

Mini Spray Dryer



IN-SD Mini

★ Only for **Liquid Material**

Warning

- All personnel involved in operation and maintenance are requested to read this manual carefully before using this machine;
- This manual can help users to operate and maintain the machine conveniently and safely;
- Failure to operate in accordance with this manual may cause damage to the equipment or even a safety accident.

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1 User Notification

1. User instructions

This manual introduces the IN-SD Mini spray dryer and provides all the information needed to operate it safely and keep it running normally. The content of the manual is provided especially for laboratory personnel.

1.1 Introduction

This manual includes general information about equipment and subsystems, process design data, operation instructions, maintenance requirements and accident resolution instructions, as well as other information related to occupational safety and health. During the lifetime of the device, modifications/retrofits may occur. In order to keep this manual as a useful reference tool in the future, the instrument information must be kept updated.

1.2 Customer Service

Our customer service includes: all technical data about instruments and equipment and system engineering application software kept by you. If you encounter difficulties, please contact the responsible local representative office Anhui INUO Corporation.

If you have any questions about this manual or want to order replacement parts, please contact us in time. This will ensure that you receive the correct manual or replacement parts required.

1.3 Copyright Notice

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Without the prior written approval of Anhui INUO Corporation, no part of this user manual may be copied in any form or by any method such as electronic, mechanical, magnetic, optical, chemical, manual or other methods. , Spread, transcribed, stored in a retrieval system, or translated into any language or computer language.

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1.4 Liability Guarantee

The information, data and instructions on the installation, operation and maintenance of the instrument in this instruction manual are the best reference information that can be given based on our current experience and professional knowledge before the date of printing.

The instruction manual includes all important information, and the user must be fully familiar with the contents before operating it.

We are not responsible for damages and losses caused by failure to strictly follow the operations in this instruction manual, including the interruption of production operations. In the case of Anhui INUO's liability guarantee, when a defect is found, it must be reported immediately in the form of a detailed written declaration with the contract number within the scope of the guarantee, and Anhui INUO must provide all relevant operations and maintenance Data and the opportunity to conduct a comprehensive inspection of the factory.

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Any software described in this instruction manual is sold "as is". Anhui INUO Company reserves the right to modify this manual and to make changes to this content.

2.Safety information

This chapter introduces the safety functions of the instrument, including general rules of conduct and warnings of dangerous situations related to the use of the instrument. The safety of users and other personnel can only be guaranteed if the safety instructions and safety-related warnings provided in each chapter are strictly followed. Therefore, this manual must be made available to all persons involved in the work described in this manual.

2.1 User Qualification

This instrument can only be used by laboratory personnel or personnel who, out of training or professional experience, have a thorough understanding of the hazards that may occur when operating the instrument. Those who have not undergone such training or are currently receiving such training need careful guidance. This operating manual can be used as a basis for providing such guidance.

2.2 Correct Use

This instrument is a laboratory instrument. It is only used to dry aqueous solutions or safety suspensions or solutions in one operation.

2.3 Incorrect Use

It cannot be used to process materials that are flammable, explosive or prone to produce a large amount of gas. In particular, materials that may release gases of unknown chemical composition.

The following application methods are also expressly prohibited:

- Do not spray dry organic solvents at will.
- Use this instrument in a room where explosion-proof instruments are required.
- Handling samples that may explode or burn due to impact, friction, heat, or sparks.
- Dispose of substances that can produce oxygen.

The operator is solely responsible for the risk of accidents due to such incorrect use.

If you have any questions about this, you can call our company for detailed inquiry.

2.4 Warning Sign



Electrical hazard



Hot surface

2.5 Instrument Safety

This instrument is designed and manufactured according to the latest technology. However, if the instrument is used incorrectly, it may cause danger to the user, property and experimental environment.

The instrument manufacturer has determined that there is a risk of residual instruments in the following situations:

- If the instrument is operated by personnel without adequate training.
- If the instrument is not operated in accordance with its proper use.

When using the instrument, if necessary, please wear personal protective equipment, such as goggles, protective clothing and gloves.

2.6 Electrical Safety

All power distribution equipment contains dangerous voltage that can cause death, and the degree of danger will decrease with the correct operation and maintenance.

Routine inspections should be carried out on the problems displayed on the electrical devices. Usually, when the surface becomes hot or burnt, it should be shut down immediately and inspected or corrected. Misoperation of electrical equipment will create an unsafe environment. The personnel allowed to operate these electrical equipment should have relevant qualification certificates and be familiar with the equipment requirements and all potential hazards contained in the equipment.

2.6.1 Dangerous Voltage

Electrical accessories containing dangerous voltage should be kept closed during operation. Many accessories have multiple power sources, and all the contacts of each device must be fully understood, so that all devices can be powered off before being allowed to enter the device.

2.6.2 Adjustment

Misadjusting the equipment can be dangerous. Before adjusting the equipment, the consequences of the change must be estimated to ensure equipment operation and personal safety. Refer to the description of each special component when making adjustments.

2.6.3 Failure

Fuse blown, circuit breaker trip or overload trip all indicate a potentially dangerous situation. The cause of the overload must be investigated before the equipment is restarted. Starting the equipment without identification or correction may cause equipment damage and personal danger.

If the fuse is blown or the circuit breaker trips, the overload current will cause damage to the equipment. If necessary, check the damage and repair the equipment before restarting.

Fuses, circuit breakers, overloads and other electrical devices must be replaced with devices that indicate voltage, current, and operating performance. The current capacity, trip performance and interruption performance cannot be changed arbitrarily, unless there is a detailed estimation of the current and load changes, and the changes can be guaranteed.

2.6.4 Maintenance

There is a danger of electric shock when working close to electrical devices. Be sure to cut off the power before working. Only trained and qualified professionals can perform work when using the correct procedures and tools. The purpose of maintenance is to keep the equipment in a good condition. Small problems will lead to bigger problems if they are not solved. A thorough and complete mechanical inspection should be done at least once a year.

Check the connections of terminals, fuses, wires and ground to prevent overheating or looseness. The connection must be clean and the loose terminal must be tightened or replaced.

The movable parts should be inspected to ensure that they move freely and are free from sticking or damage. Any parts that show a problem need to be repaired and replaced.

The vents must be unblocked, and if the equipment has auxiliary cooling devices, periodic inspections must be carried out.

The electrical cabinet cannot be used to store other materials and equipment.

The movable parts should be inspected to ensure that they move freely and are free from sticking or damage. Any parts that show a problem need to be repaired and replaced.

The vents must be unblocked, and if the equipment has auxiliary cooling devices, periodic inspections must be carried out.

The electrical cabinet cannot be used to store other materials and equipment.

2.7 High Voltage Equipment

Listed below are the safety precautions to be observed when using medical oil-free air compressors, and the safety precautions must be strictly observed when using them; to prevent fire, electric shock, personal injury and other accidents.

- ① Keep the workplace clean: disorder can easily lead to accidents.
- ② Pay attention to the environment of the workplace: the air compressor should not be left to wind or rain, and do not work in damp and dark places, and do not work in places where flammable and explosive liquids, gases, and dust are stored.
- ③ Beware of electric shock: When using the air compressor, please do not allow the machine itself to touch grounded objects (such as pipes, heating pipes, refrigerators, etc.).
- ④ Keep outsiders/children away: Keep children who have nothing to do with the work close to the air compressor to avoid electric shock and other injuries.
- ⑤ Keep the machine properly: If the air compressor is not in use, the air and sewage in the air storage tank should be discharged and stored in a dry environment.
- ⑥ Do not use this machine with overload: operate in accordance with the calibrated voltage and frequency on the air compressor or without overloading, the effect will be better and safer. (The continuous operation time should not exceed one hour, otherwise it will affect the service life).
- ⑦ Protect the cable: Do not pull the cable to unplug the plug from the power supply. The cable should be kept away from heat and oil, and avoid contact with sharp objects.
- ⑧ Properly maintain the machine: Clean the filter in time according to the use situation, check the accessories and cables regularly, and replace them immediately if they are damaged. The machine should be kept clean, dry and free from oil stains, so that it can give full play to its performance.
- ⑨ Cut off the power in time: When not in use after get off work, develop the habit of cutting off the power in time. When moving the air compressor, the power switch must be turned off.
- ⑩ Anti-over-pressure start: It is strictly prohibited to use over-pressure. The maximum pressure used by the air compressor is set to 8 Bar at the factory, and the safe pressure relief is 8.8 Bar, otherwise the gas storage tank may explode.
- ⑪ Warning: The use of non-pure original accessories can easily cause damage to the air compressor and even personal injury.
- ⑫ Power supply voltage: It should be noted that the power supply voltage is consistent with the voltage on the nameplate of the air compressor. When the power supply voltage is higher than the applicable voltage of the air compressor, it may cause a personal accident and damage the air compressor. When the power supply voltage is lower than the applicable voltage of the air compressor, it may cause poor starting and even damage the motor.
- ⑬ The compressor can only be used for pressurized air. Under no circumstances can it be used to process other gases. It cannot be used to suck liquid, particulate, solid and any substances that may cause explosive and flammable.
- ⑭ Can not be used to suck flammable and explosive gases or use in the environment containing these gases.

2.8 General Safety Rules

❖ Operator's responsibilities

The person in charge of the laboratory is responsible for training the laboratory operators.

The operator should inform the manufacturer of safety-related accidents that may occur during the operation of the instrument without delay. The laws and regulations applicable to this instrument must be strictly abided by, such as local laws, provincial and municipal laws, and national laws.

❖ Maintenance and maintenance responsibilities

The operator is responsible for ensuring that the instrument is operated only under the correct conditions and that only authorized personnel are responsible and complete maintenance and repair work on time.

❖ Spare parts used

Please use the original consumables and spare parts of the instrument to ensure good system performance and reliability. The spare parts used can only be changed with the prior written permission of the manufacturer.

❖ Change

Modifications to the instrument can only be made after consulting the manufacturer in advance and obtaining the manufacturer's approval. Modifications and upgrades can only be completed by authorized technical engineers of Anhui INUO Corporation. The manufacturer will reject any complaints caused by unauthorized changes.

2 Equipment overview

1. Technical data

This chapter introduces the technical specifications of the instrument. The content includes the scope of delivery, technical data, requirements and performance data.

