User's manual

★ Only for aqueous materials

A message of respect:

- All personnel involved in operation and maintenance should read this manual carefully before using the machine;
- This manual can help users to operate and maintain the machine conveniently and safely;
- Failure to operate according to this manual may cause damage to the equipment or even safety accidents.

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Chapter 1 User notification

1. User notes

This manual describes the IN-SD 3N small spray dryer and provides all the information needed to operate it safely and keep it running properly. The content of this manual is specifically for laboratory personnel.

1. 1 introduction

This manual contains essential documentation covering instrumentation systems, process design specifications, operational protocols, maintenance requirements, and emergency response procedures, along with other occupational safety and health-related information. As modifications or upgrades may occur during the facility's operational life, it is crucial to maintain up-to-date instrument specifications to ensure this manual remains a reliable reference resource.

1. 2 customer service

Our customer service includes: all technical data and system engineering application software related to the instruments and equipment kept by you. If there is any difficulty, please contact the local representative office Anhui Innolux.

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 user manual or the required replacement parts.

1. 3 Copyright notice

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1. 4 Liability guarantee

The information, data, and instructions in this instruction manual regarding the installation, operation, and maintenance of the instrument are the best reference information available based on our current experience and expertise prior to the date of printing.

This instruction manual contains all important information, and the user must be fully familiar with it before operation.

We shall not be liable for damages or losses resulting from failure to strictly follow the procedures outlined in this manual, including interruptions to production operations. Under Anhui Innolux Company's liability guarantee, upon discovering defects, a detailed written report with contract number must be submitted immediately within the scope of the guarantee. Anhui Innolux Company shall provide all relevant operational and maintenance data and grant the factory the opportunity for a comprehensive inspection.

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Any software described in this instruction manual is sold "as is". Anhui Innolux reserves the right to modify this instruction manual and change the content.

2. Safety information

This chapter outlines the safety protocols for the instrument, including general operational guidelines and hazard warnings. The safety of users and others can only be ensured through strict adherence to the safety

instructions and relevant warnings provided in each section. Therefore, this manual must be made available to all personnel involved in the work described herein.

2. 1 User Qualification

This instrument should only be used by laboratory personnel or by persons with training or professional experience of the risks involved in operating the instrument.

Those who have not undergone or are currently undergoing such training require careful guidance, which this manual can serve as a basis for.

2. 2 Correct use

This instrument belongs to laboratory equipment. It is only used for drying aqueous solutions or safe suspensions and solutions in one operation process.

2. 3 Incorrect use

It cannot be used to treat materials that are inflammable, explosive or prone to producing large quantities of gas. Especially materials that may release gases of unknown chemical composition.

The following applications are also explicitly prohibited:

Do not spray dry organic solvents at will.

- Use this instrument in the room where explosion-proof instruments are required.
- Handling samples that may explode or burn due to shock, friction, heat or spark.
- Process substances that produce oxygen.

The operator is solely liable for the risk of accidents arising from such improper use.

If you have any questions, you can call our company for details.

2. 4 Warning signs

Electrical hazard

Hot surface

2.5 Instrument safety

This instrument is designed and manufactured according to the latest technology. However, if not used correctly, it may cause danger to the user, property and experimental environment.

Instrument manufacturers have identified residual instrument hazards in the following situations:

If the instrument is operated by untrained personnel.

If the instrument is not operated in accordance with its intended use.

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

2.6 electrical safety

All distribution equipment contains dangerous voltages that can cause death, and the degree of danger is reduced by proper operation and maintenance.

Conduct routine inspections of electrical equipment. If the surface appears hot or emits a burnt odor, immediately shut down the device and perform checks or corrections. Improper operation of electrical equipment may create unsafe conditions. Personnel authorized to operate such equipment must hold relevant certifications and be thoroughly familiar with both the operational requirements and all potential hazards associated with the equipment.

2.6.1 Hazardous Voltage

Electrical accessories containing dangerous voltage should be kept closed during operation. Many accessories have multiple power sources and must fully understand all the contacts of each device so that all power sources can be disconnected before being allowed into the equipment.

2.6.2 Regulation

Adjusting the equipment may be dangerous. Before adjusting the equipment, the consequences of changes must be estimated to ensure equipment operation and personal safety. During adjustment, refer to the instructions for each special component.

2.6.3 Fault

Fuse blowout, circuit breaker trip or overload trip all indicate a potential dangerous situation. The cause of overload must be identified before the equipment is restarted. Failure to identify or correct the equipment 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 and repair the equipment before restarting.

Insulators, circuit breakers, overload and other electrical installations must be replaced with devices indicating voltage and current as well as operational performance. Current capacity and tripping and breaking performance may not be changed arbitrarily unless a detailed estimate of the current and load changes is made and the changes are guaranteed.

2.6.4 Maintenance

There is a risk of electric shock when working near electrical installations. Power must be cut off before work. Only qualified professionals who have been trained can work with the correct procedures and tools.

The purpose of maintenance is to keep the equipment in a good condition. If small problems are not solved, they will lead to bigger problems. A thorough mechanical inspection should be done at least once a year.

Check the connections of terminals, fuses, wires and ground wires to prevent overheating or loosening. Connections must be clean and loose terminals must be tightened or replaced.

Check the movable parts to ensure that they move freely, without adhesion and damage. Any parts showing problems need to be repaired and replaced.

The vent must be kept open and if the equipment has an auxiliary cooling device, it must be checked periodically.

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

2.7 High voltage equipment

The following safety precautions should be observed when using a medical oil-free air compressor. The safety precautions must be strictly observed to prevent fire, electric shock, personal injury and other accidents.

① Keep the workplace clean: Messiness can lead to accidents.

② Pay attention to the workplace environment: air compressor should not be exposed to wind and rain, do not work in damp and dark places, do not work in places where flammable and explosive liquids and gases and dust are stored.

③ Beware of electric shock: when using the air compressor, do not let the machine itself touch the grounded objects (such as pipes, heating pipes, refrigerators, etc.).

④ Outsiders/children do not approach: Do not allow children to approach the air compressor with people unrelated to the work, so as to avoid electric shock and other injuries.

⑤ Proper storage of machinery: unused air compressors should be emptied of air and sewage in the gas storage tank, and stored in a dry environment.

⑥ Please do not overload the use of this machine: according to the rated voltage, frequency or do not overload operation, the effect will be better and safer. (Continuous operation time should not exceed one hour, otherwise it will affect the service life).

⑦ Protect cable: Do not pull the cable from the power supply plug, the cable should be far away from heat source and oil, and avoid contact with sharp objects.

⑧ Proper maintenance of the machine: The filter should be cleaned in time according to the use, accessories and cables should be checked regularly, and damaged parts should be replaced immediately. The machine should be kept clean and dry without oil stains, so as to give full play to its performance.

⑨ Cut off the power supply in time: when you are not using it after work, develop the habit of cutting off the power supply in time. When moving the air compressor, the power switch must be cut off.

⑩ Overpressure protection: Overpressure use is strictly prohibited. The maximum pressure of air compressor is set to 8 Bar when it leaves the factory, and the safety pressure relief is 8.8 Bar. Otherwise, the gas storage tank will be in danger of explosion.

⑪ Warning: Using non-pure original accessories, it is easy to cause damage to the air compressor, or even personal injury.

⑫ Power supply voltage: attention should be paid to the power supply voltage and the voltage on the air compressor nameplate. If the power supply voltage is higher than the applicable voltage of the air compressor, it may cause personal accidents and damage the air compressor. If the power supply voltage is lower than the applicable voltage of the air compressor, it will cause poor starting, or even damage the motor.

⑬ Compressors can only be used to pressurize air and under no circumstances can they handle other gases, suck in liquids, particles, solids and anything that may cause explosive or flammable substances.

⑭ Not for use in suction of flammable and explosive gases or in environments containing these gases.

2. 8 General safety rules

Responsibility of the operator

The laboratory director is responsible for training laboratory operators.

Operators shall notify the manufacturer without delay of any safety-related accidents that may occur during the operation of the instrument. The laws and regulations applicable to the instrument, such as local laws, provincial and municipal laws and national laws, must be strictly observed.

Maintenance responsibilities

Operators are responsible for ensuring that the equipment is operated only under correct conditions and that maintenance and repairs are performed responsibly and on time by authorized personnel only.

Spare parts used

Use original consumables and spare parts to ensure good system performance and reliability. Do not modify the spare parts used without prior written permission from the manufacturer.

change

The instrument may not be modified without prior consultation and approval from the manufacturer. Modifications and upgrades can only be performed by authorized technical engineers of Anhui Innolux. The manufacturer will not accept any claims arising from unauthorized modifications.

Chapter 2 Overview of equipment

1. Technical data

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

1. 1 Scope of Delivery

Please check the delivery scope according to the order contract.

For details about the products listed, visit www.ahinuo.com or contact your local distributor.

1. 1. 1 standard instruments

Table 2-1-1-1: Standard instruments

product	model
3L/h Chinese spray dryer	IN-SD 3N

1. 1. 2 Standard Annex

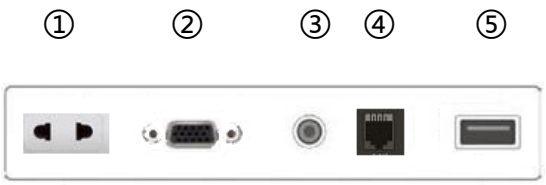
Table 2-1-1-2: Standard annex

product
user's manual
Complete 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
Tower body seal
Quick-release nozzle seal
Exhaust pipe, 2 meters

1. 1. 3* Optional Appendix

Table 2-1-1-3: Optional Appendix
product
Feed switching valve
Industrial Ethernet module
wireless router
Remote PC monitoring system (software)
Silent oil-free air compressor
Dust removal bag

- **※ Connect the optional accessories to the IN-SD 3N-C**



① Routing power supply ② PLC debugging interface

③ Connect to the feed switching valve interface

④ Connect to the remote control panel/upper computer, Ethernet interface

⑤ Touch screen optimization interface

Figure 2-1-1-3.1: Rear interface of IN-SD 3N small spray

- **※ Automatic feed switching valve and wireless remote PC monitoring**

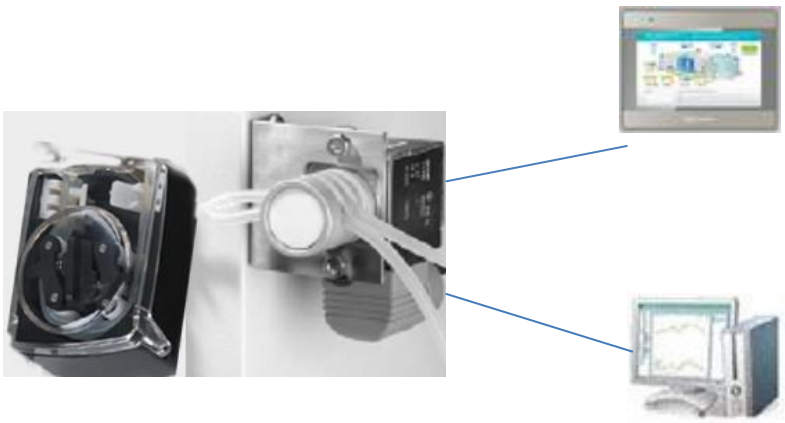


Figure 2-1-1-3.2: Feed switching valve and remote operation monitoring system

Small spray dryers in the laboratory can be easily operated remotely, even from the office. The flow rate of the air used for spraying is the only parameter that cannot be adjusted by the remote control panel.

