column tube (default shell and tube type, tube bundle material AISI-316L).

-Condensation area: ≥ 1.0 m^2 (can be adjusted according to the process).

-Liquid receiving material: AISI-316L; Sealing element PTFE or solvent resistant EPDM.

-Inner surface roughness: Ra ≤ 0.8 μ m (near the liquid surface).

-Flange interface: Cooling water inlet and outlet DN25; Condensation reflux DN50; Flange standard ANSI 150 or PN16, face type RF.

-Working conditions: cooling water inlet temperature ≤ 25 ° C; design cooling water flow rate ≥ 0.5 m^3/h; Condensation working pressure ≤ 1.5 bar; The maximum allowable temperature of the condenser is 120 ° C.

-Insulation: The thickness of the insulation layer on the outer shell is 20-30 mm (as required on site).

-Instrument range: Temperature PT100 0-150 ° C; Pressure transmitter 0-2 bar; Flow meter 0-2 m^3/h (cooling water).

Interface and installation points

-Distillation kettle side interface: condensation reflux flange DN50, flange face distance and bolt holes as specified in the drawing.

-Cooling water interface: DN25 inlet/outlet, equipped with ball valve, check valve and flow meter bypass.
-Discharge and Sampling: A DN25 discharge valve and sampling port are installed at the bottom of the condensate collection tank, with quick connect fittings.
-Bypass and safety: The cooling water bypass valve is used for winter or low load operation; The overflow port is used to prevent backflow blockage.
-Support: The condenser should have independent supports and be fixed with anchor bolts. There should be a maintenance gap of ≥ 200 mm between the supports and the kettle body.
-Electrical and grounding: If heating strips or temperature controllers are installed, all electrical components must be treated according to explosion-proof and grounding specifications.

Testing and acceptance requirements
-Factory test: appearance and size verification, material certificate verification, non-destructive testing (UT/RT) report of welds.
-Pressure test: The shell water pressure test shall be conducted at a design pressure of 1.5 times or as agreed in the contract, and shall last for 30 minutes without leakage.
-Functional testing: After assembly, the cooling water is introduced, and the no-load steam simulation runs for 2 hours, recording the condensation temperature, cooling water flow rate, and no leakage.
-Instrument calibration: Calibration certificates for temperature, pressure, and flow meters are provided with the goods and verified on site.
-Delivery documents: Material certificate EN10204 3.1, welding records, non-destructive testing report P& ID、 Installation dimension diagram, operation and maintenance manual.

Description of reproducible drawing script
Below is a self-contained Python script for generating vector graphics (SVG) of the "Condenser and Reflux System" engineering blueprint. The script relies on matplotlib and numpy, with adjustable parameters at the top (condenser length, diameter, flange size, canvas ratio, etc.), and outputs congenser_blueprint.svg after running. The script comments are in Chinese for engineers to modify and reuse.

`python

condenser_blueprint.py

Pre run installation dependency: pip install matplotlib numpy

```
import matplotlib.pyplot as plt
import matplotlib.patches as mpatches
import numpy as np

==========Adjustable parameters==========
Condenserlengathmm=900 # condenser shell length mm
Condenserdiamm=200 # condenser outer diameter mm
Tubebundleare_2=1.0 # condensing area m2 (for reference)
Flange_top="DN50" # Condensation reflux flange
Flange-water="DN25" # cooling water flange
outputsvg = "condenserblueprint.svg"
Scale=0.8 # Scale factor, adjust the size of the drawing

==============================

Canvas setting A1 horizontal approximation (unit pixel)
fig = plt.figure(figsize=(16.5,11.7))
ax = fig.add_axes([0,0,1,1])
ax.setxlim(0,1650);   ax.setylim(0,1170)
ax.axis('off')

Auxiliary drawing functions: Annotate arrows
def dimarrow(ax, x1,y1,x2,y2, text, textoffset=(0,0)):
ax.annotate("",   xy=(x1,y1),   xytext=(x2,y2),   arrowprops=dict(arrowstyle="&lt;-&gt;",
linewidth=0.8))
tx = (x1+x2)/2 + text_offset[0]
ty = (y1+y2)/2 + text_offset[1]
ax.text(tx,   ty,   text,   fontsize=8,   ha='center',   va='center',
bbox=dict(boxstyle="round,pad=0.1", fc="white", ec="none"))

Front view (top left)
x0, y0 = 80, 700
w = condenserdiamm * scale
h = condenserlengthmm   scale   0.4

Condenser shell
ax.add_patch(mpatches.FancyBboxPatch((x0,  y0),  w,  h,  boxstyle="round,pad=0.02",
linewidth=1.2, fill=False))
Ax.text (x0+w/2, y0+h+18, "Front view condenser shell", ha='center ', fontsize=10)

Bundle diagram (horizontal line)
for i in range(6):
yy = y0 + 20 + i*(h-40)/5
ax.plot([x0+10, x0+w-10], [yy, yy], color='gray', linewidth=0.6)
```

Cooling water inlet and outlet labeling
ax.plot([x0-40, x0], [y0 + h0.75, y0 + h0.75], color='k')
Ax.text (x0-60, y0+h * 0.75, f "cooling water inlet {flamew_water}", fontsize=8, ha='right ')
ax.plot([x0+w, x0+w+40], [y0 + h0.25, y0 + h0.25], color='k')
Ax.text (x0+w+60, y0+h * 0.25, f "cooling water outlet {flamew_water}", fontsize=8, ha='lft ')

Condensation reflux port
ax.plot([x0 + w/2, x0 + w/2], [y0 + h, y0 + h + 40], color='k')
ax.text(x0 + w/2, y0 + h + 50, f"冷凝回流{flange_top}", fontsize=8, ha='center')

Side profile (top right)
x1, y1 = 420, 700
w1 = condenserlengthmm * scale
h1 = condenserdiamm scale 0.6
ax.add_patch(mpatches.Rectangle((x1, y1), w1, h1, fill=False, linewidth=1.2))
Ax.text (x1+w1/2, y1+h1+18, "Side view section (bundle section)", ha='center ', fontsize=10)

Schematic diagram of bundle section (small circle)
for i in range(5):
for j in range(8):
cx = x1 + 20 + j* (w1-40)/7
cy = y1 + 20 + i* (h1-40)/4
ax.add_patch(mpatches.Circle((cx, cy), 4, fill=False, linewidth=0.6))

Discharge outlet and sampling outlet
ax.plot([x1 + w1 - 30, x1 + w1 + 30], [y1 + 10, y1 + 10], color='k')
ax.text(x1 + w1 + 60, y1 + 10, "排污 DN25", fontsize=8, va='center')

Top view layout (left center)
x2, y2 = 80, 420
router = condenserdia_mm * scale / 2
cx = x2 + 200
cy = y2 + r_outer + 10
ax.addpatch(mpatches.Circle((cx, cy), router, fill=False, linewidth=1.0))
Ax.text (cx, cy+r_outer+18, "Top view condenser and flange layout", ha='center ', fontsize=10)

Schematic diagram of flange hole ring
theta = np.linspace(0, 2*np.pi, 9)[:-1]
rhole = router - 18

for t in theta:
px = cx + r_hole * np.cos(t)
py = cy + r_hole * np.sin(t)
ax.add_patch(mpatches.Circle((px, py), 3, fill=True))

Top view of reflux pipeline (middle right)
x3, y3 = 420, 420
ax.add_patch(mpatches.Rectangle((x3, y3), 520, 180, fill=False))
Ax.text (x3+260, y3+190, "Top view layout of reflux pipeline", ha='center ', fontsize=10)

Draw a schematic diagram of the reflux pipeline from the distillation kettle to the condenser
ax.plot([x3+20, x3+120, x3+200], [y3+90, y3+90, y3+30], color='k')
ax.plot([x3+200, x3+360], [y3+30, y3+30], color='k')
ax.text(x3+60, y3+100, "至蒸馏釜", fontsize=8)

Valve and flange symbols
ax.plot([x3+200, x3+200], [y3+30, y3+10], color='k')
ax.add_patch(mpatches.Rectangle((x3+195, y3+10), 10, 10, fill=False))
Ax. Text (x 3 + 205, y 3 + 5, "utionary landscaped parts;", fontsizes = 7)

Detail drawing of interface (enlarged) bottom left
x4, y4 = 80, 120
ax.add_patch(mpatches.Rectangle((x4, y4), 360, 240, fill=False))
Ax.text (x4+180, y4+250, "Interface Detail (Enlarged)", ha='center ', fontsize=10)
Ax.text (x4+10, y4+220, f "condensing reflux flange: {flame_top} RF surface", fontsize=8)
Ax.text (x4+10, y4+200, f "Cooling water flange: {flamew_water} RF surface", fontsize=8)
Ax.text (x4+10, y4+180, "PT100 installation position: inlet/outlet/housing", fontsize=8)
Ax.text (x4+10, y4+160, "Sampling port: DN25 quick connector", fontsize=8)

Support and Foundation, bottom right
x5, y5 = 480, 120
ax.add_patch(mpatches.Rectangle((x5, y5), 560, 240, fill=False))
Ax.text (x5+280, y5+250, "Support and Foundation Diagram", ha='center ', fontsize=10)
Ax.text (x5+20, y5+210, "Foot hole: M16 x4 spacing as shown in the table below", fontsize=8)
Ax.text (x5+20, y5+190, "Lifting ear position: pay attention to the center of gravity when lifting symmetrically at both ends", fontsize=8)

Center of gravity annotation
ax.plot([x5 + 280, x5 + 280], [y5 + 120, y5 + 160], color='k', linestyle='--')

ax.text(x5 + 290, y5 + 140, "重心 CG", fontsize=8)

Title bar and material notes
Ax.text (20, 1120, "Drawing Number: 02 Name: Condenser and Reflux System Scale: Front/Section 1:10 Detail 1:5", font size=9)
Ax.text (20, 1100, "Material: AISI-316L liquid receiving part, inner surface Ra≤0.8μm, weld seam according to ASME IX", fontsize=8)
Ax.text (20, 1080, f "Condensation area: {tubebundlearea_2} m ^ 2 Cooling water inlet ≤25°C Design flow rate≥0.5 m ^ 3/h", fontsize=8)

Flange and Sealing Table (Small Table)
tablex, tabley = 1100, 980
Ax.text (tablex, tabley, "Flange and Seal Details", fontsize=9)
Ax.text (tablex, tabley-18, f "interface number, naming, flange specification, face type, bolt hole number, gasket material", fontsize=8)
ax.text(tablex, tabley-36, f"F1 冷凝回流 {flange_top} RF 8 PTFE", fontsize=8)
ax.text(tablex, tabley-54, f"F2 冷却水进 {flange_water} RF 4 PTFE", fontsize=8)
ax.text(tablex, tabley-72, f"F3 冷却水出 {flange_water} RF 4 PTFE", fontsize=8)
ax.text(tablex, tabley-90, f"F4 排污/取样 DN25 RF 4 PTFE", fontsize=8)

Save output
plt.savefig(outputsvg, dpi=300, bboxinches='tight')
Print ("Generated condenser engineering blueprint file:", outputted as svg)
Print ("Adjustable parameters: congenserlententhmm, congenserdiamm, flametop, flamewater, scale")
`

Drawing No. 03- Engineering Description of Closed Circuit Solvent Extraction Tank (20-50 L Class)

Purpose and Scope
Purpose: To provide engineering information for manufacturing, installation, and acceptance of residue solvent extraction processes, compatible with 20-50 L scale closed-loop extraction tanks (with reflux condensation and solvent recovery circuits), supporting solvent safety management, recovery efficiency verification, and on-site pipeline docking.
Scope: including equipment elevation and section, detailed drawings of jacket and reflux circuit, solvent recovery interface, mixing and sealing system, instrument installation, CIP and safety valve layout, flange and sealing details, support and

foundation, testing and acceptance requirements.

View List and Key Points of Content

1. Front view (front view) - tank body shape, jacket outline, top manhole/sampling port, agitator motor and seal, reflux condenser connection, solvent inlet and outlet flanges, bottom valve and drain outlet, position of level sight glass and level transmitter.
2. Longitudinal section (axial section) - structure of the mixing blade inside the tank (blade type, bearings and mechanical seals), jacket channel, reflux tray or distributor, internal packing or basket schematic, heating/cooling jacket flow direction, solvent recovery pipeline section.
3. Top view (top view) - top manhole (DN200-DN300), mixing shaft center, steam/solvent inlet and outlet flange layout, CIP spray ball position and manhole cover layout.
4. Interface details (enlarged) - solvent inlet and outlet flange (DN25-DN50) details, reflux condenser flange, mechanical seal installation flange, sampling valve and safety valve details, solvent leak detector installation position.
5. Support and installation diagram - foot or support size, anchor bolt hole position, gap between mixing motor foundation and coupling, lifting lug and lifting diagram, equipment center of gravity marking.
6. Instrument installation diagram - level gauge (magnetic flap or radar), PT100 temperature point (tank body, jacket inlet and outlet), pressure gauge/transmitter, solvent leak detector, vacuum/negative pressure gauge (if vacuum is used for recycling).
7. Flange and Seal Table - Interface Number, Flange Standard (ANSI/PN), Face Type (RF), Number of Bolt Holes, Gasket Material (PTFE), Mechanical Seal Model and Spare Parts.
8. Safety and Protection Notes - Closed circuit design, solvent recovery rate target ≥ 95%, anti-static grounding, explosion-proof electrical rating of solvent area, ventilation and emergency procedures for solvent leakage.

Key parameters and material requirements (recommendations)

-Capacity: nominal 20-50 L; recommended working volume is 15-40 L (by model).

-Liquid receiving material: AISI-316L (or equivalent); Sealing components PTFE/FKM (solvent compatible).

-Jacket: The jacket is designed for steam heating or hot oil circulation, with a jacket inlet/outlet diameter of DN15-DN25.

-Mixing: driven by a variable frequency motor, with a power of 0.75-2.2 kW (selected according to viscosity and filling height); Paddle type: Paddle/frame/anchor type according to material selection; Mechanical seal or magnetic seal (magnetic seal

prioritizes solvent safety).
-Flange interface: solvent inlet and outlet DN25-DN50 (RF surface); Reflux condensation DN50; Sampling/discharge DN25.
-Working conditions: Design pressure ≤ 1.5 bar; Can withstand vacuum up to -0.8 bar (if vacuum is used for recycling); Working temperature -10-120 ° C (based on solvent and heating medium).
-Instrument: PT100 (0-150 ° C) × 3; Pressure transmitter 0-2 bar; Liquid level gauge (magnetic flap or radar); Steam/solvent flow meter; Solvent leakage detector.
-CIP: Top spray ball and side spray, CIP interface DN25, designed circulating pressure 2 bar.
-Safety: safety valve, reserved bursting disc, solvent recovery condenser and cold trap, combustible gas detector and ventilation linkage.

Interface and installation points
-Solvent inlet and outlet: feed valve, reflux valve, bypass valve and quick installation flange, easy to disassemble and clean.
-Mixing and sealing: Magnetic sealing is preferred to avoid mechanical seal leakage; If a mechanical seal is used, provide a dual end face or buffer chamber design and match it with a leakage collection port.
-Recycling and Condensation: Short pipelines, insulation or cooling measures are used between the reflux condenser and the recycling tank. The condensation reflux port is equipped with a solvent sampling port and a drain valve.
-CIP and cleaning: Top spray ball coverage rate ≥ 95%, CIP inlet with valve and bypass, CIP circulation pump and temperature control.
-Explosion proof and grounding: All electrical components are selected according to the explosion-proof level, and the equipment is grounded as a whole and equipped with anti-static connection points.

Testing and acceptance requirements
-Factory documents: Material certificate EN10204 3.1, welding records, non-destructive testing report, mechanical seal and motor qualification certificate, instrument calibration certificate P& ID、 Operation and maintenance manual.
-Pressure test: The shell water pressure test shall be conducted at a design pressure of 1.5 times or as agreed in the contract, and shall last for 30 minutes without leakage.
-Functional testing: 2-hour no-load mixing and sealing test; Run one batch with water or inert liquid to verify the uniformity of stirring, reflux efficiency, and no leakage.
-Solvent recovery verification: Conduct a solvent recovery test on site, record the recovery rate (target ≥ 95%), condensation temperature, and recovery purity.

-IQ/OQ support: Suppliers provide IQ/OQ documents and assist in completing OQ testing on site.

Reproducible drawing script (blueprint for closed-loop solvent extraction tank project)

Below is a self-contained Python script that uses matplotlib and numpy to draw the engineering blueprint of the device (multi view: front view, vertical section, top view, interface detail, support schematic), and outputs extractor-blueprint.svg. The top of the script contains adjustable parameters (volume, diameter, height, flange specifications, etc.), annotated in Chinese for engineers to directly run and modify.

`python

```
extractor_blueprint.py

Pre run installation dependency: pip install matplotlib numpy
import matplotlib.pyplot as plt
import matplotlib.patches as mpatches
import numpy as np

==========Adjustable parameters==========
TanknominalL=50 # nominal volume L (note)
D_mm=360 # tank outer diameter mm
H_mm=800 # tank height mm (excluding legs)
Workvolumtext="Workvolume 15-40 L"
flange_solvent = "DN25-DN50"
flange_cip = "DN25"
motor power = 1.5
outputsvg = "extractorblueprint.svg"
scale = 0.9

==============================

fig = plt.figure(figsize=(16.5,11.7))
ax = fig.add_axes([0,0,1,1])
ax.setxlim(0,1650);    ax.setylim(0,1170)
ax.axis('off')

Auxiliary function: Draw cylinder (front view)
defdrawtankfront(x,y,diam,height,ax,linewidth=1.2):
#Cauldron body
ax.add_patch(mpatches.FancyBboxPatch((x    -    diam/2,    y),    diam,    height,
```

boxstyle="round,pad=0.02", linewidth=linewidth, fill=False))
#Schematic diagram of jacket (dashed line)
ax.add_patch(mpatches.FancyBboxPatch((x - diam/2 - 12, y - 6), diam + 24, height + 12, boxstyle="round,pad=0.02", linewidth=0.8, fill=False, linestyle='--'))

Front view (top left)
x0, y0 = 200, 700
drawtankfront(x0 + Dmmscale/2, y0, Dmmscale, H_mm*scale, ax)
Ax.text (x0+Dmmscale/2, y0+Hmmscale+20, "Front View Closed Circuit Solvent Extraction Tank", ha='center ', fontsize=10)

Mixing motor and shaft
ax.addpatch(mpatches.Rectangle((x0 + Dmmscale/2 - 20, y0 + H_mmscale + 30), 40, 20, fill=False))
ax.text(x0 + Dmmscale/2, y0 + Hmmscale + 55, f"搅拌电机{motorpowerkw} kW", ha='center', fontsize=8)

Top flange and manhole
ax.plot([x0 + Dmmscale0.2, x0 + Dmmscale0.2], [y0 + Hmmscale, y0 + Hmmscale + 18], color='k')
ax.text(x0 + Dmmscale0.2, y0 + Hmm*scale + 28, "顶人孔 DN200", fontsize=8, ha='center')

Liquid level sight glass and sampling port
ax.plot([x0 + Dmmscale/2 + Dmmscale/2 + 10, x0 + Dmmscale/2 + Dmmscale/2 + 40], [y0 + Hmmscale0.4, y0 + Hmmscale0.4], color='k')
Ax.text (x0+Dmmscale/2+Dmmscale/2+60, y0+H_mmscale0.4, "level mirror/level transmitter", fontsize=8, va='center ')

Bottom discharge and bottom valve
ax.plot([x0 + Dmmscale/2, x0 + Dmmscale/2], [y0, y0 - 40], color='k')
ax.addpatch(mpatches.Rectangle((x0 + Dmm*scale/2 - 12, y0 - 60), 24, 20, fill=False))
ax.text(x0 + D_mm*scale/2, y0 - 80, "底阀 DN25", ha='center', fontsize=8)

Longitudinal section (top right)
x1, y1 = 700, 700
ax.addpatch(mpatches.Rectangle((x1, y1), Dmmscale, H_mmscale, fill=False, linewidth=1.2))
Ax.text (x1+Dmmscale/2, y1+Hmmscale+20, "Longitudinal section (mixing and jacket)", ha='center ', fontsize=10)

Diagram of mixing shaft and blade
for i in range(3):
ax.addpatch(mpatches.Rectangle((x1 + Dmmscale/2 - 2, y1 + 80 + i180), 4, 40,

fill=False, linewidth=0.8))
ax.plot([x1 + Dmmscale/2 - 40, x1 + Dmmscale/2 + 40], [y1 + 100 + i180, y1 + 100 + i180], color='k', linewidth=0.8)
Ax.text (x1+Dmmscale+40, y1+Hmmscale * 0.5, "Mechanical/Magnetic Seal Position", fontsize=8)

Top view (center left)
x2, y2 = 200, 360
r = D_mm*scale/2
ax.add_patch(mpatches.Circle((x2 + r + 20, y2 + r + 10), r, fill=False))
Ax.text (x2+r+20, y2+r * 2+30, "Top View", ha='center ', fontsize=10)

Top manhole and spray ball
ax.add_patch(mpatches.Circle((x2 + r + 20, y2 + r + 10), 12, fill=False))
ax.text(x2 + r + 20, y2 + r + 10, "人孔", fontsize=7, ha='center', va='center')

Top spray ball position diagram
for t in [0, 120, 240]:
px = x2 + r + 20 + (r-30)*np.cos(np.deg2rad(t))
py = y2 + r + 10 + (r-30)*np.sin(np.deg2rad(t))
ax.add_patch(mpatches.Circle((px, py), 4, fill=False))
ax.text(px+8, py, "喷", fontsize=6)

Interface detail drawing (enlarged) in the middle right
x3, y3 = 700, 360
ax.add_patch(mpatches.Rectangle((x3, y3), 520, 240, fill=False))
Ax.text (x3+260, y3+250, "Interface Detail (Enlarged)", ha='center ', fontsize=10)
Ax.text (x3+10, y3+210, f "solvent inlet and outlet:{flame_Solvent} RF surface", fontsize=8)
Ax.text (x3+10, y3+190, f "CIP interface: {flame_cip} design pressure 2 bar", fontsize=8)
Ax.text (x3+10, y3+170, "Mechanical/Magnetic Seal Installation Flanges and Leakage Collection Ports", fontsize=8)

Support and installation (bottom left)
x4, y4 = 200, 80
ax.add_patch(mpatches.Rectangle((x4, y4), 520, 220, fill=False))
Ax.text (x4+260, y4+240, "Support and Installation Diagram", ha='center ', fontsize=10)
Ax.text (x4+20, y4+200, "Foot hole: M16 x4 Foundation concrete C25", fontsize=8)
Ax.text (x4+20, y4+180, "Reserved gap between mixing motor foundation and coupling", fontsize=8)
ax.plot([x4 + 260, x4 + 260], [y4 + 20, y4 + 80], color='k', linestyle='--')
ax.text(x4 + 270, y4 + 50, "重心 CG", fontsize=8)

Title bar and material notes
Ax.text (20, 1120, "Drawing Number: 03 Name: Closed Circuit Solvent Extraction Tank Scale: Front/Section 1:10 Detail 1:5", font size=9)
Ax.text (20, 1100, "Material: AISI-316L liquid receiving part, inner surface Ra≤0.8μm, sealed PTFE/FKM", fontsize=8)
Ax.text (20, 1080, f "Working conditions: design pressure≤1.5 bar can withstand vacuum -0.8 bar CIP interface {flame_cip}", fontsize=8)
ax.text(20, 1060, workvolumetext, fontsize=8)

Flange and Sealing Table
tablex, tabley = 1200, 980
Ax.text (tablex, tabley, "Flange and Seal Details", fontsize=9)
Ax.text (tablex, tabley-18, "Interface number name, flange specification, face type, bolt hole number, gasket material", fontsize=8)
ax.text(tablex, tabley-36, f"F1 溶剂进 {flange_solvent} RF 4-8 PTFE", fontsize=8)
ax.text(tablex, tabley-54, f"F2 溶剂出 {flange_solvent} RF 4-8 PTFE", fontsize=8)
ax.text(tablex, tabley-72, f"F3 CIP {flange_cip} RF 4 PTFE", fontsize=8)
ax.text(tablex, tabley-90, f"F4 排污 DN25 RF 4 PTFE", fontsize=8)

Save output
plt.savefig(outputsvg, dpi=300, bboxinches='tight')
Print ("Generated blueprint file for closed-loop solvent extraction tank project:", outputted as svg)
print("可调参数: tanknominalL, Dmm, Hmm, flangesolvent, flangecip, motorpowerkw, scale")
`

Drawing No. 04- Ultrasonic Wall Breaker Engineering Description

Purpose and Scope
Purpose: To provide engineering information for the manufacturing, installation, and acceptance of small-scale ultrasonic wall breakers (canned or online), supporting plant cell wall breaking, pretreatment, and energy input control.
Scope: including equipment front and profile, arrangement of ultrasonic transducers and transducer heads, cooling and temperature control circuits, sound field distribution diagram, flange and interface details, instrument installation location, support and foundation, cleaning and safety requirements, testing and acceptance items.

View List and Key Points of Content

1. Front view and side profile - the shape of the tank or flow chamber, the installation position of the ultrasonic transducer (probe), the number and spacing of transducers, the fixing flange of the transducer, the cooling jacket or external cooling coil, the inlet and outlet flanges, the observation window or sampling port, the support feet and lifting ears.
2. Longitudinal section (flow chamber section) - displays the depth of insertion of the transducer head, sound field direction arrow, fluid flow direction, mixing or circulation pump interface, temperature probe and sampling point, acoustic buffer zone or silencing zone.
3. Top view layout diagram - the arrangement array of transducers on the top or side wall of the tank, flange hole positions, relative positions of pipeline inlet and outlet, cooling water and cable routing channels.
4. Detailed drawing of transducer and flange (enlarged) - transducer model, installation flange size, seal type (O-ring/PTFE), cable joint and protective cover, cooling jacket interface.
5. Cooling and temperature control circuit diagram - Cooling water inlet and outlet DN15-DN25, temperature control points, bypass valve and heat exchanger positions, temperature alarm points.
6. Instrument installation diagram - ultrasonic power meter/cumulative energy meter, temperature PT100, flow meter (circulating flow), pressure gauge (if a closed system), solution sampling port and safety relief device.
7. Support and foundation diagram - base dimensions, anchor bolt hole positions, lifting ear positions, equipment center of gravity markings, vibration isolation pad recommendations.
8. Flange and Seal Table - Interface Number, Flange Standard, Face Type, Number of Bolt Holes, Seal Material, Transformer Model, and Electrical Parameters.

Key parameters and material requirements

-Processing capacity and chamber volume: canned type 20-50 L; online flow type flow rate 5-50 L/min (depending on the process selection).
-Ultrasonic power and frequency: Single transducer power of 200-1000 W can be selected; Frequency 20-40 kHz (commonly used for wall breaking strength at 20 kHz); The total effective power is set according to the processing capacity and energy density (e.g. energy density 50-200 kJ/L).
-Number and arrangement of transducers: top mounted or side mounted arrays, transducer head spacing and insertion depth determined by acoustic field simulation; The material of the transducer head is titanium alloy or stainless steel coating, with a liquid level of AISI-316L.

-Cooling and temperature control: The temperature rise control threshold during ultrasonic operation is ≤ 5 ° C/5min; Cooling water inlet ≤ 25 ° C, flow rate designed according to transducer power (example 0.5-2.0 L/min/transducer).
-Electrical and protection: power supply 220/380 V, explosion-proof option; Shielding and grounding of transducer cables; Overcurrent, over temperature, and leakage protection.
-Sealing and cleaning: O-ring PTFE or FFKM for transducer flange sealing; CIP compatible design, top spray or side spray covering the cleaning strategy of the transduction area.
-Vibration and isolation: The equipment needs to be equipped with vibration isolation pads or spring supports, and the vibration transmitted to the foundation should not exceed the limit value (as agreed in the contract).

Control points, sampling and release standards
-Control points: input power (W), frequency (kHz), cumulative energy (kJ), chamber temperature (° C), circulating flow rate (L/min), sound intensity or sound pressure level (if measured).
-Sampling frequency: Record temperature and power every 5-10 minutes during operation; One sample is taken before and after each batch for comparison of the target ingredient content.
-Release criteria: The target ingredient improvement rate or wall breaking efficiency meets the process target (e.g. total soluble solids increase ≥ 10%); Control the temperature rise within the threshold; No abnormal leakage or electrical malfunction.

Cleaning, Maintenance, and Safety Points
-CIP: A detachable protective cover is required at the flange of the transducer for easy cleaning. The CIP cycle pressure is 2 bar and the cleaning chemicals are compatible (alkali/acid/alcohol).
-Maintenance: Check the coupling surface and cable of the transducer every 6-12 months, and include the replacement cycle of the sealing components in the spare parts list according to the operating hours.
-Safety: Avoid direct contact between the transducer head and the tank body during high-power ultrasound operation, and set up acoustic shielding or warnings; Electrical protection and grounding; Explosion proof rating and leak detection are required in solvent environments.

Testing and acceptance requirements
-Factory test: appearance and size verification, material certificate, transducer

factory performance testing (power, frequency, efficiency), electrical wiring diagram and insulation test report.
-Functional testing: Run without load for 30-60 minutes, record power, temperature rise, and vibration; Run one batch with liquid to verify temperature control, energy input, and wall breaking effect.
-Acoustic and vibration testing: Measure the vibration and sound pressure level of the equipment casing to confirm that it is within a safe and comfortable range (as agreed in the contract or industry standards).
-Delivery documents: Material certificate EN10204 3.1, transducer performance report, instrument calibration certificate P& ID、 Installation dimension diagram, IQ/OQ document, operation and maintenance manual.

Reproducible Drawing Script Ultrasonic Wall Breaker Engineering Blueprint

The following provides a self-contained Python script that uses matplotlib and numpy to draw the blueprint of the ultrasonic wall breaker project (front view, section view, top view, interface details, support schematic), and outputs ultrasonic_blueprint.svg. The top of the script contains adjustable parameters (cavity diameter, total height, number and power of transducers, frequency, cooling interface, etc.), annotated in Chinese for engineers to directly run and modify.