1.1 Scope of Delivery



Please check the scope of delivery according to the order contract

For detailed information about the listed products, please contact your local distributor. For standard instruments, please check the scope of delivery in accordance with the order contract.

1.1.1 Standard Model



Table 2-1-1-1: Standard Model

Item	Model
Mini Spray Dryer	IN-SD Mini

1.1.2 Standard Accessories

Table 2-1-1-2: Standard accessories

product
User manual
Complete set of glass components
Silicone tube 1 meter

Power cord, 1.5 meters with quick release head,
Compressed air pipe, 2 meters with quick release
PT100 temperature sensor, quick release
Glass tower body sealing ring
Nozzle quick release seal
Exhaust exhaust pipe, 2 meters

1.1.3※Optional Accessories

Table 2-1-1-3: Optional accessories

product
Feed switch valve
Industrial Ethernet Module
Wireless Router
Remote host computer monitoring system
Silent oil-free air compressor
Dust bag

- ※Connect optional accessories to IN-SD Mini



- ① Routing power
- ② PLC debugging interface
- ③ Connect the feed switch valve interface
- ④ Connect to remote control panel/host computer, Ethernet interface
- ⑤ Touch screen optimized interface

Figure 2-1-1-3.1: Rear interface of IN-SD Mini spray dryer

- ※Fully automatic feed switching valve and wireless remote host computer monitoring

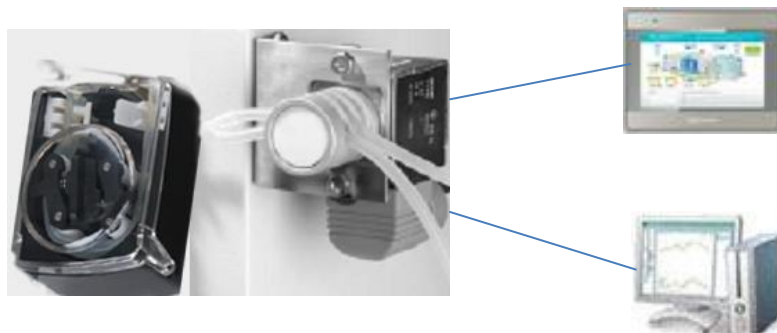


Figure 2-1-1-3.2: Feed switching valve and remote operation monitoring system

Through remote control, the small spray dryer in the laboratory can be easily operated even in the office. The flow rate of the flow meter for spray air is the only parameter that cannot be adjusted by the remote control panel.

The feed switch valve is a useful tool used in conjunction with the remote control panel. At the beginning and end of the spray process, the feed tube must be moved from the pure solvent to the product solution or vice versa. This operation can be done automatically through the feed switch valve. A three-way pipe is inserted between the peristaltic pump and the feed switching valve.

1.2 Overview of Technical Data

IN-SD Mini	
Power consumption	AC220V/3.6KW
Voltage	AC220V,50HZ
Evaporation capacity	2000ml/h
Dry air flow	70m ³ /h (MAX 600m ³ /h) ,1000Pa
Fan power	0.4KW/220V,Frequency Control
Inlet air temperature	30-250°C ±1°C
Outlet temperature	30-120°C ±1°C
Heating capacity	3.0KW/220V
Heating control	PT-100 Sensor/PID/±1°C
Air compressor	0.25KW/MAX4.2m ³ /H/2-5bar
Spray system	Spraying
Average drying time	1.0-1.5s
Automatic blocking function	Automatic needle, adjustable frequency of action
Control System	Siemens S7-200smartPLC+7 inch touch screen
Product material	Contact material material 316L stainless steel, 3.3 high
Electrical standards	National standard
Instrument size	650×570×900mm
Dust bag filter cartridge	Withstand the instantaneous temperature of 160 degrees Celsius, the long-term temperature does not exceed 90 degrees Celsius, polyester fiber non-woven fabric
Weight	60KG

1.3 Parts Material

Table 2-1-3: Parts Material	
Part	Material name
Glass components	3.3 Borosilicate glass
Nozzle/heater/cyclone separator	316L stainless steel
Seals	PTFE
Product feed pipe	Silicone Rubber
Exhaust pipe	Polyurethane

2. Function Description

This chapter introduces the basic principles and structure of the instrument, and explains the functions of each component.

2.1 What is Spray Drying

Spray drying is a process method for drying aqueous solutions, emulsions, etc. It is widely used in industrial chemistry and food industry. Dry milk powder, detergents and dyes are just a few products that are currently spray-dried. Spray drying can be used to preserve food or as a rapid drying method. It has the advantages of reduced weight and volume.

Spray drying is usually a method of spraying a fluid mixture into hot dry air. Solvents, usually aqueous solutions, evaporate immediately when exposed to hot air. This volatilization process quickly removes heat so that the product is gently dried without being affected by heat. The product turns into powder, granules or lumps within a few seconds.

2.1.1 Superiority of IN-SD Mini

The IN-SD Mini spray dryer can quickly and directly obtain good-looking powder and particle samples, and the particles are in the shape of natural spheres. It has the following remarkable performance characteristics:

- ① The instrument is exquisite and compact, and the cabinet adopts a humanized aesthetic design and uses a special painting process to make the appearance of the instrument more high-end and atmospheric;
- ② The heating pipes and auxiliary mechanical parts are made of high-strength stainless steel, with high corrosion resistance and durability;
- ③ Imported high-precision dual-fluid nozzles ensure precise atomization performance;
- ④ The loading and unloading is simple and fast, and the operation is simple and efficient. The entire spray drying process is carried out in glassware, which is convenient for the operator to observe the entire experiment process;
- ⑤ This equipment control system uses German Siemens PLC and MHI touch screen as the development platform, in line with the energy-saving and high-efficiency design principle, which makes the temperature rise faster and more stable, and the temperature control accuracy is as high as 1 °C;
- ⑥ The user-friendly human-computer interaction window allows customers to fully grasp the important elements of air inlet volume, inlet air temperature, and feed volume, and can observe the working status of the instrument in real time, so that the customer will have more information in the spray drying experiment. Lots of actual verification space;
- ⑦ The intelligent remote host computer operation monitoring system can easily complete the spray drying work in the laboratory in front of the computer in the office.

2.1.2 Applicability of IN-SD Mini

The IN-SD Mini spray dryer can be used to dry aqueous solutions and suspensions, and is suitable for experiments and production where the product is required to be uniform in powder form. Such as: pharmaceuticals, dyes, food,

beverages, pigments, milk and egg products, plant and vegetable products, heat-sensitive materials, plastics, polymers, resins, fragrances, ceramics, soaps, detergents, blood, adhesives, oxides, Textiles, bones, teeth, etc. This instrument is especially suitable for the laboratory to directly convert liquid materials into micro powders, without the need to filter, concentrate and crush the materials before drying, and has broad-spectrum applicability to all solutions such as emulsions and suspensions.

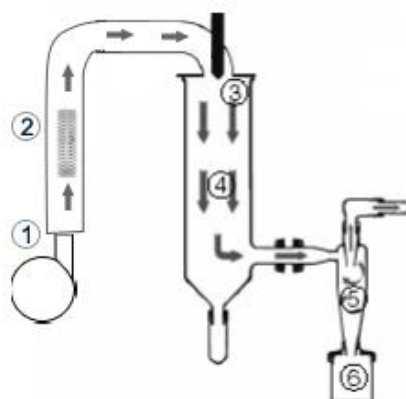


It cannot be used to process materials that are flammable, explosive or prone to produce a large amount of gas. In particular, it is not possible to release gases of unknown chemical composition.

2.2 The Functional Principle of Dry Air

The IN-SD Mini spray dryer works according to the principle of coexistence of air and product flow. The sprayed product and hot air have the same flow direction.

(Note: The direction of the arrow in Figure 2-2 is the flow direction of air)

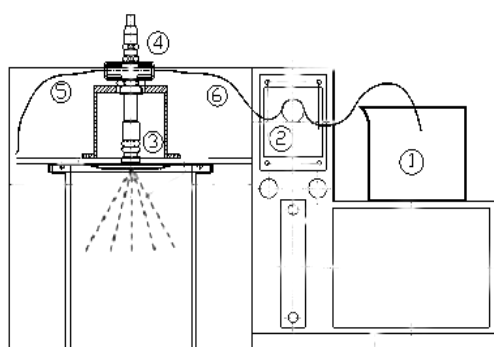


- ① Air inlet (air supply by fan)
- ② Heating pipeline and electric heater
- ③ Concentric inlet of hot air around the nozzle
- ④ Spray cylinder
- ⑤ Used to separate particles from the gas stream
- ⑥ Product collection container

Figure 2-2-2: The functional principle of dry air

2.3 Functional Principle of Sample Dispersion and Feeding

The sample solution is pumped into a two-fluid nozzle by a peristaltic pump, and the solution is sprayed into tiny droplets by compressed air into the drying chamber. The hot air entering the drying chamber quickly dries the small mist droplets into solid particles, and the dried solid particles are separated from the exhaust gas by a cyclone separator and then enter the collection bottle. The exhaust gas is directly discharged to the atmosphere or air filter device.



- ① Material
- ② Peristaltic pump
- ③ Two-fluid nozzle
- ④ Automatic nozzle through needle system
- ⑤ Compressed air pipeline
- ⑥ Feeding pipeline

Figure 2-2-3: Working principle of sample feeding and dispersion

3 Operation

This chapter introduces how to quickly run the equipment and put it into use

1. Preparations for the installation site

1.1 Instrument Placement

Place the instrument on a stable horizontal base surface (ground or experimental bench) in the room; the small spray dryer effectively covers an area of 50CM*60CM, and the effective area of the air compressor is 50CM in diameter.

1.2 Air Supply (air)

When the equipment is in a relatively turbid air condition, please filter and purify the air first, and then use it for drying; if necessary, please contact Anhui INUO Engineering Technology Co., Ltd.

1.3 Power Supply:

The working voltage of the instrument is AC220V and the power is 3.5KW; the working voltage of the air compressor is AC220V and the power is 0.55KW; the site requires a standard 3-pin 16A socket; the socket power supply needs to be supplied by an independent air switch, The current load of the power supply cable must not be less than 16A, and it must be grounded reliably.