The feed switching valve serves as a practical tool integrated with the remote control panel. During the start and stop phases of the spray process, it is essential to transfer the feed line from pure solvent to product solution or

vice versa. This operation can be automatically executed through the feed switching valve. A three-way pipe is installed between the peristaltic pump and the feed switching valve.

1. 2 Overview of technical data

Small spray dryer IN-SD Mini	
power dissipation	AC380V/7KW
supply voltage	AC380V 50HZ
evaporative power	3000ml/h, aqueous solution
Drying air flow	120m3/h (maximum 800m3/h), pressure 1000Pa
Fan power	0.75KW/220V, frequency conversion control
Inlet air temperature	30-250℃ +1℃
Air outlet temperature	30-100℃ +1℃
heating efficiency	5.0KW/380V
heating control	PT-100 temperature measurement, PID control, control accuracy
air compressor	1.5KW, maximum gas production 8m3/H, working pressure 2-
Spray system	American original imported atomizing nozzle, 0.7mm caliber dual
Average drying time	1.0-1.5s
Automatic drainage function	Automatic needle penetration, the action frequency can be
navar	Germany Siemens S7-200smartPLC+7 inch touch screen
Product material	Contact material 316L stainless steel, 3.3 high borosilicate glass
Electrical standards	Guo Biao
Instrument size	800×800×1450mm
Dust bag filter cartridge	Instant temperature 140° long-term temperature not more than
instruments weight	110KG

1. 3 Materials used

Table 2-1-3: Materials used	
component	Name of material
Glass components	3.3 High borosilicate glass
Nozzle/heater	316L stainless steel
seal components	teflon
Product feed pipe	silastic
Exhaust pipe	polyurethane

2. Functional description

This chapter introduces the basic principle and structure of the instrument, and explains the function of each component.

2. 1 What is spray drying

Spray drying is a process method for drying aqueous solutions, emulsions, and similar substances, widely used in industrial chemistry and the food industry. Dry milk powder, detergents, and dyes are just a few product categories currently processed through spray drying. This technique can be employed to preserve food or serve as a rapid drying method, offering advantages such as weight reduction and volume minimization.

Spray drying is a process where a fluid mixture is ejected into hot dry air. The solvent, typically an aqueous solution, evaporates instantly upon contact with the heated air. This rapid evaporation process efficiently removes heat, allowing the product to be gently dried without thermal stress. Within seconds, the material transforms into powder, granules, or lumps.

2. 1. 1 Advantages o of IN-SD 3N-C

IN-SD 3N-C small spray dryer can quickly and directly obtain the powder particle samples with good shape, and the particles are natural spherical. It has the following significant performance characteristics:

① The instrument is exquisite and compact. The cabinet adopts humanized aesthetic design and uses special spray painting process, so that the appearance of the instrument is more high-end and elegant;

② Heating pipes and auxiliary mechanical parts are made of high strength stainless steel, high corrosion resistance and durability;

③ High precision imported dual fluid nozzle to ensure accurate atomization performance;

④ Simple and fast loading and unloading, simple and efficient operation, the whole spray drying process is carried out in the glass vessel, convenient for operators to observe the whole experiment process;

⑤ The control system of this equipment is based on the German Siemens PLC and MHI touch screen as the development platform. Based on the design principle of energy saving and high efficiency, the heating is faster and more stable, and the temperature control accuracy is up to 1℃;

⑥ Humanized man-machine interaction window, customers can fully grasp the air intake, air temperature, feed rate and other important elements, and can observe the working status of the instrument in real time, so that in the spray drying experiment, customers will have more space for practical verification;

⑦ Intelligent remote upper computer operation and monitoring system, which can easily complete the spray drying work in the laboratory at the computer in the office.

2.1.2 Applicability of IN-SD 3N-C

The IN-SD 3N-C Mini Spray Dryer is designed for drying aqueous solutions and suspensions, ideal for experiments and industrial production requiring uniform powder products. Applications include pharmaceuticals, dyes, food and beverages, pigments, dairy products, plant-based materials, heat-sensitive materials, plastics, polymers, resins, fragrances, ceramics, soaps, detergents, blood products, adhesives, oxides, textiles, bones, and dental applications.

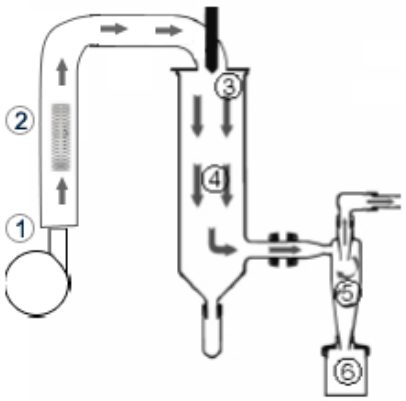
This instrument is especially suitable for the laboratory to directly convert liquid materials into trace powder, without the need to filter, concentrate and crush the materials before drying, and has a wide range of applications for all solutions such as emulsions and suspensions.

⚠ It cannot be used to treat materials that are inflammable, explosive or prone to producing large quantities of gas. In particular, it cannot release gases of unknown chemical composition.

2.2 Functioning principle of dry air

The IN-SD 3N-C small spray dryer works according to the principle of coexistence of air and product flow, and the spray product and hot air have the same flow direction.

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



① Air inlet (air supply from fan)

② Heating pipes and electric heaters

③ The concentric inlet of hot air around the nozzle

④ Spray cylinder

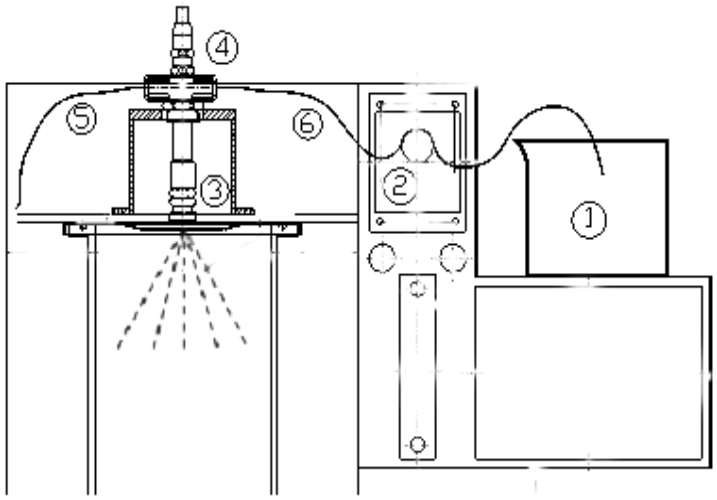
⑤ Used to separate particles from a gas stream

⑥ Product collection containers

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

2. 3 Sample dispersion and feed function principle

The sample solution is pumped into a dual-fluid nozzle using a peristaltic pump. Compressed air is then used to spray the solution into fine droplets that enter the drying chamber. The hot air inside rapidly dries these droplets into solid particles. After separation through a cyclone separator, the dried particles are collected in a collection bottle, while the exhaust gas is either discharged directly into the atmosphere or directed to an air filtration system.



① matter

② Reciprocating pumps

③ Dual fluid nozzle

④ Automatic nozzle through needle system

⑤ Compressed air pipeline

⑥ Feed line

Figure 2-2-3: Sample feeding and dispersion working principle

Chapter 3 Use of inputs

This chapter describes how to get the equipment up and running quickly

1. Preparation of the installation site

1.1 Instrument placement: The instrument should be placed on a stable horizontal base surface (ground or laboratory table) in the room; 3L/h Chinese spray dryer has an effective floor area of 100cm * 100cm, and the effective floor area of air compressor is 100cm in diameter.

1.2 Air supply (air): When the equipment is in a relatively cloudy air condition, please do air filtration and purification first, and then use it for drying; if necessary, please contact Anhui Innuo Engineering Technology Co., LTD.

1.3 Power supply: The working voltage of the instrument is 380V AC, and the total power is 8KW; the working voltage of the air compressor is 220V AC, and the power is 1.5KW; one standard 3-pin 16A socket is required on site; the socket power supply should be supplied by an independent air switch, the current load of the power cable should not be less than 25A, and there should be reliable grounding.

1.4 Tail gas discharge: during the operation of the instrument, a small amount of fine particles are discharged with the tail gas. The tail gas discharge pipe should be placed outside the window or in the ventilation kitchen. The standard high temperature resistant tail gas discharge pipe of the equipment is 2 meters.

1.5 Working noise: when the instrument and air compressor are working, there are fans and air pumps running continuously, and some decibel noise is inevitably generated.

1.6 Clean the water tank: after each spray job, the stainless steel atomization tower body and glass kit should be cleaned. The height of the stainless steel atomization tower body is 80cm and the diameter is 25cm (the widest part).

2. Correct installation of instrument accessories

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

Note: For detailed installation methods and steps, please refer to Chapter 4

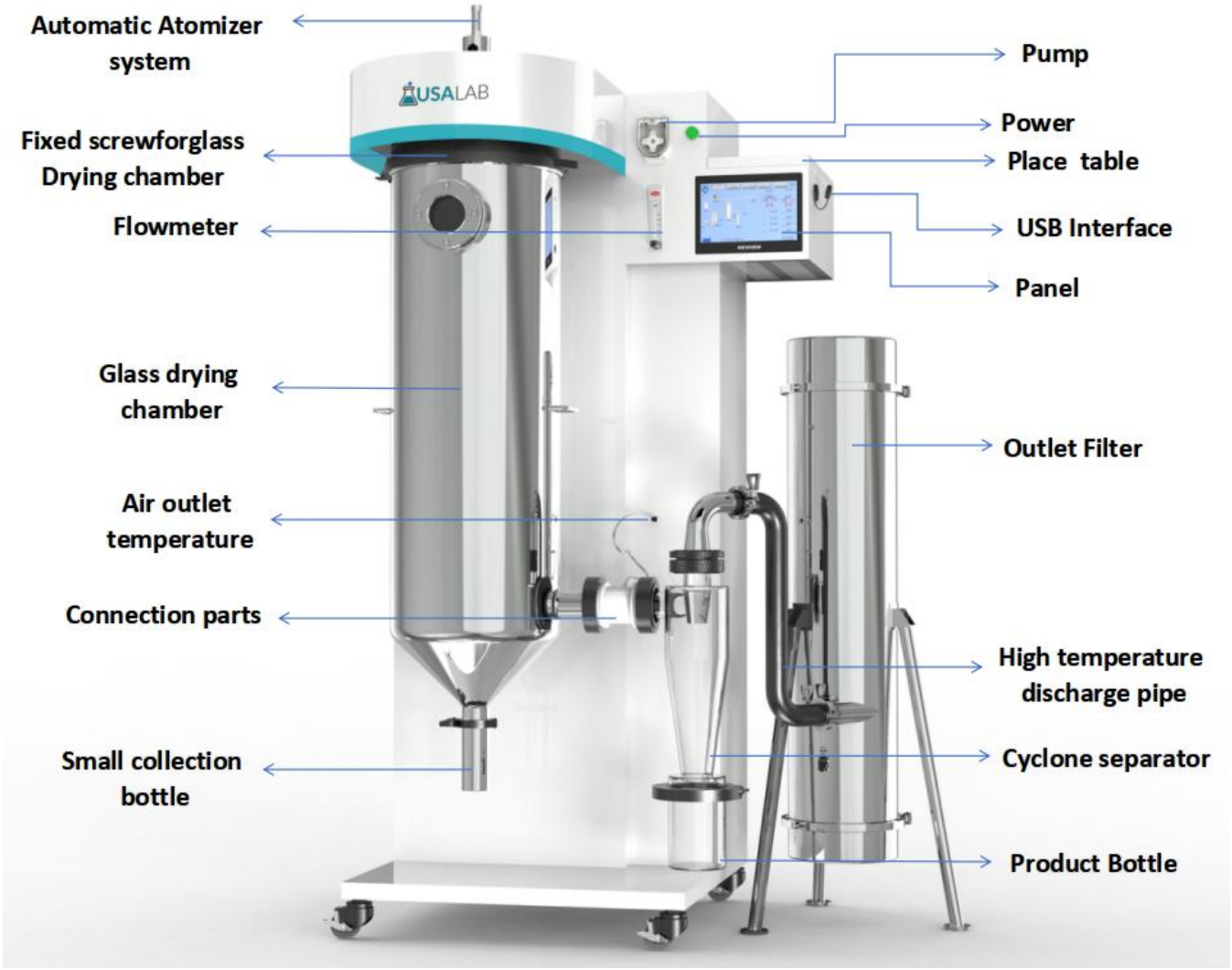


Figure 3-2: Physical analysis of standard instruments

3. Overview of the operation process

This section introduces a complete and simple process of spray drying operation, so that customers can quickly get started and independently complete spray drying tests.