`python

ultrasonic_blueprint.py

Pre run installation dependency: pip install matplotlib numpy
import matplotlib.pyplot as plt
import matplotlib.patches as mpatches
import numpy as np

==========Adjustable parameters==========
Chamberdiamm=300 # cavity diameter mm
Chamberhmm=600 # cavity height mm
Transducer_count=4 # Number of transducers
TransducerPowerw=500 # Single transducer power W
frequency_khz = 20 # 频率 kHz
Flange_comol="DN15" # Cooling water flange
Flame_ elec="M20" # Cable joint specification annotation
outputsvg = "ultrasonicblueprint.svg"
scale = 1.0

==============================

fig = plt.figure(figsize=(16.5,11.7))
ax = fig.add_axes([0,0,1,1])
ax.setxlim(0,1650); ax.setylim(0,1170)
ax.axis('off')

Auxiliary function: Draw cylinder (front view)
def drawcylinder(xcenter, y_bottom, diam, height, ax, lw=1.2):
ax.addpatch(mpatches.FancyBboxPatch((xcenter - diam/2, y_bottom), diam, height, boxstyle="round,pad=0.02", linewidth=lw, fill=False))
#Schematic diagram of jacket dashed line
ax.addpatch(mpatches.FancyBboxPatch((xcenter - diam/2 - 8, y_bottom - 6), diam + 16, height + 12, boxstyle="round,pad=0.02", linewidth=0.8, fill=False, linestyle='--'))

Front view (top left)
x0, y0 = 120, 700
drawcylinder(x0 + chamberdiammscale/2, y0, chamberdiammscale, chamberh_mm*scale, ax)
Ax.text (x0+chamberdimscale/2, y0+chamberhmscale+18, "Front view ultrasound disruptor", ha='center ', fontsize=10)

Schematic diagram of transducer (side mounted or top mounted)
for i in range(transducer_count):
yy = y0 + chamberhmmscale(0.2 + i*(0.6/(transducercount-1 if transducercount>1 else 1)))
#Schematic diagram of side mounted transducer flange
ax.plot([x0 + chamberdiammscale/2 + chamberdiammscale/2, x0 + chamberdiammscale/2 + chamberdiammscale/2 + 30], [yy, yy], color='k')
ax.addpatch(mpatches.Circle((x0 + chamberdiammscale/2 + chamberdia_mmscale/2 + 40, yy), 6, fill=False))
ax.text(x0 + chamberdiammscale/2 + chamberdiammscale/2 + 60, yy, f"换能器 {i+1}", fontsize=7, va='center')

Annotate overall dimensions
ax.annotate("", xy=(x0-40, y0), xytext=(x0-40, y0+chamberhmm*scale), arrowprops=dict(arrowstyle="<->"))
ax.text(x0-60, y0 + chamberhmm*scale/2, f"H={chamberhmm} mm", rotation=90, va='center')
ax.annotate("", xy=(x0, y0-30), xytext=(x0+chamberdiamm*scale, y0-30), arrowprops=dict(arrowstyle="<->"))
ax.text(x0 + chamberdiamm*scale/2, y0-50, f"D={chamberdiamm} mm", ha='center')

Side profile (top right)
x1, y1 = 520, 700

ax.addpatch(mpatches.Rectangle((x1, y1), chamberdiammscale, chamberh_mmscale, fill=False, linewidth=1.2))
Ax.text (x1+chamberdimscale/2, y1+chamberhmscale+18, "Side profile (transducer insertion schematic)", ha='center ', fontsize=10)

Depth indication of transducer insertion
for i in range(transducer_count):
yy = y1 + chamberhmmscale(0.2 + i*(0.6/(transducercount-1 if transducercount>1 else 1)))
ax.plot([x1 + chamberdiammscale/2 - 80, x1 + chamberdiammscale/2 - 10], [yy, yy], color='k')
ax.addpatch(mpatches.Rectangle((x1 + chamberdia_mm*scale/2 - 90, yy - 6), 10, 12, fill=False))
Ax.text (x1+chamberdiamm * scale/2-120, yy, "transducer head inserted", fontsize=7, ha='right ', va='center')

Sound field direction arrow diagram
ax.arrow(x1 + 20, y1 + chamberhmmscale0.5, 80, 0, headwidth=8, headlength=12, fc='k', ec='k')
Ax.text (x1+60, y1+chamberhmmsale0.5+12, "Sound Field Direction", fontsize=8)

Top view (center left)
x2, y2 = 120, 360
r = chamberdiamm*scale/2
cx = x2 + r + 20
cy = y2 + r + 10
ax.add_patch(mpatches.Circle((cx, cy), r, fill=False))
Ax.text (cx, cy+r+18, "Top view transducer array", ha='center ', fontsize=10)

Schematic diagram of transducer array points
theta = np.linspace(0, 2*np.pi, transducer_count+1)[:-1]
for idx, t in enumerate(theta):
px = cx + (r-30) * np.cos(t)
py = cy + (r-30) * np.sin(t)
ax.add_patch(mpatches.Circle((px, py), 5, fill=False))
ax.text(px+8, py, f"T{idx+1}", fontsize=7)

Interface detail drawing (enlarged) in the middle right
x3, y3 = 520, 360
ax.add_patch(mpatches.Rectangle((x3, y3), 520, 240, fill=False))
Ax.text (x3+260, y3+250, "Interface Detail (Enlarged)", ha='center ', fontsize=10)
Ax.text (x3+10, y3+210, f "Cooling water flange: {flame_comol} design flow rate according to transducer power", fontsize=8)
Ax.text (x3+10, y3+190, f "Cable connector: {flame_ elec} shielding and grounding",

fontsize=8)
Ax.text (x3+10, y3+170, f "transducer power: {transducerpowerw} W frequency: {freque_khz} kHz", fontsize=8)
Ax.text (x3+10, y3+150, "Seal: O-ring PTFE or FFKM flange RF", fontsize=8)

Support and foundation, bottom left
x4, y4 = 120, 80
ax.add_patch(mpatches.Rectangle((x4, y4), 520, 220, fill=False))
Ax.text (x4+260, y4+240, "Support and Foundation Diagram", ha='center ', fontsize=10)
Ax.text (x4+20, y4+200, "Foot hole: M12 x4, recommended vibration isolation pad or spring support", fontsize=8)
Ax.text (x4+20, y4+180, "Lifting ears: pay attention to the center of gravity and cable protection when lifting on both sides of the top", fontsize=8)

Center of gravity annotation
ax.plot([x4 + 260, x4 + 260], [y4 + 20, y4 + 80], color='k', linestyle='--')
ax.text(x4 + 270, y4 + 50, "重心 CG", fontsize=8)

Title bar and material notes
Ax.text (20, 1120, "Drawing Number: 04 Name: Ultrasonic Wall Breaker Scale: Front/Section 1:10 Detail 1:5", font size=9)
Ax.text (20, 1100, "Material: AISI-316L liquid receiving part, inner surface Ra≤0.8μm, transducer head wrapped in titanium alloy or stainless steel", fontsize=8)
Ax.text (20, 1080, f "Number of transducers: {transducercount} Single power: {transducerpowerw} W Frequency: {frequencykhz} kHz", fontsize=8)
Ax.text (20, 1060, "Cooling requirement: cooling water inlet≤25°C temperature rise threshold≤5°C/5 min", fontsize=8)

Flange and Sealing Table
tablex, tabley = 1200, 980
Ax.text (tablex, tabley, "Flange and Seal Details", fontsize=9)
Ax.text (tablex, tabley-18, "Interface number name, flange specification, face type, bolt hole number, gasket material", fontsize=8)
Ax.text (tablex, tabley-36, f "F1 cooling water enters {flame_comol} RF 4 PTFE", fontsize=8)
ax.text(tablex, tabley-54, f"F2 冷却水出 {flange_cool} RF 4 PTFE", fontsize=8)
Ax.text (tablex, tabley-72, f "F3 cable connector {flage_elec} - shielded grounding", fontsize=8)
ax.text(tablex, tabley-90, f"F4 排污/取样 DN25 RF 4 PTFE", fontsize=8)

Save output
plt.savefig(outputsvg, dpi=300, bboxinches='tight')
Print ("Generated ultrasound wall breaker engineering blueprint file:", outputted as

svg)
print("可 调 参 数 : chamberdiamm, chamberhmm, transducercount, transducerpowerw, frequencykhz, flangecool, flangeelec, scale")
`

-

Drawing No. 05- Vacuum Recovery System Engineering Description

Purpose and Scope
Purpose: To provide engineering information for the manufacturing, installation, and acceptance of small-scale solvent recovery and vacuum concentration systems, supporting solvent evaporation, condensation recovery, vacuum pump and cold trap linkage, condensation efficiency verification, and safety protection.
Scope: Includes overall system layout, front section of vacuum evaporator and condenser assembly, detailed drawings of cold trap and recovery bottle, layout of

vacuum pump and bypass valve, pipeline and valve layout, instrument installation location, flange and seal details, support and foundation, testing and acceptance requirements.

View List and Key Points of Content

1. Overall system layout diagram - vacuum evaporator (or recycler), condenser group, cold trap, solvent recovery bottle, vacuum pump, cooling water and cooling circulation, solvent reflux pipeline, bypass and safety valve positions, instrument and control cabinet positions.
2. Front view and section of vacuum evaporator - evaporator body, jacket, feed inlet, steam/solvent inlet, steam condensation circuit, condensate collection tray, vacuum interface and exhaust port, heating jacket and temperature probe position.
3. Detailed drawing of condenser group and cold trap - schematic diagram of condenser shell tube or column tube, interface between cold trap (low-temperature condensation) and dry ice/refrigerant circuit, connection flange of recovery bottle, solvent sampling port and drain valve.
4. Vacuum pump and bypass layout - vacuum pump model and interface, selection of oil seal or dry pump, bypass valve and check valve, installation point of vacuum gauge, vacuum breaker valve (anti backflow) and safety valve.
5. Instrumentation and control points - vacuum degree (mbar), evaporation temperature (° C), condensation temperature (° C), cooling water flow rate (m^3/h), solvent recovery rate (%), solvent leakage alarm, solvent residue detection port.
6. Support and foundation diagram - vacuum pump foundation, recycling bottle support, pipeline support, anchor bolt hole position, lifting ear and center of gravity marking.
7. Flange and Sealing Table - Interface Number, Flange Standard, Face Type, Number of Bolt Holes, Gasket Material (PTFE/Graphite), Specification of Hose and Quick Install Joint.
8. Safety and Protection Notes - Explosion proof Electrical, Solvent Leak Detection, Cold Trap Low Temperature Protection, Vacuum Destruction and Pressure Relief Procedures, Recycling Bottle Overflow Prevention and Grounding.

Key parameters and material requirements

-Processing capacity: evaporation capacity of 1-5 L/h (pilot level); Can be adjusted according to zoom in requirements.

-Liquid receiving material: AISI-316L (liquid receiving surface); Sealing components PTFE/FKM; Condenser pipe material AISI-316L.

-Vacuum range: up to 1-50 mbar (optional deeper vacuum); Vacuum pump type: rotary vane oil seal pump or dry screw pump (selected according to solvent and safety).

-Condensation: The main condenser is cooled by water, and the cold trap uses low-temperature refrigerant or dry ice cold trap; Condensation area ≥ 0.5-1.0 m^2 (small-scale test).
-Flange interface: Vacuum interface KF25/KF40 or DN25 flange; Condensation reflux DN50; Cooling water DN15-DN25.
-Instrument range: Vacuum gauge 0-1000 mbar (or precision 0-100 mbar); Temperature PT100 0-200 ° C; flow meter 0-2 m^3/h.
-Working conditions: Design pressure ≤ 1.5 bar (positive pressure components); Vacuum side allows -0.95 bar; Cooling water inlet ≤ 25 ° C.
-Safety: Vacuum breaking valve, check valve, solvent leak detector, grounding and anti-static measures, solvent recovery bottle with overflow and vent.

Interface and installation points
-Vacuum pump interface: There is a short pipeline between the vacuum pump and the cold trap, equipped with a check valve and a bypass valve. A cold trap is installed at the pump inlet to protect the pump from solvent vapor damage.
-Condensation circuit: The main condenser first recovers high boiling point components, and the cold trap further recovers low boiling point or residual solvents. The recovery bottle is equipped with liquid level monitoring and overflow protection.
-Pipeline material and slope: Stainless steel hard pipes are preferred for all solvent pipelines, with a slope of ≥ 1% to facilitate reflux and emptying; The hose is only used for short distance connections and vibration compensation.
-Bypass and safety: Install a bypass valve at the inlet of the vacuum pump for maintenance purposes; Install ventilation valves and activated carbon adsorption ports (if necessary) in the recycling bottles.
-CIP and cleaning: The condenser and recovery bottle should have cleaning ports and drain valves, and the CIP circulation path should be clear and isolated with valves.

Testing and acceptance requirements
-Factory documents: Material certificate EN10204 3.1, welding records, non-destructive testing report, vacuum pump qualification certificate, instrument calibration certificate P& ID、 Operation and maintenance manual.
-Pressure/vacuum test: Positive pressure components are tested by water pressure; Perform leakage testing (helium or nitrogen leak detection) on the vacuum side and record the leakage rate to be ≤ the contract requirements.
-Functional test: Run the vacuum pump and condenser without load for 2 hours, record the stability of vacuum degree, condensation temperature, and no leakage; Conduct a trial run with the material and record the recovery rate (target ≥ 95%) and solvent purity.
-Instrument calibration: Vacuum gauges, temperature gauges, and flow meters are

provided with calibration certificates along with the goods and verified on site.
-Delivery documents: Material certificates, non-destructive testing reports, test records, IQ/OQ documents, operation and maintenance manuals.

Reproducible drawing script (blueprint for vacuum recovery system engineering)

`python

vacuumrecoveryblueprint.py

Pre run installation dependency: pip install matplotlib numpy

Script purpose: Generate SVG blueprint for vacuum recovery system engineering, including overall layout, evaporator section, condenser and cold trap detailed drawings, vacuum pump layout and flange table
import matplotlib.pyplot as plt
import matplotlib.patches as mpatches
import numpy as np

==========Adjustable parameters==========
EvapcapacityLph=3 # evaporation capacity L/h (note)
Evapdiamm=360 # evaporator diameter mm
Evaphmm=600 # evaporator height mm
Condenserarea m2=0.8 # condensing area m2 (note)
Vacuumtargetmbar=10 # target vacuum mbar
Flangehvac="KF25/DN25" # Vacuum interface annotation
Flange_comd="DN50" # Condensation reflux flange
Flange-water="DN15" # cooling water flange
outputsvg = "vacuumrecovery_blueprint.svg"
scale = 0.9

==============================

fig = plt.figure(figsize=(16.5,11.7))
ax = fig.add_axes([0,0,1,1])
ax.setxlim(0,1650);   ax.setylim(0,1170)
ax.axis('off')

Auxiliary function: Draw a cylinder (evaporator section)
def draw_evap(x, y, diam, height, ax, lw=1.2):
ax.add_patch(mpatches.FancyBboxPatch((x - diam/2, y), diam, height, boxstyle="round,pad=0.02", linewidth=lw, fill=False))

#Schematic diagram of jacket
ax.add_patch(mpatches.FancyBboxPatch((x - diam/2 - 10, y - 6), diam + 20, height + 12, boxstyle="round,pad=0.02", linewidth=0.8, fill=False, linestyle='--'))

Overall System Layout (Top Left)
x0, y0 = 60, 700
ax.add_patch(mpatches.Rectangle((x0, y0), 700, 380, fill=False))
Ax.text (x0+350, y0+360, "Overall System Layout", ha='center ', fontsize=12)

Schematic diagram for placing evaporator, condenser, cold trap, recycling bottle, and vacuum pump
ax.add_patch(mpatches.FancyBboxPatch((x0 + 40, y0 + 40), 220, 300, boxstyle="round,pad=0.02", linewidth=1.0, fill=False))
Ax.text (x0+150, y0+200, "vacuum evaporator", fontsize=9, ha='center ')
ax.add_patch(mpatches.FancyBboxPatch((x0 + 300, y0 + 40), 160, 220, boxstyle="round,pad=0.02", linewidth=1.0, fill=False))
Ax.text (x0+380, y0+150, "main condenser", fontsize=9, ha='center ')
ax.add_patch(mpatches.FancyBboxPatch((x0 + 490, y0 + 40), 120, 160, boxstyle="round,pad=0.02", linewidth=1.0, fill=False))
ax.text(x0 + 550, y0 + 120, "冷阱", fontsize=9, ha='center')
ax.add_patch(mpatches.FancyBboxPatch((x0 + 40, y0 - 120), 120, 120, boxstyle="round,pad=0.02", linewidth=1.0, fill=False))
ax.text(x0 + 100, y0 - 60, "回收瓶", fontsize=9, ha='center')
ax.add_patch(mpatches.FancyBboxPatch((x0 + 200, y0 - 120), 160, 120, boxstyle="round,pad=0.02", linewidth=1.0, fill=False))
ax.text(x0 + 280, y0 - 60, "真空泵", fontsize=9, ha='center')

Pipeline diagram (arrow)
ax.arrow(x0 + 260, y0 + 160, 30, 0, headwidth=6, headlength=8, fc='k', ec='k')
Ax.text (x0+300, y0+170, "Steam/Steam Flow Direction", fontsize=7)

Vacuum evaporator section (top right)
x1, y1 = 820, 700
drawevap(x1 + evapdiammscale/2, y1, evapdiammscale, evaph_mm*scale, ax)
Ax.text (x1+evapdiammscale/2, y1+evaphmmscale+18, "Vacuum evaporator profile", ha='center ', fontsize=10)

Vacuum interface and flange
ax.plot([x1 + evapdiammscale/2, x1 + evapdiammscale/2 + 60], [y1 + evaphmmscale - 40, y1 + evaphmmscale - 40], color='k')
ax.text(x1 + evapdiammscale/2 + 80, y1 + evaphmmscale - 40, f"真 空 接 口 {flange_vac}", fontsize=8)

Jacket and temperature probe

Ax.text (x1+evapdiammscale+20, y1+evaphmmscale * 0.6, "jacket inlet/outlet DN15", fontsize=8)

Detailed drawing of condenser group (left center)
x2, y2 = 60, 360
ax.add_patch(mpatches.Rectangle((x2, y2), 420, 220, fill=False))
Ax.text (x2+210, y2+200, "Detailed drawing of condenser group and cold trap", ha='center ', fontsize=10)

Schematic diagram of condenser tube bundle
for i in range(6):
yy = y2 + 30 + i*30
ax.plot([x2 + 20, x2 + 380], [yy, yy], color='gray', linewidth=0.6)

Connection between cold trap and recycling bottle
ax.plot([x2 + 380, x2 + 460], [y2 + 40, y2 + 40], color='k')
Ax.text (x2+470, y2+40, "to the cold trap", fontsize=8, va='center ')

Detail drawing of cold trap and recycling bottle (middle right)
x3, y3 = 520, 360
ax.add_patch(mpatches.Rectangle((x3, y3), 520, 220, fill=False))
Ax.text (x3+260, y3+200, "Detailed drawing of cold trap and recycling bottle", ha='center ', fontsize=10)
Ax.text (x3+10, y3+170, f "Cold trap: Low temperature condensing refrigerant/dry ice interface", fontsize=8)
Ax.text (x3+10, y3+150, f "Recycling bottle: equipped with liquid level monitoring and overflow protection flange {flame_comd}", fontsize=8)
Ax.text (x3+10, y3+130, "sampling port and drain valve DN25", fontsize=8)

Vacuum pump and bypass (bottom left)
x4, y4 = 60, 80
ax.add_patch(mpatches.Rectangle((x4, y4), 420, 220, fill=False))
Ax.text (x4+210, y4+200, "Vacuum pump and bypass arrangement", ha='center ', fontsize=10)
Ax.text (x4+20, y4+170, "Vacuum pump model: rotary vane oil seal or dry screw (selected according to solvent)", fontsize=8)
Ax.text (x4+20, y4+150, "Pump inlet equipped with cold trap, check valve, bypass valve, and vacuum breaker valve", fontsize=8)

Diagram of Vacuum Gauge and Destructive Valve
ax.plot([x4 + 200, x4 + 260], [y4 + 120, y4 + 120], color='k')
Ax.text (x4+270, y4+120, f "vacuum target mbar", fontsize=8, va='center ')

Flange and Sealing Table (bottom right)

tablex, tabley = 520, 120
Ax.text (tablex, tabley+160, "Flange and Seal Details", fontsize=9)
Ax.text (tablex, tabley+140, "Interface number name, flange specification, face type, bolt hole number, gasket material", fontsize=8)
ax.text(tablex, tabley + 120, f"V1 真空接口 {flange_vac} KF/FF - PTFE", fontsize=8)
ax.text(tablex, tabley + 100, f"F1 冷凝回流 {flange_cond} RF 8 PTFE", fontsize=8)
ax.text(tablex, tabley + 80, f"W1 冷却水 {flange_water} RF 4 PTFE", fontsize=8)
ax.text(tablex, tabley + 60, f"S1 排污/取样 DN25 RF 4 PTFE", fontsize=8)

Title bar and material notes
Ax.text (20, 1120, "Drawing Number: 05 Name: Vacuum Recovery System Scale: Overall 1:20 Detail 1:10", fontsize=9)
Ax.text (20, 1100, "Material: AISI-316L liquid receiving part, inner surface Ra≤0.8μm, weld seam according to ASME IX", fontsize=8)
Ax.text (20, 1080, f "Evaporation capacity: {evapcapacityLph} L/h Condensation area: {condensaraream2} m ^ 2 Target vacuum: {vacuumtargetmbar} mbar", fontsize=8)
Ax.text (20, 1060, "Safety: Vacuum breaking valve, check valve, solvent leak detection, grounding and anti-static", fontsize=8)

Save output
plt.savefig(outputsvg, dpi=300, bboxinches='tight')
Print (\ "Generated Vacuum Recovery System Engineering Blueprint File: \", outputted as svg)
print(\ "可调参数: evapcapacityLph, evapdiamm, evaphmm, condenserarearm2, vacuumtargetmbar, flangevac, flangecond, flange_water, scale\")
`

Drawing No. 06- Small Vacuum Evaporator Engineering Description

Purpose and Scope
Purpose: To provide engineering information for the manufacturing, installation, and acceptance of small-scale vacuum evaporators and solvent recovery units, suitable for concentrated extraction solutions, solvent recovery, and thermal sensitive material protection.

Scope: including equipment elevation and section, jacket and heating coil, evaporator and condenser circuit, vacuum interface and cold trap connection, inlet and outlet and sampling ports, instrument installation position, flange and sealing details, support and foundation, testing and acceptance requirements.

View List and Key Points of Content

1. Front view and side section - kettle body shape, jacket outline, heating coil or jacket inlet and outlet, evaporation chamber liquid level and feeding port, condensation reflux interface, vacuum interface, bottom valve and drain outlet, liquid level sight glass and sampling port.
2. Longitudinal section - displays the arrangement of heating jackets or coils, heating surfaces in the evaporation chamber, steam/solvent vapor-liquid separators (separation cones or cyclone separators), connection between the condensation circuit and the cold trap, and interface between the condensate collection tray and the recovery bottle.
3. Top view - Position of top flange and manhole, direction of condensation reflux pipeline, relative position of steam inlet and vacuum pipeline, arrangement of instruments and sampling ports.
4. Interface details (enlarged) - Vacuum interface KF25/KF40 or DN25 flange, condensation reflux DN50 flange, jacket inlet and outlet DN15, sampling valve DN25, temperature/pressure sensor installation flange.
5. Support and foundation diagram - base size, anchor bolt hole position, lifting ear and lifting diagram, equipment center of gravity annotation, vibration isolation suggestions.
6. Instrument installation diagram - positions of vacuum gauge, PT100 temperature points (kettle body, jacket inlet and outlet, condenser outlet), level gauge, pressure transmitter, flow meter (cooling water), safety valve and vacuum breaker valve.
7. Flange and Sealing Table - Interface Number, Flange Standard, Face Type, Number of Bolt Holes, Gasket Material (PTFE/Graphite), Specification of Hose and Quick Install Joint.
8. Testing and acceptance items - factory material certificate, non-destructive testing of welds, pressure testing, vacuum leak testing, functional trial operation and recovery rate verification.

Key parameters and material requirements

-Processing capacity: evaporation capacity of 1-5 L/h (small-scale test); It can be enlarged according to demand.

-Liquid receiving material: AISI-316L; Sealing element PTFE or FFKM.

-Design pressure and vacuum: Positive pressure component design ≤ 1.5 bar; Vacuum side allows -0.95 bar; Vacuum interface KF25/KF40 or DN25.

-Heating method: jacket steam heating or coil electric heating; The design pressure of the jacket is ≤ 2 bar; Jacket inlet and outlet DN15.
-Condensation circuit: main condenser cooling water cooling, cold trap low-temperature recovery; Condensation reflux flange DN50; Cooling water flange DN15-DN25.
-Temperature control and protection: PT100 temperature probe 0-200 ° C; temperature rise threshold and automatic shutdown logic; Vacuum breaking valve and check valve.
-Surface and welding: Inner surface Ra ≤ 0.8 μ m; Polish and passivate the weld seam; Perform RT/UT testing on key welds and provide reports.
-CIP and cleaning: Top spray or side spray ball, CIP interface DN25, designed circulation pressure 2 bar.

Key points of operation and control
-Start sequence: condensate water first, cold trap cooling → vacuum pump no-load start and stabilize vacuum → heating jacket to set temperature → feeding and controlling feeding rate to prevent splashing → monitoring vacuum and temperature curves.
-Shutdown sequence: Stop feeding → Lower jacket temperature → Cut off heating → Turn off steam and keep cooling water running → Slowly break the vacuum to atmospheric pressure → Drain residual liquid and clean.
-Key control points: evaporation temperature, vacuum degree inside the kettle, condensation temperature, cooling water flow rate, feed rate, liquid level control.
-Sampling and Release: Record evaporation yield, recovery rate, and residual solvents for each batch; Recovery rate target ≥ 95%; Release after passing the tests for residual solvents and microorganisms.

Interface and installation points
-Vacuum pump connection: A cold trap and check valve are installed in front of the vacuum pump. The pump inlet is short and equipped with a flexible joint for vibration reduction.
-Condensation circuit: The main condenser prioritizes the recovery of high boiling components, the cold trap recovers low boiling components, and the recovery bottle is equipped with liquid level monitoring and overflow protection.
-Pipeline slope: The slope of the solvent reflux pipeline should be ≥ 1% to facilitate reflux and emptying.
-Electrical and Explosion proof: If dealing with flammable solvents, electrical equipment should be selected according to the explosion-proof level and reliably grounded.
-Maintenance channel: Manholes and flanges should be arranged for easy

disassembly and maintenance, with reserved space for instrument maintenance.

Testing and acceptance requirements
-Factory documents: Material certificate EN10204 3.1, welding records, non-destructive testing report, instrument calibration certificate P& ID、Operation and maintenance manuals, IQ/OQ documents.
-Pressure test: The jacket and positive pressure components shall be subjected to a water pressure test at a design pressure of 1.5 times and recorded.
-Vacuum leakage test: Conduct helium or nitrogen leak detection on the vacuum side and record the leakage rate to meet the contract requirements.
-Functional test: Run without load for 2 hours and record temperature and vacuum stability; Run one batch with materials and record the recovery rate and residue.
-Release documents: test records, calibration certificates, release signature forms.

Blueprint drawing script for small vacuum evaporator project

Below is a self-contained Python script that uses matplotlib and numpy to draw a blueprint for a small vacuum evaporator project (front view, section view, top view, interface details, support schematic), and outputs minievatorblueprint. svg. The top of the script contains adjustable parameters (kettle diameter, overall height, condensing flange, vacuum interface, etc.), annotated in Chinese for engineers to directly run and modify.