1.4 Exhaust gas Discharge

During the working process of the instrument, a few fine particles are discharged with the exhaust gas, and the exhaust gas discharge pipe needs to be placed outside the window or in a fume hood; the equipment is equipped with a standard high-temperature exhaust gas discharge pipe specification of 2 meters.

1.5 Working Noise

When the instrument and the air compressor are working, the fans and air pumps are running continuously, and a certain decibel noise is inevitable.

1.6 Cleaning the Water Tank:

Every time you finish spraying work, you need to clean the glass kit; the height of the glass tower is 60CM, and the diameter is 20CM (calculated by the widest part).

2 Install the Instrument Accessories Correctly

After all standard accessories are correctly installed in place, as shown in the figure below:

Remarks: For detailed installation method and step analysis, please refer to the description in Chapter 4

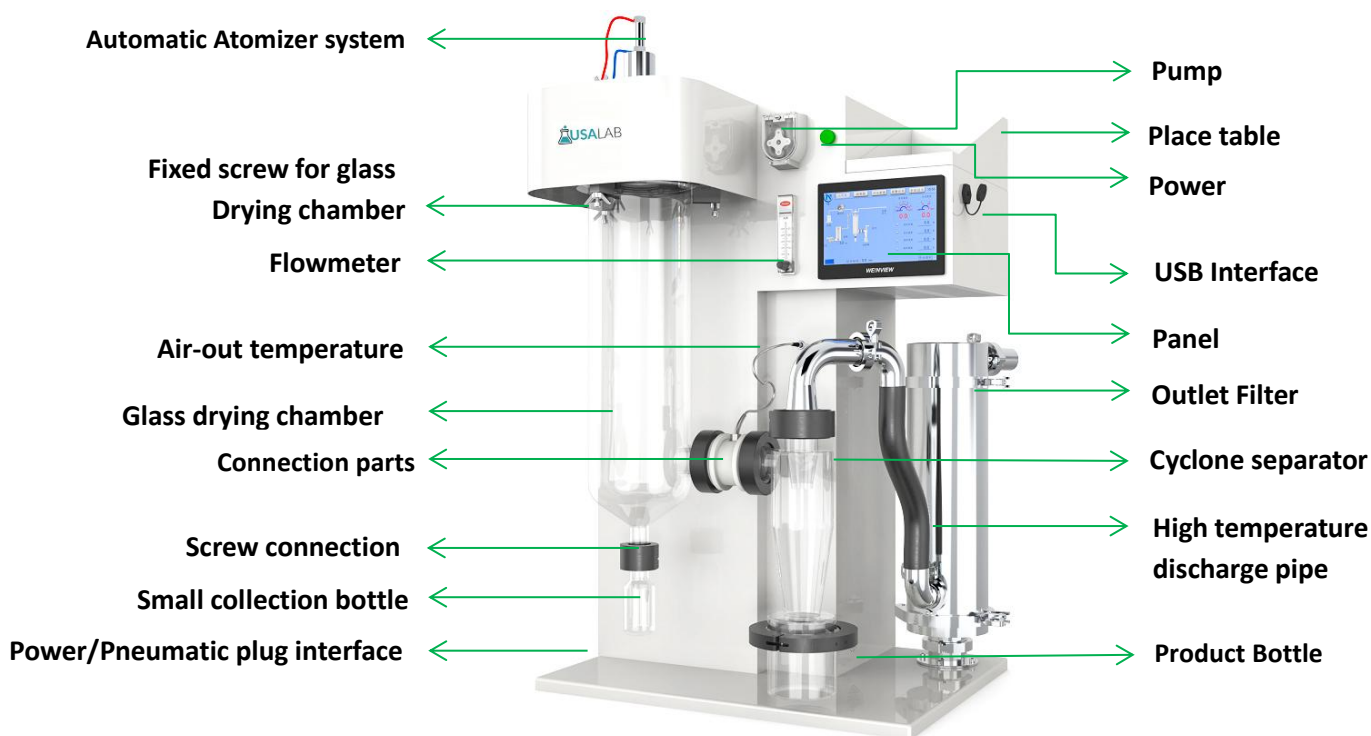


Figure 3-2:Physical analysis of standard instruments

3.Operation Process

This section introduces a complete simple process of spray drying operation, which is convenient for customers to quickly get started and independently complete the spray drying test.

3.1 Power on the Device

After checking the correct connection of the power supply, press the power control button, the indicator light is on, and the power transmission is completed.

3.2 Set Parameters and Run the System

After power on, the touch screen operation interface is automatically opened; the touch screen is a detailed experimental operation platform provided by this system: "air-int volume", "feed speed", "air-in temperature" and other parameters are completely open.

Please set "air-in volume" and "air-in temperature", and then click "start" the system start-stop function key; the system starts to run, the blower supplies air, and the heater gradually heats up the hot air; at the same time, the touch screen interface also dynamically displays the system working status in real time .

3.3 Start the Air Compressor and Adjust the Ventilation

During the heating process of the system, we can turn on the air compressor to prevent the material from clogging the nozzle due to the failure of the compressed air in the later spraying process.

- Plug in the air compressor power plug, start the air compressor, and deliver pure compressed air to the dual-fluid nozzle through the glass rotor flowmeter
- The glass rotor flowmeter is used to indicate the spray gas flow; the rotary flowmeter knob adjusts the gas supply volume to 600-1000L/H.

3.4 Temperature Balance, Pure Solvent Test Spray

When the inlet air temperature reaches the ideal spray setting temperature, the peristaltic pump can be preset to start the feed volume. Test spray with pure water in the early stage of spray drying, and the spray volume of pure water can be adjusted by changing the preset value of the feed volume. The feed rate is an important factor affecting the outlet air temperature, because the aqueous solution will absorb heat from the drying chamber through evaporation.

Therefore, the outlet temperature can be adjusted to the desired value by means of the pump speed of the peristaltic pump and the amount of spray solution. The outlet temperature can be considered as the upper limit of the thermal load of the product, so it is necessary to ensure that the product will not be damaged due to the excessively high outlet temperature.

3.5 After the commissioning is completed, the material is officially fed

When the required operating conditions have been reached and stabilized, the feed pipe is switched from pure water to the prepared feed solution.

3.6 After the material is sprayed, click to shut down

After the solution is completely spray-dried, continue to spray pure water for a period of time to remove the product deposited on the hose and nozzle. Finally, take the tube out of the pure solvent, the pump continues to work to evacuate the hose, and then click "Shutdown", the peristaltic pump is turned off, the heater stops heating; and the air compressor is turned off. At the same time, the fan continues to work.

3.7 When the temperature drops, stop the fan

When the heater stops heating, when the inlet air temperature display in the instrument drops below 60°C, the fan will automatically shut down.

3.8 Turn off the power and collect materials

Press and hold the power switch until the indicator light flashes, then immediately release the power button to power off the instrument.

Open the clamp, remove the product container, collect and store the materials.



Do not remove the product collection container when the system is running to prevent the product from being blown away by the air.

3.9 After the work is over, clean up the instrument

- If the spraying work has been completed, you can separate the glass drying chamber and cyclone components and connectors when the instrument is powered off, and clean and wipe them one by one for the next use.
- After the spray-drying work is over, please unplug the instrument power (three-pin plug end) and the air compressor power supply; pay attention to the safety of electricity.



This instrument contains a glass set, please handle it with care!

4 Device Details

1. How to operate it

1.1 Power

Connect the power plug to the instrument and AC power



Figure 4-1-1-1: plug

1.1.1 Power on



Figure 4-1-1-2: Power Button

There is a green button with light on the power operation panel, which is operability, used to control the power supply of the instrument, can also be used as an emergency stop in an emergency, and also used as an indicator of the power status and working status of the instrument.

When the power cord is connected in place and all preparations are ready, you can press the button, the instrument will be powered on, and the indicator will light green.

1.1.2 Power Off

When there is a need to power off, press and hold the green button until the button indicator flashes and then release it, indicating that the power will be cut off; when the indicator button is off, the instrument has been powered off.



After confirming that the device is powered off, if the device will not be used for a short time, for the safety of electricity use, you can unplug the white three-pin plug from the socket
The quick-release head at the end of the cabinet does not need to be removed.

1.2 Air Connection

Connect the instrument and the air compressor to supply compressed air.

1.2.1 Correct use of gas circuit quick release



Figure 4-1-2-1: Air pipe

The gas circuit quick release can be directly pressed and docked. When inserting, directly press the ① blue part and insert the ② part directly in; when pulling out, directly press the ① blue part and pull out the ② part directly. .



Please confirm that the air compressor control switch or power supply is off, and the air compressor outlet valve is closed, install the air pipeline.

1.2.2 Air Compressor

The optional air compressor of the IN-SD Mini spray dryer is a multi-purpose energy-saving mechatronics product carefully developed with imported advanced compressor technology. It has the advantages of low noise, small size, beautiful appearance, low power consumption, simple maintenance, safety and durability. It can be widely used in medical equipment, analytical instruments, teaching and research, national defense, environmental protection, light industry, food processing, pharmaceutical machinery, daily life and other fields. It is an ideal gas source for various equipment and an imported substitute product with excellent performance.

- Working principle

The oil-free air compressor is a miniature reciprocating piston compressor with a symmetrically distributed crank and rocker mechanical structure driven by a single shaft of the motor. The main movement is a piston ring, the auxiliary movement is an aluminum alloy cylindrical surface, and the piston ring is between the movement. Self-lubricating without adding any lubricant. The compressor cyclically changes the volume of the cylindrical cylinder through the reciprocating motion of the crank and rocker, and the cylinder volume changes in opposite

directions twice when the motor runs for a week. When the positive direction is the cylinder volume expansion direction, the cylinder volume is vacuum, the atmospheric pressure is greater than the air pressure in the cylinder, and the air enters the cylinder through the intake valve. At this time, it is the suction process: when the reverse direction is the volume reduction direction, the gas enters the cylinder. After being compressed, the pressure in the volume increases rapidly. When it is greater than the atmospheric pressure, the exhaust valve is opened, which is the exhaust process at this time. The single-shaft and double-cylinder structure makes the compressor gas flow rate twice that of the single-cylinder when the rated speed is constant, and the vibration and noise generated by the single-cylinder compressor are well resolved, and the overall structure is more compact.