3. 1 Power on the equipment

After checking the correct connection of the power supply, press the power control button. The indicator light is on and the power supply 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 the system for you: parameters such as "air intake", "feed speed", "air inlet temperature" are completely open.

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

3. 3 Start the air compressor and adjust the ventilation volume

During the heating process of the system, we can open the air compressor to prevent the nozzle from being blocked by material due to failure to timely supply compressed air during the later spraying process.

- Plug in the power plug of the air compressor and start the air compressor. 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 air supply to 15-20L/min.

3. 4 Temperature balance, pure solvent test spray

When the air inlet temperature reaches the preset spray temperature, the peristaltic pump can be activated based on the preset feed rate. During the initial spray drying phase, pure water should be used for trial spraying, and the spray volume of pure water can be adjusted according to the preset feed rate. The feed rate is a critical factor affecting the outlet temperature, as the aqueous solution absorbs 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 thermal load limit of the product, so it is necessary to ensure that the product will not be damaged due to excessive outlet temperature.

3. 5 After commissioning, the material is officially fed in

When the desired operating conditions have been achieved and stabilized, switch the feed pipe from pure water to the prepared feed solution.

3. 6 One-click shutdown after material spraying

After complete spray drying of the solution, continue spraying purified water for a period to remove product deposits from the hose and nozzle. Finally, withdraw the tube from the pure solvent. The pump will continue working to evacuate the hose, then click "Shut Down" to stop the peristaltic pump, halt the heater's heating, and close the air compressor. Meanwhile, the fan will remain operational.

3. 7 Stop the fan when the temperature drops

When the heater stops heating, when the air inlet temperature in the instrument is displayed to drop below 60℃, the fan will automatically shut down.

3. 8 Turn off the power supply and collect the material

Press the power switch for a long time, the indicator light flashes, and the instrument is powered off.

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

Do not remove the product collection container when the system is running to avoid the product being blown away.

3. 9 End of work and cleaning of instruments

- If the spray work has been completed, you can separate the glass drying chamber and cyclone separator assembly and connector under the condition of power off the instrument, and clean and wipe them one by one for the next use.

- After the spray drying work is finished, please unplug the power supply of the instrument (the three-legged plug end) and the power supply of the air compressor; pay attention to electrical safety.

 **This instrument contains glass kit, please be sure to handle carefully!**

Chapter 4 Details of equipment

1. Put into use

1. 1 Electrical connections

Connect the power plug to the instrument and AC power supply.

1. 1. 1 Correct use of power cord

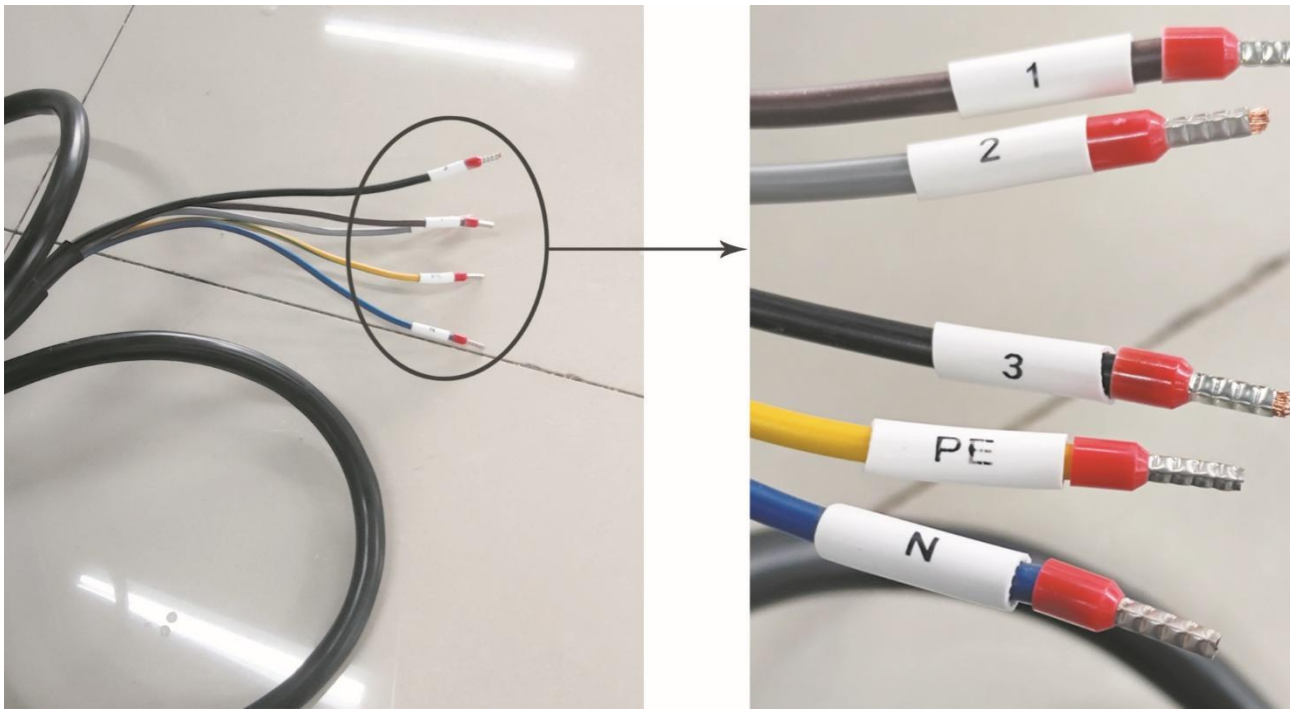


Figure 4-1-1-1: Power cable wiring diagram

There are 5 power supply connection lines. 1,2 and 3 are connected to 380V live wire, N is connected to 380V neutral wire, and PE is connected to the grounding wire.

Please do not plug or unplug the power cord while powered on! Also, Misoperation may cause electric shock!

1. 1. 2 Power on the equipment

Figure 4-1-1-2: Power button operation panel

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

When the power cable is connected in place and all preparations are ready, press the button to power on the instrument and the indicator light will be green.

1.1.3 Power failure of equipment

When power is required, press the green button (the instrument has been powered) until the button indicator light flashes, indicating that power is about to be cut off; when the indicator button is extinguished, the instrument has been powered off.

After determining the power failure of the equipment, if the equipment is not used for a short time, the white three-prong plug can be pulled out from the socket for the sake of electrical safety; the quick-release head at the end of the cabinet does not need to be removed.

1.2 Air connection

Connect the instrument and air compressor to supply compressed air.

1.2.1 Correct use of quick disconnect air line

The quick disconnect of the air circuit can be directly pressed and connected. When inserting, press the ① part directly and insert the ② part directly; when pulling out, press the ① part directly and pull out the ② part directly.

Figure 4-1-2-1: Quick disconnect of air circuit

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

1.2.2 air compressor

The IN-SD 3N Chinese-style spray dryer is equipped with an air compressor developed using advanced American compressor technology. This versatile energy-efficient electromechanical integrated product boasts low noise, compact size, sleek design, power efficiency, easy maintenance, and durable safety. Widely applicable in

medical equipment, analytical instruments, educational research, defense systems, environmental protection, light industry, food processing, pharmaceutical machinery, and daily life, it serves as an ideal air source for various industrial applications and stands as a high-performance alternative to imported products.

- **operational principle**

The oil-free air compressor is a miniature reciprocating piston compressor featuring a single-shaft motor driving a symmetrically arranged crank-rocker mechanism. The primary moving part is the piston ring, while the secondary moving part is an aluminum alloy cylinder surface. These components operate through self-lubrication between the rings without requiring additional lubricants. The compressor achieves periodic volume changes in the cylinder through the reciprocating motion of the crank-rocker. During each full rotation, the cylinder volume undergoes two directional reversals: when expanding (vacuum state), atmospheric pressure exceeds internal pressure, allowing air to enter through the intake valve during suction; when contracting (pressure reversal), compressed gas rapidly builds pressure until exceeding atmospheric pressure, triggering exhaust valve opening during discharge. The dual-cylinder design with single-shaft configuration doubles the gas flow rate at rated speed while effectively reducing vibration noise compared to single-cylinder models, resulting in a more compact overall structure.

Air enters the compressor through the air filter. The motor's rotation drives the piston to reciprocate, compressing the air. The pressurized gas then flows through a high-pressure metal hose and a check valve into the storage tank via the outlet. As the pressure gauge needle rises to 0.8 Mpa, the pressure switch automatically activates to shut off the motor. Simultaneously, the solenoid valve reduces the internal pressure in the compressor head to zero. At this stage, both the air switch pressure and the storage tank's gas pressure remain at 0.8 Mpa, allowing gas to pass through the filter pressure regulator and ball valve for discharge. When the storage tank pressure drops to 0.5 Mpa, the pressure switch reactivates, restarting the compressor operation.

- **Main accessories and functions**

Function of the pressure switch: Its main function is to control the motor's start and stop by sensing the pressure inside the gas storage tank. The machine is set to stop at 8bar and restart at 5 bar. Rotate the switch to the "-" position (connected position); rotate the switch to the "0" position (disconnected position).

Safety valve: when the pressure switch fails or for other reasons, the compressor does not stop, and the working pressure is greater than 8.8 bar, the safety valve will open automatically to reduce the exhaust pressure.

Overload protector: When the compressor is faulty and the current is too large, the protector will automatically disconnect to protect the motor from damage. This machine uses manual overload protection. After the fault is removed, the protector button should be manually reset before the compressor can run normally.

Sewage ball valve: when the gas storage tank has a certain pressure, open the sewage valve handle to discharge the accumulated water in the gas storage tank.

The filter pressure regulator serves two primary functions. First, it filters compressed gas by separating moisture from air before connecting to external equipment. The water flows out through a visible cup connected via an external hose (accessory) at the bottom. Second, it regulates pressure: By lifting the pressure adjustment lever and turning it clockwise, the pressure gauge displays the required exhaust pressure (0.1-0.8 MPa). Turning the lever clockwise increases pressure while counterclockwise decreases it. Pressing the pressure adjustment lever locks the pressure setting.