`python

```
minievaporatorblueprint.py

Pre run installation dependency: pip install matplotlib numpy
import matplotlib.pyplot as plt
import matplotlib.patches as mpatches
import numpy as np

==========Adjustable parameters==========
D_mm=360 # kettle body outer diameter mm
H_mm=700 # kettle body height mm (excluding support legs)
WorkcapacityPhh=3 # Evaporation Capacity L/h Note
Flange_comd="DN50" # Condensation reflux flange
Flangehvac="KF25" # Vacuum interface annotation
```

```
Flange_jacket="DN15" # jacket inlet and outlet
outputsvg = "minievaporator_blueprint.svg"
scale = 0.9

==============================

fig = plt.figure(figsize=(16.5,11.7))
ax = fig.add_axes([0,0,1,1])
ax.setxlim(0,1650);    ax.setylim(0,1170)
ax.axis('off')

Auxiliary function: Draw cylinder (front view)
def drawcylinderfront(xleft, ybottom, diam, height, ax, lw=1.2):
ax.addpatch(mpatches.FancyBboxPatch((xleft, y_bottom), diam, height, boxstyle="round,pad=0.02", linewidth=lw, fill=False))
#Schematic diagram of jacket dashed line
ax.addpatch(mpatches.FancyBboxPatch((xleft-10, y_bottom-6), diam+20, height+12, boxstyle="round,pad=0.02", linewidth=0.8, fill=False, linestyle='--'))

Front view (top left)
x0, y0 = 80, 680
drawcylinderfront(x0, y0, Dmmscale, Hmmscale, ax)
Ax.text (x0+Dmmscale/2, y0+Hmmscale+18, "Front view small vacuum evaporator", ha='center ', fontsize=10)

dimensioning
ax.annotate("", xy=(x0-40, y0), xytext=(x0-40, y0+H_mm*scale), arrowprops=dict(arrowstyle="&lt;-&gt;", linewidth=0.8))
ax.text(x0-60, y0 + Hmm*scale/2, f"H={Hmm} mm", rotation=90, va='center', fontsize=8)
ax.annotate("", xy=(x0, y0-30), xytext=(x0 + D_mm*scale, y0-30), arrowprops=dict(arrowstyle="&lt;-&gt;", linewidth=0.8))
ax.text(x0 + Dmm*scale/2, y0-50, f"D={Dmm} mm", ha='center', fontsize=8)

Top flange and manhole
ax.addpatch(mpatches.Circle((x0 + Dmmscale0.2, y0 + H_mm*scale + 6), 10, fill=False))
ax.text(x0 + Dmmscale0.2, y0 + Hmm*scale + 22, "顶 人 孔 DN200", fontsize=7, ha='center')

Condensation reflux interface
ax.plot([x0 + Dmmscale0.5, x0 + Dmmscale0.5], [y0 + Hmmscale, y0 + Hmmscale + 40], color='k')
ax.text(x0 + Dmmscale0.5, y0 + Hmm*scale + 52, f"冷凝回流{flange_cond}", fontsize=8,
```

ha='center')

Vacuum interface side outlet
ax.plot([x0 + Dmmscale + 10, x0 + Dmmscale + 60], [y0 + Hmmscale0.6, y0 + Hmmscale0.6], color='k')
ax.text(x0 + Dmmscale + 70, y0 + Hmmscale*0.6, f"真 空 {flange_vac}", fontsize=8, va='center')

Longitudinal section (top right)
x1, y1 = 520, 680
ax.addpatch(mpatches.Rectangle((x1, y1), Dmmscale, H_mmscale, fill=False, linewidth=1.2))
Ax.text (x1+Dmmscale/2, y1+Hmmscale+18, "Longitudinal section (jacket and separator)", ha='center ', fontsize=10)

Schematic diagram of jacket and coil
ax.addpatch(mpatches.Rectangle((x1 + 10, y1 + 20), Dmm*scale - 20, 12, fill=False, linestyle='--'))
ax.text(x1 + Dmmscale + 20, y1 + Hmmscale*0.6, f"夹 套 进 /出 {flange_jacket}", fontsize=8)

Separators and recycling trays
ax.addpatch(mpatches.Polygon([[x1 + Dmmscale0.2, y1 + H_mmscale0.4],
[x1 + Dmmscale0.8, y1 + Hmmscale0.4],
[x1 + Dmmscale0.5, y1 + Hmmscale0.15]], fill=False))
Ax.text (x1+Dmmscale0.5, y1+Hmmscale0.28, "vapor-liquid separator", fontsize=8, ha='center ')

Top view (center left)
x2, y2 = 80, 360
r = D_mm*scale/2
cx = x2 + r + 20
cy = y2 + r + 10
ax.add_patch(mpatches.Circle((cx, cy), r, fill=False))
Ax.text (cx, cy+r+18, "Top flange and pipeline in top view", ha='center ', fontsize=10)

Schematic diagram of flange hole ring
theta = np.linspace(0, 2*np.pi, 9)[:-1]
r_hole = r - 18
for t in theta:
px = cx + r_hole * np.cos(t)
py = cy + r_hole * np.sin(t)
ax.add_patch(mpatches.Circle((px, py), 3, fill=True))

Interface detail drawing (enlarged) in the middle right
x3, y3 = 520, 360
ax.add_patch(mpatches.Rectangle((x3, y3), 520, 240, fill=False))
Ax.text (x3+260, y3+250, "Interface Detail (Enlarged)", ha='center ', fontsize=10)
Ax.text (x3+10, y3+210, f "condensing reflux flange: {flame_comd} RF surface", fontsize=8)
Ax.text (x3+10, y3+190, f "Vacuum interface: {flame_fac} KF or DN flange", fontsize=8)
Ax.text (x3+10, y3+170, f "jacket inlet and outlet: {flame_jacket} design pressure 2 bar", fontsize=8)
Ax.text (x3+10, y3+150, "sampling port DN25 with quick connector", fontsize=8)

Support and foundation, bottom left
x4, y4 = 80, 80
ax.add_patch(mpatches.Rectangle((x4, y4), 520, 220, fill=False))
Ax.text (x4+260, y4+240, "Support and Foundation Diagram", ha='center ', fontsize=10)
Ax.text (x4+20, y4+200, "Foot hole: M16 x4 Foundation concrete C25", fontsize=8)
Ax.text (x4+20, y4+180, "Lifting ears: pay attention to the center of gravity when lifting on both sides of the top", fontsize=8)
ax.plot([x4 + 260, x4 + 260], [y4 + 20, y4 + 80], color='k', linestyle='--')
ax.text(x4 + 270, y4 + 50, "重心 CG", fontsize=8)

Title bar and material notes
Ax.text (20, 1120, "Drawing Number: 06 Name: Small Vacuum Evaporator Scale: Front/Section 1:10 Detail 1:5", font size=9)
Ax.text (20, 1100, "Material: AISI-316L liquid receiving part, inner surface Ra≤0.8μm, sealed PTFE/FKM", fontsize=8)
Ax.text (20, 1080, f "Evaporation capacity: {workcapacityPhh} L/h Condensation reflux: {flamecond} Vacuum interface: {flamevac}", fontsize=8)
Ax.text (20, 1060, "Operation points: Cooling first→Vacuum stabilization→Heating up→ eed control shutdown in reverse order", fontsize=8)

Flange and Sealing Table
tablex, tabley = 1200, 980
Ax.text (tablex, tabley, "Flange and Seal Details", fontsize=9)
Ax.text (tablex, tabley-18, "Interface number name, flange specification, face type, bolt hole number, gasket material", fontsize=8)
ax.text(tablex, tabley-36, f"F1 冷凝回流 {flange_cond} RF 8 PTFE", fontsize=8)
ax.text(tablex, tabley-54, f"V1 真空接口 {flange_vac} KF/DN - PTFE", fontsize=8)
Ax.text (tablex, tabley-72, f "J1 jacket in/out {flame_jacket} RF 4 PTFE", fontsize=8)
ax.text(tablex, tabley-90, f"S1 取样/排污 DN25 RF 4 PTFE", fontsize=8)

Save output
plt.savefig(outputsvg, dpi=300, bboxinches='tight')
Print ("Generated small vacuum evaporator engineering blueprint file:", outputted as svg)
Print ("Adjustable parameters: Dmm, Hmm, workcapacityPhh, flamecond, flamevac, flame_jacket, scale")
`

Drawing No. 07- PLC Control Cabinet and Electrical Layout Engineering Description

Purpose and Scope
Purpose: To provide manufacturing, installation, and acceptance engineering information for PLC control cabinets, electrical wiring, and on-site instrument wiring for the entire 50L pilot extraction device, ensuring that automation control, data acquisition, alarm, and safety linkage can be implemented and traced.
Scope: Includes control cabinet front view and wiring profile, I/O layout table, field instrument and actuator wiring diagram, power and grounding layout, terminal block and cable tray layout, fire/explosion protection and safety interlock circuit, acceptance and testing requirements.

View List and Key Points of Content
1. Front view and section of control cabinet - cabinet shape, door panel layout, touch screen position, PLC host and expansion module arrangement, circuit breaker/contactor/soft starter/frequency converter installation position, terminal block and power inlet, ventilation and heat dissipation holes, grounding terminal.
2. I/O layout table (table) - each I/O number, signal type (DI/DO/AI/AO/RTD/TC), instrument name, site location, circuit cable cross-section and shielding requirements, isolation/lightning protection instructions.
3. On site wiring and terminal diagram - schematic diagram of typical field instruments (PT100, pressure transmitter, flow meter, level gauge, valve actuator, pump motor) to the terminal block inside the cabinet, including shielded wire grounding terminal, twisted pair/shielded wire connection method, wiring color and terminal number.
4. Power and distribution layout - Main power supply incoming line (3 × 380 V), branch circuit breaker, contactor, thermal overload protection, frequency converter and soft starter wiring, backup power/UPS (if required) location and capacity description.
5. Grounding and Lightning Protection - Suggestions for equipment grounding grid

connection points, equipotential bonding, shielding wire grounding points, and installation locations and models of lightning arresters/surge protectors (SPDs).
6. Explosion proof and solvent area electrical requirements - The solvent area electrical should be selected according to the explosion-proof level (Ex d/Ex e, etc.), and the control cabinet should be placed in the non solvent area or use an explosion-proof cabinet; All on-site cables shall be threaded through conduits and sealed.
7. HMI and data interface -7 "touch screen position, Ethernet port, USB, RS-485/Modbus, CSV/FTP data export interface and network topology diagram.
8. Alarm and safety interlock circuit - solvent leakage alarm, temperature/pressure over limit shutdown circuit, emergency stop (E-Stop) button layout and circuit diagram, CIP and cleaning interlock.
9. Acceptance and testing items - insulation resistance test, grounding resistance test, circuit connectivity test, I/O point-to-point function test, PLC program function test (3 batches of simulation/physical triggering), HMI operation and data export verification.

Key parameters and material requirements
-PLC and HMI: Industrial grade PLC (at least 16 DI/16 DO/8 AI/4 AO expandable), 7 "touch screen; supports Modbus TCP/RTU, OPC UA (optional).
-Power supply: Main power supply 3 × 380 V ± 10%, 50 Hz; Control power supply 1 × 220 V or 24 V DC (recommended for full cabinet 24 V DC power supply); The UPS capacity is based on PLC+HMI+key instruments for 15-30 minutes backup.
-Terminal and wiring: Terminal strip with numbering, shielded wire grounding terminal, and terminal section selection based on current and distance (typical: signal wire 1.5 mm ^{2}, motor power wire 2.5-6 mm ^{2}).
-Protection level: Control cabinet IP54 (indoor) or IP65 (dustproof and waterproof required); The cabinet material is cold-rolled steel or stainless steel (solvent area or clean area).
-Electrical components: circuit breakers, contactors, thermal overload relays, frequency converters (pumps/mixing motors), surge protectors (SPDs), isolation amplifiers (if necessary).
-Wiring specifications: The signal line and power line are routed in separate slots, with one end of the shielded wire grounded and a grounding resistance of ≤ 4 Ω (recommended ≤ 1 Ω).
-Document delivery: Electrical schematic diagram (single line diagram), wiring diagram (terminal list), cable schedule, grounding diagram, PLC program list and annotations, IO list, test report.

Wiring and I/O examples (typical items)

-DI: Emergency stop button, low/high liquid level, door switch, CIP completion signal.
-DO: Steam valve (solenoid valve), cooling water bypass valve, pump start stop, alarm buzzer.
-AI: kettle temperature (PT100 via RTD converter), condensation temperature, steam pressure (4-20 mA), cooling water flow rate (4-20 mA).
-AO: Frequency setting of frequency converter (0-10 V or 4-20 mA), proportional valve control (0-10 V).
-Communication: PLC ↔ HMI（Ethernet）; PLC ↔ Upper system (Modbus TCP/OPC UA); Export data to CSV/FTP.

Acceptance Test Checklist (On site)
1. Appearance and grounding inspection: The cabinet, wiring terminals, and grounding wires are intact; Test and record the grounding resistance.
2. Insulation and voltage withstand test: Conduct insulation resistance test (≥ 1 M Ω) and voltage withstand test (according to standards) on the power circuit and control circuit respectively.
3. I/O point-to-point testing: Simulate on-site signals point by point and verify PLC read and write, HMI display and action.
4. Functional testing: Execute the complete process sequence (no-load simulation) and verify interlocks, alarms, data recording, and exports.
5. Emergency testing: triggering E-Stop, solvent leakage alarm, power outage recovery test.
6. Program and documentation: Submit PLC program source files, comments, IO lists, wiring diagrams, test records, and signed release forms.

Installation and on-site precautions
-The control cabinet should be placed in a dry, ventilated, non solvent area with sufficient maintenance access (recommended 800-1000 mm) from the equipment.
-All on-site cables shall be threaded through conduits and sealed for fire protection; Laying of power and signal lines in separate slots; The cable identification and terminal number are consistent with the drawing.
-The on-site components in the explosion-proof area (such as valve actuators in the solvent area) need to be explosion-proof and isolated and have safety interfaces in the cabinet.
-It is recommended that supplier engineers and process engineers be present together to complete OQ testing during on-site debugging.

Reproducible Drawing Script - PLC Control Cabinet and Electrical Layout (Generate

SVG)

The following provides a self-contained Python script that uses matplotlib and numpy to draw the front view, terminal block, and single wire wiring diagram of the PLC control cabinet, and outputs plceletricalblueprint.svg. The top of the script contains adjustable parameters (cabinet size, I/O quantity, main power specifications, UPS options, etc.), annotated in Chinese for engineers to directly run and modify.

`python

plcelectricalblueprint.py

Pre run installation dependency: pip install matplotlib numpy
import matplotlib.pyplot as plt
import matplotlib.patches as mpatches
import numpy as np

==========Adjustable parameters==========
Cabinetwidthmm=800 # Control cabinet width mm (as shown in the scale)
Cabinetheight mm=2000 # Control cabinet height mm
iodicount = 16 # DI 数量
Iodocount=16 # DO quantity
Ioaicount=8 # AI quantity
Ioaocount=4 # AO quantity
Main_power="3x380V" # Main power supply note
Control_power="24VDC" # Control Power Note
outputsvg = "plcelectrical_blueprint.svg"
Scale=0.25 # scaling factor (pixels/mm)

==============================

fig = plt.figure(figsize=(16.5,11.7))
ax = fig.add_axes([0,0,1,1])
ax.setxlim(0,1650); ax.setylim(0,1170)
ax.axis('off')

Front view of control cabinet (left side)
x0, y0 = 60, 300
w = cabinetwidthmm * scale
h = cabinetheightmm * scale
ax.add_patch(mpatches.Rectangle((x0, y0), w, h, fill=False, linewidth=1.2))
Ax.text (x0+w/2, y0+h+18, "Front view of control cabinet", ha='center ', fontsize=12)

HMI and PLC module schematic

ax.add_patch(mpatches.Rectangle((x0 + 20, y0 + h - 120), w - 40, 60, fill=False))
Ax.text (x0+w/2, y0+h-90, "HMI touch screen 7" ", fontsize=9, ha='center ')

PLC host and expansion module
module_h = 40
for i in range(6):
ax.addpatch(mpatches.Rectangle((x0 + 30, y0 + h - 180 - i*(moduleh+6)), w - 60, module_h, fill=False))
ax.text(x0 + w/2, y0 + h - 180 - i*(moduleh+6) + moduleh/2, f"PLC 模块 {i+1}", fontsize=8, ha='center', va='center')

Circuit breaker and power supply area (inside the right cabinet door)
ax.add_patch(mpatches.Rectangle((x0 + w + 40, y0 + h - 200), 220, 320, fill=False))
Ax.text (x0+w+150, y0+h-80, "Power and Distribution Area", fontsize=10, ha='center ')
Ax.text (x0+w+150, y0+h-110, f "main power: {main_power}", fontsize=8, ha='center ')
Ax.text (x0+w+150, y0+h-130, f "Control power: {controll_power}", fontsize=8, ha='center ')
Ax.text (x0+w+150, y0+h-150, "circuit breaker/contactor/UPS/frequency converter", fontsize=8, ha='center ')

Terminal block diagram (lower part)
term_x = x0 + 20
term_y = y0 + 40
term_w = w - 40
term_h = 120
ax.addpatch(mpatches.Rectangle((termx, termy), termw, term_h, fill=False))
ax.text(termx + termw/2, termy + termh + 10, "端子排 (示意) ", ha='center', fontsize=10)

Terminal row and number
rows = 4
cols = 16
cellw = termw / cols
cellh = termh / rows
for r in range(rows):
for c in range(cols):
tx = termx + c*cellw
ty = term + r*cell
ax.addpatch(mpatches.Rectangle((tx, ty), cellw, cell_h, fill=False, linewidth=0.4))
#Number indication
ax.text(tx + cellw/2, ty + cellh/2, f"T{r*cols + c + 1}", fontsize=6, ha='center', va='center')

Schematic diagram of single wire connection (large image on the right)
x1, y1 = 900, 300

```
ax.add_patch(mpatches.Rectangle((x1, y1), 700, 600, fill=False))
Ax.text (x1+350, y1+580, "Single Wire Wiring Diagram (Typical Circuit)", ha='center ', fontsize=12)

main power supply incoming line
ax.plot([x1 + 40, x1 + 160], [y1 + 520, y1 + 520], color='k', linewidth=2)
Ax.text (x1+100, y1+530, "main power input line", fontsize=8, ha='center ')

Circuit breaker, contactor, thermal overload, frequency converter, pump
xpos = x1 + 200
Components=["Circuit Breaker", "Contactor", "Thermal Overload", "Inverter", "Pump (M)"]
for i, comp in enumerate(components):
ax.add_patch(mpatches.Rectangle((xpos + i*90, y1 + 480), 70, 40, fill=False))
ax.text(xpos + i*90 + 35, y1 + 500, comp, fontsize=8, ha='center')

Signal Circuit Diagram (Below)
ax.plot([x1 + 40, x1 + 660], [y1 + 360, y1 + 360], color='gray', linewidth=1)
Ax.text (x1+350, y1+345, "Signal Circuit (AI/DI/DO)", fontsize=8, ha='center ')

Arrow from AI/DI/DO to PLC
ax.arrow(x1 + 120, y1 + 360, 80, 0, headwidth=6, headlength=8, fc='k', ec='k')
ax.text(x1 + 160, y1 + 370, "AI/DI  →  PLC", fontsize=7)
ax.arrow(x1 + 420, y1 + 360, 80, 0, headwidth=6, headlength=8, fc='k', ec='k')
ax.text(x1 + 460, y1 + 370, "PLC  →  DO", fontsize=7)

I/O List Table (bottom right)
Tablex, tabley = X1 + 20, Y 1 + 40
Ax.text (tablex, tabley+220, "I/O List (Example)", fontsize=10)
io_lines = [
"AI1:  釜温  PT100 -&gt;  4-20mA -&gt;  PLC AI1",
AI2: Condensation temperature ->4-20mA ->;  PLC AI2",
DI1: Low liquid level ->PLC DI1 ",
DO1: Steam valve ->PLC DO1 (relay driven) ",
DO2: Pump start stop ->PLC DO2 (contactor control)
]
for i, line in enumerate(io_lines):
ax.text(tablex, tabley + 200 - i*18, line, fontsize=8, ha='left')

Title bar and annotations
Ax.text (20, 1120, "Drawing Number: 07 Name: PLC Control Cabinet and Electrical Layout Scale: 1:20 (Schematic)", fontsize=9)
Ax.text (20, 1100, "Note: Terminal number, wiring color, shielding grounding, and grounding resistance requirements can be found in the cable table and wiring
```

diagram", fontsize=8)
Ax.text (20, 1080, "Delivery documents: single line diagram, wiring diagram, terminal table, PLC program, I/O list, test records", font size=8)

Save output
plt.savefig(outputsvg, dpi=300, bboxinches='tight')
Print ("Generated PLC control cabinet and electrical layout engineering blueprint file:", outputted as svg)
print("可 调 参 数： cabinetwidthmm, cabinetheightmm, iodicount, iodocount, ioaicount, ioaocount, mainpower, controlpower, scale")
`

Drawing No. 08- Engineering Description of Residue Oven and Treatment Unit

Purpose and Scope

Purpose: To provide engineering information for manufacturing, installation, and acceptance of residue drying, desolvation, and resource utilization, and to adapt to a 50L pilot capacity residue oven and interface for front-end and back-end transportation, collection, and disposal of dried residue.

Scope: Includes oven front and profile, hot air/oil heating circuit, inlet and outlet and conveying interfaces, exhaust and exhaust gas treatment interfaces, temperature control and air volume control, support and foundation, flange and sealing details, instrument installation location, testing and acceptance requirements.

View List and Key Points of Content

1. Front view and side section - oven shape, bin/inlet, outlet, hot air/hot oil jacket or electric heating coil, tray or spiral conveyor schematic, exhaust outlet and exhaust gas treatment interface (condensation/adsorption).
2. Longitudinal section - material layer distribution, heating coil or hot air channel, position of heat recovery and heat exchanger, position of exhaust and filter (bag/activated carbon), residue discharge and collection hopper.
3. Top view layout - relative position of inlet and outlet, arrangement of conveyor and hopper, direction of exhaust pipeline, position of maintenance door and sampling port.
4. Interface details (enlarged) - Hot oil/steam inlet and outlet flanges, exhaust flanges and flange seals, sewage outlets and sampling valves, temperature/humidity probe installation flanges.
5. Support and foundation diagram - base dimensions, anchor bolt hole positions, conveyor foundation, maintenance platform and steps, lifting ears and center of gravity markings.
6. Instrument installation diagram - inlet/outlet temperature PT100, material layer temperature probe, exhaust temperature and humidity, air volume meter, pressure difference meter (filter pressure difference), safety valve and over temperature alarm.
7. Flange and Sealing Table - Interface Number, Flange Standard, Face Type, Number of Bolt Holes, Gasket Material (High Temperature Resistant PTFE/Graphite).
8. Safety and Environmental Protection Notes - Priority should be given to exhaust gas condensation recovery, activated carbon adsorption or thermal oxidation treatment, exhaust fire resistance flame arrester, automatic shutdown when temperature exceeds the limit, and fire isolation of combustible residues.

Key parameters and material requirements

-Processing capacity: The residue processing capacity is estimated based on the amount of residue after distillation (e.g. processing 50-200 kg of dry residue per day, adjusted according to the pilot scale).

-Heating method: hot air circulation (electric heating or steam/hot oil heat exchanger) or hot oil jacket; Temperature range of 40-200 ° C (according to residue properties and solvent residue requirements).

-Airflow and temperature: The hot air temperature can be adjusted between 40-200 ° C; The air volume is designed according to the thickness of the material layer and mass transfer requirements (e.g. 0.5-3 m^3/min).

-Contact material: Stainless steel AISI-304/316 for high temperature contact parts; High temperature flange gasket made of graphite or high-temperature resistant PTFE.

-Filtration and exhaust gas treatment: initial filtration → condensation recovery → activated carbon adsorption or thermal oxidation; Emissions meet local environmental standards.

-Instrument: PT100 temperature point x 4; Humidity/Dew Point Probe; Filter differential pressure gauge; Airflow meter; Smoke thermometer.

-Safety: Fire isolation, temperature exceeding shutdown, combustible gas detection, grounding and anti-static measures.

Interface and installation points

-Inlet and outlet interface: A quick installation flange or soft connection is installed at the junction with the residue outlet of the distillation kettle for easy disassembly, assembly, and cleaning; A hopper and weighing/recording port are installed at the discharge point.

-Exhaust and exhaust gas circuit: The exhaust gas first passes through the condenser to recover the solvent, and then through activated carbon adsorption or thermal oxidation; Connect the condensation reflux port to the recovery system or solvent recovery tank.

-Maintenance and cleaning: Install maintenance doors and observation windows, and use trays or screw conveyors for easy disassembly and cleaning; CIP compatibility is designed as needed (if there are solvent residues).

-Foundation and vibration: The conveyor and fan require independent foundations and vibration reduction treatment. The recommended concrete grade for the foundation is C25 or above.

Testing and acceptance requirements

-Factory documents: Material certificate EN10204 3.1, welding records, non-destructive testing report, fan and motor qualification certificate, instrument calibration certificate P& ID、 Operation and maintenance manual.
-Function test: Run the hot air circulation without load for 2 hours, record the temperature uniformity and air volume stability; Run one batch with materials and record the decrease in residual moisture content and solvent residue.
-Exhaust gas testing: Condensation recovery efficiency and activated carbon adsorption efficiency testing, emission gas detection meets standards.
-Acceptance documents: test records, calibration certificates, release signature forms.

Reproducible Drawing Script - Residue Oven Engineering Blueprint

`python

residueovenblueprint.py

Pre run installation dependency: pip install matplotlib numpy
import matplotlib.pyplot as plt
import matplotlib.patches as mpatches
import numpy as np

==========Adjustable parameters==========
Oven length mm=1600 # oven total length mm
Oven width mm=800 # oven width mm
Ovenheightmm=1200 # oven height mm
Tray_count=6 # Schematic diagram of tray layers
Flange-exhaust="DN100" # Exhaust flange annotation
Flange_ceat="DN25" # Hot oil/steam flange annotation
outputsvg = "residueoven_blueprint.svg"
Scale=0.35 # scaling factor (pixels/mm)

==============================

fig = plt.figure(figsize=(16.5,11.7))
ax = fig.add_axes([0,0,1,1])
ax.setxlim(0,1650);   ax.setylim(0,1170)
ax.axis('off')

Front view (top left)
x0, y0 = 60, 700
w = ovenwidthmm * scale

h = ovenheightmm * scale
ax.add_patch(mpatches.Rectangle((x0, y0), w, h, fill=False, linewidth=1.2))
Ax.text (x0+w/2, y0+h+18, "Front view residue oven", ha='center ', fontsize=12)

Tray diagram
for i in range(tray_count):
yy = y0 + 20 + i*(h-40)/(traycount-1 if traycount>1 else 1)
ax.add_patch(mpatches.Rectangle((x0 + 20, yy), w - 40, 8, fill=False, linestyle=':'))

Import and export of materials and conveyor
ax.add_patch(mpatches.Rectangle((x0 - 120, y0 + h*0.6), 100, 60, fill=False))
Ax.text (x0-70, y0+h * 0.6+30, "feed inlet", fontsize=8, ha='center ')
ax.add_patch(mpatches.Rectangle((x0 + w + 20, y0 + h*0.6), 100, 60, fill=False))
Ax.text (x0+w+70, y0+h * 0.6+30, "discharge port", fontsize=8, ha='center ')

Side profile (top right)
x1, y1 = 420, 700
ax.addpatch(mpatches.Rectangle((x1, y1), ovenlengthmm scale, ovenheight_mm scale, fill=False, linewidth=1.2))
ax.text(x1 + (ovenlengthmmscale)/2, y1 + ovenheightmmscale + 18, Side profile (heating and exhaust) ", ha='center ', fontsize=12)

Heating coil schematic
for i in range(5):
ax.plot([x1 + 40 + i200scale, x1 + 120 + i200scale], [y1 + ovenheightmmscale0.7, y1 + ovenheightmmscale0.7], color='r', linewidth=1)
Ax.text (x1+20, y1+ovenheightmmscale 0.75, f "heating coil/jacket flange {flame_ceat}", fontsize=8)

Exhaust and exhaust gas treatment
ax.plot([x1 + ovenlengthmmscale - 60, x1 + ovenlengthmmscale + 60], [y1 + ovenheightmmscale0.9, y1 + ovenheightmmscale0.9], color='k')
ax.text(x1 + ovenlengthmmscale + 80, y1 + ovenheightmmscale*0.9, f"排 风 {flange_exhaust}", fontsize=8, va='center')

Top view layout (left center)
x2, y2 = 60, 360
ax.addpatch(mpatches.Rectangle((x2, y2), ovenlengthmm scale, ovenwidth_mm scale, fill=False))
ax.text(x2 + (ovenlengthmmscale)/2, y2 + ovenwidthmmscale + 18, Top view of material inlet and outlet and pipeline layout, ha='center ', fontsize=12)

Conveyor and maintenance door
ax.addpatch(mpatches.Rectangle((x2 + 20, y2 + ovenwidth_mm*scale + 5), 120, 30,

fill=False))
Ax.text (x2+80, y2+ovenwidthmm * scale+20, "access door/sampling port", fontsize=8, ha='center ')

Interface detail drawing (enlarged) in the middle right
x3, y3 = 420, 360
ax.add_patch(mpatches.Rectangle((x3, y3), 520, 240, fill=False))
Ax.text (x3+260, y3+250, "Interface Detail (Enlarged)", ha='center ', fontsize=12)
Ax.text (x3+10, y3+210, f "exhaust flange: {flame-exhaust} with flame arrester/condensation recovery interface", fontsize=8)
Ax.text (x3+10, y3+190, f "Heating medium flange: {flame_teat} jacket/coil inlet/outlet", fontsize=8)
Ax.text (x3+10, y3+170, "Sampling port: DN25 quick installation filter differential pressure gauge installation position", fontsize=8)

Support and foundation, bottom left
x4, y4 = 60, 80
ax.add_patch(mpatches.Rectangle((x4, y4), 520, 220, fill=False))
Ax.text (x4+260, y4+240, "Support and Foundation Diagram", ha='center ', fontsize=12)
Ax.text (x4+20, y4+200, "Foot hole: M16 x8 foundation concrete C25", fontsize=8)
Ax.text (x4+20, y4+180, "Independent foundation and vibration reduction for fan and conveyor", fontsize=8)
ax.plot([x4 + 260, x4 + 260], [y4 + 20, y4 + 80], color='k', linestyle='--')
ax.text(x4 + 270, y4 + 50, "重心 CG", fontsize=8)

Title bar and material notes
Ax.text (20, 1120, "Drawing Number: 08 Name: Residue Oven and Processing Unit Scale: Front/Section 1:20 Detail 1:10", font size=9)
Ax.text (20, 1100, "Material: High Temperature Contact AISI-304/316 Gasket: Graphite or High Temperature Resistant PTFE", fontsize=8)
Ax.text (20, 1080, "Waste gas treatment: condensation recovery→activated carbon adsorption/thermal oxidation emissions meet local environmental standards", fontsize=8)
Ax.text (20, 1060, f "Parameter Example: Airflow 0.5-3 m ^ 3/min Temperature 40-200°C Tray Layers {tray_count}", fontsize=8)

Flange and Sealing Table (bottom right)
tablex, tabley = 1200, 980
Ax.text (tablex, tabley, "Flange and Seal Details", fontsize=9)
Ax.text (tablex, tabley-18, "Interface number name, flange specification, face type, bolt hole number, gasket material", fontsize=8)
ax.text(tablex, tabley-36, f"E1 排风 {flange_exhaust} RF 8 石墨 / PTFE", fontsize=8)

Ax.text (tablex, tabley-54, f "H1 heating medium {flame_ceat} RF 4 PTFE", fontsize=8)
ax.text(tablex, tabley-72, f"S1 取样/排污 DN25 RF 4 PTFE", fontsize=8)

Save output
plt.savefig(outputsvg, dpi=300, bboxinches='tight')
Print ("Generated residue oven engineering blueprint file:", outputted as svg)
print("可 调 参 数 : ovenlengthmm, ovenwidthmm, ovenheightmm, traycount, flangeexhaust, flange_heat, scale")
`

Drawing No. 09- CIP System and Cleaning Circuit Engineering Description

Purpose and Scope

Purpose: To provide manufacturing, installation, and acceptance engineering information for the centralized cleaning (CIP) system of the entire 50L pilot device, covering cleaning pumps, cleaning tanks, heat exchangers, pipeline valves, CIP circulation loops, and control linkage.

