

FLUE GAS ANALYSIS SYSTEM CEM-500

USERS MANUAL



1. System Overview

1.1 System introduction

CEM-500 type flue gas emissions on-line monitoring system is a combination of the world's most advanced online analytical techniques and environmental monitoring special requirements, combined with my company for many years in the field of industrial processes and environmental monitoring in the field of accumulated rich experience. It can be applied to the on-line monitoring of gaseous pollutants (SO₂, NO_x, CO, CO₂, O₂) in flue gas as well as temperature, pressure and flow rate (T,P,F are optional). The data acquisition and processing system can generate diagram curve and environmental reports (optional), which is fully meet the government standard of Environmental Bureau of "Specifications and Test Procedures for Continuous Emission Monitoring Systems of Flue Gas Emitted from Stationary Sources".

1.2 The scope of application

This system is applicable to thermal power plant boilers, industrial & civil boilers & industrial kilns and fixed pollution source flue gas CEMS with solid fuel or raw material as fuel or raw material.

1.3 Working environment

- ✓ Ambient temperature: -5 °C ~ 40 °C, to avoid direct sunlight and close to the heat source;
- ✓ Air-conditioning from -15 °C ~ 40 °C or -5 °C ~ 50 °C
- ✓ Atmospheric pressure: 86 ~ 106KPa
- ✓ Relative humidity: ≤90%
- ✓ Flue gas temperature: <500 °C
- ✓ There is no strong vibration on site, the maximum vibration does not exceed 100Hz, 0.3m / s².

1.4 Facilities

- ✓ Power: 220V AC 50Hz
- ✓ Startup power: 5KVA (single set, with heating pipe does not exceed 30 meters)
- ✓ Working power: 3KVA (single set, with heat pipe does not exceed 30 meters)
- ✓ Gas source: Compressed air , 0.4 ~ 0.8MPa clean, no oil, no water
- ✓ Compressed air consumption: less than 20L / h (based on the actual dust content of the site smoke)
- ✓ Water requirement: None
- ✓ Others: The equipment room requires the installation of ventilation equipment, dust-proof facilities, air-conditioning equipment, lighting equipment and so on.