Air enters the compressor from the air filter. The rotation of the motor causes the piston to move back and forth, compressing the air, so that the pressure gas is opened from the air outlet through the high-pressure metal hose to open the one-way valve into the air tank, and the pressure gauge pointer shows up accordingly. To 0.8 Mpa, more than 0.8 Mpa, the pressure switch is automatically closed, the motor stops working, and the air pressure in the compressor head is reduced to 0 through the solenoid valve. At this time, the air switch pressure and the gas pressure in the gas storage tank are still 0.8 Mpa, and the gas is exhausted through the filter pressure regulating valve and the ball valve. When the air pressure in the air storage tank drops to 0.5 Mpa, the pressure switch is automatically turned on and the compressor restarts to work.

- Main accessories and functions

The function of the pressure switch: The main function is to control the start and stop of the motor by sensing the pressure in the gas storage tank. The machine is set to stop at 8bar; restart at 5bar. Rotate the switch to the "-" position (on position); rotate the switch to the "0" position (off position).

- **Safety valve:** When the pressure switch fails or other reasons, the compressor does not stop, and the working pressure is greater than 8.8 bar, the safety valve opens automatically, and the exhaust pressure is reduced.
- **Overload protector:** When the compressor encounters a fault and the current is too large, the protector will automatically disconnect to protect the motor from damage. This machine uses manual overload protection. When the fault is removed, the protector button must be manually reset to allow the compressor to operate normally.
- **Blowdown ball valve:** When there is a certain pressure in the gas storage tank, open the handle of the blowdown valve to discharge the water accumulated in the gas storage tank.
- **The role of the filter regulator:** There are mainly two functions. The first is filtration: the water in the compressed gas is separated from the air before it is connected to external equipment. The water flows out from the external hose (accessory) at the bottom through the visible container. The second is to adjust the pressure: you can pull up the pressure regulating handle on the filter regulator, turn the handle, and the pressure gauge can display the exhaust pressure you need (0.1~0.8 Mpa). Turn clockwise to increase the pressure, and turn counterclockwise to decrease the pressure. Press the pressure regulating handle to lock the pressure.

- Installation and use

- **Requirements for use:** The air compressor should be used indoors at no lower than 5 degrees Celsius, no higher than 40 degrees Celsius, and relative humidity no more than 80%. The surrounding environment must be kept clean, dry, ventilated, and protected from direct sunlight.
The machine should be placed on a flat and firm ground to prevent the machine from shifting during work. This machine uses a single-phase 220V/50HZ power supply, and should be equipped with a 15A fuse or automatic circuit breaker. Abnormal voltage will cause difficulty in starting or overheating of the compressor.

In order to ensure the normal use of the machine, in areas where the power supply voltage is abnormal, please use a single-phase power stabilizer. The power of the stabilizer must be greater than 2000VA.

➤ Preparation before starting:

- ① Check whether the drain valve is closed, whether the pressure control switch is in the "0" position (disconnected position), the ball valve of the exhaust port is in the closed state, and check whether the power supply voltage is normal.
- ② Remove the plug of the air inlet and screw on the air filter so that the PU pipe faces directly below.
- ③ Unscrew the exhaust port quick-tightening ferrule and put it on one end of the gas pipe, insert the gas pipe into the quick-twist and tighten the ferrule, and connect the other end of the gas pipe to the external equipment.
- ④ Insert the power plug of the machine into the power socket, and the installation is complete.

➤ Debugging:

Set the pressure switch control to the on position (start position), the air compressor should start immediately, and at the same time supply air to the air tank. The pointer of the pressure gauge slowly rises accordingly. When the pressure gauge indicates 8Bar, the pressure control switch should automatically cut off the power supply of the air compressor, and the air compressor should stop working immediately. When the pressure of the air storage tank is equal to 5Bar, the pressure control switch should be closed automatically, and the air compression should be automatically started again, and the cycle is repeated to achieve the purpose of control.

After the debugging work is over, the machine can be put into normal operation.



Please check that the air inlet is not blocked before starting the compressor.

The temperature of the top surface of the cylinder may be high, especially after the motor has been running for a period of time, please do not touch it during operation

- Drain the gas tank

When the air compressor is running, it will compress the moisture contained in the air and condense it in the air storage tank. Excessive accumulation of moisture will affect the air quality of the air storage tank and directly affect the normal operation of the air appliance, so it must be removed in time. The drainage cycle of the accumulated water in the gas storage tank depends on the environmental conditions and the length of the use time. Generally, it must be drained every 3 days.

Drainage method: When there is no pressure in the gas storage tank, open the ball valve to allow the water to flow out of the drain valve and drain it through the sewage hose until the water is released. After the water is discharged, close the ball valve and ensure that there is no air leakage.

- Replace the filter element

An air filter is installed at the suction port of the air compressor to prevent dust in the air from entering the air compressor and has the function of silencing. The filter element of the air filter is blocked after being used for a period of time, which affects the suction capacity of the air compressor, so the filter element must be replaced

regularly. The replacement method is to open the suction muffler cover, take out the filter element, and replace with a new filter element. Then recap it and install it again.

- Routine inspection

Please check and replace the air intake filter appropriately on a regular basis. We recommend an inspection after 300 hours of operation. The user decides the frequency of the inspection based on the usage. Keeping the filter and muffler clean can avoid most of the failures, and a dirty filter can reduce the performance of the compressor and the service life of the compressor.

1.3 Atomizer

This section mainly introduces the performance parameters and advanced nature of the instrument BUCHI nozzle.

1.3.1 Overview

BUCHI nozzles can spray dry heat-sensitive materials under mild temperature conditions.

1.3.1 SPRAYING Nozzle

SPRAYING nozzle is an excellent high-precision spray nozzle. The nozzle used in this instrument is an external mixing type, and the air and liquid flow can be controlled separately, which can effectively spray high-viscosity liquids and suspended abrasives, and at the same time increase the cooling function.

The nozzle is installed in the center of the top of the air distributor and sprays directly and vertically downward into the tower body. The feed material enters through a material pipe inlet of the nozzle with a minimum pressure, and is atomized with compressed air.

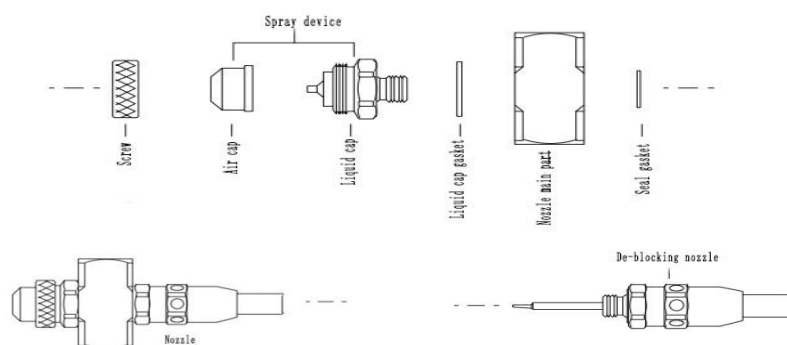


Figure 4-1-3-2.1: Nozzle

- The use and maintenance of the nozzle

The nozzle used in this instrument is externally mixed with liquid flow and compressed air; air and liquid flow can be controlled separately; atomization can be achieved by adjusting the gas pressure and liquid pressure in the spray device; by increasing the gas pressure and/or reducing the liquid pressure A finer atomization effect is obtained, resulting in a higher gas/liquid flow ratio.

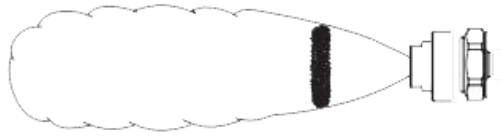


Figure 4-1-3-2.2: Spray form

The spray system comes with the function of clearing the needle blockage. The needle can automatically clean up the blockage when the needle slides through the liquid nozzle hole, so it can effectively spray high-viscosity liquids and suspended abrasives. However, excessively viscous materials and misoperation can also cause nozzle blockage. When human intervention is required to clean the nozzle, the nozzle needs to be removed for gradual cleaning.

- Characteristic parameters

The compressed air supply pressure of the nozzle is between 4-5 bar.

The air flow rate is between 600-1000L/h.

Equipped with a flow meter to monitor and control the flow rate.

1.4 Feeding

This section mainly introduces the components and working performance of the instrument feeding system.

1.4.1 Pump

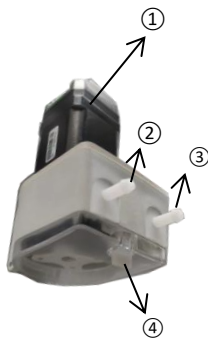


Figure 4-1-4-1: Pump

- ① Stepper motor
- ② Feed Outlet
- ③ Feed Inlet
- ④ Lock

Transparent protective cover, can observe the pump head and hose operation at any time;
 Driven by multiple motors;
 Using special sanitary hose, the whole section is snap-in installation;
 Standard quick-plug connector, convenient for connecting different material hoses;
 No joints simplify the design and avoid the risk of leakage and contamination.

1.4.2 ✖ Feed switch valve



Figure 4-1-4-2: Feed switch valve(optional)

The feed switch valve is an optional accessory. The switching valve is driven by an electromagnetic solenoid, and is controlled to open and close by squeezing or loosening the hose. The medium only passes through the hose, and other parts in the valve body will not come into contact with the chemically corrosive medium. You only need to replace the silicone tube.

It is connected to the peristaltic pump feeding silicone tube through the tee, and then the pumping of the material and the solvent is automatically switched.

1.4.3 Running Mode

The operation control mode of the peristaltic pump can be loaded into different applications according to different optional accessories.

- Autonomous and controllable flow
 - The feed rate is controlled by the customer, and the feed rate can be adjusted by inputting the value. Within the operating range of the feed volume, the numerical value operation can be switched arbitrarily.
- Material return
 - One-click recovery of materials in the silicone tube.
- ✂Smart extension
 - When selected, it is equipped with a feed switching valve, which can switch the operating mode between manual and automatic. The system can automatically complete the switching of materials and solvents at different stages of the work process without manual intervention.
- Replace hose



Figure 4-1-4-3: Replace hose

First, open the upper cover, remove the tube clamp, gently turn the rotor clockwise, and remove the tube to be replaced or worn; cut a new tube of the same length, and then turn the wheel clockwise to slowly load the tube into the pump Head; then, clamp the fixed pipe clamp and close the cover.