Scope: including overall system layout, CIP tank front section view, circulation pump and valve layout, CIP pipeline and bypass, CIP stage control (pre flushing→ alkali washing→ neutral flushing→ acid washing→ final flushing), flange and seal details, instrument installation, support and foundation, testing and acceptance requirements.

View List and Key Points of Content

-System overall layout diagram: CIP tank (clean water/alkali/acid tank), CIP circulation pump, heat exchanger, three-way bypass valve, multi way distribution valve for reflux to equipment, waste liquid collection and neutralization port, control cabinet location.

-CIP tank sectional view: tank volume (e.g. 200-500 L), jacket or coil heating, liquid level probe, agitator, inlet and outlet flanges, overflow and discharge ports, sampling port.

-Circulation circuit detailed diagram: main circulation valve position sequence, bypass circuit, spray ball and spray coverage diagram, temperature/pressure/flow measurement points, check valve and bypass valve next to CIP circulation pump.

-Interface details (enlarged): CIP distribution valve flange, spray ball installation flange, sampling/discharge DN25, heat exchanger inlet and outlet DN25, temperature probe and flow meter installation flange.

-Support and foundation: CIP tank foundation holes, pump foundations, pipeline supports, maintenance platforms, and safety railings.

-Instrumentation and control points: liquid level (high/low/overflow), temperature (inlet/outlet/tank), flow rate (circulation flow), pressure (circulation pressure), CIP stage signal (start/finish/fault), safety interlock (E-Stop, abnormal solution concentration).

Key parameters and material requirements

-Tank capacity: 200-500 L (selected according to process and circuit number); Liquid receiving material AISI-316L; The inner surface Ra is ≤ 0.8 μ m.

-Pump: Sanitary centrifugal pump or self-priming pump, flow rate 0.5-5 m^3/h, alkali/acid resistant; The pump material is 316L.

-Spray coverage: The spray coverage rate of each device is ≥ 95%, the spray ball material is 316L, and the spray hole is designed to prevent blockage.

-Temperature/Time: Alkali wash with 0.5-2% NaOH, 40-60 ° C, 15-30 min; Acid wash 0.5-1% HNO ∝ at room temperature for 10-15 minutes.

-Valves and flanges: sanitary grade quick release clamps or RF flanges; PTFE gasket; All valves are equipped with positioning and pneumatic/electric actuators (as required by automation).
-Safety: Solution concentration/temperature over limit alarm, overflow protection, waste liquid neutralization port and collection tank, CIP circulation loop with bypass to protect pump from idling.

Testing and acceptance requirements
-Factory documents: Material certificate EN10204 3.1, welding records, non-destructive testing report, pump and valve qualification certificate, instrument calibration certificate P& ID, CIP program, and OQ testing table.
-Functional test: No load cycle for 30 minutes (check sealing, flow rate, temperature control); Run the complete program once with water/cleaning solution circulation and record the temperature, flow rate, and decrease in residual conductivity (or TOC).
-Cleaning verification: After CIP, sample and test for residual (conductivity or TOC), and sign for release after meeting the release criteria.
-Delivery documents: P& ID, CIP program, IQ/OQ document, operation and maintenance manual, test records.

Drawing 09- CIP System Drawing Script (Reproducible SVG)
`python

cipsystemblueprint.py

Pre run installation dependency: pip install matplotlib numpy

Description: Generate a CIP system engineering blueprint SVG, including overall layout, CIP tank section, circulationcircuit and interface details
import matplotlib.pyplot as plt
import matplotlib.patches as mpatches
import numpy as np

==========Adjustable parameters==========
CiptankL=300 # CIP tank capacity L (note)
Pumpflowm3h=1.2 # circulating pump flow m3/h (note)
Spray coverage pct=95 # Spray coverage note
Flange_cip="DN25" # CIP interface flange annotation
outputsvg = "cipsystem_blueprint.svg"
scale = 0.9

==============================

```
fig = plt.figure(figsize=(16.5,11.7))
ax = fig.add_axes([0,0,1,1])
ax.setxlim(0,1650);    ax.setylim(0,1170)
ax.axis('off')
```

Overall System Layout (Top Left)

```
x0, y0 = 60, 700
ax.add_patch(mpatches.Rectangle((x0, y0), 700, 380, fill=False))
Ax.text (x0+350, y0+360, "CIP System Overall Layout", ha='center ', fontsize=12)
```

CIP tank schematic

```
ax.add_patch(mpatches.Circle((x0 + 140, y0 + 220), 80, fill=False))
ax.text(x0 + 140, y0 + 220, f"CIP 罐 {ciptankL} L", fontsize=8, ha='center', va='center')
```

Circulating pump and heat exchanger

```
ax.add_patch(mpatches.Rectangle((x0 + 300, y0 + 160), 120, 80, fill=False))
ax.text(x0 + 360, y0 + 200, f"循环泵\n{pumpflowm3h} m3/h", fontsize=8, ha='center')
ax.add_patch(mpatches.Rectangle((x0 + 460, y0 + 160), 140, 80, fill=False))
Ax.text (x0+530, y0+200, "Heat exchanger \ n (heating/cooling)", fontsize=8, ha='center ')
```

Schematic diagram of pipelines and distribution valves

```
ax.plot([x0 + 220, x0 + 300], [y0 + 220, y0 + 200], color='k')
ax.plot([x0 + 420, x0 + 460], [y0 + 200, y0 + 200], color='k')
Ax.text (x0+360, y0+240, "Distribution valve group ->multiple to equipment spray", fontsize=8, ha='center ')
```

CIP tank profile (top right)

```
x1, y1 = 820, 700
ax.add_patch(mpatches.Rectangle((x1, y1), 300, 300, fill=False))
ax.text(x1 + 150, y1 + 320, "CIP 罐 剖面 ", ha='center', fontsize=12)
```

Blender and liquid level

```
ax.add_patch(mpatches.Rectangle((x1 + 140, y1 + 220), 20, 60, fill=False))
Ax.text (x1+150, y1+260, "mixer", fontsize=7, ha='center ')
ax.plot([x1 + 150, x1 + 150], [y1 + 80, y1 + 40], color='k')
ax.text(x1 + 160, y1 + 60, "排污 DN25", fontsize=7)
```

Loop Circuit Detail (Middle Left)

```
x2, y2 = 60, 360
ax.add_patch(mpatches.Rectangle((x2, y2), 420, 220, fill=False))
Ax.text (x2+210, y2+200, "Circulation Loop Detail (Spray and Bypass)", ha='center ', fontsize=10)
```

Spray ball and coverage diagram
for i in range(5):
ax.add_patch(mpatches.Circle((x2 + 60 + i*70, y2 + 120), 8, fill=False))
ax.text(x2 + 60 + i*70, y2 + 140, "喷", fontsize=6, ha='center')
ax.text(x2 + 210, y2 + 80, f"喷淋覆盖率≥{spraycoveragepct}%", fontsize=8, ha='center')

Interface detail drawing (enlarged) in the middle right
x3, y3 = 820, 360
ax.add_patch(mpatches.Rectangle((x3, y3), 520, 240, fill=False))
Ax.text (x3+260, y3+250, "Interface Detail (Enlarged)", ha='center ', fontsize=12)
Ax.text (x3+10, y3+210, f "CIP distribution flange: {flame_cip} quick installation/clamp priority", fontsize=8)
Ax.text (x3+10, y3+190, "Spray ball: 316L anti blocking design CIP inlet with valve and flow meter", fontsize=8)
Ax.text (x3+10, y3+170, "Liquid level: high/low/overflow temperature: tank interior/outlet/reflux", fontsize=8)

Support and Foundation (bottom left)
x4, y4 = 60, 80
ax.add_patch(mpatches.Rectangle((x4, y4), 420, 220, fill=False))
Ax.text (x4+210, y4+200, "Support and Foundation Diagram", ha='center ', fontsize=10)
Ax.text (x4+20, y4+170, "Pump foundation independent and shock-absorbing foot hole M16 x4", fontsize=8)
Ax.text (x4+20, y4+150, "Liquid level alarm for waste collection tank and neutralization port", fontsize=8)

Title bar and material notes
Ax.text (20, 1120, "Drawing Number: 09 Name: CIP System and Cleaning Circuit Scale: Overall 1:20 Detail 1:10", font size=9)
Ax.text (20, 1100, "Material: AISI-316L spray ball/valve 316L gasket PTFE", fontsize=8)
Ax.text (20, 1080, "CIP program example: pre rinse → alkaline wash (0.5-2% NaOH, 40-60 ° C, 15-30min) → neutral rinse → acid wash → final rinse", fontsize=8)

Flange and Sealing Table (bottom right)
tablex, tabley = 1200, 980
Ax.text (tablex, tabley, "Flange and Seal Details", fontsize=9)
Ax.text (tablex, tabley-18, "Interface number name, flange specification, face type, bolt hole number, gasket material", fontsize=8)
ax.text(tablex, tabley-36, f"C1 CIP 分配 {flange_cip} RF/ 卡箍 4 PTFE", fontsize=8)
ax.text(tablex, tabley-54, f"C2 排污/取样 DN25 RF 4 PTFE", fontsize=8)
Ax.text (tablex, tabley-72, f "C3 heat exchanger inlet and outlet DN25 RF 4 PTFE",

fontsize=8)

Save output
plt.savefig(outputsvg, dpi=300, bboxinches='tight')
Print ("CIP system engineering blueprint file generated:", outputted as svg)
Print ("Adjustable parameters: ciptankL, pumpflowm3h, spraycoveragepct, flame_cip, scale")
`

Drawing No. 10- Process Pipeline Assembly P& Description of ID and Equipment Foundation Layout Engineering

Purpose and Scope
Purpose: To provide process pipeline assembly P& amp; amp; for a complete set of 50L pilot devices; ID and equipment basic layout plan, used for on-site installation, pipeline wiring, valve positioning, instrument access, and foundation embedding.
Scope: Includes overall process flow P& ID (distillation kettle→ condenser→ recovery→ extraction tank→ vacuum recovery→ CIP→ residue oven, etc.), pipeline direction and slope, valve and flange positioning, instrument access points, equipment foundation layout, pipeline supports and wall sleeves, fire/ventilation and safety passages.

View List and Key Points of Content
-Process flow P& ID (main image): using standard P& The ID symbol represents equipment, pumps, valves (manual/electric/pneumatic), instruments (PT100, pressure, flow, liquid level), control circuits (PLC I/O numbers), safety interlocks, and bypasses.
-Pipeline layout plan: Equipment in workshop plan position, main pipeline direction, slope arrows, through wall/through floor position, valve well and maintenance port.
-Basic layout plan: coordinates of foundation holes, foundation dimensions, embedded part positions, grounding terminal positions, maintenance channels, and platforms for each equipment.
-Valve and flange table: Each interface number, valve type (ball valve/butterfly valve/globe valve/check valve), flange specification, gasket material, actuator type, and control signal.
-Instrument and I/O Comparison Table: P& The label, measurement point, signal type, PLC IO number, and on-site wiring terminal of each instrument on the ID.
-Safety and maintenance notes: emergency stop location, solvent leakage discharge path, ventilation and explosion-proof zoning, maintenance and lifting channels.

Key parameters and design points
-Pipe diameter and slope: Main reflux and steam pipes DN25-DN50 (selected

according to flow rate and viscosity); Slope of solvent reflux pipe ≥ 1%; Cooling water pipe DN15-DN25.
-Material: Process pipeline made of stainless steel 316L (liquid contact); Carbon steel painting for brackets and bridge frames; Soft joints are used for vibration compensation.
-Valve selection: Sanitary grade clamp ball valve is used for frequent disassembly and assembly points; Electric/pneumatic actuators are used for automatic control points; Check valve protects the pump.
-Maintenance and safety: The distance between equipment ensures that the maintenance channel is ≥ 800 mm; critical valves and instruments are equipped with bypass and bypass for maintenance purposes; All solvent areas are equipped with combustible gas detection and linked ventilation.

Testing and acceptance requirements
- P& ID verification: Process engineers and electrical engineers jointly verify P& ID， Confirm IO number, valve position, and safety interlock.
-Pipeline pressure test: Conduct a water pressure test and record it according to the design pressure of 1.5 times or as agreed in the contract.
-Installation acceptance: verification of equipment foundation dimensions and embedded part positions, installation of pipeline slopes and supports, functional testing of valves and instruments, point-to-point verification of IO.
-Delivery documents: Final P& ID (with revision number), Pipeline Material List (MTO), Valve List, Instrument List, Foundation Drawing, Installation and Debugging Record, IQ/OQ Document.

Drawing 10- P& ID and device layout drawing script (simplified visual SVG)
`python

pidlayoutblueprint.py

Pre run installation dependency: pip install matplotlib numpy

Explanation: Generate simplified process pipeline assembly P& ID and device basic layout SVG (schematic diagram) for easy on-site layout and verification
import matplotlib.pyplot as plt
import matplotlib.patches as mpatches
import numpy as np

=========Adjustable parameters=========
Plantwidthmm=12000 # Workshop Plan Width (Note)
Plantdepthmm=8000 # workshop plan depth (note)
Scale=0.0009 # Scale factor (pixels/mm), used to compress a large plane onto a

```
canvas
outputsvg = "pidlayout_blueprint.svg"

Example of Equipment Coordinates (Unit: mm, Workshop Coordinates)
devices = {
Distillation kettle ": (2000, 3000),
Condenser ": (3200, 3000),
Recycling bottles: (4200, 3000),
Extraction tank ": (2000, 4500),
Vacuum pump ": (4200, 4500),
CIP tank ": (6000, 3000),
Residue oven ": (8000, 3000),
Control cabinet: (6000, 4500)
}

fig = plt.figure(figsize=(16.5,11.7))
ax = fig.add_axes([0,0,1,1])
ax.setxlim(0,1650);    ax.setylim(0,1170)
ax.axis('off')

Draw the boundary of the workshop plan
ax.addpatch(mpatches.Rectangle((40, 40), plantwidthmmscale, plantdepth_mmscale, fill=False, linewidth=1.2))
ax.text(40 + (plantwidthmm*scale)/2, 20. Process pipeline assembly P&amp; ID and device layout (schematic) ", ha='center ', fontsize=12)

Draw equipment boxes and labels
for name, (px, py) in devices.items():
x = 60 + px*scale
y = 60 + py*scale
w = 220
h = 120
ax.add_patch(mpatches.Rectangle((x, y), w, h, fill=False))
ax.text(x + w/2, y + h/2, name, fontsize=9, ha='center', va='center')

Draw the main process pipelines (schematic connections)
def connect(deva, devb, label=None):
xa, ya = 60 + devices[deva][0]scale + 110, 60 + devices[deva][1]scale + 60
xb, yb = 60 + devices[devb][0]scale + 110, 60 + devices[devb][1]scale + 60
ax.arrow(xa, ya, xb-xa-20, yb-ya, headwidth=8, headlength=12, fc='k', ec='k', linewidth=1)
if label:
ax.text((xa+xb)/2, (ya+yb)/2 + 20, label, fontsize=7, ha='center')
```

Connect ("Distillation kettle", "Condenser", "Steam/Reflux")
Connect ("condenser", "recycling bottle", "condensate")
Connect ("Distillation kettle", "Extraction tank", "Residue conveying")
Connect ("extraction tank", "vacuum pump", "solvent recovery")
Connect (CIP tank, distillation kettle, CIP cycle)
Connect ("Residue Oven", "Recycling Bottle", "Waste Gas Recovery")

Annotate valve and slope diagram (simplified)
Ax.text (300, 900, "Valve/Flange Table (Example)", fontsize=10)
valve_table = [
V-101: DN25 electric steam valve,
V-201: Condensation reflux valve DN50 manual ",
V-301: CIP distribution valve DN25 electric ",
V-401: Vacuum bypass valve KF25 manual
]
for i, line in enumerate(valve_table):
ax.text(300, 880 - i*16, line, fontsize=8, ha='left')

Title bar and annotations
Ax.text (20, 1120, "Drawing Number: 10 Name: Process Pipeline General Assembly P& amp; Proportion of ID and equipment basic layout: 1:2000 "in plan view, fontsize=9)
Ax.text (20, 1100, "Note: This diagram is a schematic layout, and the final installation diagram is subject to on-site measurements and pipeline engineering drawings", font size=8)
Ax.text (20, 1080, "Delivery Document: Final P& ID (with revision number), pipe material list, valve list, foundation drawing, installation record ", fontsize=8)

Save output
plt.savefig(outputsvg, dpi=300, bboxinches='tight')
Print (generated P& ID and Equipment Layout Engineering Blueprint File: ", outputted as svg)
Print ("Adjustable parameters: plantwidthmm, plantdepthmm, devices dictionary, scale")
`

Overview of Parameter Summary

I have compiled a list of all adjustable parameters from 10 engineering blueprint scripts for easy editing. The first table is a quick index (each cell is a single line, multiple items are separated by semicolons), followed by listing the parameter names and default values that can be directly copied and pasted item by item according to the drawing, and finally providing batch modification suggestions.

Drawing number	Drawing name	Key adjustable parameters (brief)
01	50L 篮式蒸馏釜	Dmm; Hmm; flangedn.top/steam/cond/drain; scale; outputsvg
02	Condenser and reflux system	Condenserlengathmm; condenserdiamm; tubebundleaream2; flangetop; flangewater; scale; outputsvg
03	Closed loop solvent extraction tank	tanknominalL; Dmm; Hmm; flangesolvent; flangecip; motorpowerkw; scale; output_svg
04	超声破壁器	chamberdiamm; chamberhmm; transducercount; transducerpowerw; frequencykhz; flangecool; flangeelec; scale; output_svg
05	真空回收系统	evapcapacityLph; evapdiamm; evaphmm; condenserarеam2; vacuumtargetmbar; flangevac; flangecond; flangewater; scale; outputsvg
06	Small vacuum evaporator	Dmm; Hmm; workcapacityLph; flangecond; flangevac; flangejacket; scale; outputsvg
07	PLC control cabinet and electrical layout	cabinetwidthmm; cabinetheightmm; iodicount; iodocount; ioaicount; ioaocount; mainpower; controlpower; scale; output_svg
08	残渣烘箱	ovenlengthmm; ovenwidthmm; ovenheightmm; traycount; flangeexhaust; flangeheat; scale; outputsvg
09	CIP 系统	ciptankL; pumpflowm3h; spraycoveragepct; flangecip; scale; outputsvg
10	P& ID and equipment layout	plantwidthm; plantdepthmm; Devices dictionary; scale; output_svg

---

List of parameters per drawing (can be copied and pasted at the top of the script)

Drawing 01 50L Basket Distillation Kettle
- D_mm = 420
- H_mm = 1200
- flange_dn = {"top":"DN300","steam":"DN25","cond":"DN50","drain":"DN25"}
- scale = 1.5
- outputsvg = "outputblueprint.svg"

Drawing 02 Condenser and Reflux System
- condenserlengthmm = 900
- capacitor diameter = 200
- tubebundlearea_m2 = 1.0
- flange_top = "DN50"
- flange_water = "DN25"
- scale = 0.8
- outputsvg = "condenserblueprint.svg"

Drawing 03 Closed Circuit Solvent Extraction Tank
- tanknominalL = 50
- D_mm = 360
- H_mm = 800
-Workvolumtext="Workvolume 15-40 L"
- flange_solvent = "DN25-DN50"
- flange_cip = "DN25"
motor power = 1.5
- scale = 0.9
- outputsvg = "extractorblueprint.svg"

Drawing 04 Ultrasonic Wall Breaker
- chamberdiamm = 300
- chamberhmm = 600
- transducer_count = 4
- transducerpowerw = 500
- frequency_khz = 20
- flange_cool = "DN15"
- flange_elec = "M20"
- scale = 1.0
- outputsvg = "ultrasonicblueprint.svg"

Drawing 05 Vacuum Recovery System

- evapcapacityLph = 3
- evapdiamm = 360
-evaphmm = 600
- condenserarearm2 = 0.8
- vacuumtargetmbar = 10
- flange_vac = "KF25/DN25"
- flange_cond = "DN50"
- flange_water = "DN15"
- scale = 0.9
- outputsvg = "vacuumrecovery_blueprint.svg"

Drawing 06 Small Vacuum Evaporator
- D_mm = 360
- H_mm = 700
- workcapacityLph = 3
- flange_cond = "DN50"
- flange_vac = "KF25"
- flange_jacket = "DN15"
- scale = 0.9
- outputsvg = "minievaporator_blueprint.svg"

Drawing 07 PLC Control Cabinet and Electrical Layout
- cabinetwidthmm = 800
- cabinetheightmm = 2000
-iodicount = 16
- iodocount = 16
-ioaicount = 8
-iocount = 4
- main_power = "3x380V"
- control_power = "24VDC"
- scale = 0.25
- outputsvg = "plcelectrical_blueprint.svg"

Drawing 08 Residue Oven
- ovenlengthmm = 1600
- ovenwidthmm = 800
- ovenheightmm = 1200
- tray_count = 6
- flange_exhaust = "DN100"
- flange_heat = "DN25"
- scale = 0.35
- outputsvg = "residueoven_blueprint.svg"

Drawing 09 CIP System

-ciptankL = 300
- pumpflowm3h = 1.2
- spraycoveragepct = 95
- flange_cip = "DN25"
- scale = 0.9
- outputsvg = "cipsystem_blueprint.svg"

Drawing 10 P& ID and Equipment Layout
- plantwidthmm = 12000
- plantdepthmm = 8000
-Devices={"Distillation kettle": (2000, 3000), "Condenser": (320, 03000),...}
- scale = 0.0009
- outputsvg = "pidlayout_blueprint.svg"

Batch generation and modification suggestions (operating steps)
1. Centralized parameter file
-Copy the parameters of each image above to a separate JSON/INI/CSV file (such as blueprint_marams. json), with field names consistent with the variables at the top of the script.
2. Batch Script Entrance
-Read parameter files in a main script, import or exec the drawing functions of each drawing script in the order of the drawings, pass in the corresponding parameters, and save the SVG.
3. Unified naming and output directory
-Set the output dir uniformly and name it f "{output dir}/{drawing number} {output svg}" for easy archiving and printing.
4. Proportion and size verification
-When modifying the scale, first test it in a single script to confirm that the dimensions do not overlap with the text, and then apply it in bulk.
5. Refine manufacturing drawings
-If you need to make a detailed drawing (flange hole position, groove) into manufacturing grade DXF/SVG, first enlarge the view in the script and replace it with precise geometry (aperture, bolt ring diameter, bolt hole number), and then export high-resolution SVG for CAD conversion.
6. Version control
-Save each parameter change as a new version (e.g. paramsv1.json → paramsv2. json), and annotate the version number and revision description in the drawing title block.

-

},

Parameter file blueprint params. json (can be directly saved as JSON)

Description: Contains adjustable parameters for all drawings, and the main script will read this file and generate SVG in bulk. Copy the following content and save it as blueprint params. json.

`json
{
"outputdir": "blueprintsoutput",
"01_kettle": {
"D_mm": 420,
"H_mm": 1200,
"flange_dn": {"top":"DN300","steam":"DN25","cond":"DN50","drain":"DN25"},
"scale": 1.5,
"outputsvg": "01kettle_blueprint.svg"
},

"02_condenser": {
"condenserlengthmm": 900,
"condenser diameter": 200,
"tubebundlearea_m2": 1.0,
"flange_top": "DN50",
"flange_water": "DN25",
"scale": 0.8,
"outputsvg": "02condenser_blueprint.svg"
},
"03_extractor": {
"tanknominalL": 50,
"D_mm": 360,
"H_mm": 800,
Workvolumtext ":" Workvolume 15-40 L ",
"flange_solvent": "DN25-DN50",
"flange_cip": "DN25",
"motor powerkw": 1.5,
"scale": 0.9,
"outputsvg": "03extractor_blueprint.svg"
},
"04_ultrasonic": {
"chamberdiamm": 300,
"chamberhmm": 600,
"transducer_count": 4,
"transducerpowerw": 500,
"frequency_khz": 20,
"flange_cool": "DN15",
"flange_elec": "M20",
"scale": 1.0,
"outputsvg": "04ultrasonic_blueprint.svg"
},
"05vacuumrecovery": {
"evapcapacityLph": 3,
"evapdiamm": 360,
"evaphmm": 600,
"condenseraream2": 0.8,
"vacuumtargetmbar": 10,
"flange_vac": "KF25/DN25",
"flange_cond": "DN50",
"flange_water": "DN15",
"scale": 0.9,
"outputsvg": "05vacuumrecoveryblueprint.svg"
},
"06minievaporator": {

"D_mm": 360,
"H_mm": 700,
"workcapacityLph": 3,
"flange_cond": "DN50",
"flange_vac": "KF25",
"flange_jacket": "DN15",
"scale": 0.9,
"outputsvg": "06minievaporatorblueprint.svg"
},
"07_plc": {
"cabinetwidthmm": 800,
"cabinetheightmm": 2000,
"iodicount": 16,
"iodocount": 16,
"ioaicount": 8,
"ioaocount": 4,
"main_power": "3x380V",
"control_power": "24VDC",
"scale": 0.25,
"outputsvg": "07plcelectricalblueprint.svg"
},
"08residueoven": {
"ovenlengthmm": 1600,
"ovenwidthmm": 800,
"ovenheightmm": 1200,
"tray_count": 6,
"flange_exhaust": "DN100",
"flange_heat": "DN25",
"scale": 0.35,
"outputsvg": "08residueovenblueprint.svg"
},
"09_cip": {
"ciptankL": 300,
"pumpflowm3h": 1.2,
"spraycoveragepct": 95,
"flange_cip": "DN25",
"scale": 0.9,
"outputsvg": "09cipsystemblueprint.svg"
},
"10pidlayout": {
"plantwidthmm": 12000,
"plantdepthmm": 8000,
"devices": {
Distillation kettle ": [2000, 3000],

Condenser ": [3200, 3000],
Recycling bottles: [4200, 3000],
Extraction tank ": [2000, 4500],
Vacuum pump ": [4200, 4500],
CIP tank ": [6000, 3000],
Residue oven ": [8000, 3000],
Control cabinet: [6000, 4500]
},
"scale": 0.0009,
"outputsvg": "10pidlayoutblueprint.svg"
}
}
`

Batch generate the main script generateallblueprints. py

Explanation: Read the JSON above and generate all SVGs in the order of the drawings. The script contains drawing functions for each image (simplified version), making it easy to generate all the drawings in one run. Place this script in the same directory as blueprint params. json and run it. The script uses matplotlib and numpy.

`python

generateallblueprints.py

Pre run installation dependency: pip install matplotlib numpy

Usage: Python generateallblueprints. py
import os
import json
import matplotlib.pyplot as plt
import matplotlib.patches as mpatches
import numpy as np

Read parameter file
with open("blueprint_params.json", "r", encoding="utf-8") as f:
params = json.load(f)

outputdir = params.get("outputdir", "blueprints_output")
os.makedirs(outputdir, existok=True)

==========The drawing function for each image (simplified)==========

```
def draw_kettle(p):
D = p["Dmm"];    H = p["Hmm"];    flange = p["flange_dn"];    scale = p["scale"]
svg = os.path.join(outputdir, p["outputsvg"])
fig = plt.figure(figsize=(11.69,8.27))
ax = fig.add_axes([0,0,1,1]);    ax.axis('off')
#Look straight at the indication
ax.add_patch(mpatches.FancyBboxPatch((100,100),    Dscale,    Hscale*0.6,
boxstyle="round,pad=0.02", fill=False))
Ax.text (200, Hscale0.6+160, "Front view of 50L basket distillation kettle", fontsize=10)
plt.savefig(svg, dpi=300, bbox_inches='tight');    plt.close(fig)
Print ("generate", svg)

def draw_condenser(p):
svg = os.path.join(outputdir, p["outputsvg"])
fig = plt.figure(figsize=(11.69,8.27));    ax = fig.add_axes([0,0,1,1]);    ax.axis('off')
Ax.text (200600, "Schematic diagram of condenser and reflux system", fontsize=12)
plt.savefig(svg, dpi=300, bbox_inches='tight');    plt.close(fig)
Print ("generate", svg)

def draw_extractor(p):
svg = os.path.join(outputdir, p["outputsvg"])
fig = plt.figure(figsize=(11.69,8.27));    ax = fig.add_axes([0,0,1,1]);    ax.axis('off')
Ax.text (200600, "Schematic Diagram of Closed Circuit Solvent Extraction Tank",
fontsize=12)
plt.savefig(svg, dpi=300, bbox_inches='tight');    plt.close(fig)
Print ("generate", svg)

def draw_ultrasonic(p):
svg = os.path.join(outputdir, p["outputsvg"])
fig = plt.figure(figsize=(11.69,8.27));    ax = fig.add_axes([0,0,1,1]);    ax.axis('off')
Ax.text (200600, "Schematic Diagram of Ultrasonic Wall Breaker", fontsize=12)
plt.savefig(svg, dpi=300, bbox_inches='tight');    plt.close(fig)
Print ("generate", svg)

def drawvacuumrecovery(p):
svg = os.path.join(outputdir, p["outputsvg"])
fig = plt.figure(figsize=(11.69,8.27));    ax = fig.add_axes([0,0,1,1]);    ax.axis('off')
Ax.text (200600, "Schematic Diagram of Vacuum Recovery System", font size=12)
plt.savefig(svg, dpi=300, bbox_inches='tight');    plt.close(fig)
Print ("generate", svg)

def drawminievaporator(p):
svg = os.path.join(outputdir, p["outputsvg"])
fig = plt.figure(figsize=(11.69,8.27));    ax = fig.add_axes([0,0,1,1]);    ax.axis('off')
```

```
Ax.text (200600, "Schematic diagram of small vacuum evaporator", fontsize=12)
plt.savefig(svg, dpi=300, bbox_inches='tight');    plt.close(fig)
Print ("generate", svg)

def draw_plc(p):
svg = os.path.join(outputdir, p["outputsvg"])
fig = plt.figure(figsize=(11.69,8.27));    ax = fig.add_axes([0,0,1,1]);    ax.axis('off')
Ax.text (200600, "PLC Control Cabinet and Electrical Layout Diagram", font size=12)
plt.savefig(svg, dpi=300, bbox_inches='tight');    plt.close(fig)
Print ("generate", svg)

def drawresidueoven(p):
svg = os.path.join(outputdir, p["outputsvg"])
fig = plt.figure(figsize=(11.69,8.27));    ax = fig.add_axes([0,0,1,1]);    ax.axis('off')
Ax.text (200600, "Diagram of Residue Oven", fontsize=12)
plt.savefig(svg, dpi=300, bbox_inches='tight');    plt.close(fig)
Print ("generate", svg)

def draw_cip(p):
svg = os.path.join(outputdir, p["outputsvg"])
fig = plt.figure(figsize=(11.69,8.27));    ax = fig.add_axes([0,0,1,1]);    ax.axis('off')
Ax.text (200600, "CIP System Diagram", font size=12)
plt.savefig(svg, dpi=300, bbox_inches='tight');    plt.close(fig)
Print ("generate", svg)

def drawpidlayout(p):
svg = os.path.join(outputdir, p["outputsvg"])
fig = plt.figure(figsize=(16.5,11.7));    ax = fig.add_axes([0,0,1,1]);    ax.axis('off')
Ax.text (200600, "Process Pipeline Assembly P&amp; ID and Device Layout Diagram ",
font size=12)
plt.savefig(svg, dpi=300, bbox_inches='tight');    plt.close(fig)
Print ("generate", svg)

==========Batch call==========
drawkettle(params["01kettle"])
drawcondenser(params["02condenser"])
drawextractor(params["03extractor"])
drawultrasonic(params["04ultrasonic"])
drawvacuumrecovery(params["05vacuumrecovery"])
drawminievaporator(params["06minievaporator"])
drawplc(params["07plc"])
drawresidueoven(params["08residueoven"])
drawcip(params["09cip"])
drawpidlayout(params["10pidlayout"])
```

Print ("All drawings have been generated to directory:", outputted)
`

Manufacturing grade detail drawing 1 flange hole position script flamedn300elabl.py

Purpose: To generate manufacturing grade detailed drawings (flange outer diameter, bolt ring diameter, bolt hole number, hole diameter, gasket width) for the DN300 flange of the 50L kettle top manhole, which is convenient for direct use in drilling and cutting verification. Script outputs high-resolution SVG.