2. System Details

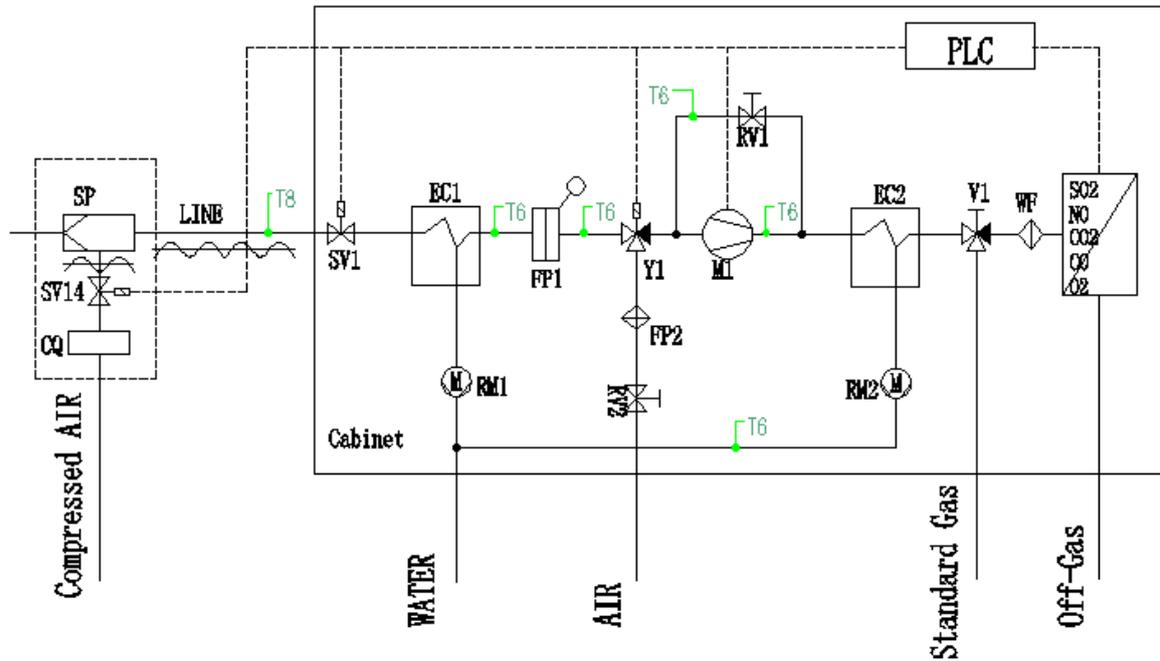
2.1 Working principle

CEM-500 flue gas emissions on-line monitoring system is a combination of heating extraction sampling + non-dispersive infrared absorption measurement principle. The flue gas collected by the heated sampling probe goes through heated sampling tube and two dehydrations, then inlet the analyzer. Stainless steel sampling probe with built-in particles filter (filter element made of titanium sintered), can remove the diameter of more than 2 μm of particles from the sample gas, to avoid

sampling pre-treatment system blocked. The flue gas to maintain its original state after filtering, and avoid the sample gas condensation with heating tube. Before entering the analyzer, the flue gas is rapidly dewatered at two stages of pretreatment equipment to "dry" the flue gas into the analyzer.

2.2 system components

Figure 1: System gas flow chart



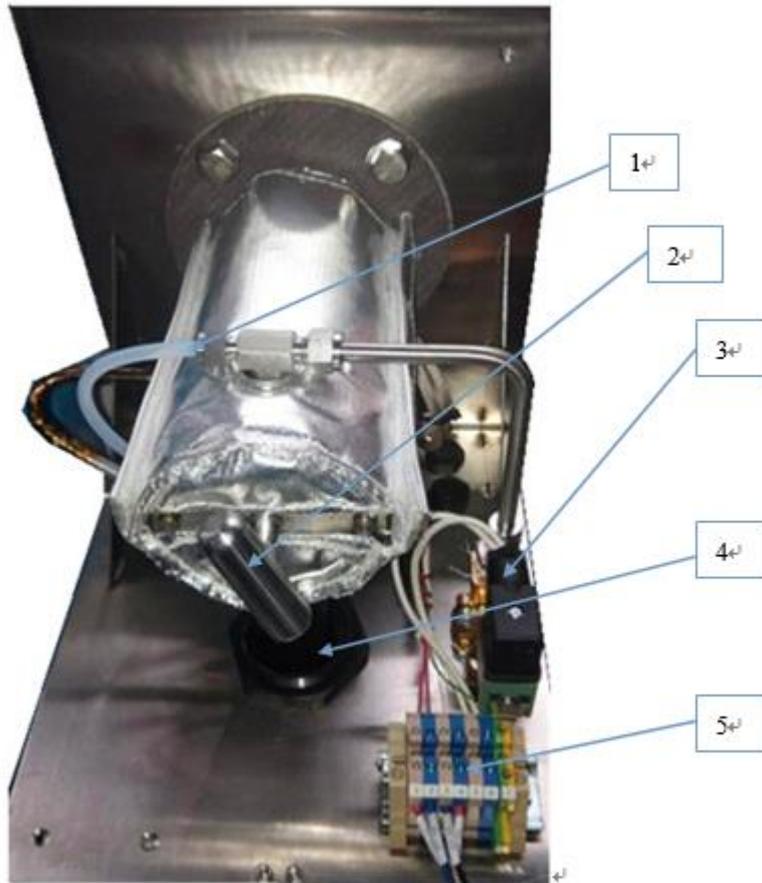
2.2.1 Sampling probe

The sampling probe collects the gas samples in the stack and then filter dust primarily in order to reduce the blockage and pollution in the gas pipe and gas pretreatment system caused by particles and moisture. The sampling probe is heated by a constant temperature controller and have backflushing system, to blow away the dust from the sample gas regularly.