- **Installation and use**

operating requirement ：

Air compressors should be used in indoor rooms not lower than 5 degrees Celsius, not higher than 40 degrees Celsius, and the relative humidity is not greater than 80%. The surrounding environment must be kept clean, dry, ventilated, and avoid direct sunlight.

This machine should be placed on a flat and firm ground to prevent the machine from moving during operation.

This machine uses a single-phase 220V/50Hz power supply and should be equipped with a 15A fuse or automatic circuit breaker. Abnormal voltage may cause difficult startup or compressor overheating. To ensure normal operation of this machine, in areas with abnormal power supply voltage, please use a single-phase power voltage stabilizer. The power of the voltage 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 (open position), whether the exhaust port ball valve is closed, and check whether the power supply voltage is normal.

② Remove the air intake plug and screw on the air filter so that the PU pipe is directly downward.

③ Unscrew the quick screw clamp of the exhaust port and put it on one end of the gas pipe. Insert the gas pipe into the quick screw and tighten the clamp, and connect the other end of the gas pipe to the external equipment.

④ Insert the power plug of this machine into the power socket, and the installation is complete.

shakedown test ：

When the pressure switch is set to the on position (start position), the air compressor should immediately activate and begin supplying air to the storage tank. The pressure gauge needle will gradually rise. When it reaches 8 bar, the pressure control switch will automatically cut off the power supply to the compressor, causing it to stop immediately. Once the storage tank pressure drops to 5 bar, the pressure control switch will reset to its original position, restarting the compressor automatically. This cycle repeats continuously, achieving precise pressure regulation through this mechanism.

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

Check that the air inlet is not blocked before starting the compressor.

The top surface of the cylinder may be hot, especially after the motor has been running for some time. Do not touch those parts during operation.

- **Drainage of gas tank**

During operation, the air compressor compresses moisture in the air and condenses it into the storage tank. Excessive moisture accumulation can degrade air quality in the tank, directly affecting the normal operation of pneumatic equipment. Therefore, it's essential to drain accumulated water from the tank promptly. The drainage cycle depends on environmental conditions and usage duration, typically requiring drainage every three days.

Drainage method: When the gas storage tank is not under pressure, open the ball valve to make the water outflow from the drain valve, and discharge through the drain hose until the water is drained. After the water is drained, close the ball valve and ensure no leakage.

- **Replace the filter element**

The air compressor's intake port is equipped with an air filter to prevent dust from entering and to reduce noise. Over time, the filter element may become clogged, which can affect the compressor's suction capacity.

Therefore, it's essential to replace the filter element regularly. To replace it: Open the intake silencer cover, remove the old filter element, install a new one, and then reassemble the unit.

- **routine inspection**

Please check and replace the air intake filter regularly and appropriately. We recommend that you check the air intake filter once after 300 hours of operation, and users can decide the frequency of inspection according to their own use. Keeping the filter and muffler clean can avoid most faults, and unclean filter can reduce the performance and service life of the compressor.

1. 3 Atomization system

This section mainly introduces the performance parameters and advanced features of the instrument dual fluid nozzle.

1. 3. 1 Overview

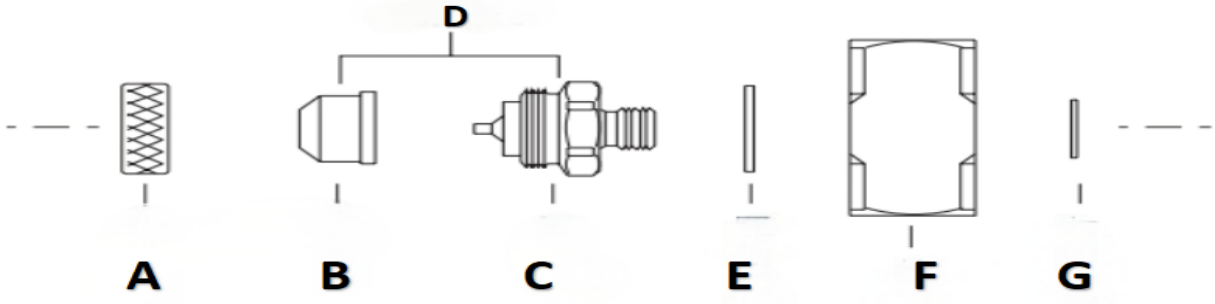
The concurrent dual fluid nozzle enables the spray drying of heat sensitive materials at moderate temperatures.

1. 3. 2 Spray Dual Fluid Nozzle, USA

The Spray dual fluid nozzle is an excellent high precision spray nozzle. The instrument uses an external mixing nozzle, air and liquid flow can be controlled separately, which can effectively spray high viscosity liquids and suspended abrasives.

The dual fluid nozzle is installed at the center of the top of the air distributor and directly sprays downward into the tower. The feed enters through a nozzle inlet at a minimum pressure and is atomized with compressed air.

- **Nozzle assembly**



A、Nozzle Nut;B、Air Cap;C、Liquid Cap;D、Spray Device;E、Liquid Cap Gasket;F、Nozzle Body;G、Sealing Washer;

Figure 4-1-3-2.1: Schematic diagram of nozzle body and spray device

- **Use and maintenance of nozzles**

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

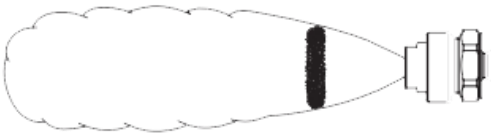


Figure 4-1-3-2.2: Spray morphology

The spray system features an integrated needle cleaning mechanism that automatically removes obstructions when the nozzle passes over liquid nozzles, ensuring effective spraying of high-viscosity liquids and suspended abrasives. However, excessively viscous materials or operational errors may cause nozzle clogging. When manual cleaning is required, simply unscrew the nozzle cap and clean both the air cap and liquid cap with pure solution.

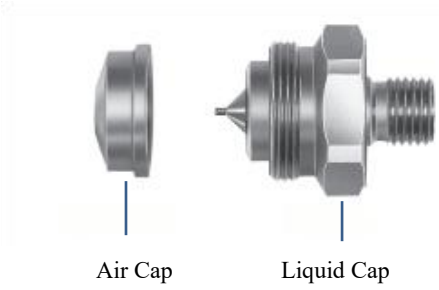


Figure 4-1-3-2.3: Remove and wash the nozzle

- **natural parameter**

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

Air flow rate is between 600-1000L/h.

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

1. 4 Feed system

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

1. 4. 1 Reciprocating pumps

Figure 4-1-4-1: Schematic diagram of peristaltic pump

1、Stepper motor；2、Hose；3、Installation hole；4、Pump head；5、Fastening pin

Transparent protective cover, allowing for easy observation of the pump head and hose operation at any time;
Multiple motor drives are adopted;
Special hygienic-grade hoses are used, with the entire section installed in a snap-in manner;
Standard quick-connect joints, facilitating the connection of different materials of hoses;
No joints, simplified design to avoid leakage and contamination risks.Jointless simplified design to avoid leakage and contamination risks.

1. 4. 2※ Feed switching valve

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

The feed switching valve is an optional accessory. The switching valve is driven by an electromagnetic solenoid and controlled by squeezing or releasing the hose. The medium only passes through the hose, and other components in the valve body do not come into contact with the chemical corrosive medium. Simply replace the silicone hose.

The three tubes are connected to the peristaltic pump feeding silicone tube, and then the pumping of materials and solvents is automatically switched.

1. 4. 3 Operation Mode

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

- **Autonomous control of flow**

The feed rate is controlled by the customer. The input value can be adjusted to adjust the feed rate. Within the range of feed operation, the value can be arbitrarily switched to run.

- **Material reflux**

One-click recovery of material in silicone tube.

- **※ Intelligent expansion**

The selected equipment is equipped with a feed switching valve, which can be switched between manual and automatic operation mode at will. The system can automatically complete the switching of materials and solvents in different stages of the working process without manual participation.

- **Replace hose**

A、As shown in the figure, tighten the fastening pin to the unlocking position.

B、Open the transparent cover

C、Install the hose

D、Close the transparent cover and tighten the fastening pin to the locked position.

Figure 4-1-4-3: Diagram of Replacing the Pulsator Pump Tubing

First, open the top cover, remove the pipe clamp, gently turn the rotor clockwise, and remove the tube to be replaced or worn;

Cut a new tube of the same length, then rotate the wheel clockwise and slowly install the hose into the pump head;

Then, fix the tube card on the card and cover it with a lid.

When you replace the hose, make sure that the main power to the instrument is turned off.

Do not turn off the machine to replace the hose or turn the pump head rotor!

1.5 Heating system

This section introduces the characteristics and use of the instrument heating system.

1.5.1 Performance indicators

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

Table 4-1-5-1: Heater Performance indicators

metric	parameter
working voltage	AC380V，50HZ
power rating	5KW
heating efficiency	0-250℃
material quality	316L stainless steel
stability	±1℃

1.5.2 Maintenance and maintenance of heaters

When the electric heater has not been used for a long time (more than 3 weeks), it is difficult to restart because of leakage of electricity caused by condensate and moisture inside or on the surface of the insulation material of the heating element.

To remove moisture through gradual heating element warming (preventing electrical leakage), follow these steps for restarting the heater: First, turn on the heater switch and wait at least half a minute before turning it off. After approximately one minute, restart the process for another half-minute. Repeat this cycle several times based on the duration of previous shutdowns, gradually extending the on-time while shortening the off-time. After about 30 to 60 minutes, the heater is ready for continuous operation.

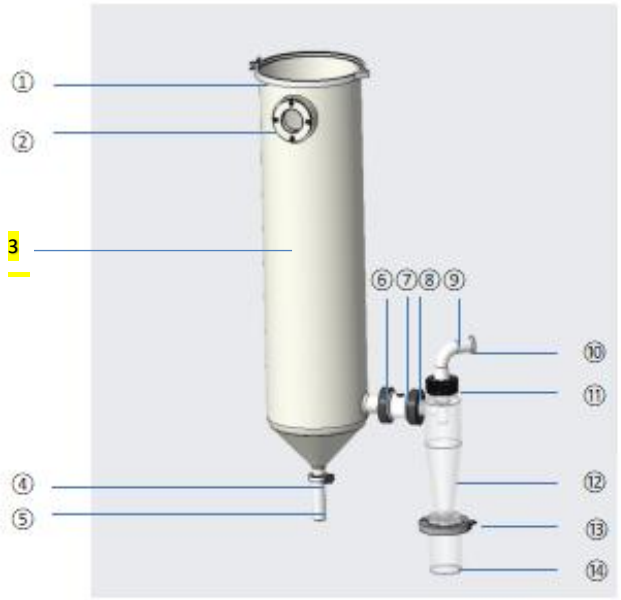
Because condensate water is related to the humidity of air, attention should be paid to the storage conditions.

If the heater cannot be troubleshooting, please contact our technical staff in time.

1.6 Drying and collection

This section describes in detail the installation and use of glass components and precautions.