`python

flangedn300detail.py

Pre run installation dependency: pip install matplotlib numpy

Description: Generate DN300 flange manufacturing detailed drawing (unit: mm), parameters can be modified and reproduced
import matplotlib.pyplot as plt
import matplotlib.patches as mpatches
import numpy as np
import math

==========Adjustable parameters==========
flange_nominal = "DN300"
Flangeouter OD=340 # flange outer diameter mm
Flangebolted circle=295 # bolt circle diameter mm
Bolt_comunt=12 # number of bolt holes
Bolt-DIa=18 # bolt hole diameter mm
Flange_thickness=20 # flange thickness mm
Gasketwidth=8 # gasket width mm
outputsvg = "flangedn300_detail.svg"

==============================

fig, ax = plt.subplots(figsize=(8,8))
ax.setxlim(-200,200); ax.setylim(-200,200)
ax.set_aspect('equal'); ax.axis('off')

outer diameter
outer = mpatches. Circle((0,0), flangeouterOD/2, fill=False, linewidth=1.2)

```
ax.add_patch(outer)
Ax.text (0, flameouterOD/2+10, f "flange outer diameter OD={flameouterOD} mm", ha='center ')

Bolt ring
boltcircle = mpatches. Circle((0,0), flangebolt_circle/2, fill=False, linestyle='--')
ax.addpatch(boltcircle)
ax.text(0, -flangeouterOD/2 - 20, f"螺 栓 圈 直 径 PCD = {flangeboltcircle} mm", ha='center')

Distribution of bolt holes
angles = np.linspace(0, 2*math.pi, bolt_count, endpoint=False)
for a in angles:
x = (flangeboltcircle/2) * math.cos(a)
y = (flangeboltcircle/2) * math.sin(a)
hole = mpatches. Circle((x,y), bolt_dia/2, fill=False)
ax.add_patch(hole)

Central hole and gasket diagram
ax.add_patch(mpatches.Circle((0,0), 40, fill=False, linestyle=':'))
Ax.text (0, -10, "Manhole opening schematic diameter 40 mm (example)", ha='center ', fontsize=8)

Annotate schematic lines
ax.annotate("", xy=(flangeboltcircle/2, 0), xytext=(flangeouterOD/2, 0), arrowprops=dict(arrowstyle="&lt;-&gt;"))
ax.text((flangeboltcircle/2 + flangeouterOD/2)/2, 6. "Flange ring width", fontsize=8, ha='center ')

Table annotation on the right
table_x = 120
Ax.text (table-x, 80, "flange manufacturing parameters", fontsize=10, ha='left')
ax.text(tablex, 60, f"公称: {flangenominal}", fontsize=8, ha='left')
ax.text(tablex, 45, f"外径 OD: {flangeouter_OD} mm", fontsize=8, ha='left')
ax.text(tablex, 30, f"螺栓圈 PCD: {flangebolt_circle} mm", fontsize=8, ha='left')
ax.text(tablex, 15, f"螺栓孔数: {boltcount} xØ{bolt_dia} mm", fontsize=8, ha='left')
Ax.text (tablex, 0, f "flange thickness: {flamethickness} mm", fontsize=8, ha='left')
Ax.text (tablex, -15, f "gasket width: {gasketwidth} mm", fontsize=8, ha='lft ')
Ax.text (table-x, -35, "Material: AISI-316L Surface: Ra≤0.8μm", fontsize=8, ha='lft ')

Title Bar
Ax.text (-180, 180, "Manufacturing details: kettle top manhole flange DN300", fontsize=10)
Ax.text (-180, 165, "Scale: Detail 1:2 (schematic), all dimensions in mm", fontsize=8)
```

plt.savefig(outputsvg, dpi=600, bboxinches='tight')
Print ("Generated flange detail:", outputted as svg)
`

Manufacturing grade detail drawing 2: Condensation reflux flange DN50 flangedn50elabl.py

Purpose: To generate manufacturing grade detailed drawings (hole positions, bolt rings, gaskets, flange surface types) for condensing reflux DN50 flanges, facilitating cutting and drilling.

`python

flangedn50detail.py

Pre run installation dependency: pip install matplotlib numpy
import matplotlib.pyplot as plt
import matplotlib.patches as mpatches
import numpy as np
import math

==========Parameters==========
flange_nominal = "DN50"
outer_OD = 110
bolt_circle = 85
bolt_count = 4
bolt_day = 14
thickness = 14
gasket_width = 6
outputsvg = "flangedn50_detail.svg"

======================

fig, ax = plt.subplots(figsize=(6,6))
ax.setxlim(-80,80);   ax.setylim(-80,80)
ax.set_aspect('equal');   ax.axis('off')

ax.addpatch(mpatches.Circle((0,0), outerOD/2, fill=False, linewidth=1.2))
ax.addpatch(mpatches.Circle((0,0), boltcircle/2, fill=False, linestyle='--'))
angles = np.linspace(0, 2*math.pi, bolt_count, endpoint=False)
for a in angles:

x = (bolt_circle/2) * math.cos(a)
y = (bolt_circle/2) * math.sin(a)
ax.addpatch(mpatches.Circle((x,y), boltdia/2, fill=False))
ax.text(0, -outerOD/2 - 10, f"DN50 法兰 OD={outerOD} PCD={boltcircle} {boltcount}x Ø{bolt_dia}", ha='center', fontsize=8)
Ax.text (-70,60, "Material: AISI-316L surface Ra≤0.8μm", fontsize=7)
Ax.text (-70, 48, f "flange thickness: {thickness} mm gasket width: {gasketwidth} mm", fontsize=7)
Ax.text (-70,30, "Face type: RF bolt grade: 8.8 or as per contract", fontsize=7)

plt.savefig(outputsvg, dpi=600, bboxinches='tight')
Print ("DN50 flange detailed drawing generated:", outputted as svg)
`

Manufacturing grade detail drawing 3: Weld groove and weld detail of the kettle body, weldgrovedetail. py

Purpose: To generate detailed drawings of the weld groove between the kettle body and the jacket (V-shaped or U-shaped groove, groove angle, root gap, weld height, non-destructive testing requirements) for easy manufacturing and inspection.

`python

weldgroovedetail.py

Pre run installation dependency: pip install matplotlib numpy
import matplotlib.pyplot as plt
import matplotlib.patches as mpatches
import numpy as np

==========Parameters==========
Groove type="V" # V or U
Groove angle=60 #
Rootgapmm=2.0 # Root gap mm
Weld-reinforcement=1.5 # weld excess height mm
material = "AISI-316L"
Ndt="RT or UT"
outputsvg = "weldgroove_detail.svg"

=====================

fig, ax = plt.subplots(figsize=(8,6))

```
ax.setxlim(0,200);    ax.setylim(0,140)
ax.axis('off')

Draw a schematic diagram of the bevel profile
x0, y0 = 40, 20
height = 80
if groove_type == "V":
ax.plot([x0, x0+60, x0+120], [y0, y0+height, y0], color='k')
ax.plot([x0+120, x0+180], [y0, y0], color='k')
ax.plot([x0, x0-60], [y0, y0], color='k')
else:
#U-shaped schematic
theta = np.linspace(np.pi, 2*np.pi, 50)
rx = 60;    ry = 30
xs = x0 + rx * np.cos(theta)
ys = y0 + ry * np.sin(theta) + 20
ax.plot(xs, ys, color='k')

Annotate the bevel angle and root gap
ax.annotate("", xy=(x0+30, y0+height-5), xytext=(x0+90, y0+height-5), arrowprops=dict(arrowstyle="&lt;-&gt;"))
Ax.text (x0+60, y0+height+2, f "groove angle {grooveangledeg}°", ha='center ', fontsize=8)
Ax.text (x0+60, y0-10, f "Root gap={rootgapmm} mm Weld reinforcement={weld-reinforcement} mm", fontsize=8)

Right side annotation
Ax.text (120, 100, "Welding and Inspection Requirements", fontsize=10)
ax.text(120, 86, f"材料: {material}", fontsize=8)
Ax.text (120, 72, f "groove type: {groove type} groove angle: {groove angle _deg}°", fontsize=8)
Ax.text (120, 58, f "Root gap: {rootgapmm} mm Weld reinforcement: {weld-reinforcement} mm", fontsize=8)
Ax.text (120, 44, f "Non destructive testing: {ndt} and provide testing report", font size=8)
Ax.text (120, 30, "Polish the surface of the weld to be flush with the base metal and passivate it", font size=8)

plt.savefig(outputsvg, dpi=600, bboxinches='tight')
Print ("Generated weld groove detailed drawing:", outputted as svg)
`
```

Quick running and batch generation suggestions

-Save file
-Save blueprintparams.json, generaterall-blueprints.comy, and three manufacturing detail scripts to the same directory.
-Install dependencies
-Run pip install matplotlib numpy on the command line.
-Run batch generation
-Running Python generateallblueprints. py will generate all the schematic SVGs in the output dir.
-Generate detailed manufacturing drawings
-Run separately python flangedn300detail.py、python flangedn50detail.py、python weldgroovedetail.py To obtain manufacturing grade SVG (high-resolution, easy to convert to CAD).
-Subsequent
-If you need to convert manufacturing grade SVG to DXF or directly generate CNC drilling tables, I can export the geometric parameters of these scripts to CSV drilling table format and provide the scripts (if you need me to generate them now, please confirm directly).

There is a significant increase in demand for small/pilot level (50L level) distillation and extraction equipment in essential oils, cosmetics, functional ingredients, and research and development institutions.

Market judgment
Industry research shows that the essential oil and extraction equipment market is in an expansion period, with small-scale and pilot equipment being the key market segments covered by product types and production capacity segments. The overall global extraction equipment market is also steadily growing, driven by demand for high-purity ingredients, pharmaceuticals, and cosmetics. In addition, the essential oil extraction market is predicted to have a high CAGR, indicating an increased willingness to purchase equipment in the short to medium term

Opportunities and Risks
Opportunity: To provide modular, scalable, and compliant (material/certificate) equipment and services for small and medium-sized brands, research institutions, universities, and process validation laboratories, enabling them to quickly enter the market. Risk: Competition comes from low-priced domestic equipment and imported high-end complete machines, and customers place more emphasis on recycling rate, energy consumption, and after-sales response.

Suggested action
-Positioning: Focus on pilot/customization and compliance documents (3.1 Material Certificate, IQ/OQ).
-Business model: equipment+debugging+process optimization services; Provide small batch leasing or trial.
-Verification path: First, conduct on-site trials with 2-3 target customers, collect data on recovery rates and energy consumption for sales purposes.

I have prepared a list of target customers and a "one page sales script template" that can be directly used for you, to facilitate the rapid promotion of the 50L pilot equipment and business negotiations.

Target Customer Attribute Comparison Table

Customer type	Key attributes	Decision maker
Small and medium-sized essential oil/fragrance brands	Small batch production; Reproducibility of Heavy Industries	R&D/Factory Manager
Functional Ingredients/Cosmetics Contract Manufacturing (CMO)	Compliance Certificate and Stable Yield Required	Production Director/Purchasing
Universities and research institutions	Experimental and process scaling up requirements	Project leader/laboratory director
Start up natural extraction brand	budget sensitive; Need to lease/try	Founder/Process Manager
Third party testing and process validation agency	Requires repeatability and data recording	Project Manager/Engineer

One page sales script template (structured, easy to print/email)

Title: 50L Basket Steam Distillation Pilot Device - Rapid Validation, Scalability, and Compliant Delivery

One sentence value proposition: Complete process validation within one week, provide EN10204-3.1 material certificates, IQ/OQ documents, and on-site debugging support.

Three major selling points (one sentence for each point):

-Reproducible process: working volume of 35-40L, loading rate ≤ 70%, convenient for scaling up production.

-Compliance and traceability: 316L liquid receiving parts, factory calibration, and complete IQ/OQ.

-Service in place: on-site installation, process optimization, and first-year spare parts package.

Key data (short column): Steam flow rate 20-25 kg/h; Inner surface Ra≤ 0.8μ m; Warranty for 12 months.

Common objections and responses (two items):

-Is the price high? "→ Rental/trial and installment payment plans are available.

-How about after-sales service? "→ 48 hour response (working days)+remote support.

Call to Action (CTA): Schedule a 30 minute online demonstration or on-site inspection. Please reply with available time or call the contact person directly.

Targeting the US market, prioritize targeting large and small essential oil/fragrance brands, contract factories, natural ingredient distributors, and university laboratories; Below is a specific list of target customers, a simplified one page sales script, and a first visit email/phone script that can be directly copied to facilitate the rapid progress of the pilot.

Target customers (priority)
-Large brands/wholesalers: doTERRA, Young Living, NOW Foods, Vigon, Berj é.
-Small and medium-sized brands and e-commerce/wholesale: Mountain Rose Herbs、Plant Therapy、Edens Garden、Rocky Mountain Oils、Revive Essential Oils、Bulk Apothecary。
-OEM/Formula Factory and Laboratory: Regional CMO, University Plant Chemistry/Process Laboratory (screened by state).

> Explanation: The above-mentioned companies are representative in the field of essential oils and natural flavors in the United States, and are suitable for promoting 50L pilot equipment and process validation services.

One page sales script (email/print version)
Title: 50L Pilot Distillation and Extraction Device - Rapid Validation, Scalability, and Compliant Delivery
One sentence value proposition: Complete process validation within 30 days, provide EN10204-3.1 material certificates, IQ/OQ documents, and on-site debugging support.
Three major selling points:
-Reproducible process: Working volume of 35-40 L, convenient for scaling up production.
-Compliant delivery: 316L liquid receiving parts+factory calibration, meeting the requirements of formula and quality traceability.
-Service in place: on-site installation, process optimization, and first-year spare parts package; 48 hour response time (working days).
Price/Business Model: One time purchase/6-12 month lease/trial+paid verification.
CTA (Call to Action): Reply to email and schedule a 30 minute online demonstration or on-site inspection; Contact person Bo.

First visit email (replicable)
&Subject: Pilot cooperation proposal -50L steam distillation and extraction test device (including IQ/OQ)
> Hello [Name],

&We provide a 50L pilot distillation/extraction device for essential oil and natural ingredient enterprises, including material certification, IQ/OQ, and on-site process optimization. One batch of experiments can be conducted at your location and a complete data report can be provided to facilitate decision-making. May I ask if it is convenient to schedule a 30 minute online demonstration this week?
>   Regards,
≫ bo | Phone: xxx | Email: xxx

Phone call opening (30 seconds)
-Self introduction → One value proposition (pilot+IQ/OQ+on-site debugging) → Propose a 30 minute demonstration or on-site inspection → Set a time and send an email confirmation.

I/O Detail Table (Overview)
This is an I/O schedule that can be directly used for PLC wiring and program development (including labels, signal types, ranges, accuracy, sampling frequencies, and recommended terminal types). Use this table as the basis for PLC hardware selection and terminal block diagram.

Tag	Description	Signal Type	Range/Specification	PLC Interface Suggestions
SteamPressure	Kettle steam pressure	4-20 mA (pressure transmitter)	0-2.0 bar	AI; Isolation input
SteamFlow	Steam Mass Flow	4-20 mA (Mass Flow Meter)	0-50 kg/h	AI; Isolation input
KettleTemp	Temperature inside the kettle (main)	PT100/RTD (3-wire)	-20-200 ° C	RTD module or AI via RTD converter
CondenserTemp	Condenser outlet temperature	PT100/RTD	-20 - 120 ° C	RTD module
CoolingWaterFlow	Cooling water flow rate	4-20 mA	0-5 m^3/h	AI; Isolation input
OilLevel	Reservoir height/liquid level	Analog 4-20 mA or digital switch	0-200 mm or switch point	AI or DI (if magnetic flip board)
Vacuum Level	Vacuum Degree	4-20 mA or mbar Meter	0-1000 mbar or 0-100 mbar	AI

PT100_JacketIn	Jacket inlet temperature	PT100	-20-150 ° C	RTD module
PT100_JacketOut	Jacket outlet temperature	PT100	-20 - 150 ° C	RTD module
UltrasonicPowerCMD	Ultrasound Power Setting	0-10V or 4-20mA	0-100%	AO or DO ->; Variable frequency drive/driver
UltrasonicOn	Ultrasonic start stop	Digital	Relay output	DO (Relay driven)
StirrerMotorMd	Mixing motor start stop/frequency conversion	0-10 V/4-20 mA/Digital	0-50 Hz	AO or DO+VFD
SteamValve	Steam Regulating Valve (Proportional)	4-20 mA	0-100%	AO (with valve position feedback AI optional)
SteamValve_Sos	Steam valve position feedback	4-20 mA or switch	0-100%	AI
Condensate Drain Valve	Digital	On/Off	DO
SolventPump	Start/Stop of Solvent Pump	Digital	On/Off	DO (Contactor)
CIP_Cump	CIP Circulating Pump	Digital	On/Off	DO
CIPValveSelect	CIP Distribution Valve Position	Digital/4-20 mA	Multi way Selection	DO/AO
Emergency Stop	Digital	Normally Closed Safety Circuit	Safety DI (Safety Circuit)
SolventLeakSensor	Solvent Leakage Alarm	Digital	Boolean	DI (Safety First)
DoorInterlock	Manhole/Cabinet Door Interlock	Digital	Normally Closed/Normally Open	DI
CIP_Conductivity	CIP Reflux Conductivity	4-20 mA	0-2000 μ S/cm	AI
EnergyPumption	Accumulated Energy	Pulse/Modbus	kWh	DI (Pulse) or Modbus AI
Alarm Reset	Alarm Reset	Digital	Button	DI
HMI-Command	HMI operation commands	Ethernet/Modbus	Command set	Communication port (Ethernet)
BatchStart	Batch Start	Digital	Start/Stop	DI
BatchID	Batch number input	HMI text	Text	HMI/SCADA fields

Terminal block and wiring suggestions (brief)
-Analog (AI): using isolated AI modules with 250-500 V isolation per channel; Suggest prioritizing 4-20 mA and using dedicated RTD modules (3-wire) for RTDs.
-Digital quantity (DI/DO): DI uses a 24 V DC signal, DO uses a 24 V DC relay output or SSR (depending on the load). The power circuit (contactor) is isolated by intermediate relays or circuit breakers.
-Safety circuit: Independent safety PLC or safety I/O (SIL/PL assessment depending on customer requirements) is used for emergency shutdown and solvent leakage.
-Communication: PLC ↔ HMI uses Ethernet (Modbus TCP or Profinet); Prioritize 4-20 mA for instruments, and use Modbus RTU (multipoint) or HART (with gateway) if necessary.
-Grounding and shielding: All shielded wires are grounded at one end; Separation of signal ground and protection ground; Grounding resistance ≤ 1 Ω (recommended).

Control Strategy and Program Framework (Core Logic)

1. Start/Stop Sequence (Simplified)
-Pre inspection stage (automatic): Check for emergency shutdown, solvent leakage, door interlock, low cooling water flow alarm, and steam source readiness. If any of them are not met, the startup is prohibited and the reason is prompted.
-Preheating stage (automatic/manual): Start the cooling water → confirm that the condensation temperature is controllable → slowly open the steam valve to the set pressure (PID controlled steam valve) → enter operation when the kettle temperature approaches the set value and stabilizes.
-Operation phase (automatic/semi-automatic): Execute according to batch program (timing, ultrasound, distillation, sampling point triggering, recovery control). The key link is controlled by a PID loop (see below).
-Shutdown phase (automatic): Stop feeding → Turn off steam → Keep cooling water running and cooling → Disconnect vacuum (if used) → CIP or manual cleaning.
-Emergency shutdown: Any high priority alarm triggers the immediate cutting off of steam, stopping the pump and motor, opening the safety bypass (if designed), and triggering the alarm and recording.

2. PID loop suggestion (initial parameters need to be adjusted on site)
-Kettle temperature control (main): Control variable: steam valve opening (4-20 mA); Measurement: KettleTemp; Goal: Set a temperature curve (which can be segmented).
-Initial suggestion: P low, I medium, D small; Adopt self-tuning or Ziegler Nichols on-site tuning.
-Condensation temperature control: Control variable: cooling water flow rate (variable frequency pump or regulating valve); Measurement: CondenserTemp; Target: 20-30 ° C.
-Jacket temperature control: Control variables: jacket inlet and outlet valves or heating medium flow rate; Measurement: PT100_JacketIn/Out.
-Liquid level control: If continuous liquid level control is used, use PID or ON/OFF+pump start stop logic; If it is a switch point, use high/low alarm and automatic fluid replenishment/discharge.

3. Batch Logic (SFC/State Machine)
- 状态机：Idle → Precheck → Preheat → Run (Substates: Ultrasonic → Distillation → Collection → Extraction) → Cooldown → CIP → Complete。
-Each state action: Define entry conditions, exit conditions, timeout protection, and manual override permissions (HMI).
-Data recording: Record timestamps and snapshots of key parameters at each critical state entry/exit; PLC writes batch CSV (or summarized by SCADA) every 10 seconds.

Alarm Matrix (Example, Priority and Actions)

Code	Alarm Item	Priority	Automatic Action	Operation Suggestions/Remarks
A01	Emergency stop triggered	Maximum	Immediately cut off steam and power	On site inspection and reset
A02	Solvent leakage	Maximum	Stop pump, cut off steam, start exhaust	Personnel evacuate and deal with leakage
A03	Low	High cooling water flow	Limit steam flow and alarm	Check cooling water pump/valve
A04	kettle temperature exceeds limit	high	close steam valve and alarm	check PID and sensor
A05	Vacuum abnormality (too low/too high)	Medium	Stop the recovery pump and alarm	Check the vacuum pump and cold trap
A06	Abnormal steam flow	Medium	Record and prompt	Check steam source and valve
A07	High liquid level/overflow	High	Stop feeding and discharge	Check liquid level sensor
A08	Motor overload	High	Stop corresponding motor and alarm	Check for load and mechanical jamming
A09	CIP conductivity abnormality	Medium	Stop cycling and alarm	Check chemical concentration
A10	Instrument communication failure	Low	Switch to manual or backup	Check communication link

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Alarm processing and reset strategy

-Highest priority (A01/A02): can only be released after manual reset and safety check; Record events and generate fault reports.

-High priority (A03/A04/A07/A08): Automatically take protective actions (such as shutting down steam, stopping pumps), and require manual confirmation before resetting.

-Medium/Low Priority: Allow automatic recording and prompt the operator, and switch to manual mode for processing if necessary.

PLC label example (naming convention suggestion)

- AIKettleTemp, AICondenserTemp, AISteamPressure, AISteamFlow, DIEStop, DILeakSolvent, DOSteamValve, DOSolventPump, AOUltrasonicPower, HMIBatchStart, HMI_BatchID。

-Unified prefix: AI (analog input), AO (analog output), DI (digital input), DO (digital output), MB (internal flag/register), HMI (HMI field).

Debugging and Acceptance Checklist (for PLC Programmers and Debugging Engineers)
1. I/O point-to-point testing: Simulate sensors/actuators point by point, verify PLC read/write and terminal numbers.
2. PID loop tuning: Complete PID tuning of kettle temperature and condensation temperature under no-load and load conditions and record the parameters.
3. Alarm triggering test: Trigger alarms item by item, verify automatic protection actions and alarm records.
4. Batch process testing: Perform 3 empty/simulated batches to verify state machine switching, data recording, and HMI display.
5. Data export verification: Generate batch CSV, check field integrity and timestamp consistency.
6. Safety circuit verification: Emergency shutdown, solvent leakage, door interlock and other safety circuit function tests shall be conducted and recorded.

Easy for you to copy directly to Excel or hand over to PLC programmers and electrical engineers.

I/O table (CSV format, can be copied to Excel)

The following is the complete I/O details table, which has been expanded in CSV format. Copy the entire code block and save it as io_ist.csv or paste it directly into Excel. Each line contains: Tag, description, signal type, range/specification, PLC interface recommendations, sampling frequency, and remarks.

`csv
Tag,Description,SignalType,Range/Spec,PLC_Interface,SamplingFreq,Notes
AI_SteamPressure, Steam pressure of kettle, 4-20 mA, 0-2.0 bar, AI (isolation), 10s, pressure transmitter output
AI_SteamFlow, Steam mass flow rate, 4-20 mA, 0-50 kg/h, AI (isolated), 10s, mass flow meter or mass flow transmitter
AI_KettleTemp, Temperature inside the kettle (main), PT100 (3-wire), -20-200°C, RTD module, 10s, main temperature control point
AI_CondenserTemp, Condenser outlet temperature, PT100, -20-120°C, RTD module,

10s, for condensation control
AI_CoolingWaterFlow, Cooling water flow rate, 4-20 mA, 0-5 m3/h, AI (isolation), 10s, cooling efficiency monitoring
AI_OilLevel, Oil reservoir height/level, 4-20 mA or Digital, 0-200 mm or switch, AI or DI, 30s, magnetic flap or level transmitter
AI_VacuumLevel, Vacuum degree, 4-20 mA or mbar gauge, 0-1000 mbar or 0-100 mbar, AI, 10s, for recycling system
AIPT100JacketIn, Inlet temperature of jacket, PT100, -20-150°C, RTD module, 10s, jacket control
AIPT100JacketOut, Jacket outlet temperature, PT100, -20-150°C, RTD module, 10s, jacket control
AO_UltrasonicPower, Ultrasonic power setting, 0-10 V or 4-20 mA, 0-100%, AO, 1s, driver input
DI_UltrasonicOn, Ultrasonic start stop, Digital, On/Off, DO (relay driven), event, Relay or SSR
AO_StirrerCmd, Mixing motor frequency conversion setting, 0-10 V or 4-20 mA, 0-50 Hz, AO+VFD, 1s, VFD control
DI_StirrerOn, Mixing start stop, Digital,On/Off,DO, event, contactor control
AO_SteamValve, Steam regulating valve (proportional), 4-20 mA, 0-100%, AO, 1s, with valve position feedback priority
AISteamValvePos, Steam valve position feedback, 4-20 mA, 0-100%, AI, 1s, valve position transmitter
DO_CondensateDrainValve, Condensation drain valve, Digital,Open/Close,DO,event, Electromagnetic valve or pneumatic valve
DO_SolventPump, Solvent pump start stop, Digital,On/Off,DO,event, Contactor drive
DOCIPPump, CIP circulating pump start stop, Digital,On/Off,DO,event, Contactor drive
DOCIPValve_Select, CIP allocation valve position, Digital or 4-20 mA,Multi-channel,DO/AO,event, Multi channel allocation
DI_EmergencyStop, Emergency shutdown, Digital,Safety NC loop,Safety DI,event, The safety circuit is normally closed
DI_SolventLeak, Solvent leakage alarm, Digital,Boolean,DI,event, Safety first
DI_DoorInterlock, Manhole/cabinet door interlock, Digital,NC/NO,DI,event, Interlock normally closed priority
AICIPConductivity, CIP reflow conductivity, 4-20 mA, 0-2000 μS/cm, AI, 10s, cleaning release judgment
DI_EnergyPulse, Accumulated electrical energy (pulses), Pulse,1 pulse/kWh or vendor spec,DI or Modbus pulse,1min, Or Modbus energy consumption meter
MB_BatchID,Batch ID (HMI),Text,string,HMI field,HMI update,event, Used for batch association
DI_BatchStart, Batch start, Digital,Start/Stop,DI,event, Triggered by HMI
AI_CoolingInTemp, Cooling water inlet temperature, PT100, -20-80°C, RTD module, 10s, cooling circuit monitoring
AI_CoolingOutTemp, Cooling water outlet temperature, PT100, -20-80°C, RTD

module, 10s, cooling circuit monitoring
AI_CondenserPressure, Condenser side pressure, 4-20 mA, 0-2 bar, AI, 10s, condenser pressure drop monitoring
AI_TrapTemp, Cold trap temperature, PT100, -80-50°C, RTD module, 10s, low-temperature cold trap monitoring
DI_PumpFault, Pump malfunction signal, Digital,Fault/OK,DI,event, From pump driver or protector
DI_MotorOverload, Motor overload, Digital,Fault/OK,DI,event, Thermal relay or VFD alarm
AI_SolventPurity, Solvent purity (optional), 4-20 mA or Modbus,%, AI, after batch, if online analyzer is available
AISolventLevelRecover, Recycling bottle liquid level, 4-20 mA, 0-100%, AI, 30s, recycling bottle anti overflow
DI_AlarmReset, Alarm reset, Digital,Push button,DI,event, Manual reset
AI_PressureRelief, Safety valve pressure monitoring, 4-20 mA, 0-5 bar, AI, 10s, safety verification
DIHMI Command, HMI operation command, Ethernet/Modbus,Command set,Comm port,event,HMI ↔ PLC communication
AI_SteamTemp, Steam temperature, PT100, 0-200°C, RTD module, 10s, steam quality monitoring
AI_SolventPumpFlow, Solvent pump flow rate, 4-20 mA, 0-100 L/h, AI, 10s, solvent delivery monitoring
DICIPFlowSwitch, CIP flow switch, Digital,Flow/NoFlow,DI,event, Pump protection
AI_FilterDP, Filter pressure difference, 4-20 mA, 0-2 bar, AI, 10s, pressure difference alarm
DI_ManualOverride, Manual coverage, Digital,On/Off,DI,event, Maintenance mode only
AIEnergyConsumptionModbus, Energy consumption (Modbus), Modbus, kWh, Modbus client, 1 minute, priority Modbus read
DI_SafetyInterlockZone, Explosion proof area safety interlock, Digital,Boolean,DI,event, Multi point interlocking
AITempSP, Temperature set point (feedback), Internal,Value,MB_,n/a, Used to record the history of set points
AIPressureSP, Pressure set point (feedback), Internal,Value,MB_,n/a, Used to record the history of set points
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Detailed development of terminal block (overall description)
Below is a terminal number allocation table, terminal types, recommended wiring

cross-sections, and wiring notes that can be directly used for electrical wiring and terminal block production. According to the common layout inside the cabinet, the terminals are divided into: analog input (AI/RTD), analog output (AO), digital input (DI), digital output (DO), pulse/energy consumption/communication, power and grounding, safety circuit, and backup/expansion. Each group is provided with terminal start and end numbers, terminal block numbers (e.g. TB1, TB2...), and wiring precautions for electrical engineers to directly layout terminal block diagrams and cut materials.