It has following features:

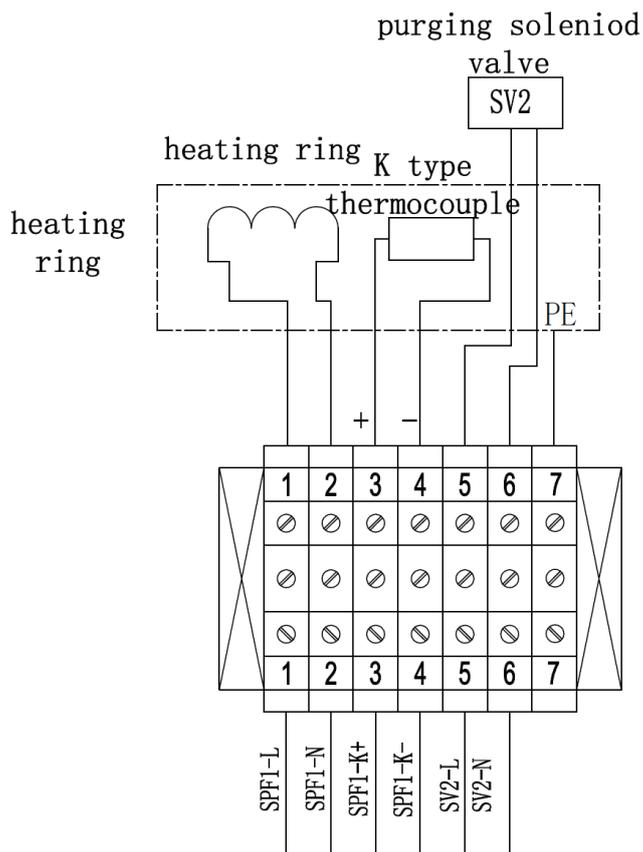
- 1) Sampling probe easy to use and maintain: the sampling probe installed the particulate filter inside. The cartridge design and quick-release handle structure of the probe filter make it easy to remove, install and replace.
- 2) Automatic Backflushing system: The default automatic cycle is 6 hours, and the blowback cycle can also be adjusted according to the emission of on-site pollution sources and customer requirements.

Figure 2: internal layout of sampling probe



1. calibration port
2. filter element handle: anticlockwise rotate it to bring out of the filter element.
3. purging solenoid valve: DC24V, 6.9W, G1/2 connector
4. Heated tube inlet
5. Wiring terminal

Figure 3: electricity wiring of sampling probe



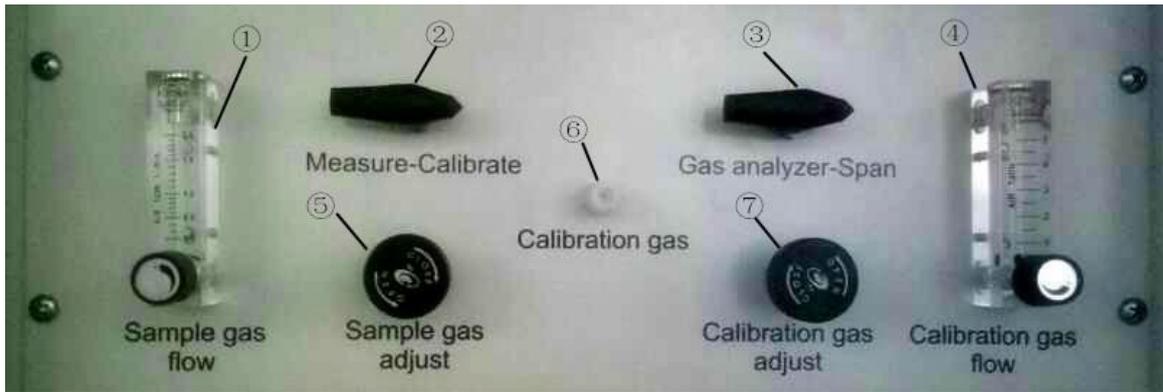
2.2.2 Pretreatment unit

Pre-treatment unit includes: gas condenser, sampling pump, flow control unit, high precision filter, condensating water drainage unit and so on. The functions are gas purification, dust removal, dehumidification, with dust filtration accuracy up to 0.1 μ m, continuously sent clean and dry sampling gas to the analytical instruments, thus ensuring that the analytical accuracy and long-term reliability.