When you replace the hose, please make sure that the main power of the instrument is turned off.
Do not start the machine to replace the hose or rotate the pump head rotor!

1.5 Heating

This section mainly introduces the characteristics and usage of the heating system of the instrument.

1.5.1 Performance Index

The instrument uses a special electric heater to provide a hot air source for spray drying.

Table 4-1-5-1: Performance Index	
index	parameter
Operating Voltage	AC220V, 50HZ
rated power	3KW
Heating capacity	0-250°C
Material	316L stainless steel
stability	±1°C

1.5.2 Heater maintenance and maintenance

When the electric heater has not been used for a long time (more than 3 weeks), it is difficult to restart due to the leakage of condensed water and moisture inside or on the surface of the insulating material of the heating element.

The heating element is slowly heated to remove moisture (to avoid leakage), and the heater is restarted as follows: first turn on the heater switch for no more than half a minute, then turn it off, and restart it again for half a minute after about 1 minute. According to the length of time the heater is out of use, repeat this procedure several times to gradually extend the on time and shorten the off time. After about 30 to 60 minutes, the heater can be ready for continuous operation.

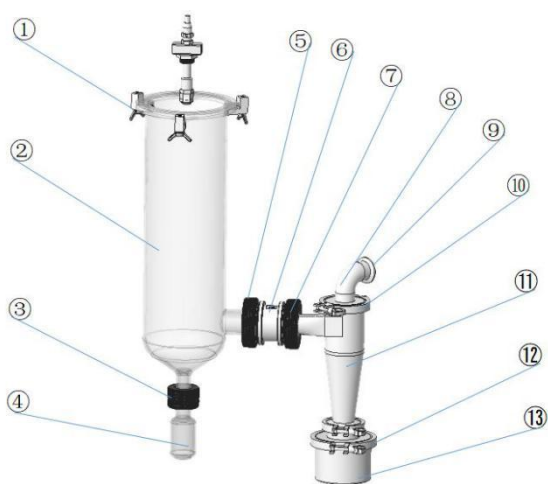


Because the condensed water is related to the humidity of the air, the storage conditions should be paid attention to. If the heater has a problem that cannot be eliminated, please contact our technicians in time.

1.6 Drying and collection

This section introduces the installation, use and precautions of glass and other components in detail.

1.6.1 Material collection components



- ① Drying tower body fixed claw
- ② Drying tower
- ③ Small collection bottle screw connector
- ④ Small collection bottle
- ⑤ Flange screw joint
- ⑥ PTFE connector
- ⑦ Flange screw joint
- ⑧ elbow
- ⑨ Exhaust exhaust port
- ⑩ Flange screw joint
- ⑪ Cyclone separator
- ⑫ Material collection bottle clamp
- ⑬ Material container

Figure 4-1-6-1: Material collection components

1.6.2 Installation process

- First, adjust the drying tower fixed claw ① to the outside to free enough space for the glass tower body.
- Place the tower body sealing ring in the fixed groove, hold the drying tower body ② with both hands, and insert it vertically into the tower body fixing groove; then adjust the fixed claws to a certain degree of support for the tower body, and then twist the drying tower body one by one Fixing claw ①, initially fix the tower body at the center of the tower body mounting plate, and keep the tower body protruding part ⑤ parallel to the vertical plane of the cabinet body for subsequent installation.
- Use flange screw joint ⑤ to tighten the PTFE connector ⑥ on the drying tower body ②; please keep the temperature sensor during installation
- The PT100 mounting hole faces upward position.
- Fix and tighten the cyclone separator ⑪ through the flange screw head ⑦
- Use the small collection bottle screw connector ③ to fasten the small collection bottle ④ on the bottom of the tower body (there is a PTFE sealing ring in the middle).
- Use a clamp ⑫ to clamp the material container ⑬ to the lower end of the cyclone separator.
- Screw the elbow ⑧ to the top of the cyclone separator with a flange screw ⑩ (there is a PTFE sealing ring in the middle).
- Put the exhaust gas discharge pipe on the exhaust gas discharge port ⑨, and place the other end of the exhaust gas discharge pipe outside the fume hood or window.

- Reconfirm whether all the glass kits are in place, then rotate the PT100 sensor into the temperature detection fixing hole of the PTFE connector ⑥, tighten it, and then insert the plug into the cabinet PT100 connection female connector.
- The installation of the material collection component is completed.
- The PT100 quick release head is a quick plug-in type, do not rotate forcibly.
- 1.6.1 Disassembly and assembly process
- After each spray-drying experiment, the material collection components need to be disassembled, cleaned in time, packaged and stored for use in the next experiment.
- After the spray-drying experiment is over, when it is determined that the fan has stopped running, remove the exhaust gas discharge pipe, and remove the elbow ⑧ through the counter-rotating flange screw joint ⑩.
- Then, reversely rotate the screw joint ⑦, the cyclone separator ⑪ and the material receiving container ⑬ are separated from the PTFE connector ⑥, and put it aside, and then use a test tube brush to clean the material particles and collect and save.
- Then loosen the screw joint ⑤, and remove the connecting piece ⑥.
- Rotate the screw connector ③ in the opposite direction, and remove the small collection bottle ④. There are a small amount of large particles in the small collection bottle. Decide whether to use large particles according to your needs.
- With the drying chamber ② supported, slowly loosen the fixed claw ① of the tower body until it is enough, and then adjust the direction of the fixed claw to remove the drying tower body.
- Clean the material collection components one by one and save them.
- The disassembly and assembly work is complete.



When cleaning the PT100 quick-release parts, please do not get water on the quick-release head, as misoperation may cause the circuit to short-circuit.

1.6.3 Precautions for use

- The glass kits are all fragile, please be sure to handle them with care.
- Before each spray drying experiment, please make sure that each accessory is in place and tightened.
- During the normal spray drying process, the temperature of the glass set is relatively high. Be careful of burns.
- During the normal spray-drying process, the exhaust gas in the exhaust gas discharge pipe is also hot, so don't get burned.
- After the spray drying is over, please wait until the surface temperature of the tower body is low enough before disassembling and assembling to prevent unnecessary accidents.
- After spray drying, please keep the glass kit clean.
- Since the spray materials of this equipment are completed in a high-temperature, semi-closed environment, do not use any volatile, flammable, and explosive organic solvents for spray drying.

1.7 Fan

This section mainly introduces the relevant performance indexes of the instrument's exhaust system.

1.7.1 DaGang



Figure 4-1-7-1: Fan



This section mainly introduces the relevant performance indexes of the instrument's exhaust system.

1.7.2 Control Mode

This section mainly introduces the relevant performance indexes of the instrument's exhaust system.



If your experiment has very high requirements for the purity of the air source, please attach an air filter device.

1.7.3 Gas

Because of spray drying work, there will be a little very fine dust will be discharged with the hot air. The exhaust gas discharge pipe at the end of the instrument needs to be led into the fume hood or outdoor. If there is a certain degree of pollution, please do a good job of filtering.



During the experiment, the exhaust gas is hot air with a higher temperature. Be careful of burns!

2.0 Operation

This chapter introduces how to correctly and safely identify and recognize the operation of the instrument.

2.1 Layout of operation and display parts

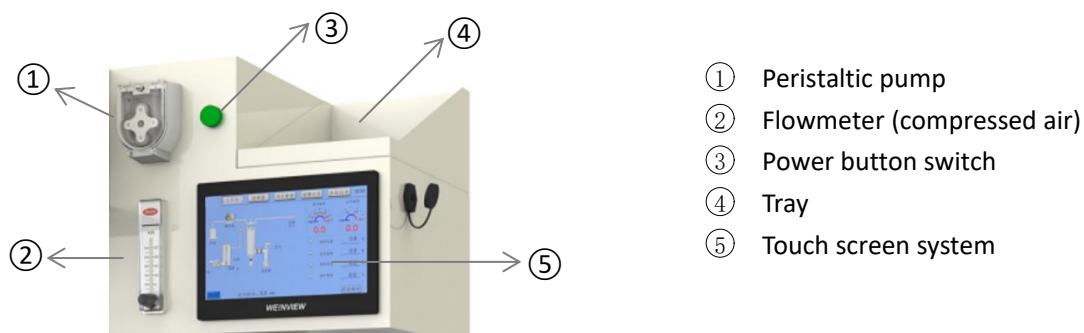


Figure 4-2-1: Operate Unit



Do not spill water or other liquids on the tray, let alone standing water! Misoperation will cause water to penetrate into the control cabinet and cause electrical short-circuit failure!

2.2 Parameter conversion

This section introduces how to convert the parameters on the operating system into more practical data.

2.2.1 Glass Rotameter

The rotameter is used to adjust the flow of indicating spray gas.

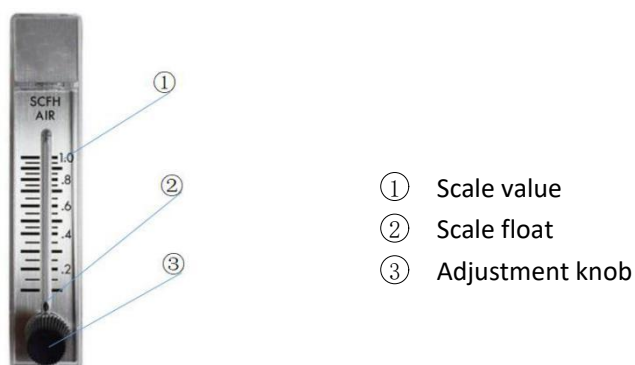


Figure 4-2-2-1: Rotameter

2.2.2 Pump

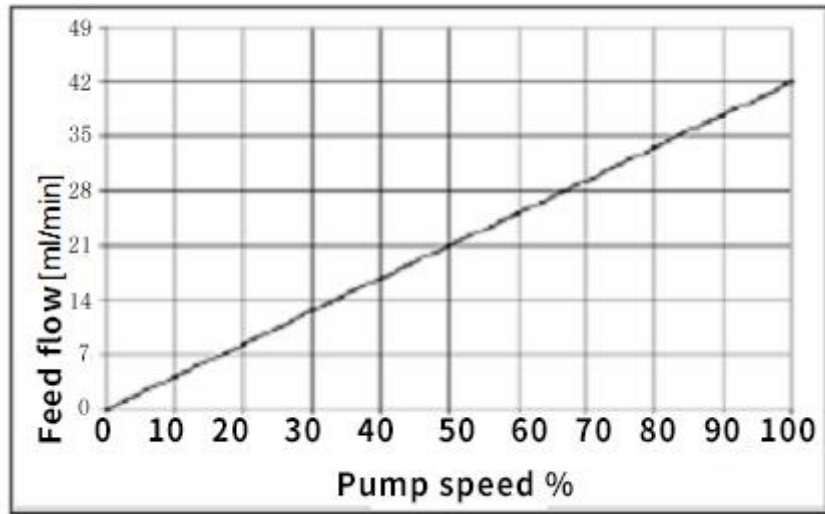


Figure 4-2-2-2: The relationship between pump set value and output flow



The peristaltic pump can be adjusted for tubes with different inner and outer diameters. The diameter of the tube is different, the absolute flow is also different. The figure shows this relationship for the standard 16# silicone tube.