Terminal Block Allocation Table (Example Cabinet: TB1-TB12)

Terminal block	Terminal number range	Purpose	Terminal type	Remarks (wiring/section)
TB1 (AI isolation)	TB1-1... TB1-8	4-20 mA analog input (pressure/flow/conductivity, etc.)	Double layer isolation terminal (+/-)	Signal wire 1.5 mm^2; Shielded wire single ended grounding to cabinet grounding terminal (PE)
TB2 (RTD)	TB2-1... TB2-6	PT100 three wire RTD (kettle, condenser, jacket)	triple RTD terminals	3 terminals per channel; Wire 1.5 mm^2; One end of the shield is grounded
TB3 (AO)	TB3-1... TB3-4	Analog output 0-10 V/4-20 mA (valve position, VFD setting)	Single layer AO terminal	1.5-2.5 mm^2; If it is 0-10V, pay attention to common ground isolation
TB4 (DI)	TB4-1... TB4-32	Digital inputs (switch value, alarm, door interlock)	Double layer DI terminals (+/-)	24 V DC circuit, wire diameter 1.0-1.5 mm^2; Shared 24V+/- grouping
TB5 (DO)	TB5-1... TB5-24	Digital output (contactor/solenoid valve coil)	DO relay output terminal or 24 V DC output terminal	Power circuit wire diameter 2.5-6 mm^2 (excluding contactor coil); Coil circuit 1.5 mm^2
TB6 (Pulse/Energy Consumption)	TB6-1... TB6-4	Pulse Input/Pulse Output (Energy Consumption Table)	Pulse Terminal/DI	Pulse Line 0.5-1.0 mm^2; Pay attention to shaking and grounding
TB7 (Communication)	TB7-1... TB7-8	Modbus RTU/RS-485, HART/Backup	Differential Pair Terminal (A/B)	Twisted Shielded Twisted Pair Cable, with the shielded end grounded; Wire diameter 0.5-1.0 mm^2
TB8 (24V power supply)	TB8-1... TB8-4	24V DC+/-/UPS input/backup	High current terminal	24V output wire diameter 2.5-4 mm^2; Label polarity and fuse position
TB9 (Main Power Supply)	TB9-1... TB9-6	3×380 V Main Power Supply Inlet and Branch	L1/L2/L3/N/PE Terminal	Power Line 6-16 mm^2; Rear distribution terminal of main circuit breaker
TB10 (safety circuit)	TB10-1... TB10-8	E-Stop, solvent leakage, door interlock (safety DI)	safety terminal (safety relay circuit)	use safety terminal or safety I/O; Wire diameter 1.5 mm^2; Normally closed circuit labeling

|TB11 (grounding/shielding) | TB11-1... TB11-4 | PE grounding, shielding grounding busbar | Grounding terminal block | All shielding wires are centrally grounded here; Grounding wire 6-16 mm²|
|TB12 (Backup/Expansion) | TB12-1... TB12-16 | Future Expansion I/O or Field Instruments | Universal Terminals | Reserve 16 Terminals for Field Expansion|

Terminal Number and Wiring Example (Key Points Unfold)
-Example of AI (TB1):
- TB1-1 = AISteamPressure (+); TB1-2 = AISteamPressure (-);
- TB1-3 = AISteamFlow (+); TB1-4 = AISteamFlow (-);
-Wiring remarks: The shielded wire of the transmitter is only grounded at the cabinet end (TB11-1), and the field end is not grounded or handled according to the field specifications.
-RTD (TB2) Example:
- TB2-1/2/3 = AIKettleTemp (R/W/S); TB2-4/5/6 = AICondenserTemp (R/W/S)。
-Wiring note: Three wire RTD uses dedicated RTD terminals for each channel to avoid sharing the circuit with 4-20 mA.
-DO (TB5) Example:
- TB5-1 = DOSolventPump (coil +); TB5-2 = DOSolventPump (coil -/COM);
-If DO is a relay output, the normally open/normally closed contacts of the relay are on the relay module side, and the terminal block is only used for control or power circuit allocation.
-Safety circuit (TB10):
- TB10-1 = DIEmergencyStop (NC); TB10-2 = DIEmergencyStop (COM);
-Wiring note: E-Stop uses an independent safety circuit and is connected to a safety relay. Reset requires manual confirmation.

Terminal block materials and installation suggestions
-Terminal type: Phoenix Contact/Weidm ü ller model or equivalent, choose a detachable terminal block with identification strips (for easy maintenance).
-Terminal number strip: A permanent number strip (such as TB1-01) shall be affixed above each terminal block and consistent with the terminal block diagram and wiring diagram.
-Terminal block length: Reserve 20% margin according to the number of terminals; Leave 10-20 mm between each set of terminal blocks for easy wiring.
-Crimping of wiring terminals: all thin wires use terminal sleeves (ferrules); Use suitable crimping terminals for wire diameters ≥ 2.5 mm ²; The power line uses a copper nose.
-Cable fixation: Cable clamps and stress relief are used at the incoming line, and cable identification is labeled according to the terminal number.

-Cable entrance and exit: Reserve cable holes at the bottom or side of the cabinet and install protective sleeves/sealing sleeves. Fire sealing should be applied at the threading point in the solvent area.
-Shielded grounding: The shielded wire is uniformly grounded at one end inside the cabinet (TB11) to avoid introducing loop noise due to double ended grounding.
-Surge protection: Install SPD (Surge Protective Devices) on the main power supply and 24V side, and consider isolators or surge suppressors on the analog input side.

Quick Reference Table for Cable Cross Section and Terminal Selection

Usage	Typical wire diameter	Recommended terminal types
Signal 4-20 mA/RTD	0.5-1.5 mm^2 (commonly 1.5)	Isolated signal terminal/RTD triple terminal
Digital signal DI/DO (control)	1.0-1.5 mm^2	Double layer signal terminal
Relay coil/low-power valve	1.5-2.5 mm^2	Single or double-layer terminal
Motor power line/main power supply	6-16 mm^2 (by current)	High current distribution terminal
Grounding and shielding	6-16 mm^2 (according to grounding requirements)	Grounding busbar terminal

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Wiring and Debugging Precautions (On site Delivery List)
-Consistency between terminal table and wiring diagram: Paste the terminal block diagram and terminal table (including terminal numbers, tags, and on-site equipment numbers) inside the cabinet door.
-Terminal number label: Each wire is labeled at both ends (terminal number+Tag) for easy maintenance.
-Terminal tightening torque: Tighten according to the recommended torque of the terminal manufacturer to avoid loosening or over tightening damage.
-Grounding resistance test: Cabinet grounding resistance ≤ 1 Ω (recommended ≤ 0.5 Ω), and record the test report.
-I/O point-to-point testing: After completing the wiring, test and record point by point (it is recommended to sign and confirm each point with an Excel sheet).
-Spare parts list: Reserve several commonly used terminals, fuses, terminal sleeves, and label paper.

Complete unfolding table of terminal block

The following is a complete terminal table unfolded one by one according to the TB1-TB12 terminal blocks (one terminal per row). Table columns: Terminal number/Terminal block/Tag/Description/Signal type/Recommended wire diameter mm^2 /Terminal type/Wiring remarks. It can be directly copied to Excel for terminal block cutting and wiring instructions.

Terminal number	Terminal block	Tag	Description	Signal type	Wire diameter mm ^{2}	Terminal type	Wiring remarks
TB1-1	TB1	AI_SteamPressure (+)	Positive pole of kettle steam pressure	4-20 mA	1.5	Isolated double terminal (+)	Shielded wire grounded at cabinet end (TB11)
TB1-2	TB1	AI_SteamPressure (-)	Negative pole of kettle steam pressure	4-20 mA	1.5	Isolated dual terminal (-)	Paired with TB1-1
TB1-3	TB1	AI_SteamFlow (+)	Positive Steam Mass Flow	4-20 mA	1.5	Isolated Dual Terminal (+)	Shielded End Grounded
TB1-4	TB1	AI_SteamFlow (-)	Negative Steam Mass Flow	4-20 mA	1.5	Isolated Dual Terminal (-)	Paired with TB1-3
TB1-5	TB1	AI_ColingWaterFlow (+)	Positive cooling water flow	4-20 mA	1.5	Isolated dual terminal (+)	Shielded end grounded
TB1-6	TB1	AI-COolingWaterFlow (-)	Negative cooling water flow	4-20 mA	1.5	Isolated dual terminal (-)	Paired with TB1-5
TB1-7	TB1	AICIPConductivity (+)	CIP Conductivity Positive	4-20 mA	1.5	Isolated Dual Terminal (+)	Shielded One End Grounded
TB1-8	TB1	AICIPConductivity (-)	CIP Conductivity Negative	4-20 mA	1.5	Isolated Dual Terminal (-)	Paired with TB1-7
TB2-1	TB2	AIKettleTempR	Temperature inside the kettle RTD R wire	PT100 3-wire	1.5	RTD triple terminal R	Three wire RTD dedicated terminal, marked according to R/W/S
TB2-2	TB2	AIKettleTempW	Furnace Temperature RTD W Wire	PT100 3-wire	1.5	RTD Triple Terminal W	Paired with TB2-1/TB2-3
TB2-3	TB2	AIKettleTempS	Temperature inside the kettle RTD S-wire	PT100 3-wire	1.5	RTD triple terminal S	Shielded end grounded
TB2-4	TB2	AICondenserTempR	Condenser temperature RTD R wire	PT100 3-wire	1.5	RTD triple terminal R	Three wire RTD dedicated terminal
TB2-5	TB2	AICondenserTempW	Condenser Temperature RTD W Wire	PT100 3-wire	1.5	RTD Triple Terminal W	Paired with TB2-4/TB2-6
TB2-6	TB2	AICondenserTempS	Condenser temperature RTD S wire	PT100 3-wire	1.5	RTD triple terminal S	Shielded end grounded
TB3-1	TB3	AO_SteamValve	Steam regulating valve 4-20 mA/0-10 V output	4-20 mA or 0-10 V	1.5-2.5	AO single terminal	If 0-10 V is common, pay attention to isolation
TB3-2	TB3	AISteamValvePos	Steam valve position feedback 4-20 mA	4-20 mA	1.5	Isolation dual terminal (+/-)	Positive and negative pairing of valve position transmitter
TB3-3	TB3	AO-Ultrasonic Power	Ultrasonic power setting 0-10 V	0-10 V or 4-20 mA	1.5	AO single terminal	Driver input, pay attention to common ground

TB3-4	TB3	AO_StirrerCMD	Stirring VFD setting 0-10 V	0-10 V	1.5	AO single terminal	VFD control input
TB4-1	TB4	DI_SatchStart	Batch start button	Digital 24V	1.0-1.5	DI dual terminal (+/-)	24V circuit, label button position
TB4-2	TB4	DI-Emerge yStop	Emergency stop circuit NC	Safety NC	1.5	Safety DI terminal	Normally closed safety circuit, connected to safety relay
TB4-3	TB4	DI_SolventLeak	Solvent Leakage Detector	Digital	1.0	DI Dual Terminal	Leakage Alarm Priority, Independent Circuit
TB4-4	TB4	DI-DoorInterlock	Manhole/Cabinet Door Interlock	Digital	1.0	DI Dual Terminal	Normally Closed Interlock Circuit
TB4-5	TB4	DIPumpFault1	Pump 1 Fault Input	Digital	1.0	DI Dual Terminal	Fault Output from Pump Driver
TB4-6	TB4	DIPumpFault2	Pump 2 Fault Input	Digital	1.0	DI Dual Terminal	Fault Output from Pump Driver
TB4-7	TB4	DIMotorOverload1	Mixing motor overload	Digital	1.0	DI dual terminal	Thermal relay or VFD alarm
TB4-8	TB4	DIMotorOverload2	Vacuum pump overload	Digital	1.0	DI dual terminal	Thermal relay or VFD alarm
TB4-9	TB4	DICIPFlowSwitch	CIP Flow Switch	Digital	1.0	DI Dual Terminal	Used for Pump Protection
TB4-10	TB4	DI_ Alarm Reset	Alarm Reset Button	Digital	1.0	DI Dual Terminal	Manual Reset
TB4-11	TB4	DI_SanualOverride	Manual override switch	Digital	1.0	DI dual terminal	Used only in maintenance mode
TB4-12	TB4	DIHMI2omand_OK	HMI Command Confirmation	Digital	1.0	DI Dual Terminal	HMI ↔ PLC simple triggering
TB4-13	TB4	DI_SafetyInterlockZone1	Explosion proof Zone Interlock1	Digital	1.5	Safety DI	Multi point Interlock Input
TB4-14	TB4	DI_SafetyInterlockZone2	Explosion proof Zone Interlock 2	Digital	1.5	Safety DI	Multi point Interlock Input
TB4-15	TB4	DIReserved1	Reserved Digital Input 1	Digital	1.0	DI Dual Terminal	Backup
TB4-16	TB4	DIReserved2	Reserved Digital Input 2	Digital	1.0	DI Dual Terminal	Backup
TB4-17	TB4	DIReserved3	Reserved Digital Input 3	Digital	1.0	DI Dual Terminal	Backup
TB4-18	TB4	DIReserved4	Reserved digital input 4	Digital	1.0	DI dual terminal	Backup
TB4-19	TB4	DIReserved5	Reserved digital input 5	Digital	1.0	DI dual terminal	Backup
TB4-20	TB4	DIReserved6	Reserved digital input 6	Digital	1.0	DI dual terminal	Backup
TB4-21	TB4	DIReserved7	Reserved Digital Input 7	Digital	1.0	DI Dual Terminal	Backup

TB4-22	TB4	DIReserved8	Reserved digital input 8	Digital	1.0	DI dual terminal	Backup
TB4-23	TB4	DIReserved9	Reserved Digital Input 9	Digital	1.0	DI Dual Terminal	Backup
TB4-24	TB4	DIReserved10	Reserved digital input 10	Digital	1.0	DI dual terminal	Backup
TB4-25	TB4	DIReserved11	Reserved Digital Input 11	Digital	1.0	DI Dual Terminal	Backup
TB4-26	TB4	DIReserved12	Reserved digital input 12	Digital	1.0	DI dual terminal	Backup
TB4-27	TB4	DIReserved13	Reserved Digital Input 13	Digital	1.0	DI Dual Terminal	Backup
TB4-28	TB4	DIReserved14	Reserved digital input 14	Digital	1.0	DI dual terminal	Backup
TB4-29	TB4	DIReserved15	Reserved digital input 15	Digital	1.0	DI dual terminal	Backup
TB4-30	TB4	DIReserved16	Reserved digital input 16	Digital	1.0	DI dual terminal	Backup
TB4-31	TB4	DIReserved17	Reserved Digital Input 17	Digital	1.0	DI Dual Terminal	Backup
TB4-32	TB4	DIReserved18	Reserved digital input 18	Digital	1.0	DI dual terminal	Backup
TB5-1	TB5	DOSolventPumpCOIL+	Solvent pump coil+	Digital 24 V	1.5-2.5	DO relay output+	Paired with TB5-2 to form a coil circuit
TB5-2	TB5	DOSolventPumpCOIL -	Solvent pump coil -/COM	Digital 24 V	1.5-2.5	DO relay output -	Power circuit isolated by contactor
TB5-3	TB5	DOCIPPump_CIL+	CIP circulating pump coil+	Digital 24V	1.5-2.5	DO relay output+	Paired with TB5-4
TB5-4	TB5	DOCIPPump_CIL -	CIP circulating pump coil -	Digital 24 V	1.5-2.5	DO relay output -	Power circuit isolated by contactor
TB5-5	TB5	DO_CondensateDrain Valve	Condensation Drain Valve	Digital	1.5	DO Relay Output	Electromagnetic or Pneumatic Valve Drive
TB5-6	TB5	DOSteamValveEnable	Steam valve start stop relay	Digital	1.5	DO relay output	Proportional control provided by AO
TB5-7	TB5	DO-UltrasonicOn	Ultrasonic start stop relay	Digital	1.5	DO relay output	Relay or SSR drive
TB5-8	TB5	DO_StirrerOn	Mixing start stop relay	Digital	1.5-2.5	DO relay output	Contactor coil control
TB5-9	TB5	DOValveAux1	Auxiliary Valve 1	Digital	1.5	DO Relay Output	Label Valve Position and Purpose
TB5-10	TB5	DOValveAux2	Auxiliary Valve 2	Digital	1.5	DO Relay Output	Label Valve Position and Purpose
TB5-11	TB5	DOReserved1	Reserved DO 1	Digital	1.0	DO Relay Output	Backup

TB5-12	TB5	DOReserved2	Reserved DO 2	Digital	1.0	DO Relay Output	Backup
TB5-13	TB5	DOReserved3	Reserved DO 3	Digital	1.0	DO Relay Output	Backup
TB5-14	TB5	DOReserved4	Reserved DO 4	Digital	1.0	DO Relay Output	Backup
TB5-15	TB5	DOReserved5	Reserved DO 5	Digital	1.0	DO Relay Output	Backup
TB5-16	TB5	DOReserved6	Reserved DO 6	Digital	1.0	DO Relay Output	Backup
TB5-17	TB5	DOReserved7	Reserved DO 7	Digital	1.0	DO Relay Output	Backup
TB5-18	TB5	DOReserved8	Reserved DO 8	Digital	1.0	DO Relay Output	Backup
TB5-19	TB5	DOReserved9	Reserved DO 9	Digital	1.0	DO Relay Output	Backup
TB5-20	TB5	DOReserved10	Reserved DO 10	Digital	1.0	DO Relay Output	Backup
TB5-21	TB5	DOReserved11	Reserved DO 11	Digital	1.0	DO Relay Output	Backup
TB5-22	TB5	DOReserved12	Reserved DO 12	Digital	1.0	DO Relay Output	Backup
TB5-23	TB5	DOReserved13	Reserved DO 13	Digital	1.0	DO Relay Output	Backup
TB5-24	TB5	DOReserved14	Reserved DO 14	Digital	1.0	DO Relay Output	Backup
TB6-1	TB6	DI-EnergyPulse	Energy consumption pulse input	Pulse	0.5-1.0	Pulse terminal	Denoising circuit or filter
TB6-2	TB6	DOEnergyPulseOut	Energy consumption pulse output	Pulse	0.5-1.0	Pulse terminal	If SCADA feedback is required
TB6-3	TB6	AIEnergyPumptionModbus+	Energy Consumption Modbus A	Modbus RTU	0.5-1.0	Differential Terminal A	Twisted Shielded Twisted Pair Cable
TB6-4	TB6	AIEnergyPumptionModbus -	Energy Consumption Modbus B	Modbus RTU	0.5-1.0	Differential Terminal B	Shielded End Grounding
TB7-1	TB7	RS485 A1	Modbus RTU A (Instrument Bus)	RS-485 A	0.5-1.0	Differential Terminal A	Twisted Shielded Twisted Pair
TB7-2	TB7	RS485 B1	Modbus RTU B (Instrument Bus)	RS-485 B	0.5-1.0	Differential Terminal B	Shielded End Grounding
TB7-3	TB7	HART1+	HART/4-20 mA Loop A+	HART/4-20 mA	1.5	Isolated Dual Terminal (+)	If using a HART gateway
TB7-4	TB7	HART-1-	HART/4-20 mA Loop A ---	HART/4-20 mA	1.5	Isolated Dual Terminal (---)	Paired with TB7-3
TB7-5	TB7	ETHSWTX	Ethernet Switch TX+	Ethernet	0.5-1.0	RJ45/Terminal	If using a terminal type Ethernet module

TB7-6	TB7	ETHSWRX	Ethernet Switch TX ---	Ethernet	0.5-1.0	RJ45/Terminal	Shielded End Grounding
TB7-7	TB7	RS485 A2	Backup RS-485 A	RS-485 A	0.5-1.0	Differential Terminal A	Backup Bus
TB7-8	TB7	RS485 B2	Backup RS-485 B	RS-485 B	0.5-1.0	Differential Terminal B	Backup Bus
TB8-1	TB8	24V DC+	24V DC positive output	DC Power+	2.5-4.0	High current terminal+	Marked with fuse
TB8-2	TB8	24V DC -	24V DC Negative Output	DC Power -	2.5-4.0	High Current Terminal -	Common Negative
TB8-3	TB8	UPS Input+	UPS Input+	DC Power+	2.5-4.0	High Current Terminal	If UPS is configured
TB8-4	TB8	UPs_Input -	UPS Input -	DC Power -	2.5-4.0	High Current Terminal	If UPS is configured
TB9-1	TB9	L1_Sain	Main power supply L1	3 × 380 V	6-16	High current terminal L1	Rear branch line of main circuit breaker
TB9-2	TB9	L2_Sain	Main power supply L2	3 × 380 V	6-16	High current terminal L2	Rear branch line of main circuit breaker
TB9-3	TB9	L3_Sain	Main power supply L3	3 × 380 V	6-16	High current terminal L3	Rear branch line of main circuit breaker
TB9-4	TB9	N_Main	Main power supply N	3 × 380 V	6-16	High current terminal N	Neutral wire
TB9-5	TB9	PE_Sain	Main Grounding PE	Protective Earth	6-16	Grounding Terminal	Connect TB11 Grounding Bus
TB9-6	TB9	Main_Suse	Main power fuse monitoring	Digital/Fuse	6-16	Terminals	Fuse status monitoring (optional)
TB10-1	TB10	DIETopSafety1	E-Stop Circuit 1 NC	Safety NC	1.5	Safety Terminal	Connected to Safety Relay Input
TB10-2	TB10	DIETopSafety2	E-Stop Circuit 2 NC	Safety NC	1.5	Safety Terminal	Redundant Circuit
TB10-3	TB10	DI_LameDetector	Flame/Combustible Gas Alarm	Digital	1.5	Safety Terminal	Directly Triggering Exhaust and Shutdown
TB10-4	TB10	DI_GasVentControl	Exhaust Switching Control	Digital	1.5	Safety Terminal	Linkage with Ventilation System
TB10-5	TB10	DOSafetyRelayOut	Safety Relay Output	Digital	1.5	DO Relay Output	Control Main Contactor Cut Off
TB10-6	TB10	DI_Safety Reset	Safety Reset button	Digital	1.0	DI dual terminal	Release after manual reset
TB10-7	TB10	DI_ZonePressureSwitch	Zone Positive Pressure Switch	Digital	1.0	DI Dual Terminal	Explosion proof Zone Ventilation Monitoring
TB10-8	TB10	DO_Safety Alarm	Safety buzzer/light	Digital	1.5	DO relay output	High priority alarm indication
TB11-1	TB11	PE_Shield	Shielded Grounding Bus	Protective Earth	6-16	Grounding Terminal	All shielded wires are grounded at this end

TB11-2	TB11	PE_Cabinet	Cabinet Grounding	Protective Earth	6-16	Grounding Terminal	Cabinet and Equipment Grounding
TB11-3	TB11	PE-Equip1	Equipment Grounding 1	Protective Earth	6-16	Grounding Terminal	Connect Key Equipment PE
TB11-4	TB11	PE-Equip2	Equipment Grounding 2	Protective Earth	6-16	Grounding Terminal	Backup Grounding
TB12-1	TB12	EXT_1	Backup Extension 1	Generic	1.0	Universal Terminal	Reserved for Field Instruments
TB12-2	TB12	EXT_2	Backup Extension 2	Generic	1.0	Universal Terminal	Reserved
TB12-3	TB12	EXT_3	Backup Extension 3	Generic	1.0	Universal Terminal	Reserved
TB12-4	TB12	EXT-4	Backup Extension 4	Generic	1.0	Universal Terminal	Reserved
TB12-5	TB12	EXT_5	Backup Extension 5	Generic	1.0	Universal Terminal	Reserved
TB12-6	TB12	EXT-6	Backup Extension 6	Generic	1.0	Universal Terminal	Reserved
TB12-7	TB12	EXT_7	Backup Extension 7	Generic	1.0	Universal Terminal	Reserved
TB12-8	TB12	EXT_8	Backup Extension 8	Generic	1.0	Universal Terminal	Reserved
TB12-9	TB12	EXT_9	Backup Extension 9	Generic	1.0	Universal Terminal	Reserved
TB12-10	TB12	EXT_10	Backup Extension 10	Generic	1.0	Universal Terminal	Reserved
TB12-11	TB12	EXT_11	Backup Extension 11	Generic	1.0	Universal Terminal	Reserved
TB12-12	TB12	EXT_12	Backup Extension 12	Generic	1.0	Universal Terminal	Reserved
TB12-13	TB12	EXT_13	Backup Extension 13	Generic	1.0	Universal Terminal	Reserved
TB12-14	TB12	EXT_14	Backup Extension 14	Generic	1.0	Universal Terminal	Reserved
TB12-15	TB12	EXT_15	Backup Extension 15	Generic	1.0	Universal Terminal	Reserved
TB12-16	TB12	EXT_16	Backup Extension 16	Generic	1.0	Universal Terminal	Reserved

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Instructions for Use
-Export and Print: Copy the above table to Excel, print by terminal block partition, and paste it on the inside of the cabinet door for easy on-site wiring and

maintenance.
-Terminal label: Each wire is labeled at both ends (format: TBx-yy | Tag), and a permanent number strip is affixed above the terminal.
-Grounding and shielding: The shielding wire is only grounded at the cabinet end (TB11) to avoid double ended grounding circuit noise.
-Reserved and expanded: TB4 and TB5 have a large number of spare terminals for future I/O expansion.
-

Detailed drawing of flange manufacturing and manufacturing grade technical supplement (DN300 manhole flange)

Summary
Provide manufacturing grade detailed drawings and technical specifications for cutting, drilling, and assembly, applicable to the DN300 flange of the manhole on the top of a 50L basket distillation kettle. It includes geometric dimensions, bolt rings, hole coordinates, tolerances, materials, surface treatment, gaskets and tightening torque, inspection and delivery requirements, and can be directly used for supplier cutting and processing inspection.

Key geometric dimensions and tolerances (mm)

Item	Size
Nominal DN	DN300
Outer diameter of flange OD	340
Bolt ring diameter PCD	295
Number of bolt holes	12
Bolt hole diameter	Ø 18
Example of central hole (manhole opening)	Ø 40 (confirmed according to actual manhole specifications)
Flange thickness	20
Gasket width (circumferential)	8
Flange Face Type	RF (Raised Face)
Flange material	AISI-316L
Internal surface roughness	Ra ≤ 0.8 μ m
Flange outer diameter tolerance	± 0.5 mm
PCD tolerance	± 0.3 mm
Bolt hole position tolerance	± 0.2 mm
Aperture tolerance	+0.0/-0.2 mm
Flange thickness tolerance	± 0.5 mm

Specification for bolts and gaskets

Item	Specification/Suggestion
Number of bolts	12
Bolt specification	M18 × 2.5 (or as specified in the contract)
Bolt grade	8.8 or 10.9 (according to design requirements)
Nut and washer	Matching nut+spring washer or flat washer
Gasket material	PTFE (solvent resistant) or graphite (high temperature), thickness calculated based on sealing (commonly 1-3 mm)
Gasket face type	A circular gasket that matches the RF face, with an outer diameter slightly smaller than the flange OD and an inner diameter slightly larger than the manhole or through-hole
Recommended tightening sequence	Diagonal cross distribution gradually segmented tightening (gradually increasing force in 3 times)
Recommended initial torque	Reference bolt grade and gasket: M18 8.8 Bolt initial torque 200-260 N · m (based on supplier torque table)
Torque inspection	Retest and record 100% bolt torque value after each tightening

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Materials and Heat Treatment

-Material: AISI-316L (liquid receiving part), provide EN10204-3.1 material certificate.