Gas pretreatment equipment working flow chart is like this: the sample gas goes through a cooler to remove moisture and condensating water is collected in the bottom and through peristaltic pump to discharge; and then it goes through a high precision filter to remove dust above 0.1 μ m, followed by gas sampling pump takes out and enters the second stage condenser with a fixed dew point followed by a manual three-way valve, then through the gas-water filter and into the gas analyzer, which can be checked by injecting a standard gas through a manual three-way valve to test instrument sensitivity and accuracy. The analyzer continuously and simultaneously has the option of measuring up to five gases. After the measurement, the gas goes outside the room and flows into the atmosphere. The condensate of the gas is discharged through the peristaltic pump under the condenser. The sample gas pretreatment system can improve the accuracy of the monitoring data by minimizing the loss of SO₂ and NO_x from the condensate during the sample gas transmission.

The system works continuously and need regular maintenance, depending on the emission of pollutants and on-site environment to adjust the maintenance cycle. If the gas condenser or sampling probe have problem, the alarm signal will be generated, the sampling pump power will be cut off, and the system will be shut down and into a protection status. System fault indicator lights, maintenance personnel can be found in time. After the fault is solved, the system will automatically switch to normal operation and the sampling pump will start automatically.

Figure 4: Gas pretreatment panel



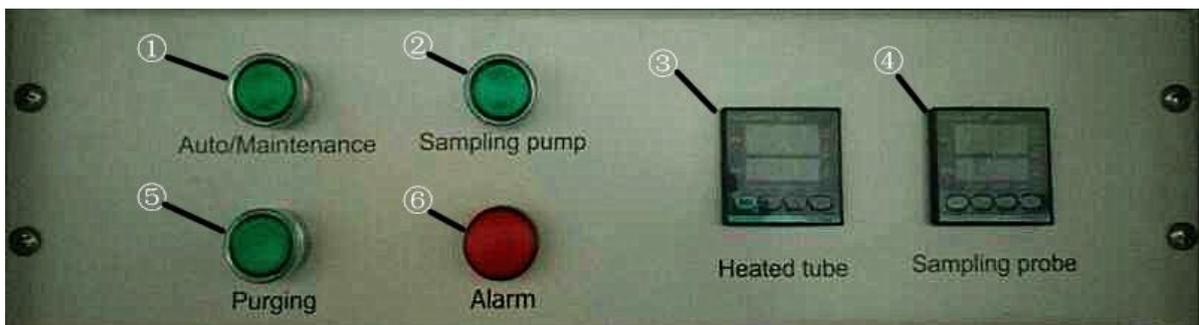
1. sample gas flow
2. switch valve for measurement and calibration
3. span point calibration
4. calibration gas flow
5. sample gas bypass adjust
6. calibration gas inlet
7. calibration gas bypass adjust

2.2.3 Control Unit

The system adopts S7-200 PLC module. It can connect DCS systems for monitoring, automated data processing and remote transfer.

The CEM-500 output signals include: fault, calibration error, power failure, maintenance, range indication, and calibration. In addition, it has the function of holding data before calibration.

Figure 5: PLC control panel



1. Auto/ maintenance switch
2. sampling pump indication and pumping manually
3. heated tube temperature control
4. sampling probe temperature control
5. Purging indication and purging manually
6. Alarm indication

2.2.4 Analysis Unit

The analysis unit of the CEM-500 is the ZRE infrared analyzer manufactured by Fuji of Japan. The

concentration of SO₂, NO, CO and CO₂ is determined by non-dispersive infrared absorption technique. The concentration of O₂ is determined by electrochemical technique.