2.2.3 Air supply

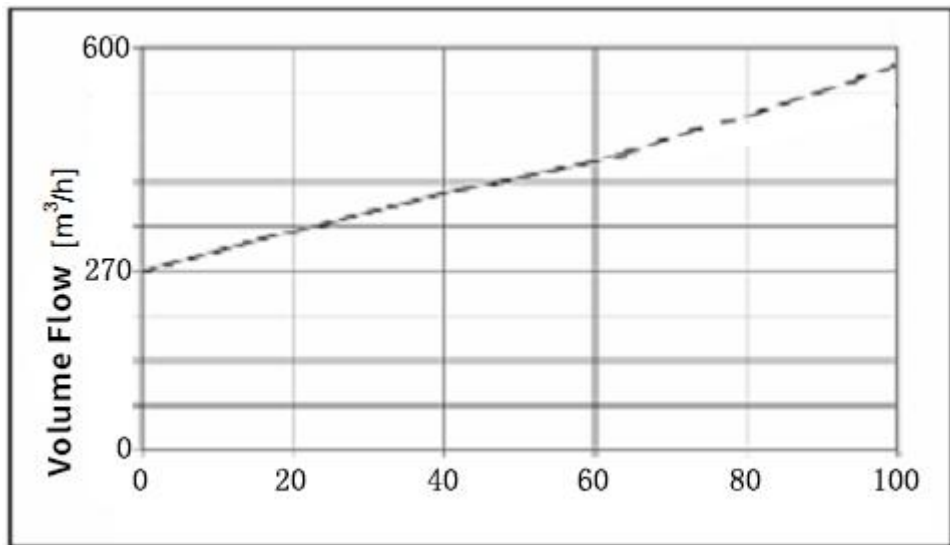


Figure 4-2-2-3: The relationship between air volume setting value and output flow

2.2 General operating system steps

After the instrument is powered on, the touch screen is activated, and the initial drawing is the standby interface; after this screen stays for 3 seconds, it will automatically jump to the main operation interface. The key data settings and system start and stop in the spray drying experiment are all completed on this interface.

- Set the air-in volume and target inlet air temperature, and then touch the system start/stop button (main control chapter), the system starts, the blower runs, the heater works, and the heating and air supply are started.
- When the inlet air temperature is reached, the system will automatically prompt with a warning sound (it is invalid in the silent state);
Then, set the feed volume, test spray with pure water, and adjust the feed volume to make the outlet air temperature reach the target temperature until the temperature balance is stable.
- Replace the pure water with a pre-prepared material solution, and the preset value of the feed volume and the inlet air temperature remain unchanged.
- When the material is relatively viscous and easy to block the nozzle, the automatic plugging function should be turned on. At this time, it is necessary to set the needle passing frequency. When it is 0, the default does not work. When it is greater than 0, the needle passing block is removed at a certain interval.
- After the material is sprayed dry, spray again with pure water for 1-2 minutes to achieve the purpose of cleaning the nozzle; then take the silicone tube out of the pure water and pump it naturally until the solution in the tube is emptied; then click "turn off" to feed the material. The amount becomes 0, the peristaltic pump stops, the inlet air temperature becomes 0, and the heater stops.
- Adjust the glass rotor flowmeter (the float is at the bottom end) to stop the delivery of compressed air; turn off the power switch on the air compressor.
- The fan keeps running until the inlet air temperature drops to 60°C; the system automatically turns off the fan; at this time, you can press and hold the power switch to stop the power supply; wait for the surface of the tower to cool down, and then you can do other follow-up work.

2.4 ✖ Automatic integration of operating system steps

- Prepare one part of pure water and one part of material solution to be sprayed.
- After the system is officially turned on, the parameters "air-in volume" and "air-in temperature" are preset at one time.
- Click the system start/stop control button, the system starts to run automatically, and set the "feed rate".
- The instrument has its own troubleshooting and information monitoring system, real-time reporting of the phased working status; or the host computer remotely monitors and intervenes in the experiment process.
- The spraying of the instrument is finished, and the system informs to collect the material.

3. Detailed explanation of touch screen system

This system includes: main interface, trend chart, historical data, alarm record, system setting, five human-computer interaction interfaces. Easy to operate and powerful.

3.1 Main control interface

This interface is the center of the IN-SD Mini control system. Customers can conveniently control the important experimental data of "set air-in temperature", "feed speed", "air-in volume", and "needle frequency", and real-time control of the heater's working conditions by observing the percentage.

"Running time" is the accumulated time that the instrument has been working.

"Run" is the system start/stop control button.

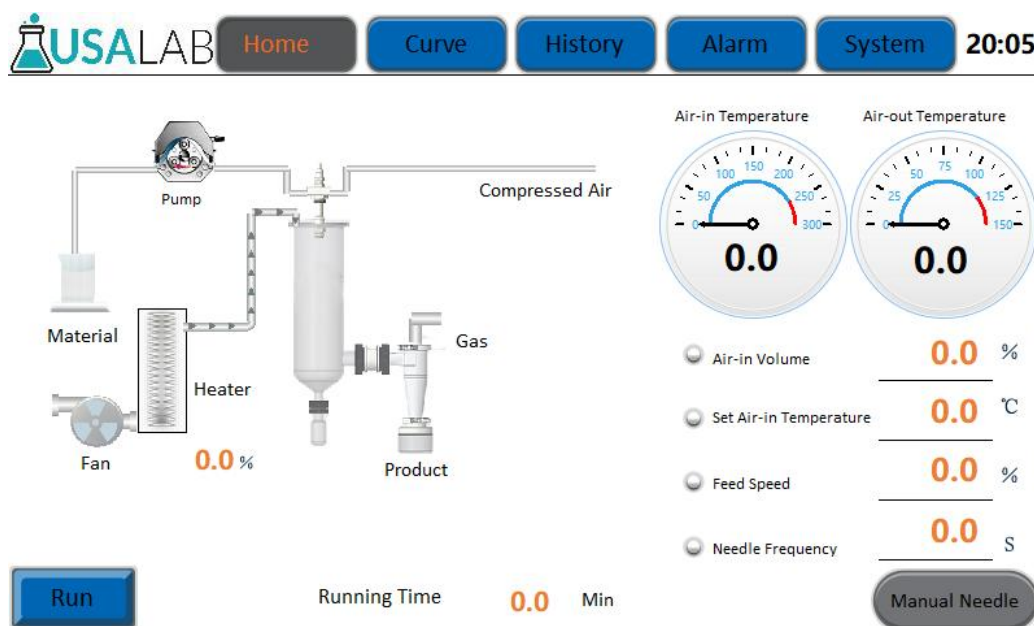



Figure 4-3-1: Screen

- In the interface switching title bar, customers can switch the interface by touching a button. Take the "curve" button as an example:

When in other interfaces, the display state of the "curve" button is ;

When you touch the "Curve" button, the interface will switch to the "Curve" interface, and the button state will change to , Indicates that you have successfully switched screens.

- The screen display area of the main control interface displays the real-time working status of the IN-SD Mini spray dryer in the form of dynamic images. The "heating" here is the real-time display value, which is used to mark the working status of the heater. The value cannot be modified.
- The system one-key start/stop button has two main functions: start the system and shut down.



The "Run" button and "Shutdown" button on the screen can only be used as a start/stop control system, and do not have the function of turning on/off the power of the instrument.

- Instrument running time: As a time monitoring window, it is used to display the working time of the instrument in real time; here the time unit is "minute".
- Data unit, including display data and preset data.
 - Display data: marked in red fonts, which dynamically reflect the real-time "air-in temperature" and "air-out temperature" respectively, which are very intuitive and not changeable.
 - Preset data: leave the settings of "air-in volume", "air-in temperature", and "feed speed" to the customer's grasp; in the experimental work, it is easy to create the best spray environment.
 - ❖ "air-in volume": open in the form of percentage control volume, used to adjust the air supply volume of the blower.
The setting range is 0-100%:
When set to 0%, the fan stops working;
When set to 100%, the maximum air volume is 540m³/h.



The heating function of the instrument is effective only when the fan is running normally; when running manually, the air volume and temperature coexist.

- ❖ "air-in temperature": The temperature is set in degrees Celsius, and the temperature setting range is 30-250°C; the customer sets the temperature value, and after starting the system, the intelligent PID temperature system automatically heats and adjusts the temperature.
- ❖ "Feed speed": Percentage: the setting interval is 0-100%; when 0%, the peristaltic pump does not work; 100% is the maximum pumping volume.
The feed rate has a great influence on the outlet air temperature. Choosing an appropriate feed rate is decisive for the final material characteristics.
- ❖ "Needle frequency": when the nozzle is blocked, the system will automatically remove the blockage function; the range can be set to 0-600 seconds;
When set to 0, the blocking removal function is canceled by default. When it is greater than 0, the needle blocking removal is enabled. This function will only be effective after the system is running;



Due to the friction and damage to the print head during the needle movement, it is not recommended to enable this function for a long time.

The prompt information display area is a display panel for prompt information and alarm information. The system implicitly includes the function of automatically reminding customers when the preset temperature is reached and the function of automatic alarm when there is a failure. When prompt information appears, customers can quickly make corresponding information judgments by referring to the fault information reference table and take countermeasures.