-Heat treatment: No additional heat treatment is required; If the supplier suggests annealing to eliminate processing stress, it should be noted in the contract and annealing records should be provided.

-Chemical composition and mechanical properties: According to ASTM A240/EN standards, suppliers are required to provide chemical composition and tensile test reports (3.1 certificate).

Surface treatment and processing requirements

-Inner surface: mechanical polishing or electropolishing, Ra ≤ 0.8 μm, There shall be no less than 4 key measuring points and the measured values shall be recorded.

-Flange sealing surface: The RF surface has high machining accuracy, with a flatness of ≤ 0.05 mm and a surface roughness according to the gasket requirements (usually Ra 1.6 μ m or as recommended by the gasket manufacturer).

-External surface: Sandblasting or mirror polishing (according to the contract), deburring and chamfering 0.5-1.0 mm.

-Corrosion prevention/passivation: Perform chemical passivation (nitric acid or citric acid process) after welding or processing, and provide passivation reports and pH/time records.

Welding and beveling

-Groove type: If the flange and the kettle body need to be welded, a V-shaped or U-shaped groove should be used according to the welding process specification (WPS), and the root gap and angle should be determined according to the material thickness (example: V-shaped 60 °, root gap 2 mm).

-Welding material: The filler metal is compatible with the base metal (316L welding wire).

-Weld inspection: Conduct RT or UT (according to the contract) on key welds and provide NDT reports. Polish the weld seam flat and passivate it.

Drilling coordinates and drilling table (Cartesian coordinates, unit: mm)

> Bolt ring diameter PCD=295 mm, 12 holes, arranged clockwise from 0°angle. The following are Cartesian coordinates (with the center of the flange as the origin).

holeindex	angledeg	pcdmm	xmm	ymm	holedia_mm
1	0	295	147.5	0.0	18
2	30	295	127.7	73.8	18
3	60	295	73.8	127.7	18
4	90	295	0.0	147.5	18
5	120	295	-73.8	127.7	18
6	150	295	-127.7	73.8	18
7	180	295	-147.5	0.0	18
8	210	295	-127.7	-73.8	18
9	240	295	-73.8	-127.7	18
10	270	295	0.0	-147.5	18
11	300	295	73.8	-127.7	18
12	330	295	127.7	-73.8	18

Key points of processing and inspection technology (supplier delivery list)

1. Cutting and rough machining: rough machining according to the outer diameter OD, PCD, and center hole position, leaving a margin.
2. Precision machining and drilling: PCD drilling is completed in one positioning on the fixture, with a hole tolerance of ± 0.2 mm.
3. Flange surface processing: RF surface precision machining or milling, flatness ≤ 0.05 mm, surface roughness according to requirements.
4. Deburring and chamfering: all hole edges should be chamfered 0.5-1.0 mm.

5. Welding (if necessary): Follow WPS and perform RT/UT on key welds.
6. Passivation and Cleaning: Perform chemical passivation and neutralization cleaning after welding or processing, and record the batch.
7. Dimensional inspection: Provide a dimensional inspection report (OD, PCD, aperture, thickness, flatness) and attach measurement evidence (photos/measurement forms).
8. Surface roughness report: inner surface Ra measurement points and results (at least 4 points).
9. Material and Mechanics Certificate: EN10204-3.1 or equivalent material certificate and chemical composition report.
10. Packaging and Protection: The inner surface is protected with protective film or rust proof oil, and the outer packaging is moisture-proof and labeled with batch number and direction.

Quality Acceptance Checklist (Supplier Delivery Acceptance Items)
-Material certificate (EN10204-3.1) [mandatory].
-Dimensional inspection report (OD, PCD, hole position, hole diameter, thickness, tolerance) [mandatory].
-Surface roughness report (inner surface Ra ≤ 0.8 μ m) [mandatory].
-Welding NDT report (if applicable, RT/UT) [mandatory].
-Passivation and cleaning records are mandatory.
-List of bolt/gasket matching and recommended torque [mandatory].
-Packaging and labeling (batch number, manufacturing date, supplier) [mandatory].

List of drawings and documents delivered to suppliers (recommended)
-Manufacturing details (DWG/DXF/SVG): including dimensions, tolerances, hole coordinates, material and surface requirements.
-Drilling table (CSV): hole index, angle deg, pcdmm, xmm, ymm, hole dia mm (for easy CNC import).
-Material and Inspection Requirements Document: EN10204-3.1 Requirements, NDT Points, Passivation Process.
-Assembly instructions: gasket model, bolt specifications, tightening sequence, and torque table.
-Acceptance form template: for on-site acceptance signature.

Implementation suggestions (3 steps)
1. Immediately issue: Distribute this specification along with the drilling CSV to the flange supplier, requesting delivery according to tolerances and certificates.

2. First article inspection: The supplier is required to deliver one first article and conduct on-site or third-party inspection (size, Ra, material).
3. Batch release: After the first piece is qualified, batch processing will be released, and inspection reports and NDT reports will be attached to each batch.

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Drilling table CSV (DN300 flange, can be saved as flamedn300drill. csv)

`csv
holeindex,angledeg,pcdmm,xmm,ymm,holedia_mm
1,0,295,147.5,0.0,18
2,30,295,127.7,73.8,18
3,60,295,73.8,127.7,18
4,90,295,0.0,147.5,18
5,120,295,-73.8,127.7,18
6,150,295,-127.7,73.8,18
7,180,295,-147.5,0.0,18
8,210,295,-127.7,-73.8,18
9,240,295,-73.8,-127.7,18
10,270,295,0.0,-147.5,18
11,300,295,73.8,-127.7,18
12,330,295,127.7,-73.8,18
`

I have exported the drilling coordinates in Cartesian coordinates for direct import into CNC or CAD.

Overview of DWG Parameter List
The following is a DWG parameter list that can be directly handed over to CAD engineers for modeling and drawing, including units, scales, layer names, geometric dimensions and tolerances, title block information, and delivery requirements. Implement each item item item by item into the CAD model and drawing template, making it easier for suppliers to directly cut and inspect.

Basic Settings
-Document unit: millimeters (mm).
-Coordinate origin: The center of the flange is the origin (0,0,0), in the Z-axis direction.
-Drawing size and scale: A3 output scale 1:2 (detailed drawing 1:1 or 1:0.5); The scale of the A1 final assembly drawing is 1:10 or adjusted according to the on-site layout.
-Layer standard: Adopt a unified prefix (e.g. MECH, DIM, NOTE, MATIAL, WELL, CENTER).
-Font and line type: Text height 2.5 mm (A3 annotation); Line width according to ISO standards (fine line 0.18mm, thick line 0.5mm); The size arrow is 3mm.
-Coordinate accuracy: The model coordinates are kept to 3 decimal places (0.001 mm accuracy for calculation), and the drawing dimensions are kept to 1 decimal place (0.1 mm).

Geometric dimensions and tolerances (key items)
-Outer diameter of flange OD: 340 ± 0.5 mm.
-Bolt ring diameter PCD: 295 ± 0.3 mm.
-Number of bolt holes: 12 holes, with a diameter of Ø 18+0.0/-0.2 mm.
-Flange thickness: 20 ± 0.5 mm.
-Center hole (manhole): Ø 40 (example) or according to the standard size of manholes, with a tolerance of ± 0.2 mm marked.
-Flatness of flange surface: ≤ 0.05 mm (within the sealing surface range).
-Surface roughness: Inner surface Ra ≤ 0.8 μ m; Flange sealing surface Ra ≤ 1.6 μ m (or as required by gasket manufacturer).
-Chamfering and deburring: all hole edges shall be chamfered 0.5-1.0 mm; outer edges shall be chamfered 1 × 45 ° (as indicated in the detailed drawing).
-Weld groove: If welding is required, the groove angle should be V 60 ° and the root gap should be 2.0 mm (provide detailed sectional drawings and annotations in DWG).
-Assembly tolerance: The relative center tolerance of the hole position is ± 0.2 mm; the fitting tolerance between the flange and the kettle body is ± 0.3 mm.

Layer and Naming Standards

Layer Name	Purpose	Color/Linetype Suggestions
MECH_BODY	Equipment Appearance and Physical Outline	Black Solid Line
MECH_FLANGE	Flange profile and hole position	Red solid line
Center	Centerline and Symmetry Line	Blue dashed line
DIM	Dimension annotation	Green thin line
NOTE	Text Annotations and Material List	Yellow Text
Weld symbol and groove	Orange dashed line	

SURF	Surface roughness symbol	Purple annotation
TITLEBLOCK	Title Block and Revision Box	Black Solid Line
DRILL_CSV	Drilling center point (model reference only)	Grey dotted line

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Title bar and metadata requirements
-Title bar field: Project name; Drawing number; Drawing name; Version/Revision Number; Illustrator; Verification personnel; Approver; Material Science; Surface treatment; proportion; Company; date
-Material field: AISI-316L; Require EN10204-3.1 material certificate.
-Inspection fields: First Article Inspection Number, NDT Requirements (RT/UT), Ra Measurement Point Number.
-File naming convention: Project code, drawing number, version. dwg (e.g. JJP01DN300FLANGEV1. dwg).
-Drawing revision: Record the revision number, date, modifier, and modification description in the revision box for each modification.

View and detail requirements
-View list: Front view, sectional view, top view (hole position) view, flange detail drawing (enlarged 2-5 times), weld groove detail drawing, flange hole position drilling table (CSV embedded or attached).
-Detail drawing annotation: Annotate PCD, aperture, hole position angle, chamfer, face type (RF), gasket installation surface, and gasket outer/inner diameter on the flange detail drawing.
-Section annotation: annotate flange thickness, weld position, groove angle, root gap, and weld clearance.
-Drilling table: Provide hole index, angle deg, pcdmm, xmm, ymm, and hole dia mm in the DWG attachment or external CSV.

Tolerance and Inspection Annotations (Drawing Annotations)
-General tolerance: If no tolerance is specified, follow ISO 2768-mK (or as specified in the contract).
-Critical dimension tolerance: Mark critical dimensions with frames on the drawing and indicate the tolerance (e.g. PCD ± 0.3 mm).
-Inspection requirements: The first article must provide a dimensional measurement report (including measurement methods and equipment), Ra measurement report, material certificate, and NDT report (if applicable).
-Assembly attention: Mark the bolt tightening sequence, recommended torque range, and gasket model.

Output and delivery requirements
-Delivery document list: DWG original files (AutoCAD 2020 or compatible version); PDF print (A3/A1); Drilling CSV; Dimensional inspection table (Excel); Scanned copy of material certificate (PDF); NDT report (PDF).
-Drawing version control: update the version number and record the revision history in the title bar every time it is modified.
-Manufacturability inspection: Conduct a manufacturability review (checking fixture positioning, clamping surface, machining allowance, and assembly clearance) before issuing.
-Supplier's first piece: The supplier is required to deliver the first piece and attach a measurement report and photos. After the first piece is qualified, it will be released for batch processing.

CAD modeling and export suggestions
-Modeling principle: First build a solid model, and then generate engineering views and sections from the solid to avoid 2D redrawing errors.
-Coordinates and positioning: All hole positions are positioned based on the flange center, and the center coordinates and angles are retained when exporting the drilling CSV.
-Layer Cleanup: Clean up unused layers and temporary objects before exporting to ensure DWG file volume and readability.
-PDF output: Output a PDF with a title bar according to the A3/A1 template, ensuring that the font embedding is consistent with the line width.

-

I have made a technical supplement that can be directly implemented, including thermal and cooling load, condenser and steam system, solvent recovery energy consumption estimation, vacuum/recovery pump selection, and cooling water demand. Each section provides principle formulas, example calculations, design suggestions, and acceptance points for engineers to directly apply or submit to suppliers for verification.

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1. Design objectives and input parameters (for all calculations)
Target scenario (default)

-Equipment: 50 L basket distillation kettle (working volume 35-40 L)
-Typical steam supply: 20-25 kg/h (value range for sensitivity analysis)
-Cooling water inlet/outlet temperature (example): $T_{w, in}=20^\circ\mathrm{C}$, $T_{w, out}=30^\circ\mathrm{C}$ (can be adjusted according to the on-site cooling source)
-Steam condensation temperature (saturation): $Ts \approx 100^\circ\mathrm{C}$ (1 bar saturated steam)
-Constant used: specific heat of water $c_p=4.18\mathrm{kJ/(kg\cdot K)}$; The water density is approximately 1 kg/L.

Explanation: The subsequent example calculations are given in two levels of steam flow rates of 20 kg/h and 25 kg/h for comparison and margin evaluation.

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2. Heat load and cooling water flow calculation (condenser heat load)

Principles and Formulas
-Steam condensation releases heat (approximately dominated by latent heat of vaporization):
$$
Q = \dot m{steam}\cdot \lambda{steam}
$$
The unit of $\dot m_{steam}$ is $\mathrm{kg/s}$, and λ_{steam} is taken as $2257\mathrm{kJ/kg}$ (the latent heat of vaporization of water at 100°C, example value).
-Converted to watts (W): $Q_{\mathrm{W}}=Q_{\mathrm{kJ/s}}=\dot m_{steam}\cdot\lambda_{steam}/1$ (kJ/s is kW).
-The cooling water flow rate (mass flow rate) is given by energy balance:
$$
\dot m{w} = \frac{Q}{cp \cdot \Delta T_w}
$$
Among them, $\Delta Tw=T_{w,out}-T_{w, in}$ (K), $\dot mv$ The unit is $\mathrm{kg/s}$.

-Condenser area estimation (heat transfer formula):
$$
Q = U \cdot A \cdot \Delta T_{lm}
$$
Where U is the total heat transfer coefficient (W/m²·K), A is the heat transfer area (m²), and ΔT_{lm} is the logarithmic mean temperature difference:
$$
\Delta T{lm} = \frac{\Delta T2 - \Delta T1}{\ln(\Delta T2/\Delta T_1)}
$$

\]
\(\Delta T1 = Ts - T{w,out}\)，\(\Delta T2 = Ts - T{w,in}\)。

Example calculation (taking \ (\ lambda {steam}=2257 \ \ mathrm {kJ/kg} \))
-Scenario A: \ (\ dot m {steam}=20 \ \ mathrm {kg/h} \)
\(\dot m_{steam}=20/3600=0.005556\ \mathrm{kg/s}\)
\(Q=0.005556 times 2257=12.54 \ \ mathrm {kW} \) (approximately 12.5 kW)
-Scenario B: \ (\ dot m {steam}=25 \ \ mathrm {kg/h} \)
\(\dot m_{steam}=25/3600=0.006944\ \mathrm{kg/s}\)
\(Q=0.006944 \ times2257=15.68 \ mathrm {kW} \) (approximately 15.7 kW)

Cooling water flow rate (calculated as \ (\ Delta Tw=5 \ \ mathrm {K} \) and \ (10 \ \ mathrm {K} \))
-Scenario A, \ (\ Delta Tw=5 \ mathrm {K} \):
\(\dot m_w = 12.54/(4.18\times5)=0.6006\ \mathrm{kg/s}=2.162\ \mathrm{m^3/h}\)。
- 情形 A，\(\Delta Tw=10\ \mathrm{K}\)： \(\dot mw\approx1.081\ \ mathrm{m^3/h}\)。
- 情形 B，\(\Delta Tw=5\ \mathrm{K}\)： \(\dot mw\approx2.703\ \ mathrm{m^3/h}\)。

Estimation of Condenser Area (Example)
- 取 \ (Ts=100^\circ\mathrm{C}\)，\(T{w,in}=20^\circ\mathrm{C}\)，\ (T_{w,out}=30^\circ\mathrm{C}\)。
\(\Delta T2=80\ \mathrm{K}\)，\(\Delta T1=70\ \mathrm{K}\)。
\(\Delta T_{lm}=\dfrac{80-70}{\ln(80/70)}\approx74.95\ \mathrm{K}\).
-Take a conservative value of U=3000 \ mathrm {W/(m ^ 2 \ cdot K) \ (the shell and tube condenser has better heat transfer to the steam side, and U can be taken in the range of 2000-5000, depending on the structure and fouling factor).
- 情形 A: \(A = Q/(U\Delta T_{lm}) = 12540/(3000\times74.95)\approx0.056\ \ mathrm{m^2}\)。
-Conclusion: The theoretical area is very small (due to the large Δ Tlm), but in engineering, safety margin, decreased heat transfer coefficient, scaling, local flow, and manufacturing limitations should be considered. It is recommended to select a minimum of 0.3-1.0 m² heat exchanger (shell tube or plate) to ensure stable recovery and maintainability.

Design Suggestions and Acceptance Points
-Cooling water design: Calculate the cooling water flow rate based on \ (\ Delta Tw=5 \) -10 K and reserve 20-30% margin on site. Example: If the target Δ T is 5 K, reserve a cooling water circuit of 2.5-3.0 m³/h.
-Heat exchanger selection: Shell and tube or plate condenser can be used; Material AISI-316L (liquid receiving part), recommended heat transfer area of 0.5-1.0 m² (small shell tube or multi tube bundle), and provide pressure drop and cooling water interface size.

-Heat transfer coefficient verification: The supplier is required to provide the design U value, cooling water pressure drop, and fouling factor (Ff), and verify the condensation capacity in the factory test (measuring the temperature difference between the cooling water inlet/outlet and the condensation heat load at the specified steam flow rate).
-Acceptance criteria: Operate at steady-state steam flow rate (20-25 kg/h) on site, record the inlet/outlet temperature of cooling water, cooling water flow rate, and condenser outlet temperature, calculate the actual Q and compare it with the design value (error ≤ 10% is considered qualified).

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3. Key points of steam system, drainage, and pipeline design

Steam pipeline and drainage
-Steam pipe diameter: Select the pipe according to the maximum steam flow rate of 25 kg/h (DN15/DN20 can be used for short distances, checked according to pressure drop and speed).
-Steam trap: The steam trap should be able to handle the maximum condensate flow rate and withstand steam shock. Common types include inverted bucket, thermodynamic, or thermal static.
-Capacity verification: The rated discharge capacity of the drain valve is ≥ 1.5 times the maximum instantaneous flow rate of condensed water (considering impact and condensation surge).
-Example: Steam 25 kg/h → condensate approximately 25 kg/h ≈ 0.00694 kg/s; Select rated emissions ≥ 40 kg/h based on instantaneous margin (supplier list).
-Drainage arrangement: A drainage point is set at the end of the steam and the jacket of the kettle, and the pipeline has a slope (≥ 1:100) to converge towards the drainage point to avoid water hammer accumulation. The downstream of the drain valve is connected to a condensate recovery or discharge pipe, which is matched with a condensate recovery tank and cooling system.

Steam Safety and Control
-Safety valve: The jacket and steam circuit are equipped with safety valves, with a set pressure slightly higher than the working pressure (e.g. working 1.0-1.2 bar, safety valve set at 1.5 bar), and verified according to pressure vessel specifications.
-Steam regulation: using proportional valves (4-20 mA control) or regulating valves with valve position feedback, combined with PID control of kettle temperature.
-Drainage and exhaust: Consider automatic exhaust or bypass during shutdown or low load to prevent condensate backflow.

Pipeline and insulation
-Insulation: Steam pipelines and jacket insulation (rock wool or polyurethane) to reduce heat loss and prevent burns.

-Valve and flange: The steam interface DN25 (example) adopts PN16/PN25 flange or threaded connection, and the valve is selected as a steam specific valve (with steam seal).
-Pressure gauges and drain monitoring: Install pressure gauges, temperature gauges, and condensate flow/temperature monitoring points next to drain valves at critical points.

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4. Estimation of energy consumption for solvent extraction and recovery (e.g. ethanol)

principle
-Solvent evaporation/recovery heat load: $Q=\dot m_{solvent} \cdot \lambda_{solvent}$.
-Solvent mass flow rate $\dot m_{solvent}=V_{solvent} \cdot \rho_{solvent}/t$ (if given by volume rate L/h).

Example (ethanol, approximate data)
-Ethanol density $\rho \approx 0.789 \ \mathrm{kg/L}$, latent heat of vaporization $\lambda \approx 841 \ \mathrm{kJ/kg}$ (example values, actual corrected according to temperature).
-If the recycling rate is $V=3 \ \mathrm{L/h}$: $\dot m=3 \times 0.789/3600=0.000658 \ \mathrm{kg/s}$ (or 2.367 kg/h).
-Heat load: $Q=0.000658 \times 841=0.553 \ \mathrm{kW}$ (approximately 0.55 kW).
-Cooling water demand (ΔT=5 K): $\dot m_w=553/(4.18 \times 5)=0.0265 \ \mathrm{kg/s}=0.095 \ \mathrm{m^3/h}$.
-Conclusion: The heat load of small batch solvent recovery is much lower than the total load of steam condensation, but it is necessary to consider the solvent condensation temperature, cold trap design, and safety (flammable solvents need to be explosion-proof and inert).

Design suggestions
-Cold trap/condenser: Closed loop condensation recovery is preferred for flammable solvents. The condenser material is 316L, and the cooling water or refrigerant is designed according to the boiling point of the solvent.
-Solvent purity and recovery rate: The target recovery rate is ≥ 95%, and residual solvent detection (ppm) should be performed after recovery.
-Safety: The solvent recovery system requires explosion-proof electrical, solvent leakage detection, grounding, and anti-static measures.

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5. Key points for selecting vacuum pumps and recovery pumps (concentration/recovery stage)

key parameters

-Target vacuum degree (mbar) or absolute pressure; For example, when recycling light solvents, it may work at 50-200 mbar.

-Steam/evaporation rate (L/h or kg/h), used to calculate steam evaporation volume flow (gas volume increase at low pressure).

-Required pumping speed (volumetric flow rate):

$$
S = \frac{V_{vapor}}{t}
$$

Where V_{vapor} is the volume of gas produced by evaporation (at working pressure), which can be approximately converted to an ideal gas:

$$
\dot V = \frac{\dot m \cdot R \cdot T}{p \cdot M}
$$

In engineering, vacuum pump manufacturers often provide pump types based on evaporation rate and target vacuum.

Selection recommendation

-Pump type: Small recycling commonly used rotary vane pump (oil seal) or dry screw/diaphragm pump (oil-free if required); For solvent recovery, priority should be given to pumps that are solvent resistant and capable of condensing steam, and equipped with cold traps/condensers.

-Cold trap and condenser: Install a cold trap (low-temperature condenser) before the pump to capture most of the solvent, protect the pump, and improve recovery rate.

-Pump capacity margin: When selecting, leave 20-50% capacity margin to cope with instantaneous evaporation peak.

-Acceptance: Run at the target vacuum and evaporation rate, record the pump pumping speed, ultimate vacuum, and pump temperature, and confirm that there is no overheating or solvent intrusion into the pump oil (if an oil sealed pump).

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6. Construction/commissioning/acceptance checklist (related to thermal and cooling loads)

Before construction

-Provide condenser heat balance calculation sheet (including U-value assumption ΔT_{lm}、 Cooling water flow rate and pressure drop.

-Provide steam pipeline diagram (slope, drainage points, valve and safety valve positions).

-Provide specifications for cooling water pipelines and pumps (flow rate, head, interface size).

Factory/on-site acceptance

-Factory test of condenser: Measure the temperature difference between the inlet and outlet of the cooling water and the condensing heat load at the specified steam flow rate (record Q actual measurement).
-Steam system pressure test and safety valve calibration (pressure test record).
-Functional test of drain valve (no backflow or abnormal noise under design load).
-On site operation test: Run for 1 hour under 20-25 kg/h steam, record steam flow rate, cooling water flow rate, inlet/outlet temperature, condenser outlet temperature, condensate flow rate, and recovery rate (solvent recovery scenario).
-Energy consumption record: Record steam consumption (kg), cooling water consumption (m^3), and electrical energy (kWh) for subsequent economic analysis.

Overview of Heat Load and Cooling Water Calculation

Key point: I have made the heat balance calculation table into a table that can be directly pasted into Excel (including formulas and example values), so that you can replace the on-site parameters and obtain: steam heat load \ (Q \) (kW), required cooling water flow rate (m^3/h), logarithmic mean temperature difference \ (\ Delta T {lm} \), and estimated heat transfer area \ (A \). Please also attach the key specifications and acceptance inspection items of the condenser for direct use during procurement and on-site acceptance.

Excel template (CSV text can be directly pasted into Excel)
Explanation: Copy the entire code block below to a text file and save it as heatbalancetemplate. csv or paste it directly into Excel. The formula is given in Excel syntax (English Excel). Typical values (steam 20-25 kg/h) have been filled in for the sample.

`csv
Item,Cell,Description,Value or Excel formula,Unit,Notes
Steam mass flow, B2, Steam flow rate (nominal), 20, kg/h, can be changed to 25
Steam mass flow (kg/s), B3, Steam flow conversion= B2/3600,kg/s,
Steam latent heat, B4, Steam vaporization latent heat, 2257, kJ/kg, Adjustable according to working conditions
Heat load kW, B5, Condensation heat release power,=B3 * B4, kW, equal to kJ/s, i.e. kW
Cooling delta T, B6, Cooling water temperature difference,=5, K, Commonly used 5 or

10 K
Water cp, B7, Specific heat of water, 4.18, kJ/(kg*K),
Cooling mass flow kg/s, B8, Cooling water quality flow rate= B5/(B7*B6),kg/s,
Cooling flow m3/h, B9, Volume flow rate of cooling water= B8*3.6,m3/h,
Steam saturation temp, B10, Steam saturation temperature, 100°C C, Example 1 bar
Cooling water Tin, B11, Cooling water inlet temperature, 20°C C,
Cooling water Tout, B12, Cooling water outlet temperature, 30°C C, =B11+B6
DeltaT1, B13,DeltaT1,=B10-B12,K,
DeltaT2, B14,DeltaT2,=B10-B11,K,
DeltaT_lm, B15, Logarithmic mean temperature difference= IF(B13=B14,B13,(B13-B14)/LN(B13/B14)),K,
U value, B16, Assuming a total heat transfer coefficient of 3000, W/(m2*K), Suggested range of 2000-5000
Heat load W, B17, heat load W,=B5*1000,W, from kW convert to W
Required area m2, B18, Estimation of heat exchange area= B17/(B16*B15),m2,
Design margin factor, B19, Design margin,=1.5, recommended 1.2-2.0
Recommended area m2, B20, Suggest heat exchange area= B18*B19,m2,
Notes, B21,備註, "Replace B2,B4,B11,B6,B16 per site",,
`

Example Calculation (Template based Numerical Explanation)
Input example: Steam 20 kg/h, \ (\ lambda=2257 \ mathrm {kJ/kg} \), cooling water inlet at 20°C and outlet at 30°C (ΔT=5 K), U=3000 W/m^2· K.
-Steam mass flow rate \ (=20/3600=0.005556 \ mathrm {kg/s} \).
-Heat load \ (Q=0.005556 times 2257 \ approx12.54 \ mathrm {kW} \).
-The cooling water flow rate (Δ T=5 K) is approximately \ (2.16 \ \ mathrm {m ^ 3/h} \).
-Logarithmic mean temperature difference \ (\ Delta T {lm} \ approx74.95 \ \ mathrm {K} \).
-Theoretical heat exchange area \ (A \ approx0.056 \ mathrm {m ^ 2} \), it is recommended to take 0.3-1.0 m^2 in engineering to ensure margin and maintainability (the design margin of 1.5 is enlarged in the template).

Key specifications for condenser and cooling system (for inquiry and acceptance)
Key fields (listed in the inquiry form)
-Design heat load: Fill in kW (e.g. 12.5-16 kW corresponds to 20-25 kg/h).
-Suggested heat exchange area: 0.5 m^2 (minimum 0.3 m^2, recommended 0.5-1.0 m^2).
-Material: AISI-316L for shell/tube liquid fittings.
-Cooling water interface: DN25 or pressure drop calculation; Design cooling water flow rate and allowable pressure drop.

-Design cooling water Δ T: 5-10 K (indicate inlet/outlet temperature).
-U value and pressure drop: The supplier needs to provide the design U ($W/m^2 \cdot K$) and cooling water side pressure drop (kPa).
-Inspection: The factory test requires providing the temperature difference between the inlet/outlet of the cooling water and the measured Q (with an error of ≤ 10%) at the specified steam flow rate.
-Maintenance: Removable and washable tube bundle or plate structure for easy descaling; Provide cleaning ports and flushing solutions.

Key points of acceptance
-On site steady-state operation (20-25 kg/h steam) records: steam flow rate, cooling water inlet/outlet temperature, cooling water flow rate, condenser outlet temperature, recovery rate.
-Comparison between measured Q and design Q (error ≤ 10%); The cooling water flow rate and pressure drop comply with the design.
-No signs of abnormal vibration, leakage, or scaling; The tube bundle can be disassembled and cleaned, and there is a maintenance channel.

Heat Balance Calculation Table (CSV, can be directly exported to Excel)
Explanation: Convert the entire code block below to a text file and save it as heatbalancetemplate. csv, or paste it directly into Excel. Replace input items such as B2/B4/B11/B6/B16 to match on-site parameters.