Gas Analyzer

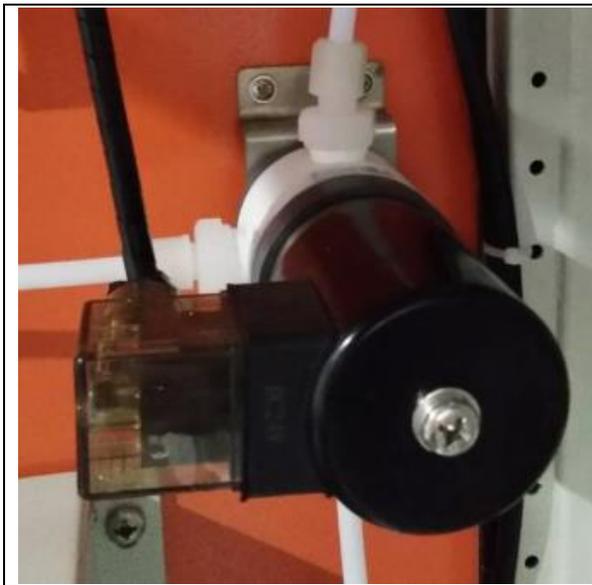


- ✓ Continuous monitoring of 5 flue gas components in one analyzer.
- ✓ Human-machine interface friendly: LCD display, adjustable backlight, simple operation, fast programming, menu operation (programming, testing and calibration, etc.), easy maintenance and automatic calibration. Two scale ranges can be set in the measurement range which can be overrun automatic switching.
- ✓ Sample gas chamber with a unique removable technology, removable cleaning.
- ✓ It uses zero-point air calibration to reduce zero drift, making long-term operation more stable.
- ✓ Air can be used as the standard gas for calibration of oxygen.

2.3 System main components

Picture	Function
	<p>Name: stop valve Function: stop purging Parameter: Valve type: normally closed solenoid valve Power supply: DC24V, 6W Interface specification: G1/4.</p>
	<p>Name: sampling pump Function: sampling the gas Parameter: Pump type: diaphragm pump Power supply: AC220, 60W Flow rate: 5.5L/min Working pressure: -160mbar~2.5bar</p>

	<p>Name: condenser Function: remove the sample gas moisture Parameter: Type: compressor type Power supply: 220V + 10% 50Hz Entrance gas dew point: ≤80°C Dew point of outlet gas sample: +4 °C The sample gas handling capacity: ≤300L/H</p>
	<p>Name : peristaltic pump Function: drainage Parameter: Power supply: 220V 50Hz Revolutions: 7.5 RPM</p>
	<p>Name: precision filter FP-2T Function: precision filtration of the sample gas Parameter: Filter material: glass fiber Filtration accuracy: 0.1um Interface specification: G1/4</p>
	<p>Name: hydrophobic filter Function: removal moisture Parameter: Filter material: PTFE Filtration accuracy: 0.2 μm Interface specification: F8</p>



Name: three-way solenoid valve
Function: air/calibration gas switch
Parameter:
Solenoid material: three way
Power supply: DC24V,6W
Interface specification: G1/4

3. System technical parameters

3.1 Pre-treatment unit technical parameters

- ✓ Cabinets: size 800 * 600 * 2100, the cabinet is made of 2mm steel electrostatic spraying
- ✓ Control system: Siemens PLC, automatic backflushing system, sampling, drainage, eliminating manual maintenance
- ✓ Sampling pump: The German KNF pump, sample gas extraction volume $\geq 4\text{L} / \text{min}$, stable operation for a long time to ensure that the system response time
- ✓ Dust removal: Adopt titanium alloy filter in the sampling probe to remove dust above $2\mu\text{m}$; then through the secondary filter, the filtration precision can reach $0.1\mu\text{m}$ to reach the requirement of gas analyzer, then through the hydrophobic filter ($0.2\mu\text{m}$) to ensure the stable operation of the analyzer
- ✓ Removal moisture: the sample gas into the condenser, the rapid removal of gas in the sample gas, and the use of peristaltic pump automatic drainage; and then into the condenser secondary condensation to further ensure the dehydration
- ✓ Protection: Sampling probe, heating pipe and condenser have alarm function. When the system heats up and the condenser is in abnormal water removal, the alarm signal will be transmitted to the PLC to cut off the system operation and ensure the safe use of the analyzer. Alarm signal.