1.6.1 Material collection unit



1、Clamp
2、Sight glass
3、Atomization drying chamber
4、Small collection bottle connector
5、Small collection bottle
6、Flange screw joint
7、PTFE connectors
8、Flange screw joint
9、Elbow
10、Exhaust gas emission outlet
11、Flange screw joint
12、Cyclone Separator
13、Clamp
14、Product collection bottle

Figure 4-1-6-1: Schematic diagram of material collection component

1.6.2 Installation procedure

- Place the stainless steel dryer tower's sealing ring into the upper chuck slot. Hold the dryer tower ② with both hands and align it with the box's connecting chuck. Then use K319 clamps ① to secure the tower at the center of the installation plate, ensuring the protruding part ⑤ remains parallel to the cabinet's vertical plane for subsequent assembly.
- Use flange screw joint ⑤ to tighten and fix the polytetrafluoro connector ⑥ on the drying tower body ②; keep the temperature sensor during installation

  The installation hole of pt100 is positioned upward.
- Fix the cyclone separator ⑪ by flange screw head ⑦

- Connect the small collection bottle with a screw connector ③ and fix the small collection bottle ④ at the bottom of the tower (with polytetrafluoroethylene seal in the middle).
- Use the clamp ⑫ to clamp and fix the material receiver ⑬ at the lower end of the cyclone separator.
- Tighten the elbow ⑧ with flange screw head ⑩ and fix it at the top of the cyclone separator (there is a polytetrafluoroethylene seal in the middle).
- Put the exhaust pipe on the exhaust outlet ⑨, and place the other end of the exhaust pipe outside the fume hood or window.
- Confirm again whether the glass kit is fully in place, then rotate the PT100 sensor into the temperature detection fixing hole of the polytetrafluoroethylene connector ⑥, tighten it, and then insert the plug into the PT100 connection hub of the cabinet.
- Material collection assembly installation is completed.

The Pt100 quick-release head is quick-plug and pull. Do not rotate it forcefully.

1.6.3 Disassembly process

After each spray drying experiment, the material collection assembly should be disassembled, cleaned and packaged for storage for the next experiment.

- First, after the spray drying experiment is completed, remove the exhaust pipe and remove the elbow ⑧ by rotating the flange screw joint ⑩ in reverse when it is determined that the fan has stopped running.
- Then, rotate the screw joint ⑦, cyclone separator ⑪ and material receiver ⑬ in reverse to separate from the polytetrafluoroethylene connector ⑥, and put it aside. Then, use a test tube brush to clean the material particles and collect and preserve them.

Then loosen the screw joint ⑤ and remove the connector ⑥.

- Remove the quick-fit clamp ③ and remove the small collection bottle ④. The small collection bottle contains a small amount of large particles, and decide whether to use the large particles or not according to your needs.

- Then, under the condition of holding the drying chamber ②, slowly loosen the K319 quick-clamp and remove the drying tower body. Pay attention to lifting the drying tower body to avoid injury.
- Clean the material collection components one by one and save them.
- The disassembly work is finished.

When cleaning the Pt100 quick-release parts, do not touch the quick-release head with water. Misoperation may cause short circuit.

1. 6. 4 Usage Notes

- The glass kit is fragile, please handle it carefully.
- Before each spray dry experiment, make sure that each accessory is in place and tightened.
- During normal spray drying, the temperature of glass kits is high. Be careful not to burn.
- During normal drying process, the exhaust gas in the exhaust pipe is also high temperature, do not scald.
- After spray drying, please wait for the surface temperature of the tower to be low enough before disassembly, in order to prevent unnecessary accidents.
- Keep the glass kit clean after spray drying.
- Since the spray material of this equipment is completed in a high temperature and semi-closed environment, do not use any volatile, flammable or explosive organic solvents for spray drying.

1. 7 Air supply system

This section mainly introduces the relevant performance indicators of the instrument exhaust system.

1. 7. 1 Dagang fan

Figure 4-1-7-1: Dagang fan

The fan is an internal mechanical structure, do not disassemble by non-professionals!

1. 7. 2 Control model

The instrument air supply system adopts frequency conversion control to achieve infinitely adjustable air volume, so as to better adapt to the needs of different process spray drying experiments.

If your experiment requires very high purity of the air source, please add an air filter.

1. 7. 3 Exhaust emissions

In the process of spray drying, a small amount of extremely fine dust will be discharged with hot air. The exhaust pipe at the end of the instrument should be put into a ventilation kitchen or outdoors. If there is certain pollution, filtration should be done.

During the experiment, the exhaust gas is hot air with high temperature. Be careful not to burn!

2. Operation

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

2. 1 Layout of operation and display components

（1）Peristaltic pump; (2) air flow meter (atomization effect); (3) power switch; (4)solvent tray; (5)operation display screen.

Figure 4-2-1: Operation unit

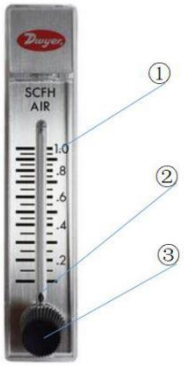
Please do not pour water or other liquids on the tray, and do not have water accumulation! Misoperation will lead to water infiltration into the control cabinet, resulting in electrical short circuit fault!

2. 2 Parameter conversion

This section describes how to convert parameters on the operating system into more useful data.

2. 2. 1 Glass rotor flowmeter

The rotor flowmeter is used to regulate the indicated spray gas flow of the dual fluid atomizer.



(1): scale value; (2): scale float; (3) adjustment knob.

Figure 4-2-2-1: Flowmeter

2. 2. 2 Creeping pump

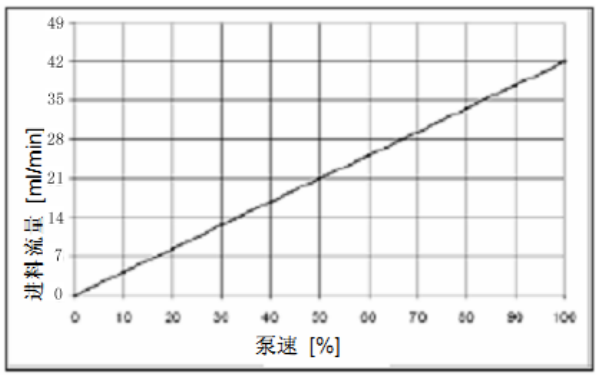


Figure 4-2-2-2: Relationship between pump set value and output flow

Peristaltic pumps can be adjusted for tubes with different inner and outer diameters. The absolute flow rate varies with the diameter of the tube. The figure shows this relationship for standard 16# silicone tubes.

2. 2. 3 Air supply device

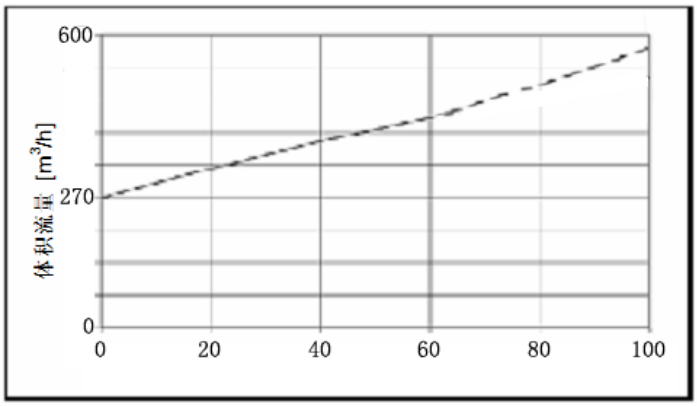


Figure 4-2-2-3: Relationship between air volume setting value and output flow

2. 3 General operating system steps

After the instrument is powered on, the touch screen starts up and the initial drawing is the standby interface; this screen stays for 3 seconds and then automatically jumps to the main operation interface, where the key data setting and system start/stop of spray drying experiment are completed.

- Set the air intake and target air temperature, then touch the system start/stop button (main control section), the system starts, the blower runs, the heater works, and the heating air is started.
- When the air inlet temperature reaches, the system will automatically use an audible warning (not effective in silent state);
- Then, the feed rate is set, and the test spray is made with pure water. By adjusting the feed rate, the outlet temperature reaches the target temperature until the temperature balance is stable.
- Replace the pure water with a pre-prepared material solution, and keep the preset feed rate and air inlet temperature unchanged.
- When the material is relatively viscous and easy to block the nozzle, the automatic unblocking function should be opened. At this time, the needle frequency should be set. When it is 0, it will not work by default, and when it is greater than 0, the needle will be unblocked at a certain interval.
- After the material is sprayed dry, spray with pure water for 1-2 minutes again to clean the nozzle. Then remove the silicone tube from the pure water and pump it naturally until the solution in the tube is emptied. Then click "Shut down", the feed rate becomes 0, the peristaltic pump stops, the air inlet temperature becomes 0, and the heater stops.
- Adjust the glass rotor flowmeter (the float is at the bottom), stop conveying compressed air; turn off the power switch on the air compressor.

- The fan continues to run until the air inlet temperature drops to 60℃; the system automatically shuts down the fan; at this time, you can press the power switch for a long time to stop the power supply; after the surface of the tower is cooled, other follow-up work can be carried out.

2.4 ※ Steps for automated integration of operating systems

- Prepare a solution of pure water and a solution of the material to be sprayed.
- After the system is officially started, the preset parameters "air intake" and "air intake temperature" are preset once.
- Click the start/stop control button of the system, and the system starts to run automatically. Set the "feeding rate".
- The instrument is equipped with troubleshooting and information monitoring system, which can report the working status of the stage in real time; or the upper computer can remotely monitor and interfere with the experimental process.
- The instrument sprays itself to end, and the system informs that the material is collected.

3. Detailed description of touch screen system

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

3.1 Main control interface

This interface serves as the control center for the IN-SD 3N-C system. Users can conveniently adjust key experimental parameters including "set temperature", "material feed rate", "air intake volume", and "needle piercing frequency". The system provides real-time monitoring of both "air intake temperature" and "set temperature", while allowing precise control of heater performance through continuous monitoring of "heating capacity".

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

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

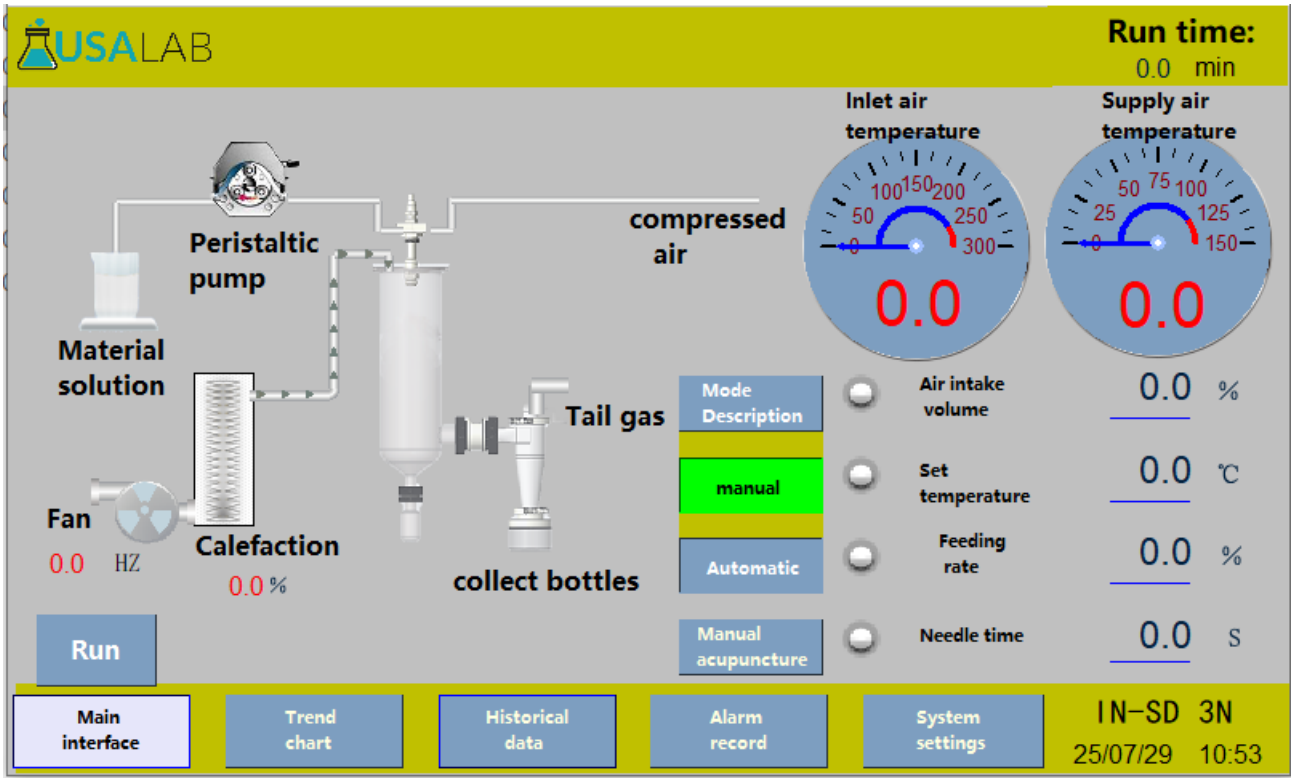


Figure 4-3-1: Main control interface

- Interface Switching In the title bar, customers can switch between interfaces by touching buttons.