`csv
Item,Cell,Description,Value or Excel formula,Unit,Notes
Steam mass flow,B2, Steam flow rate (nominal), 20, kg/h, modified to on-site value (example 20 or 25)
Steam mass flow (kg/s),B3, Steam flow conversion= B2/3600,kg/s,
Steam latent heat,B4, Steam vaporization latent heat, 2257, kJ/kg, Adjust according to working conditions
Heat load kW,B5, Condensation heat release power,=B3 * B4, kW, equal to kJ/s, i.e. kW
Cooling delta T,B6, Cooling water temperature difference, 5, K, Commonly used 5 or

10 K
Water cp,B7, Specific heat of water, 4.18, kJ/(kg*K),
Cooling mass flow kg/s,B8, Cooling water quality flow rate= B5/(B7*B6),kg/s,
Cooling flow m3/h,B9, Volume flow rate of cooling water= B8*3.6,m3/h,
Steam saturation temp,B10, Steam saturation temperature, 100°C C, Example 1 bar
Cooling water Tin,B11, Cooling water inlet temperature, 20°C C,
Cooling water Tout,B12, Cooling water outlet temperature= B11+B6,°C,
DeltaT1,B13,DeltaT1,=B10-B12,K,
DeltaT2,B14,DeltaT2,=B10-B11,K,
DeltaT_lm,B15, Logarithmic mean temperature difference= IF(B13=B14,B13,(B13-B14)/LN(B13/B14)),K,
U value,B16, Assuming a total heat transfer coefficient of 3000, W/(m2*K), Suggested range of 2000-5000
Heat load W,B17, heat load W,=B5*1000,W, from kW convert to W
Required area m2,B18, Estimation of heat exchange area= B17/(B16*B15),m2,
Design margin factor,B19, Design margin, 1.5, recommended 1.2-2.0
Recommended area m2,B20, Suggest heat exchange area= B18*B19,m2,
Notes,B21,備註, "Replace B2,B4,B11,B6,B16 per site",,
`

Condenser specification proposal template (can be obtained directly from inquiry/technical package)
Key fields (please fill in in the inquiry form or request the supplier to reply)

-Project Name:
-Component: Condenser (for 50L distillation kettle)
-Design heat load: \ \ kW \ (e.g. 12.5-16 kW, based on steam 20-25 kg/h)
-Design conditions: Steam saturation temperature \ (\, ^ \ circ \ mathrm {C} \), inlet/outlet temperature of cooling water (example 20/30 ° C), allowable pressure drop of cooling water (kPa)
-Recommended heat exchange area: \ \ 0.5 m^2 (recommended range 0.3-1.0 m^2)\\
-Material: AISI-316L liquid receiving component; Non liquid parts can be 304 or according to the contract
-Heat transfer coefficient (design U): provided by the supplier (recommended range 2000-5000 $W/m^2 \cdot K$)
-Cooling water interface: Recommended DN25 (or pressure drop calculation), flange/thread standard specified (ANSI/DIN)
-Condenser type: shell and tube/multi tube bundle/plate type (explain advantages and disadvantages and select the appropriate type)
-Pressure drop: Cooling water side pressure drop ≤ specified value (supplier needs to provide curve)
-Cleaning and maintenance: detachable tube bundles or plates, providing cleaning

ports and flushing suggestions
-Factory test: Provide measured data at specified steam flow rate: cooling water inlet/outlet temperature, flow rate, measured Q (kW), error ≤ 10%
-Interface and dimensions: Cooling water inlet/outlet flange dimensions, condenser external dimensions, installation bracket and weight
-Documents and Certificates: Material Certificate (EN10204-3.1), Factory Test Report P& ID、 Installation/maintenance manual, warranty terms
-Delivery and delivery time: Delivery time (weeks), packaging and transportation requirements
-Acceptance criteria: Run a steady-state test for 1 hour (specified steam flow rate), record and submit the test report; No leakage, no abnormal vibration, cooling water pressure drop and flow rate meet the design requirements

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On site acceptance and testing form
-Steady state operating conditions: steam flow rate (kg/h), cooling water flow rate (m^3/h), cooling water inlet/outlet temperature (° C)
-Record item: Steam flow rate; Cooling water inlet temperature; Cooling water outlet temperature; Cooling water flow rate; Tested Q (kW); Condenser outlet temperature; Condensed water recovery capacity (if applicable)
-Qualification judgment: The error between the measured Q and the design Q is ≤ 10%; The cooling water pressure drops within the supplier's promised range; No leakage or abnormal noise; Structure and flange without deformation
-Acceptance documents: factory test report, on-site test records, material certificates, installation photos

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Example of Multi stage Steam Flow Thermal Balance (20/22.5/25 kg/h)

I provide detailed calculation results and engineering recommendations for three typical steam flow rates for direct comparison and incorporation into on-site parameters. Default parameters: Steam vaporization latent heat \ (\ lambda=2257 \ mathrm {kJ/kg} \), cooling water inlet/outlet temperature of 20/30°C (\ (\ Delta Tw=5 \ mathrm {K} \)), assuming a total heat transfer coefficient \ (U=3000 \ mathrm {W/(m ^ 2 \ cdot K)} \), and a design margin factor of 1.5. The values in the table can be directly copied to Excel for sensitivity analysis or replaced with parameters for recalculation.

Steam flow rate kg/h	Steam mass flow rate kg/s	Heat load Q kW	Cooling water flow rate m^3/h (Δ T=5K)	Cooling water flow rate m^3/h (Δ T=10K)	Δ Tlm K	Theoretical heat transfer area m^2 (U=3000)	Recommended heat transfer area m^2 (margin 1.5)
20	0.005556	12.54	2.16	1.08	74.95	0.056	0.084
22.5	0.006250	14.11	2.43	1.21	74.95	0.063	0.095
25	0.006944	15.68	2.70	1.35	74.95	0.070	0.105

Key calculation formulas and explanations

-Steam mass flow conversion: \ (\ dot m {\ text {steam}}=\ dfrac {\ text {steam \ kg \ d_h}} {3600} \)

-Heat load:\[
Q=\dot m_{\text{steam}}\cdot\lambda
\]

(Unit: \ (\ mathrm {kW} \), where \ (\ lambda \) is represented by \ (\ mathrm {kJ/kg} \)\ (\mathrm{kJ/s}=kW\)) 。

-Cooling water quality flow:\[
\dot mw=\dfrac{Q}{cp\cdot\Delta T_w}
\]

（\(cp=4.18\ \mathrm{kJ/(kg\cdot K)}\)) 。Volume flow \ (=\ dot mv \ times3.6 \) yields m^3/h.

-Logarithmic mean temperature difference:\[
\Delta T{lm}=\frac{\Delta T2-\Delta T1}{\ln(\Delta T2/\Delta T_1)}
\]

其中\ (\Delta T1=Ts-T{w,out}\)，\(\Delta T2=Ts-T{w,in}\)。

-Estimation of heat exchange area:\[
A=\frac{Q{\mathrm{W}}}{U\cdot\Delta T{lm}}
\]

(Q_ {\ mathrm {W}}=Q \) converted to W.

-Engineering margin: It is recommended to multiply by the margin factor (for example, take 1.2-2.0, use 1.5 in the table).

Engineering Suggestions and Acceptance Points

-Suggestion for heat exchanger selection: The theoretical area is small, but in engineering, a condenser of 0.3-1.0 m^2 level should be selected to ensure stability and maintainability; Recommend using 0.5 m^2 as the starting point and request the supplier to provide the U value and pressure drop curve.

-Cooling water reservation: Calculated at Δ T=5 K and reserved at ≈ 2.7 m^3/h (corresponding to 25 kg/h) plus 20-30% margin. It is recommended to reserve 3.5 m^3

/h of cooling water capacity on site.
-Factory test requirements: The supplier is required to provide measured data (cooling water inlet/outlet temperature, flow rate, measured Q) at the specified steam flow rate. During on-site acceptance, the measured Q should have an error of ≤ 10% compared to the design Q.
-Maintenance and cleaning: Priority should be given to removable and washable structures (shell tube detachable bundle or plate detachable plate), and the cleaning port and maintenance space should be clearly specified in the inquiry.
-Safety margin: Considering scaling, decreased heat transfer coefficient, and uneven local flow, the lower limit of U value and fouling factor should be included in the risk assessment during design.

Multi level heat balance Excel template (CSV format can be directly pasted)
Copy the CSV file below to Excel to obtain a calculation table for multiple steam flow rates. Replace the top input item to obtain real-time results.

`csv
Parameter,Cell,Value,Unit,Notes
Steamflowkgh,InputSteam,20,kg/h, Change to 20, 22.5, or 25
Latentheat,InputLambda,2257,kJ/kg, Latent heat of vaporization of steam
Watercp,Inputcp,4.18,kJ/(kg*K),
CoolingTdelta,Input_dTw,5,K, Temperature difference between inlet and outlet of cooling water
SteamTsat, InputTs, 100°C, Steam saturation temperature
CoolingTin, InputTwin, 20°C, cooling water inlet temperature
Uvalue,InputU,3000,W/(m2*K), Assumption of overall heat transfer coefficient
Designmargin,Inputmargin, 1.5, margin factor
,,,
Label,Formulaorvalue,Unit,Notes
Steamkgs,=Input_Steam/3600,kg/s, Steam mass flow
QkW,=Steamkgs*InputLambda,kW, heat load
Coolingmassflowkgs,=QkW/(Inputcp*Input_dTw),kg/s, Cooling water quality flow
Coolingflowm3h,=Coolingmassflowkg_s*3.6,m3/h, Volume flow of cooling water
CoolingOut,=InputTwin+Input_deTw,°C, cooling water outlet temperature
DeltaT1,=InputTs-CoolingTout,K,
DeltaT2,=InputTs-InputTwin,K,
DeltaT_lm,=IF(DeltaT1=DeltaT2,DeltaT1,(DeltaT1-DeltaT2)/LN(DeltaT1/DeltaT2)),K,
QW,=QkW*1000,W,
Aream2,=QW/(InputU*DeltaTlm),m2, Theoretical heat exchange area
Recommendedaream2,=Aream2*Inputmargin,m2, Margin included
`

I will continue to advance based on the default on-site assumption and supplement the results of the multi stage steam flow heat balance as follows:① Suggestions for cooling water pipe diameter and pump selection;② Key points for condenser selection (can be directly used for RFQ);③Quick checklist for on-site acceptance. All calculations are based on the following assumptions (if the on-site parameters are different, they can be directly replaced and recalculated):

Default assumption (already used for the following calculations)
-Steam flow rate: 20/22.5/25 kg/h (3 levels)
-Steam saturation temperature: 100 ° C (approximately 1 bar)
-Cooling water inlet/outlet temperature: 20/30 ° C (Δ T=5 K, additional reference for Δ T=10 K)
-Specific heat of water $c_p=4.18 \mathrm{kJ/(kg \cdot K)}$
-Steam vaporization latent heat $\lambda=2257 \mathrm{kJ/kg}$
-The overall heat transfer coefficient of the design is taken as $U=3000 \mathrm{W/(m^2 \cdot K)}$, with an engineering margin of 1.5 (see table)

1、Final comparison table (including cooling water flow rate and recommended heat exchange area)

Steam flow rate (kg/h)	Q (kW)	Cooling water flow rate m^3/h (Δ T=5K)	Cooling water flow rate m^3/h (Δ T=10K)	Theoretical heat exchange surface A (m^2, U=3000)	Recommended heat exchange surface (m^2, margin 1.5)
20	12.54	2.16	1.08	0.056	0.084
22.5	14.11	2.43	1.21	0.063	0.095
25	15.68	2.70	1.35	0.070	0.105

Engineering suggestion conclusion: The theoretical heat transfer area is small, but to ensure stability and maintainability, it is recommended to choose a minimum of 0.5 m^2(preferably 0.5-1.0 m^2); The cooling water capacity is designed withΔT=5 K and a margin of 20-30%. For a capacity of 25 kg/h, it is recommended to reserve approximately 3.5 m^3/h of cooling water capacity on site.

2、Cooling water pipe diameter and pump selection suggestions (quick and easy to land)
Reference for cooling water flow rate: The maximum design flow rate is taken as 3.5 m^3/h (including margin).
Pipe diameter suggestion:
-0.5-4 m^3/h Common pipe diameter: DN20 (3/4 ") can be used for≤2.5 m^3/h; To

ensure pressure drop and maintenance, DN25 (1 ") is recommended as the preferred option (with a smaller pressure drop at 3.5 m^3/h and easier installation of valves/meters).
Initial selection of cooling water pump (estimated based on experience):
-Flow rate: 3.5 m^3/h (≈ 0.97 L/s)
-Estimate the total pressure drop of the system (including condenser, piping, and valves) within the range of 2-6 mCE (0.2-0.6 bar) (common for small systems).
-Suggested pump head: 6-10m (including safety margin)
-Suggested motor power: 0.37-0.75 kW (check with pump factory curve when selecting, commonly used 0.55 kW or 0.75 kW models)
Acceptance points (pump/pipeline): After arrival, measure the flow rate and pressure drop on site, and ensure that the pump has an efficiency of≥60% at the design point; The pipe diameter, flange, valve, and condenser interface should be consistent.

3、Condenser RFQ Text (can be directly copied and pasted)
`

Project: 50L basket distillation kettle condenser inquiry

1) Design working conditions
-Design heat load: 12.5-16.0 kW (corresponding to 20-25 kg/h of steam)
-Steam saturation temperature: approximately 100 ° C (1 bar)
-Cooling water inlet/outlet temperature: 20/30 ° C (Δ T=5 K, please also provide information on Δ T=10 K)
-Cooling water design flow rate: verified at 3.5 m^3/h (including margin)

2) Technical requirements
-Type: Shell and tube or plate type (please indicate advantages, disadvantages, and recommended models)
-Liquid receiving material: AISI-316L (all liquid receiving parts)
-Recommended heat exchange area: 0.5-1.0 m^2 (please provide calculation basis)
-Design U value: Supplier provides and explains calculation assumptions (fouling factor)
-Cooling water interface: DN25 flange or thread (please indicate standard ANSI/DIN)
-Allowable pressure drop on the cooling water side: Please provide pressure drop curves at different flow rates
-Cleaning and maintenance: detachable tube bundle or detachable plate design, providing cleaning ports and maintenance suggestions
-Factory test: Provide measured data (cooling water inlet/outlet temperature, flow rate, measured Q) at the specified steam flow rate, with an error of ≤ 10% between the measured Q and the design Q
-Documents: Material Certificate (EN10204-3.1), Factory Test Report P& ID、Installation/maintenance manual, warranty terms

3) Delivery and delivery time
-Delivery time (weeks):
-Packaging and transportation requirements: moisture-proof, anti-collision, and inner surface protection

4) Acceptance requirements (on-site)
-Steady state operation for 1 hour records: steam flow rate, cooling water flow rate, inlet/outlet temperature, measured Q
-No leakage, no abnormal vibration, cooling water pressure drop and flow rate meet the design requirements
`

4、Quick checklist for on-site acceptance (condenser and cooling circuit)
-Arrival inspection: model, material certificate, flange/interface size, factory test report.
-Pipeline installation: interface sealing, insulation, slope and bracket fixation.
-Pump and valve: Check the pump curve with the on-site flow point; The valve has a scale and can be adjusted.
-Run test (steady state for 1 hour): Record steam flow rate, cooling water inlet/outlet temperature, cooling water flow rate, condenser outlet temperature, measured Q; the measured Q has an error of ≤ 10% compared to the design Q and is qualified.
-Cleaning and maintenance: Confirm the cleaning port, disassembly space, and detachable tube bundle.

RFQ technical package complete text (bilingual in Chinese and English)

Chinese version of RFQ complete text
Project Name: Procurement and Delivery of 50L Pilot Distillation and Solvent Recovery Unit
Bid number:
Bid deadline: 17:00 (Beijing time)

Contact person: bo; Email:; Telephone:

Scope of Delivery

-Equipment: 50L basket distillation kettle (working volume 35-40 L), jacket, condenser, cold trap, vacuum/recovery pump, cooling water circuit, fittings and flanges.

-Instrumentation and Control: PLC+HMI, I/O modules, temperature/pressure/flow/liquid level/conductivity sensors, terminal blocks and wiring.

-Files: Complete DWG (including flange drilling CSV), P& ID、 Material certificate EN10204-3.1, welding records, factory test reports, IQ/OQ documents, installation and maintenance manuals.

-Services: Factory FAT, on-site installation, debugging, IQ/OQ support, operation and maintenance training, PQ support (3 batches).

-Spare parts: Key spare parts list and price (minimum 6-month consumption).

Design conditions and performance requirements

-Steam supply: Design steam flow rate of 20-25 kg/h; Steam interface DN25; The design pressure/temperature of the jacket shall be in accordance with the supplier's specifications and meet the safety factor.

-Cooling water: The design inlet/outlet temperature is 20/30 ° C, and the design cooling water flow rate is verified at 3.5 m^3/h (including margin); Cooling interface DN25.

-Condenser: Recommended heat exchange area is 0.5-1.0 m^2; Liquid receiving parts AISI-316L; Suppliers are required to provide U values and pressure drop curves.

-Solvent recovery: target recovery rate ≥ 95%; The type and boiling point of the solvent shall be confirmed by the buyer before the contract.

-Surface and material: AISI-316L for liquid receiving parts; Inner surface Ra ≤ 0.8 μ m; Flange RF surface; Provide EN10204-3.1 material certificate for flanges and key components.

-Safety: Explosion proof grade description for solvent area; Solvent leakage detector and linked ventilation and shutdown; E-Stop and safety interlock.

-Data recording: PLC records temperature, pressure, flow rate, and liquid level every 10 seconds; Batch data can be exported as CSV.

Three Factory Test FAT Requirements

-First article inspection: size Ra、 Flatness of flange surface, material certificate, NDT report (if applicable).

-Performance test: Run for 1 hour at specified steam flow rates (20, 22.5, 25 kg/h), record cooling water inlet/outlet temperature, flow rate, steam consumption, condenser pressure drop, and measured Q; the measured Q has an error of ≤ 10% compared to the design Q.

-Provide complete test reports, photos, and data files.

IV. Acceptance and Release
-IQ: Sign the IQ report after installation and file verification are approved.
-OQ: Complete point-to-point I/O, alarm matrix, PID loop tuning, CIP verification, and sign OQ report.
-PQ: Conduct at least 3 batches of real raw material tests, record yield, GC-MS fingerprints, residual solvents, and energy consumption; Release criteria: GC-MS fingerprint similarity≥95%, residual solvent below regulatory limits.
-Release documents: equipment list, IQ/OQ report, 3 batches of PQ report, material certificate, FAT report.

5. Business and Delivery Time
-Delivery time: 8-12 weeks from the effective date of the contract (the bidder shall fill in the specific delivery time and explain its feasibility).
-Warranty period: 12 months; During the warranty period, key spare parts will be replaced free of charge and a response time of 48 hours will be provided.
-Payment terms: 30% advance payment upon signing the contract, 40% before leaving the factory, and 30% after acceptance and release (negotiable).
-The bid bond, performance bond, and breach of contract terms shall be executed in accordance with the contract terms.

Requirements for Six Bidding Documents
-Technical documents: Respond to this technical package item by item and provide evidence (drawings, calculations, test plans).
-Business documents: quotation, payment terms, delivery time, warranty, spare parts list.
-Required Certificates: EN10204-3.1 Material Certificate, First Article Inspection Report, FAT Report, Similar Project Cases, and Customer Contact Person.
-Bid validity period: The quotation is valid for 90 days from the date of submission.

Seven evaluation and grading
-After passing the technical qualification, the scores will be sorted according to the comprehensive evaluation matrix. The rating matrix is attached.
-The supplier's Q&A period is 7 days, and the quotation will be reviewed 21 days after the deadline.

English Version RFQ Full Text
Project: Procurement and Delivery of 50L Pilot Distillation and Solvent Recovery Unit
Bid Reference:
Submission Deadline: (Beijing Time 17:00)
Contact: bo; Email: ; Phone:

Scope of Supply

- Equipment: 50L basket still (35–40 L working volume), jacket, condenser, cold trap, vacuum/recovery pump, cooling water loop, piping and flanges.
- Instruments and Control: PLC + HMI, I/O modules, sensors for temperature/pressure/flow/level/conductivity, terminal blocks and wiring.
- Documentation: Full DWG (including flange drill CSV), P& ID, EN10204-3.1 material certificates, welding records, FAT report, IQ/OQ documentation, installation and maintenance manuals.
- Services: FAT, on-site installation, commissioning, IQ/OQ support, operator training, PQ support (3 batches).
- Spares: Critical spare parts list and pricing for at least 6 months consumption.

Design Conditions and Performance
- Steam supply: 20–25 kg/h; steam inlet DN25; jacket rated for specified pressure/temperature.
- Cooling water: 20/30 °C in/out; design cooling flow 3.5 m^3/h (including margin); cooling connections DN25.
- Condenser: recommended heat transfer area 0.5–1.0 m^2; wetted parts AISI-316L; vendor to provide U-value and pressure drop curves.
- Solvent recovery: target ≥95% recovery; solvent types to be confirmed pre-contract.
- Surface and materials: wetted parts AISI-316L; internal Ra ≤0.8 µm; RF flange; provide EN10204-3.1 certificates.
- Safety: explosion proof classification for solvent area; solvent leak detectors with ventilation and shutdown interlocks; E-Stop and safety interlocks.
- Data logging: PLC logs every 10 s; batch CSV export.

Factory Acceptance Test
- First article inspection: dimensions, Ra, flange flatness, material certificates, NDT if applicable.
- Performance test: 1 hour runs at 20, 22.5, 25 kg/h; record cooling water in/out temps, flow, steam consumption, condenser pressure drop, measured Q; measured Q within ±10% of design.
- Provide full test report, photos and data files.

Acceptance and Release
- IQ: installation and documentation verification.
- OQ: I/O point-to-point, alarm matrix, PID tuning, CIP verification.
- PQ: minimum 3 batches with real raw material; record yield, GC-MS fingerprint, residual solvent, energy consumption; release criteria: GC-MS fingerprint similarity ≥ 95%, residual solvent below regulatory limits.
- Release deliverables: equipment list, IQ/OQ reports, 3 PQ reports, material certificates, FAT report.

Commercial and Delivery

- Delivery: 8–12 weeks from contract award (vendor to specify).
- Warranty: 12 months; spare parts and 48-hour response during warranty.
- Payment: 30% contract signing, 40% before shipment, 30% after acceptance (negotiable).
- Bid bond, performance bond and liquidated damages per contract.

Bid Submission Requirements
- Technical: point-by-point response with supporting documents.
- Commercial: price, payment, delivery, warranty, spare parts.
- Mandatory attachments: EN10204-3.1 certificates, first article report, FAT report, similar project references.
- Validity: 90 days.

Evaluation
- Technical compliance required for commercial evaluation. See scoring matrix.

Complete template for rating matrix (can be copied as Excel)

Scoring items	Weight%	Sub items	Scoring rules
Technical compliance	50	Equipment specification 20; Material and surface 10; IQ/OQ document 8; FAT scheme 6; Safety and Explosion Prevention 6	Each sub item is scored from 0 to 10 points, multiplied by the weight of each sub item, and then summed up
Price and Payment	25	Total Price 15; Payment terms 5; Spare parts price 5	The lowest price will receive full marks, while others will be scored according to the terms
Delivery Time and Service	15	Delivery Time 8; After sales response 7	High score for short delivery time and fast response
Past cases and acceptance records	10	Similar project experience 6; Customer Recommendation 4	Provide case studies and contact person verification scores

scoring process
-The technical team will evaluate each item first, and if the technology is not qualified, it will be eliminated.
-The business team scores the quotations of technically qualified suppliers.
-The final score is weighted and summarized by weight.
-Suggest a bid evaluation team of 5 people (3 technical, 2 business) and record the reasons and evidence for the scoring.

IQ OQ PQ Verification Script Detailed Version

IQ Installation Confirmation Form and Steps

IQ document header: project, equipment number, supplier, arrival date, inspector, signature column.

IQ inspection items (record measured values, qualified/unqualified, and notes one by one)

-File verification: DWG, P& ID、 Material certificate EN10204-3.1, welding records, FAT report.

-Appearance and dimensions: flange OD, PCD, hole position, flange thickness, center hole size (compared with DWG).

-Surface roughness: Measure the inner surface Ra at 4 points and record the value (≤ 0.8 μ m).

-Flange sealing surface: flatness measurement value (≤ 0.05 mm) and Ra (≤ 1.6 μ m or according to gasket requirements).

-Weld and groove: weld appearance, NDT report (RT/UT) review.

-Electrical installation: Terminal block and PLC I/O comparison, measured grounding resistance value (≤ 1 Ω).

-Instrument calibration: PT100, pressure transmitter, flow meter, level gauge calibration certificates and on-site readings.

-Attachments and spare parts: Check the spare parts list.

IQ signature: inspector, supplier representative, date.

OQ run confirmation item by item testing script

OQ document header: project, equipment number, testing date, testing personnel, signature column.

OQ test items (recording steps, expected results, actual results, judgments)

-I/O point-to-point: Simulate input and output point by point, verify PLC/HMI display and response.

-Alarm matrix: Trigger alarms item by item and verify linkage (shutdown, ventilation, buzzing, lights).

-PID loop tuning: PID tuning of kettle temperature, jacket temperature, and condensation temperature, recording parameters and step response curves.

-CIP program verification: Execute CIP, record the conductivity/TOC values before and after cleaning and release standards.

-FAT performance review: Run on-site according to FAT conditions, record cooling water inlet/outlet temperature, flow rate, steam consumption, condenser pressure drop, measured Q; compare with factory data.

-Safety function testing: E-Stop, door interlock, solvent leakage linkage, emergency exhaust test.

OQ signature: Test Manager, Supplier Representative, Date.

PQ Performance Confirmation Detailed Plan

PQ document header: project, batch number, raw material batch number, testing personnel, signature column.

PQ test plan: At least 3 batches of real raw materials, record the process parameters and results of each batch.
PQ record items (per batch)
-Loading weight and composition; Steam flow rate and cumulative consumption; Cooling water flow rate and inlet/outlet temperature; Running time; Quality and yield of recycled materials; GC-MS fingerprinting and similarity calculation; Residual solvent ppm; Energy consumption (kWh); Abnormal event record.
Release criteria: GC-MS fingerprint similarity≥95%; The residual solvent is below the regulatory limit; The yield is within the target range; No security incidents.
Statistical analysis: Calculate the mean, standard deviation, confidence interval, and provide conclusions and recommendations.
PQ signature: Process Manager, Quality Manager, Supplier Representative, Date.

Complete Supplier Questionnaire Form

Question Number	Question	Supplier Answer
Q1	Can you provide EN10204-3.1 material certificate	
Q2	Is it possible to conduct FAT as required and provide a complete report	
Q3	Delivery Time (weeks)	
Q4	Warranty period and after-sales response time	
Q5	Do you provide on-site IQ/OQ support and training	
Q6	Spare parts list and price (including delivery time)	
Q7	Similar project cases and customer contacts	
Q8	Do you accept the first article inspection and performance guarantee clauses in the contract	

Draft Key Terms of the Contract (Key Terms)

-Delivery and acceptance: The supplier delivers the technical package according to the contract, and the buyer has the right to conduct first article inspection FAT、IQ/OQ、PQ； Suppliers who fail the project are responsible for rectification and bear the costs.
-Performance guarantee: The equipment shall meet the technical package requirements in terms of performance under the contracted operating conditions; If PQ does not meet the standard, the supplier is responsible for free rectification and bears the cost of re PQ.
-Warranty and after-sales service: The warranty period is 12 months; Key spare parts respond within 48 hours; During the warranty period, non human made faults will be repaired or replaced free of charge.
-Default and Penalty: Delay in delivery shall be subject to a penalty of 0.1% of the

total contract price per day, and the cumulative penalty shall not exceed 10% of the total contract price; The buyer has the right to terminate the contract and demand compensation for major breaches.
-Payment terms: 30% advance payment upon contract signing, 40% before leaving the factory, and 30% after acceptance and release; The final payment is conditional on PQ release (negotiable).
-Confidentiality and Intellectual Property: Both parties shall keep confidential technical information to each other; Suppliers are not allowed to use buyer's process data for third parties.
-Dispute Resolution: Through friendly negotiation, if negotiation fails, the dispute shall be submitted to the mutually agreed upon arbitration institution for arbitration.

Sample bidding email and schedule

Template email body
> Subject: RFQ for 50L Pilot Distillation and Solvent Recovery Unit
> Dear [Vendor],
> Please find attached the RFQ package for a 50L pilot distillation and solvent recovery unit. Submission deadline: [date]. Required documents: technical proposal, commercial proposal, EN10204-3.1 material certificates, FAT report, and similar project references. Please submit questions within 7 days. Contact: bo, email: [email]. Best regards, bo

Proposal for bidding schedule
-Post RFQ: Day 0
-Supplier Q&A period: Day 0-7
-Quotation deadline: Day 21
-Technical Review: Days 22-28
-Business Review and Bargaining: Days 29-42
-Contract signing: Day 43-56
-Delivery time: 8-12 weeks after contract signing

Attachment templates and tables (can be directly copied and used)

Key points of FAT report template
-Project and equipment number; Test date; Testers; Testing conditions; Test data sheet (steam flow rate, cooling water flow rate, inlet/outlet temperature, measured Q, pressure drop); Photos and conclusions; Signature column.

Key points of IQ report template

-Document checklist; Size and surface measurement record sheet; Electrical wiring and grounding test records; Instrument calibration certificate attachment page; Signature column.

Key points of OQ report template
-I/O point-to-point testing table; Alarm Matrix Test Table; PID tuning record and response curve; CIP verification records; Record of safety function testing; Signature column.

PQ Data Record Form (per batch)
-Batch number; Raw material batch number; Loading capacity; Steam consumption (kg); Cooling water consumption (m^3); Running time; Recycling quantity (kg); Yield%; GC-MS file name; Residual solvent ppm; Energy consumption kWh; Conclusion and signature.

Delivery method and follow-up suggestions
-Immediate action: Package this RFQ technical package, scoring matrix, supplier questionnaire, and contract points as attachments and publish them.
-Parallel preparation: Prepare a printed version of the IQ/OQ/PQ form for on-site signature.
-Risk control: Mandatory first article inspection and factory performance test reports are required for bidding in the contract, and performance guarantee or bond shall be retained.