3.2 Gas analyzer specifications

- ✓ Measurement components: SO_2 , NO , CO , CO_2 , O_2
- ✓ Measurement methods: SO_2 , NO , CO , CO_2 --- non-dispersive infrared absorption method (NDIR)
 O_2 --- electrochemical method
- ✓ Measuring range: SO_2 :0-1500mg/m³, NO_x :0-400mg/m³, O_2 :0-25%, CO :0-250mg/m³, CO_2 :0-50%
- ✓ Measurement accuracy: $\leq 2\%$ FS
- ✓ Response time: $\leq 60\text{s}$
- ✓ Automatic calibration: The instrument built-in automatic zero adjustment device can be automatically calibrated without standard gas zero
- ✓ Power supply: AC180 ~ 240V, 50Hz, 60W
- ✓ Output signal: standard RS-232/485, DC 4 ~ 20mA current output;

- ✓ Dimensions: 482.6mm (19 ") * 390mm * 132mm (3U)
- ✓ Instrument weight: about 12kg
- ✓ Operating temperature: 5 °C ~ 45 °C
- ✓ Relative humidity: <90% RH
- ✓ Atmospheric pressure: 85 ~ 105 Kpa

4. System installation

4.1 Sampling point selection

- ✓ Monitoring sampling points should be selected downstream of the emission control equipment of solid pollution source; vertical pipe section and stack negative pressure area should be selected first; and the location of stack bend and the section with sharp changes should be avoided. Monitoring sampling points need to build a monitoring platform to facilitate the installation and maintenance of technical staff, monitoring platform easy to reach, there is enough space for routine maintenance and comparison monitoring. When the sampling platform is set at a height of ≥5 meters from the ground, there should be a Z-ladder / escalator / elevator leading to the platform.
- ✓ Monitoring sampling points need to open two flange holes (main sampling hole, test comparison hole). If it is positive pressure, need to install gate valve and sleeve.
- ✓ Flange welding must coincide with the vertical direction, in accordance with the flue gas flow
- ✓ Flange welding point in the center of the flue, some flange can be adjusted accordingly. The distance between the flanges should be greater than 50cm, depending on the site conditions.
- ✓ Flange welding must be anti-acid corrosion treatment

4.2 Monitoring equipment workshop construction

- ✓ The equipment should be set up in a safe place close to the sampling points of the monitoring and shall be built with brick and concrete structures with the indoor area of not less than 10 square meters.
- ✓ Should install exhaust fan and air-conditioner
- ✓ Standard security door, the door width of not less than 800mm.

4.3 System of strong electrical installation

- ✓ The system's strong power requirements for the power supply single-phase 220V, 20A, 5KW must be equipped with ground protection. Use three-core power cord 4 square cable. Harsh environment can be laid through the pipe laying, pipe material through the seamless steel pipe, the size is greater than $\phi 24$.
- ✓ Distribution box selection of well-known brand air switch, and with leakage protector.
- ✓ The lightning protection device must be installed on site.
- ✓ Note: The power from the factory to the equipment room, the equipment room must be installed between the ground protection

4.4 System weak electrical installation

- ✓ The system uses a structured design, installation of weak systems outside the equipment room only 4-core shielded cable routing.
- ✓ The signal input part (referring to the inter-device sampling probe and monitoring host computer and the communication between the monitoring part): 4-core shielded cable as the transmission medium from the monitoring platform to the analytical instrument. Specific alignment to be determined at the scene, should pay attention not to be co-laying with strong electricity, the use of pipe or bridge laying.
- ✓ Signal output part: 4-20mA standard current output or RS485 communication interface.

4.5 Clean gas requirement

- ✓ Flue gas automatic monitoring equipment is a high-precision optical analysis instrument. To ensure the long-term stable operation of the monitoring instrument, the monitoring and analysis data are accurate and effective. The instrument must be clean and not contaminated. Therefore, it is required to provide the gas source for cleaning the instrument.
- ✓ Compressed gas source is provided by the factory and requires the clean gas source to be transported to the equipment room by the gas pipe.
- ✓ Gas source requirements: gas source of oil-free, anhydrous, non-suspended particulate matter, pressure to the equipment room is not less than 0.4MPa.
- ✓ If there is no compressed air source in the factory, it is suggested to purchase air compressed air pump for clean air supply.
- ✓ Gas source to the equipment room provided by the factory
- ✓ Request the factory to complete the above five items in the system project before the installation of the technical requirements.