Take the "Trend Chart" button as an example:

When in another interface, the trend chart button is displayed as; Trend chart ;

When you touch the "Curve" button, the interface is switched to the "Curve" interface, and the button status becomes, indicating that you have successfully switched the screen. Trend chart

- The picture display area of the main control interface shows the real-time working status of IN-SD 3N-C small spray dryer in the form of dynamic image.

The "heating" here is the real-time display value, which is used to indicate the working status of the heater and cannot be modified.

- The system has a one-key start/stop button, which has two main functions: starting the system and stopping the system.
  - When the button display status is running, it means that the system is in a stopped state;
  - Touch the button. When the button is displayed as running, it indicates that the system is in running state.

⚠ **The "Run" button can only be used as the start/stop control system, and does not have the function of turning on/off the instrument power supply.**

- Instrument running time, as a time monitoring window, is used to display how long the instrument has been working in real time; here the time unit is "minutes".
- Data units, including display class data and preset class data.

Display data: marked in red font, respectively dynamically reflect the real-time "inlet temperature" and "outlet temperature", which is very intuitive and cannot be changed.

Preset data: The setting of "air intake", "air intake temperature" and "feed rate" is completely left to the customer; in the experimental work, it is convenient to create the best spray environment.

"Air intake volume": is opened in the form of percentage control quantity to adjust the air supply volume of the blower.

Set the range to 0-100%:

When it is set to 0%, the fan stops working;

When set to 100%, the maximum air volume is 120m³/h.

⚠ **The heating function of the instrument is only effective when the fan is running normally; in manual operation, air volume and temperature coexist.**

"Air intake temperature": in degrees Celsius, the temperature setting range is 30-250℃; after the customer sets the temperature value and starts the system, the intelligent PID temperature system will automatically heat and adjust the temperature.

"Feed rate": percentage: set the range of 0-100%; 0% means that the peristaltic pump does not work; 100% is the maximum pumping capacity.

The feed rate has a great influence on the outlet temperature, so it is of decisive significance to choose an appropriate feed rate for the final material properties.

"Needle frequency": that is, when the nozzle is blocked, open the automatic system drainage function; The range can be set from 0 to 600 seconds;

When set to 0, the blocking function is cancelled by default, and when greater than 0, the blocking of the needle is enabled. This function is only effective after the system runs;

⚠ **Because the needle action will cause some friction damage to the nozzle, it is not recommended to open this function for a long time.**

The advisory information display panel serves as a section for displaying both advisory and alarm messages. The system is equipped with two automatic functions: an alert notification when preset temperatures are reached, and an automatic alarm activation during equipment malfunctions. When advisory messages appear, customers can quickly refer to the fault information reference table to make informed judgments and take appropriate countermeasures.

When the prompt information appears, there will be a "beep" alarm prompt sound. At this time, pressing the message subtitle is equivalent to manual confirmation that the alarm sound disappears; if the alarm is removed, the prompt information will also disappear automatically after a while; if the alarm remains, the system will alarm again.

3.2 Trend chart interface

As a real-time monitoring data dynamic trend chart for human-computer interaction, the trend diagram interface enables customers to intuitively control the dynamic relationship between "air intake", "feed rate", "set temperature", "air intake temperature" and "air outlet temperature", so as to better use the system and spray the most ideal material.

There are five trend graphs in this interface:

Air intake (green), feed rate (yellow), set temperature (black), air intake temperature (red) and air outlet temperature (blue).

Through manual selective adjustment, one or more curves in any time period of the experiment can be displayed

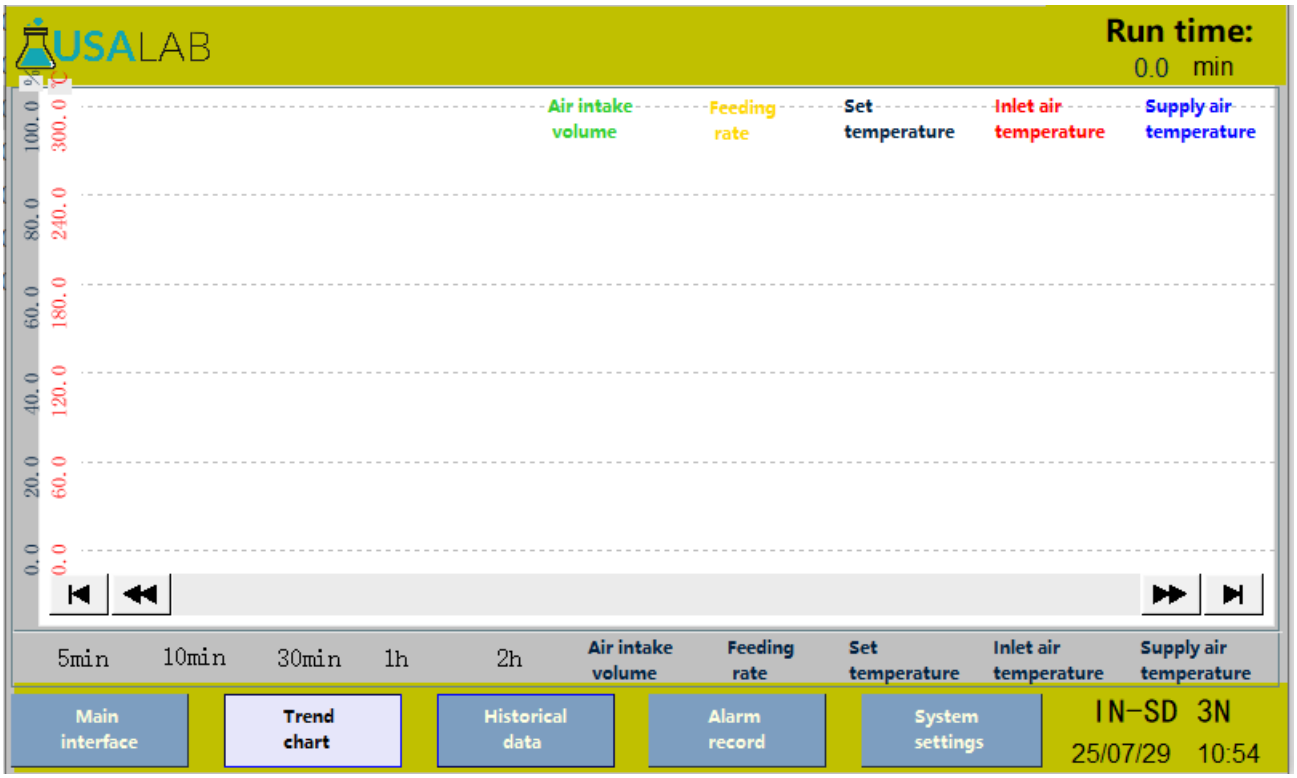
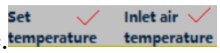


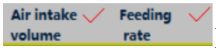
Figure 4-3-2: Trend chart

- Dynamic curve display area, mainly shows the real-time dynamic trend of "air intake", "feed rate", "set temperature", "air inlet temperature" and "air outlet temperature" and other important experimental data.
- The vertical coordinate is the reference value of the curve data; feed/wind--%, temperature--℃.
- Observation of the curve function keys: You can view the curve of any period by touching these 4 keys.
- Time interval assignment. The system displays the curve only for 1 minute by default. You can adjust the curve for a wider range of time periods by touching the number here;

  For example, when it turns red for 5 minutes, it means that the trend chart is viewed over a 5-minute time interval.
- Curve color identification: In order to facilitate clear observation of the dynamic trend of different curves, five different colors, green, yellow, black, red and blue are selected to mark the five curves of "air intake", "feed rate", "set temperature", "air inlet temperature" and "air outlet temperature".
- X-coordinate, time axis.

- Selective display curve: customers can easily choose to display only one parameter or two or three parameters, which is easy to observe and compare.

For instance, if a customer needs to analyze the dynamic relationship between preset and actual intake air temperature values independently, they can press the "Set Temperature" and "Intake Air Temperature" buttons respectively. When the status changes to [marked by a check symbol in the upper-right corner of the corresponding option], it indicates that these parameters are selected. At this point, only the curves for these two parameters will be displayed on the curve interface. If the customer wishes to observe the "Intake Air Temperature" curve separately, they can press the "Intake Air Temperature Predefined" button again. The check symbol in its upper-right corner will disappear, indicating that the selection has been canceled. The curve interface will then display only the "Intake Air Temperature" curve. 

For instance, if a customer needs to analyze the dynamic relationship between preset and actual intake air temperature values, they can press the "Set Temperature" and "Intake Air Temperature" buttons respectively. When the status changes to [marked by a check symbol in the upper-right corner of the corresponding option], the curve display interface will only show the curves for these two parameters. If the customer wishes to observe the "Intake Air Temperature" curve separately, they can press the "Intake Air Temperature Predefined" button again. The check symbol in its upper-right corner will disappear, indicating the option has been unselected, and the curve interface will display only the "Intake Air Temperature" curve. 

For instance, if a customer needs to analyze the dynamic relationship between preset and actual intake air temperature values independently, they can press the "Set Temperature" and "Intake Air Temperature" buttons respectively. When the status changes to [marked by a check symbol in the upper-right corner of the corresponding option], it indicates that these parameters are selected. At this point, only their respective curves will be displayed on the curve interface. If the customer wishes to observe the "Intake Air Temperature" curve separately, they can press the "Intake Air Temperature Predefined" button again. The check symbol in its upper-right corner will disappear, indicating the selection has been canceled. The curve interface will then display only the "Intake Air Temperature" curve.

3. 3 Historical data interface

The historical data interface exists as an auxiliary to the curve interface and updates the data every 10 seconds. Through the data interface, customers can visually observe the experimental data at any time during the spray drying process.