When a reminder message appears, it will be accompanied by a "didi" alarm sound. At this time, touching the message subtitle is equivalent to manually confirming that the alarm sound disappears; if the alarm is cleared, the reminder information will disappear automatically after a while; if the alarm is Now, the system will alarm again.

3.2 Curve

The curve interface is used as a human-computer interaction real-time monitoring data dynamic trend chart, and customers can intuitively control the "air-in volume", "feeding speed", "set temperature", "inlet air temperature", and "outlet air temperature" complement each other. The dynamic change of the relationship, and then better use the system, spray the most ideal material.

This interface contains five trend graphs:

Inlet air volume (green), feed speed (yellow), set temperature (black), inlet air temperature (red) and outlet air temperature (blue).

Through manual selective adjustment, one or more curves can be displayed at any time during the experiment

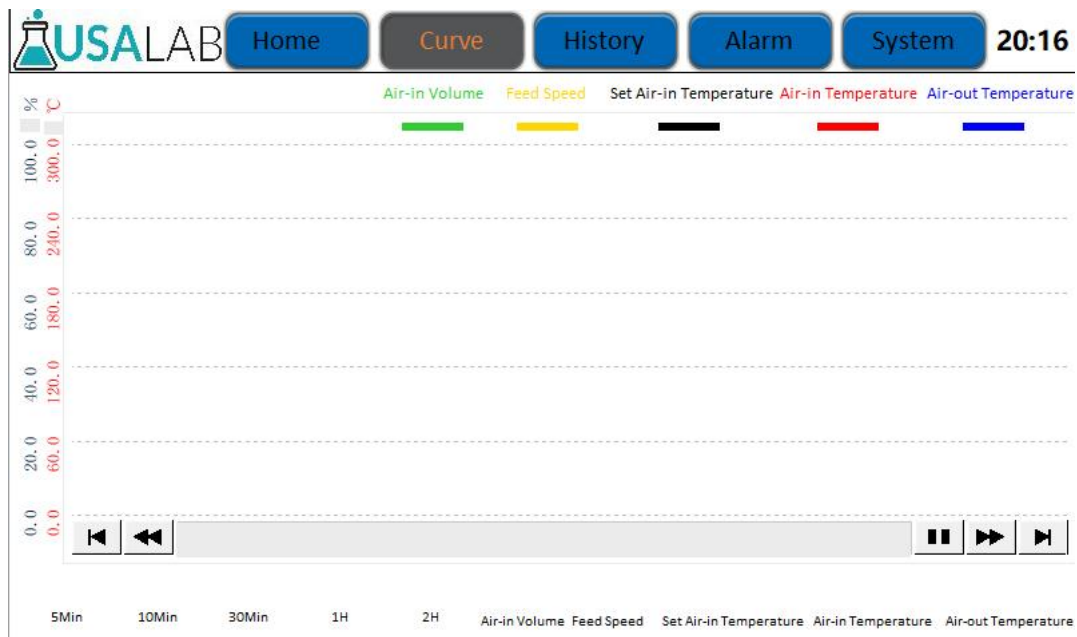




Figure 4-3-2: Curve

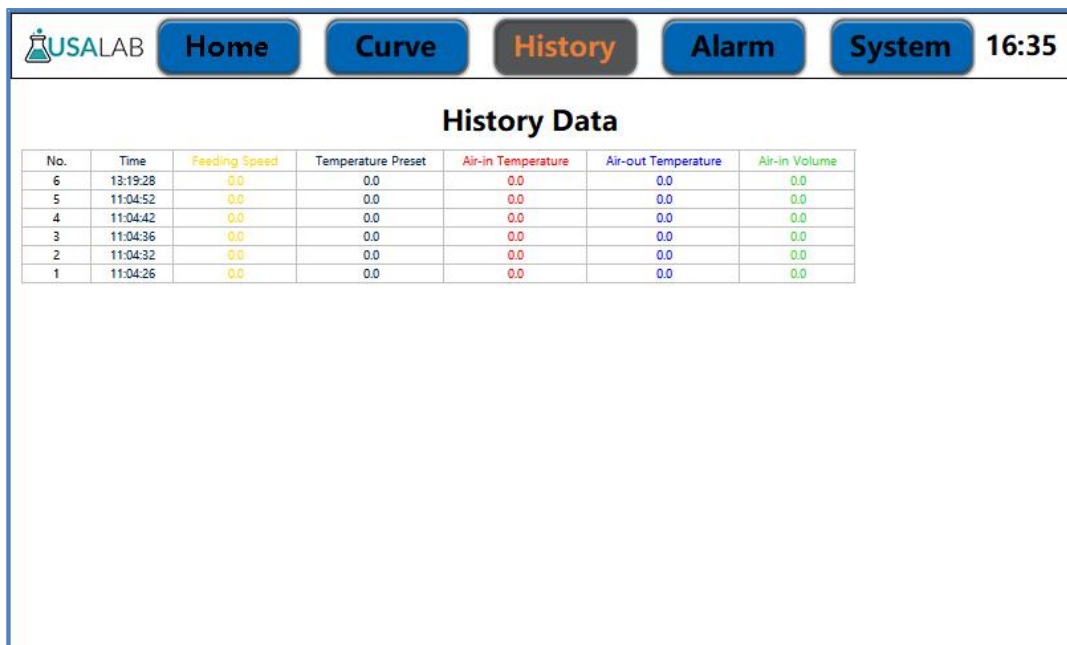
- ◆ Dynamic curve display area, which mainly displays the real-time dynamic trends of several important experimental data such as "air-in volume", "feed speed", "set air-in temperature", "air-in temperature" and "air-out temperature".
- ◆ The ordinate is the reference value of the curve data; feed/air--%, temperature--°C.
- ◆ Observe the curve function key, you can check the curve at any time by touching these 4 keys.
- ◆ Time interval assignment, the system defaults only to display the curve within 1 minute; you can adjust and display the curve in a wider range of time by touching the number here; For example, when it turns to 5 minutes in red, it means that you are viewing the trend graph in the 5-minute time interval at this time.
- ◆ Curve color identification, in order to facilitate and clearly observe the dynamic trend of different curves, select 5 different colors of green, yellow, black, red, and blue to indicate "air-in volume", "feed speed", "set air-in temperature", "air-in temperature" and "air-out temperature".
- ◆ Abscissa, time axis.
- ◆ Selective display of the curve, customers can easily choose to display only a certain parameter or the curve of two or three parameters, which is easy to observe and compare.

If the customer needs to separately study the direct dynamic change relationship between the preset value of the inlet air temperature and the actual value, you can touch the two text buttons "set air-in temperature" and "air-in temperature" respectively, and when the status changes to  , That is, when the corresponding option has a check mark in the upper right corner, it indicates that it is selected. At this time, only the curves of these two parameters are displayed on the curve display interface; if you plan to observe the "set air-in temperature" curve separately at this time, you can touch and press the "air-in temperature" curve again. "Air-in temperature " text button, the check mark in the upper right corner disappears

 , It means to cancel the selection, and only the "set air-in temperature" curve will be displayed on the curve interface.

3.3 History

The historical data interface exists as an aid to the curve interface, and the data is updated every 10 seconds. Through the data interface, customers can intuitively observe the experimental data at any time during the drying process.



No.	Time	Feeding Speed	Temperature Preset	Air-in Temperature	Air-out Temperature	Air-in Volume
6	13:19:28	0.0	0.0	0.0	0.0	0.0
5	11:04:52	0.0	0.0	0.0	0.0	0.0
4	11:04:42	0.0	0.0	0.0	0.0	0.0
3	11:04:36	0.0	0.0	0.0	0.0	0.0
2	11:04:32	0.0	0.0	0.0	0.0	0.0
1	11:04:26	0.0	0.0	0.0	0.0	0.0

Figure 4-3-3: History

- ◆ **Real-time data monitoring display area**, "feed speed", "set air-in temperature ", "air-in temperature", "air-out temperature" and " air-in volume" sample data every 1 second and display it here.
- ◆ Move the viewing toolbar. Due to the limited amount of data displayed on the page at a time, you can scroll through the sampling data in different time periods by touching the slider of the toolbar or often pressing the up and down arrows.

3.4 Alarm

The alarm record interface displays the alarms that occurred during this operation according to the time sequence, and the button at the lower right corner is to reset all current alarms.

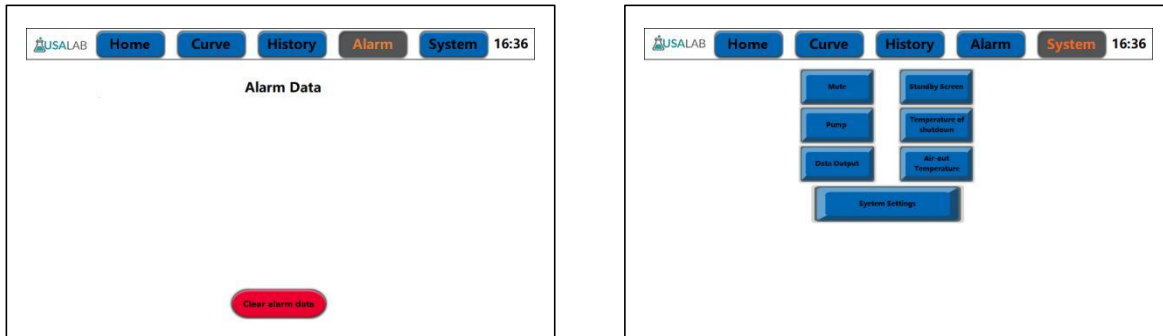


Figure 4-3-4.1: Alarm and System

The following operations can be performed on the system setting interface

- ◆ **Mute:** In order to enhance the operability of HMI, the operation of the touch button of this system will be accompanied by a "didi" operation success prompt sound; if the environment of the customer needs to be quiet, you can click this button to turn off the sound effect; if you want to restore To hear the key tone, just touch the key again.
- ◆ **Standby:** After touching, the screen automatically jumps to the "standby interface".
- ◆ **Shutdown temperature:** After touching, when the blue button turns into a gray button, a small interface for customizing shutdown temperature will pop up. As shown in Figure 4-3-4.2. Then, touch this button again, the small interface will disappear automatically.