4.6. System installation

- ✓ Step 1: Install the sampling probe.
- ✓ Step 2: The steel pipe or bridge is set up between the work platform and the equipment. The sample heated tube and the cable are laid through steel pipe or bridge.
- ✓ Step 3: heated tube connects to sampling probe; the other end should be equipped with exproof terminal, sampling probe electricity wirings
- ✓ Step 4: Heat tube goes into the cabinet and use the bracket to fix it throught the inlet of SV1 (stop valve)
- ✓ Step 5: Connect the heat tube control line and the heat tube belt with 4mm² wire and connect it well.
- ✓ Step 6: Insert the temperature sensor of heat tube and be close to the sampling pipe;
- ✓ Step 7: All the signal lines enter the cabinet and enter the electrical backplane along the upper lead frame and connect to the X2 terminal pile according to the label;
- ✓ Step 8: Connect Power supply of the sampling probetos X3 terminal pile;
- ✓ Step 9: System cabinet main power cable into the cabinet according to the drawings of X3 wiring pile;
- ✓ Step 10: Connect the exhaust and drain lines (leading to the outdoors).

4.7 Power on and test

Test sampling probe and the analyzer calibration after 24 hours of stable operation

5. System operation

- ✓ Instrument operation

After powering on, operate air switch as following.

Step	Air switch number	Function
Step 1:	ZK1	The main power supply in the cabinet
Step 2:	ZK9	Power supply of heat tube
Step3:	ZK3	Power supply for sampling probe
Step4:	ZK8	Power supply for cabinet lights
Step5:	ZK2	Power supply of cooler
Step6:	ZK4	Power supply for gas analyzer
Step7:	ZK5	PLC controller power supply
Step8:	ZK6	Power supply for 24V switching power supply
Step9:	ZK7	Power supply for inspection power socket

- ✓ According to the above steps to open the air switch, power on the analyzer, the system enters into the working state.
- ✓ The instrument calibration: after the stable operation of the equipment, connect the calibration gas with instrument interface, using the calibration function (see the operation manual of the analyzer).

6. Daily inspection, common faults and Solutions

6.1 Daily precautions

- ✓ For the field data timely view, abnormal timely contact with the manufacturer, the manufacturer will be rushed to the scene within 24 hours of maintenance.
- ✓ The utility condition to keep the normal indoor instrument (lighting, air conditioning, ventilation etc.).
- ✓ The sample gas and standard gas are toxic and harmful gases, beware of leakage!!! When the standard gas is not used, the main valve of the gas cylinder should be closed. Pay attention to maintaining a good indoor ventilation environment.
- ✓ If have not use instrument for a long time, pls use clean air blowing pipe 5 - 10 minutes to ensure that no corrosive gas in the gas analyzer, and then cut off all power, and careful storage, avoid sunlight or humidity
- ✓ Please use the power for the system with rated specifications, otherwise it may cause a fire or system abnormal work.
- ✓ Please make sure the system or equipment on the ground according to the provisions of the construction, otherwise it may cause electric shock or abnormal instrument.
- ✓ The system for the stack is strictly prohibited without permission to adjust and move.
- ✓ The operation of the equipment must ensure that the sample gas already removed water, dust and oil and other pre-processing operation, otherwise affect the accuracy of measurement instrument. If condensate discharged from the drain pipe is corrosive and should be discharged to the safety drain.
- ✓ The equipment in diagnostic or testing condition, please do not turn on or turn off the

instrument power, otherwise it will damage the equipment

- ✓ The instrument calibration must be in accordance with the instructions, in order to ensure the accuracy of measurement instrument.

6.2 Daily precautions

No	Maintenance content	Request	Fault analysis
1	Inspection analyzer	Flow rate: 0.5-1L/min	The air tightness or the blockage of the pipeline or probe and the normal operation of the air pump
		Is the display interface normal?	Look at the running record and refer to "analyzer manual"
2	Check each protection filter	The filter element is white, and no discoloration or particles are allowed. And there's no water or moisture inside	Discoloration: replace the filter element;
			◦ Filter element with particulate matter: check the filter core is damaged or sealed is intact, and replace the filter element.
3	Check the cooler rear pipe	Any moisture	If yes, check the cooler and peristaltic pump
4	Check cooler	Refrigeration temperature: 2 °C -4°C	See if the setting temperature is correct or the refrigerator is working properly. The analyzer fan is functioning properly. Is the air conditioner normal.
5	Check peristaltic pump	Whether the drainage is normal, whether there is condensate discharge, the joints are loose	Replace the peristaltic pump tube or peristaltic pump.
6	Check the sampling pipeline	Is there heating (hand touch with heat pipe skin is hot or not)?	Check whether the power supply and temperature control are connected correctly
7	Check sampling probe	Heating is normal (do not use hand touch directly! Gloves with heat insulation)	Check whether the power supply and temperature control are connected correctly, and whether the heating rod is damaged.
8	Check sampling system	Whether the sampling system is airtight, whether the sample gas is normal or not, whether the gas path in the cabinet is normal or not is analyzed,	Check the filter in the sampling probe, whether the heating system is normal or not, and whether the power supply is normal