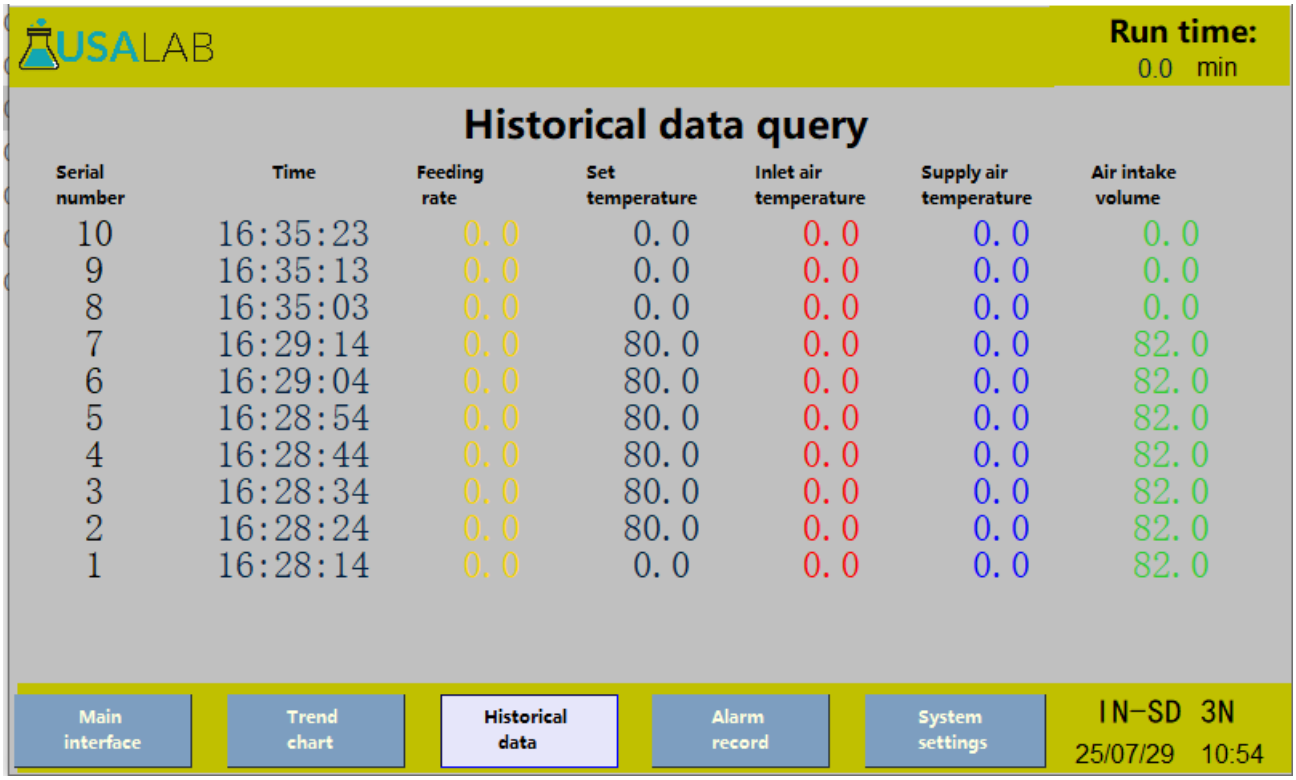


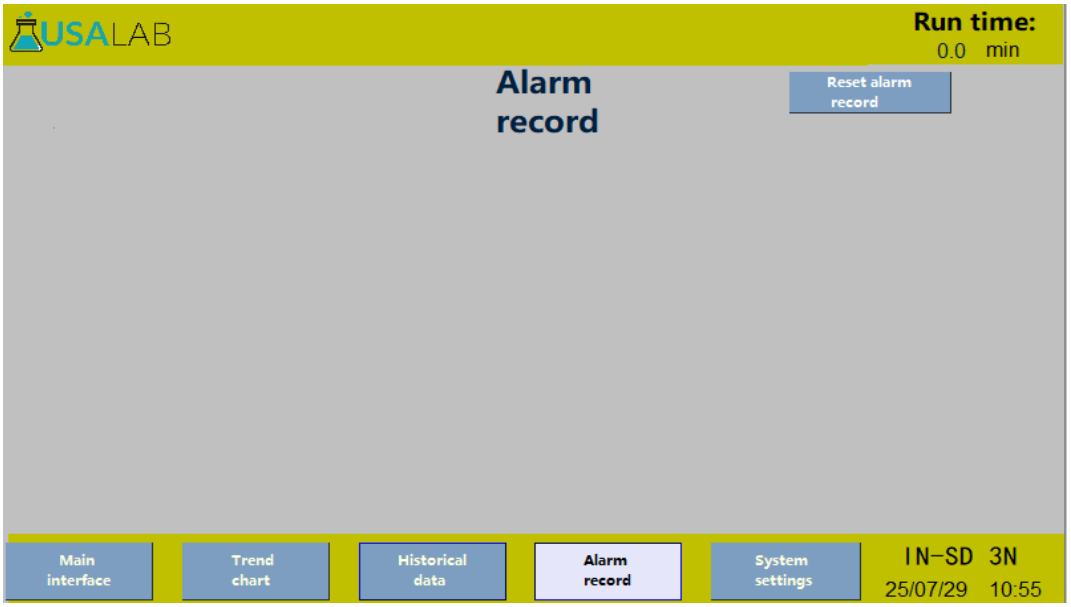
Figure 4-3-3: Historical data interface

- In real time data monitoring display area, "feed rate", "air inlet temperature setting", "air inlet temperature", "air outlet temperature" and "air inlet volume" are sampled every 1 second and displayed here.

- Swipe the toolbar to view the data. As the amount of data displayed on a page is limited at one time, you can swipe the slider of the toolbar or press the up and down arrows to view the sampling data of different time periods in sequence.

3. 4 Alarm record and system setting interface

The alarm record interface displays the alarms occurred during the operation in chronological order. The button in the lower right corner resets all the alarms



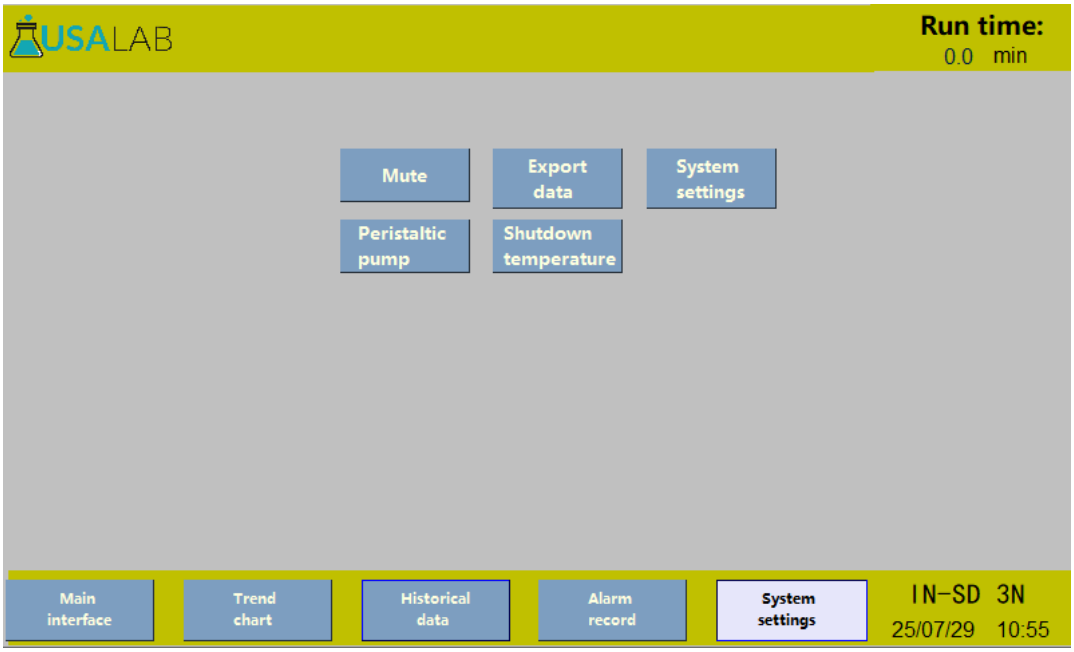


Figure 4-3-4.1: Alarm record and system setting interface

The system interface can be set up to perform the following operations

Mute: In order to enhance the operability of HMI, the operation of the touch button in this system will be accompanied by a "beep" prompt sound of successful operation; if the customer's environment needs to be quiet, you can click this button to turn off the sound effect; if you want to restore the key prompt sound, you can click the button again.

Standby: After touch, the screen automatically jumps to the "standby interface".

Shut down temperature: After touching, the blue button becomes a gray button and a small interface for customizing the shutdown temperature pops up. As shown in Figure 4-3-4.2, then, when touching this button again, the small interface automatically disappears.

Shutdown temperature: 00℃

Figure 4-3-4.2: Small shutdown interface

For example, the preset shutdown temperature is 90℃;

When the material is dried manually and is about to enter the final cooling and material taking stage, press the "shutdown" button to activate the automatic shutdown function of the system; the system will automatically turn off the feeding, needle passing and heating functions, and keep the fan air cooling;

When the air inlet temperature is detected to be low to 90℃, the fan will be automatically stopped and a prompt alarm will be issued to indicate that the material is collected.

Please close the air compressor in time and stop conveying compressed air; wrong operation will lead to moisture of materials.

Peristaltic pump: After touching, the blue button becomes gray, and the small interface of manual intervention of peristaltic pump pops up. You can control the forward and reverse rotation of peristaltic pump, which needs to be performed in non-experimental state of the equipment. Then, touch this button again, and the small interface will disappear automatically.

Forward rotation: When the system is not started, pressing the button will make the peristaltic pump run forward to feed; the feeding rate can also be preset and adjusted in "main control interface" - "feeding rate".

Reversal: Touch the button, the peristaltic pump rotates in reverse to retract the material in the tube; the speed can also be adjusted.

Export data: Press the button to pop up the data export window. Insert a USB drive into the USB port on the right side of the instrument, and click the backup data button to export the historical data to Excel.

System setting: This button is the engineer debugging button, do not operate by experiment personnel.

3. 5 Standby interface

The standby interface is an implicit interface, which is also the initial interface of the instrument when it is powered on. After 5 seconds, it will automatically jump to the "main control interface".

The system sets the interface. When the customer triggers the "standby function", the system automatically jumps to the "standby interface".

When the touch screen is touched anywhere in the standby interface, the system will jump back to the "main control interface".

Figure 4-3-5: Standby interface

4. Fault information reference table

Customers can refer to the following general fault information and possible causes and remedial measures to quickly determine the fault and resume operation.

4. 1 General fault information

fault message	Possible causes	corrective measure
The instrument cannot be powered on	Power outage in the interior	Waiting for a call
	The power plug is not plugged	Plug in the power plug
	The power cable is damaged	Change the power cable
	electrical accident	Contact Anhui Innos

The touchscreen doesn't work	The instrument was out of	Refer to the solution for the inability to
	Touch screen damaged	Replace the touch screen
The fan is not working	Fan is damaged	Change the fan
	electrical accident	Contact Anhui Innos
The electric heater cannot be heated	The heater is broken	Replace the heater
	electrical accident	Contact Anhui Innos
The feed pump is not working	Stepping or drive damage	Change the stepper or driver
	The pump head is stuck or	Retie the hose
The needle doesn't work	Low air pressure	Refer to air compressor troubleshooting
	The electromagnetic valve is	Replace the solenoid valve
The touch screen is not	Communication failure	Contact Anhui Innos
The temperature display value is too large	Pt100 is damaged or not	Replace Pt100 or reconnect
	Temperature transmitter fault	Change the temperature transmitter
The temperature can't go up	The heater is broken	Replace the heater
	Thermometer sensor fault	Replace Pt100 or check the connection
The air compressor is not working	The air compressor is not	plug in
	Air compressor failure	Replace the air compressor
Low end drop liquid of drying chamber	The air intake temperature is	Low preset temperature / Heater failure
	The air pressure of the	Adjust ventilation
	Compressed air leaks	Check the air lines
	Excessive feed	Reduce feed
Compressed air cannot be regulated	The nozzle is blocked	washing nozzle
	No gas source	Check the air compressor working

Figure 4-4-1: Comparison table of general fault information

4.2 Implicit fault information

Considering the safety and reliability of customers using the instrument, the control system has many automatic protection functions implied.