Figure 4-3-4.2: Shutdown

For example, the preset shutdown temperature is 90°C;

When the material is sprayed and dried manually, and the final cooling and reclaiming stage is about to be entered, touch the "Shutdown" button to activate the system's automatic shutdown function; the system will automatically turn off the feeding, needle, and heating functions, and keep the fan blowing Air-cooled

When it is detected that the air-in temperature is as low as 90°C, the fan will be automatically stopped, and a reminder alarm will be issued to remind the collection of materials.



Please turn off the air compressor in time and stop delivering compressed air; misoperation will cause the material to become damp.

Air outlet temperature: After touching, the blue button turns into a gray button, and a small interface for air outlet temperature customization will pop up. As shown in Figure 4-3-4.3. Then, touch this button again, the small interface will disappear automatically.

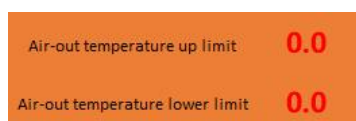


Figure4-3-4.3: Air-out temperature

The upper/lower limit of the outlet air temperature is only used as a numerical basis for determining the abnormality of the outlet air temperature in real time during the experiment.

When the outlet air temperature exceeds the upper limit or falls below the lower limit, the system will notify and record the alarm information in the form of an alarm.

Human intervention is possible, but it does not directly affect the entire control system.

- ◆ **Peristaltic pump:** After touching, when the orange button turns into a gray button, a small interface for manual intervention of the peristaltic pump pops up to control the forward and reverse rotation of the peristaltic pump. This operation needs to be performed in the non-experimental state of the device. Then, touch this button again, the small interface will disappear automatically.
- ◆ **Forward rotation:** When the system is not started, press the button, the peristaltic pump will run forward and feed; the feed rate can also be preset and adjusted in the "main control interface"- "feed rate".
- ◆ **Reversal:** Press the button, the peristaltic pump rotates in the reverse direction to withdraw the material in the tube; the rate can also be adjusted.
- ◆ **Export data:** Touch the button to pop up the data export window, insert a U disk into the USB interface on the right side of the instrument, and click the backup data button to export historical data to an excel table.
- ◆ **System Settings:** This button is for engineers to debug, and experimenters should not operate it.

3.5 Standby

The standby interface is an implicit interface and also the initial interface when the instrument is powered on. It will automatically jump to the "main control interface" after 5 seconds.

The system setting interface, when the customer triggers the "standby function", the system automatically jumps to the "standby interface".

Touch any part of the touch screen on the standby interface, the system will jump to the "main control interface" again.



Figure4-3-5: Standby

4 Fault information reference table

Customers can refer to the general failure information listed below and the possible causes and remedial measures to quickly determine the failure and resume operation.

4.1 General fault information

Accident details	Possible cause	Corrective action
The instrument cannot be powered on	Indoor blackout	Waiting for call
	The power plug is not plugged in	Plug in the power plug
	The power cord is damaged	Replace the power cord
	Electrical failure	Contact Anhui INUO
The touch screen is not working	The instrument is out of power	Refer to the solution that the instrument
	The touch screen is damaged	Replace the touch screen
Fan can't run	Fan damage	Replace the fan
	Electrical failure	Contact Anhui INUO
Electric heater cannot heat	Damaged heater	Replace the heater
	Electrical failure	Contact Anhui INUO
The feed pump is not running	Step or drive damage	Replace step or drive
	The pump head is stuck or loose	Reinstall the hose
The needle does not work	Air pressure is too low	Refer to the air compressor fault solution
	The solenoid valve is damaged	Replace the solenoid valve
The touch screen cannot	communication fail	Contact Anhui INUO
The temperature display value deviation is too large	PT100 is damaged or not connected	Replace PT100 or reconnect
	Temperature transmitter failure	Replace temperature transmitter
The temperature cannot rise	Damaged heater	Replace the heater
	Temperature sensor failure	Replace PT100 or check connection
The air compressor does not work	The air compressor is not powered	Plug in
	Air compressor failure	Replace the air compressor
Drip liquid at the lower end of the drying chamber	air-in temperature is too low	Low preset temperature / heater failure
	Atomizing air pressure is too small	Adjust ventilation
	Compressed air leaks	Check gas path
	The feed volume is too large	Reduce feed volume
Unable to adjust compressed air	Clogged nozzle	Cleaning nozzle
	No gas source	Check the working condition of the air

Table 4-4-1: Fault information reference

4.2 Implicit fault information

Taking into account the safety and reliability of the customer's use of the instrument, the control system contains a number of automatic protection functions.

When the equipment's operating condition enters an abnormal state, these specific functions will be activated and corresponding corrective and protective measures will be automatically taken.

Implied functional fault	System approach	Customer response
Air intake detection cannot heat up	The system automatically turns off the heater	Temperature sensor and transmitter failure
		The fan is not running
		Heater does not work
air-in temperature is super high	The system automatically cuts off the heater	Temperature sensor and transmitter failure
	The system automatically powers off	Other unexpected failures
System pop-up password protection	Password verification can be accessed	Contact Anhui INUO

Table 4-4-2: Implicit fault information



After the hidden function fault alarm appears (the alarm will be displayed on the touch screen interface of the host computer), the customer can make some fault judgments in time based on his own experience, and troubleshoot the fault, and then try to run the instrument under the premise of safety, or Contact Anhui INUO engineers directly.

5 How to better use IN-SD Mini spray dryer

From a practical point of view, this chapter objectively analyzes the factors affecting the work of small spray dryers. It should be understood that the various settings of the instrument cannot be considered separately from each other. All the parameters that can be adjusted by the instrument are dependent on each other. When one setting is adjusted, the setting of another parameter must also be changed.

5.1 Interaction between various parameters

- ✧ The greater the temperature difference between the inlet and the outlet, the higher the residual moisture content.
- ✧ The higher the fan speed, the shorter the residence time of the hot air in the instrument, resulting in higher residual moisture content.

- ✧ The lower the fan speed, the longer the residence time of the hot air in the instrument, and the drier the product.
- ✧ The higher the fan speed, the higher the degree of separation of the cyclone separator.
- ✧ The higher the spray flow rate, the smaller the particles.
- ✧ The higher the spray concentration, the larger the particles.
- ✧ Low spray concentration and high spray flow rate can get very small particles; and there is a danger of product loss (the degree of separation of the cyclone separator is low).
- ✧ Assuming that the temperature remains constant, the higher the pump speed, the lower the air-out temperature.

5.2 Inlet air temperature and outlet air temperature

- The inlet air temperature can be understood as the temperature of the hot dry air. The dry air is transported to the top of the heater through the fan motor. Before the hot air flows into the drying chamber, measure its temperature. When spray drying a solution, emulsion or dispersion, the solvent is removed by volatilization. The temperature of the gas stream is higher than the boiling point of water to evaporate each droplet in a short residence time. The temperature of the final product is not affected by the drying temperature. The steam surrounds the spray droplets and protects the product from heat.
- Before entering the cyclone, the temperature of the air with solid particles is designated as the outlet temperature. This temperature need not be the temperature of the product. The evaporation of water removes the heat from the product, keeping it cool. Even when the residence time is as short as about 1 second, the solid particles will not be heated to their ambient temperature. However, the rule of thumb is that outlet temperature = maximum product temperature. Unlike the inlet temperature, the outlet temperature cannot be set by the temperature regulator.

The outlet air temperature is the combined result of the following parameters:

- air-in temperature
- Fan speed (air inlet air volume)
- Peristaltic pump settings
- The concentration of the material to be sprayed

The best choice for the temperature difference between the inlet and the outlet is the most important point that should be considered during spray drying. Of course, other specific factors of the product, such as melting point or decomposition temperature, must be considered. Nevertheless, there is still some room for adjustment. The output of the instrument and the content of residual water will be affected within this temperature difference range.

The following table illustrates the interaction between inlet temperature and outlet temperature, which is related to the air consumption of the pump. Naturally, these data are for guidance only. They help to clarify the interaction between the above factors, but there are too many factors that affect the results, so the data cannot be absolute values. The following principles can be derived from the data:



For final products with very low residual moisture content, the inlet temperature must be as high as possible and the temperature difference must be as small as possible.

Increasing the temperature difference while keeping the inlet temperature constant will increase the residual moisture content in the final product and the spray speed of the instrument.

5.3 Fan

The dry air is fed into the instrument by the fan. Adjust the fan speed, the hot dry air will increase or decrease, when the amount of dry air increases or decreases, the energy used for evaporation changes. Therefore, the fan speed setting has a significant impact on the drying performance of the instrument. The evaporation performance is affected by various factors, such as the concentration of the spray solution and the water content of the dry air.



The following principles can be used to determine the best settings through experiments:

- The fan speed is high, and the cyclone separator has a high degree of separation;
- The fan speed is low, the material stays in the drying zone for a long time, and the residual moisture content is low.

5.4 Pump Speed

The peristaltic pump delivers the spray solution to the nozzle.

The speed of the pump determines the temperature difference between the inlet temperature and the outlet temperature. This is completely correct, because the temperature and amount of dry air, that is, the energy used to evaporate the solvent, are determined by the selected temperature and the speed of the medium pressure fan. If the amount of sprayed liquid is more or less, the heat consumed by the evaporation process is more or/less. In this way, the temperature of the outlet is adjusted to a lower or higher value.

The pump speed also depends on various factors, such as the viscosity of the spray solution and the pipe diameter.



The following principles can be derived from the above facts, and they are related to the pump speed:

- Increasing the pump speed can increase the temperature difference between the inlet temperature and the outlet temperature.
- Reduce the speed of the pump while keeping the inlet temperature constant and the flow rate of the aspirator constant, which can increase the dry matter content of the final product.

5.5 Flow rate of spray compressed air

The spray flow rate is the amount of compressed air required to spray the solution, emulsion or dispersion.

The spray flow rate can be set to 100-1000 liters/hour on the instrument, but the actual working range is about 600-1000 liters/hour.

The particle size of the final product is affected by the spray flow rate setting.



The principle is: the higher the spray flow rate, the smaller the particle size of the final product.

5.6 Spray material concentration

The spray concentration will affect the particle size.



The higher the concentration of the spray solution, the larger the particle size of the dry particles and the more pores.

The lower the concentration of the spray solution, the smaller the particle size of the dry particles and the fewer pores.