6.3 Common faults and treatment methods

Fault phenomenon	Fault reason	Solutions
no response after power on	No power supply; Power line damage; Fuse tube fuse.	Power supply, replace the power outlet; Replace damaged parts (insurance pipe in the power line below the socket holder)
After power on system, the screen back light, but no image or image display screen, white light	The influence of environmental temperature on LCD screen (which is caused by the influence of voltage); LCD screen contrast setting is not normal.	After the instrument normally started, the screen contrast can be adjusted by left or right key in standby mode until the best display effect is achieved.
Small flow or no flow	Sampling system fault; Sampling port leakage; Blockage of exhaust port or exhaust pipe.	Check the sampling system and eliminate external faults; Tighten the sampling port to connect the gas pipe and replace the sampling tube; Check the exhaust port; replace the exhaust pipe.
The measured numerical response is slow and the measured values change little or no change	Gas leakage of sampling gas path; Dust filter clogging; The heat tracing tube is not accompanied by heat; The sampling probe does not contain heat	Check the sampling system and refer to the "flow less or no flow" processing method; Replacing dust filter paper; Check the heating line and sampling probe to keep the heat tracing state
The magnitude of the measured value is larger than the allowable error	The instrument is not preheated enough; Sampling instability	Normal instruments start and preheat (15-30 minutes); Check sampling system.
After measurement, the value does not return to zero	The gas circuit with residual gas; Influence of instrument zero drift.	Perform measurements to remove residual gas through nitrogen or clean air; continuous air measurement for 5 minutes. Perform zero adjustment or (and) user calibration.
The deviation of standard gas data is larger	The analyzer was contaminated; There is some water content in sample gas; Exception of pretreatment system; Calibration error; Output port factory error.	Check the condenser for proper operation; Each filter is tested for normal or not; Peristaltic pump detection; Re calibration; Re search output port

Fault phenomenon	Fault reason	Solutions
Water vapor in the rear pipe of cooler	<ul style="list-style-type: none"> The pump is not in the normal position should be adjusted; Pump damage should be replaced 	The refrigerator and peristaltic pump should be inspected; Especially to check the peristaltic pump pump.
Protection filter dust accumulation	The main cause of dust accumulation is the damage of the filter of the sampling probe	Check, clean or replace in time.
Discoloration of protective filters Plugging of sampling pipeline	<ul style="list-style-type: none"> Probe heating and abnormal heating of sampling tube; Compressor condenser abnormal; Abnormal operation of peristaltic pump; 	<ul style="list-style-type: none"> Check the power supply of the probe and the sample tube; Check cooler; Check the peristaltic pump or pump; Timely replacement.
Refrigerator temperature controller abnormal	<ul style="list-style-type: none"> Cooler damage; Temperature controller damage; Damage to the safety pipe; Cold chamber damage 	Replace all instrument fittings.
Trouble light	<ul style="list-style-type: none"> Check the working temperature of the refrigerator, such as near the room temperature, the refrigerator damage. Check the probe heating temperature, such as the temperature close to the normal temperature, indicating that the probe heating failure 	Inform Supplier maintenance.

7. Transportation and storage

In the process of transportation and storage, the instrument should be rainproof, shockproof, anti inversion

Spare Parts

Item	Name	Remark	Qty
1	Filter element	Precision filter	4pcs
2	(ΦF6×1)PTFE tube tube	Gas Analysis	10m
3	Filter element	Sampling Probe	1pc
4	Peristatic pump pipe	For persitatic	4pcs