When the equipment is in an abnormal state, these specific functions will be activated and automatically make corresponding corrective and protective measures.

Implicit functional failure	**System processing method**	**Customer response measures**
The intake air test cannot be heated	The system automatically turns off the heater	Temperature sensor and transmitter are faulty
		The fan is not running
		The heater is not working

The air intake temperature is too high	The system automatically turns off the heater	Temperature sensor and transmitter failure
	The system automatically cuts off power	Other unexpected failures
The system displays password protection	Access is granted after password verification	Contact Anhui Innos

4-4-2: Correspondence table of implied fault information

After the implicit functional fault alarm appears (the alarm will be displayed on the touch screen interface of the upper computer), the customer can make some fault judgment and troubleshoot in time according to their own experience, and then try to run the instrument safely, or directly contact with engineers of Anhui Innol.

5. How to better use IN-SD 3N-C small spray dryer

This chapter objectively analyzes the working factors that affect the small spray dryer from a practical perspective. It should be understood that different Settings of the instrument cannot be considered separately, and all parameters that can be adjusted by the instrument are interdependent. When one setting is adjusted, the setting of another parameter also needs to be changed.

5. 1 Interactions between parameters

- The greater the temperature difference between import and export, the higher the residual moisture content.
- The higher the fan speed, the shorter the residence time of hot air in the instrument, resulting in a higher residual moisture content.
- The lower the fan speed, the longer the hot air stays in the instrument, and the drier the product is.
- The higher the fan speed, the higher the separation degree of the rotary separator.

- The higher the spray flow rate, the smaller the particles.
- The higher the spray concentration, the larger the particle.
- Low spray concentration and high spray flow rate can produce very small particles; and there is a risk of product loss (low separation degree of cyclone separator).
- Assuming that the temperature remains constant, the higher the pump speed, the lower the outlet air temperature.

5.2 Inlet temperature and outlet temperature

- The inlet air temperature refers to the temperature of hot dry air. Dry air is conveyed above the heater via a fan motor. Its temperature is measured before entering the drying chamber. When spray-drying solutions, emulsions, or dispersions, the solvent is removed through evaporation. The airflow temperature exceeds water's boiling point, enabling rapid droplet evaporation within a short residence time. The final product's temperature remains unaffected by the drying process. Steam envelops the spray droplets, protecting the product from thermal effects.
- Before entering the cyclone separator, the temperature of air containing solid particles is designated as the outlet temperature. This temperature does not necessarily equate to the product's actual temperature. Water evaporation removes heat from the product, keeping it cool. Even with a residence time as short as approximately 1 second, the solid particles won't be heated to their ambient temperature. However, the empirical rule states that the outlet temperature equals the product's maximum temperature. Unlike inlet temperature, the outlet temperature cannot be set through a thermostat.

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

- Air intake temperature
- Fan flow rate (air intake)
- Setting of the creeping pump
- Concentration of material to be sprayed

The optimal selection of the temperature difference between imports and exports is the most critical factor to consider when implementing spray drying. While other specific product parameters such as melting points or decomposition temperatures must be accounted for, there remains considerable flexibility in

adjustment. The equipment's production capacity and residual water content may be affected within this temperature range.

The table below illustrates the interaction between inlet and outlet temperatures, which are related to the pump's air consumption. These data are intended for guidance only. While they help clarify the interrelationships among the aforementioned factors, the number of influencing variables makes absolute values impossible. The following principles can be derived from the data:

For the final product 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 injection speed of the instrument.

5.3 fan

The instrument draws dry air through a fan. By adjusting the fan speed, the volume of hot dry air can be increased or decreased. As the airflow changes, the energy required for evaporation also varies. Therefore, the fan speed setting significantly impacts the drying performance of the instrument. The evaporation efficiency is influenced by multiple factors, including the concentration of the spray solution and the moisture content in the dry air.

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

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

5.4 Pump speed of the worm pump

The peristaltic pump delivers the spray solution to the nozzle.

The speed of the pump determines the temperature difference between the inlet and outlet temperatures. This is entirely true, because the temperature of dry air and the amount used, i.e. 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 liquid sprayed is large or small, the heat consumed by the evaporation process will be more or less. In this way, the outlet temperature can be adjusted to a lower or higher value.

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

The following principles, which relate to the rate of the pump, can be derived from the above facts:

- **Increasing the pump rate increases the temperature difference between the inlet and outlet temperatures.**
- **The drying material content of the final product can be increased by reducing the pump rate while keeping the inlet temperature and the flow rate of the ejector constant.**

5.5 Flow rate of compressed air in spray

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

The spray flow rate can be set on the instrument to 5-25L/mim, but the actual working range is about 15-20L/mim.

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

The principle is:

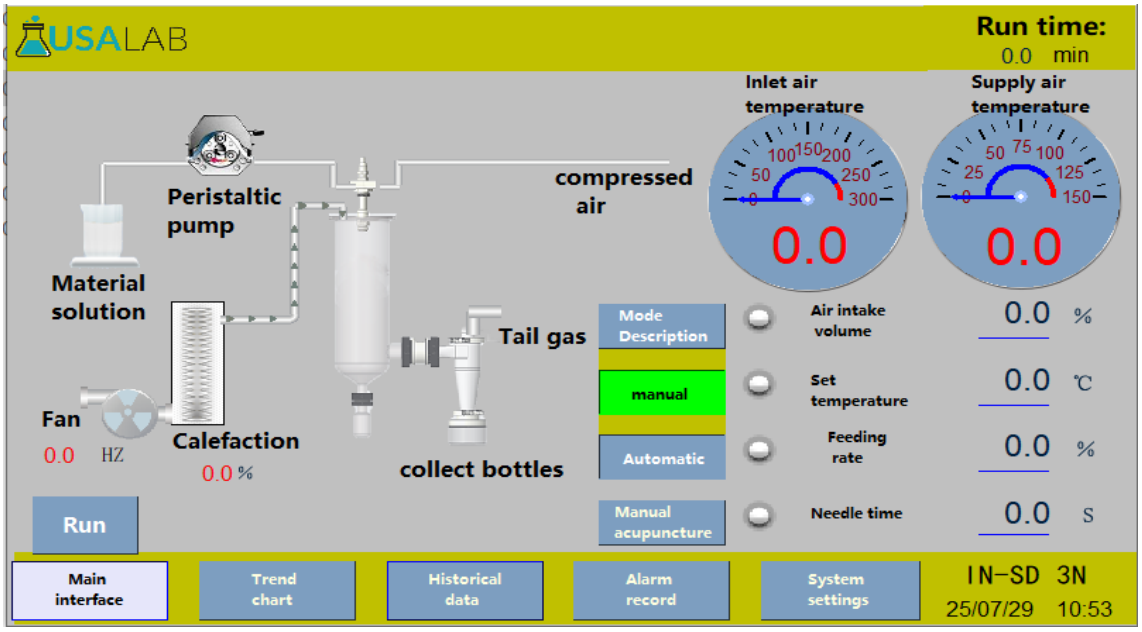
- **The higher the spray flow rate, the smaller the particle size of the final product.**

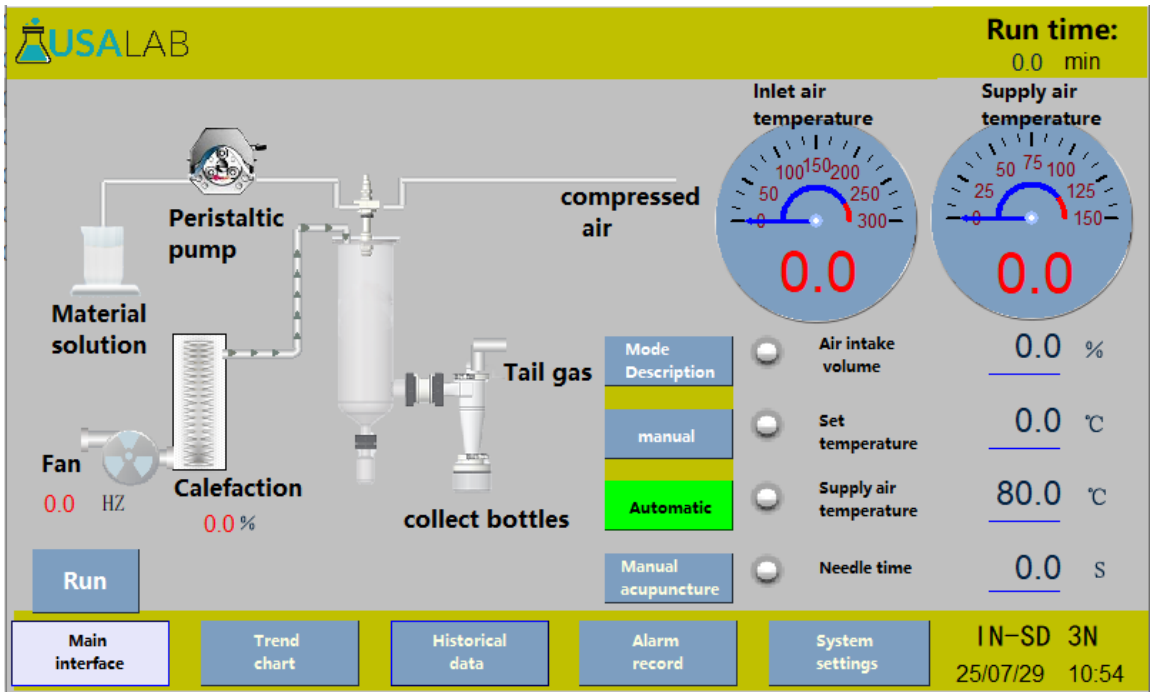
5.6 Spray material concentration

Spray concentration affects particle size.

- **The higher the concentration of the spray solution, the larger the particle size and the more pores of the dried particles.**
- **The lower the concentration of the spray solution, the smaller the particle size and the fewer the pores of the dried particles.**

Update the guide





According to user requirements, the software and interface of this product have been updated in the feeding mode of peristaltic pump, and the manual automatic feeding function of peristaltic pump has been added. The interface update is shown in the figure above

The update is described as follows:

- During the dynamic state of the player, when the peristaltic pump is fed for testing, the input feeding speed of the peristaltic pump is displayed. After observing the outlet temperature, the speed can be manually adjusted step by step.
- In the automatic selection state, when the peristaltic pump is fed for testing, the input and outlet temperature (default 80) is displayed, and the feeding speed of the peristaltic pump is automatically adjusted by the system program to match the outlet temperature.
- The default startup state is manual, the same as before update.

About after-sales

Thank you for choosing IN-SD 3N pilot spray dryer. When you choose this equipment, you have become our sincere service object, we will try our best to do everything for you.

Service hotline: Tel: 734-855-4890

Webeitr:www.usalab.com