SINCE 1889

Yamato

CE

SPRAY DRYER
DL410

- Version 1.3 -

- Thank you for purchasing "Spray Dryer, DL410" of Yamato Scientific Co., Ltd.
- To use this unit properly, read this "Instruction Manual" thoroughly before using this unit.
  Keep this instruction manual around this unit for referring at anytime.

⚠: WARNING!
Carefully read and thoroughly understand the important warning items described in this manual before using this unit.

YAMATO SCIENTIFIC RUSSIA, INC.

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1. Safety precautions

Explanation of Symbols

About the Symbols

A variety of symbols are indicated in this operating instruction and on products for safe operation. Possible results from improper operation ignoring them are as follows.

Be sure to fully understand the descriptions below before proceeding to the text.

Warning Indicates a situation which may result in death or serious injury (Note 1.)

Caution Indicates a situation which may result in minor injury (Note 2) and property damages (Note 3.)

（Note 1）Serious injury means a wound, an electrical shock, a bone fracture or intoxication that may leave after effects or require hospitalization or outpatient visits for a long time.

（Note 2）Minor injury means a wound or an electrical shock that does not require hospitalization or outpatient visits for a long time.

（Note 3）Property damage means damage to facilities, devices and buildings or other properties.

Meanings of symbols

This symbol indicates a matter that encourages the user to adhere to warning (“caution” included).
Specific descriptions of warning are indicated near this symbol.

This symbol indicates prohibitions
Specific prohibitions are indicated near this symbol.

This symbol indicates matters that the user must perform
Specific instructions are indicated near this symbol.

1. Safety precautions

List of symbols

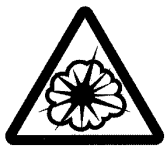
Warning

General warnings

Danger!
High voltage

Danger!
High temperature

Danger!
Moving part



Danger!
Hazard of explosion

Caution

General cautions

Electrical shock!

Burning!

Caution for no liquid heating!

Caution for water leak!

For water only

Poisonous material

Prohibitions

General bans

Fire ban

Do not disassemble

Do not touch

Compulsions

General compulsions

Connect ground wire

Install levelly

Pull out the power plug

Regular inspection

1. Safety precautions

Warning・Cautions

⚠ Warning

Do not use this unit in an area where there is flammable or explosive gas

Never use this unit in an area where there is flammable or explosive gas. This unit is not explosion-proof. An arc may generate when the power switch is turned on or off, and a fire/explosion may result. (Refer to page 42 “15. List of Dangerous Substances”.)

Always ground this unit

Always ground this unit on the power equipment side in order to avoid electrical shock due to a power surge.

Apply the source of rated power or more

Be sure to apply the source of rated power or more. Applying non-rated voltage or non-rated power supply could cause a fire or electric shock.

Prohibition of use for error

If a smoke or abnormal smell occurred, turn off the power switch of the main unit immediately, and turn off the original power source, and contact to either the dealer you purchased this unit or our sales office. Leaving the failure could cause fire or electric shock. Since the repairing of this unit is dangerous for non-specified service person, never repair the unit by the customer himself.

Do not use the power cord if it is bundled or tangled

Do not use the power cord if it is bundled or tangled. If it is used in this manner, it can overheat and fire could occur.

Do not damage power cord

Do not damage power cord by bending, pulling, or twisting forcedly. It may cause fire or electric shock. Besides, operating the unit with something on the cord may cause overheat, and resulting a fire.

Never use an explosive or a flammable material with this unit.

Never use an explosive material, a flammable material or a material containing them. Using the said material will result to an explosion or an electrical shock. **DL410 supports organic solvents by connecting it to the optional GAS410. Carefully read the operation manual of GAS410 and take special care for handling of organic solvents.**
See section “15. List of Dangerous Substances” on page 42.

Never try to touch a hot part.

Some parts of the unit are hot during and immediate after operation. Take special care for possible burning.

Never try to disassemble or alter the unit.

Never try to disassemble or alter the unit. A malfunction, fire or an electrical shock could occur.

1. Safety precautions

Warning・Cautions

⚠ Caution

During a thunder storm

During a thunderstorm, turn off the power key immediately, then turn off the circuit breaker and the main power. If this procedure is not followed, fire or electrical shock could occur.

- **If an electric failure occurs,**

When power is shut off during operation (while the blower is operating or liquid is being sent) due to turning of the ELB to "OFF" or a power failure, all operation modes will reset to the initial states after recovery. When the temperature inside the chamber has been high, the blower will keep operating until it cools down to 45°C or below after the recovery from a power failure.

- **Do not perform unattended operation during activating the unit**

Do not perform unattended operation during activating the unit. Since the unit is in idling status and the nozzle is blocked of after the operation using sample, the temperature around outlet is increased and the remaining sample is flown from the sample tube disconnected from the unit, and this failure may cause an indeterminism accident.

About countermeasures against static electricity

The cyclone may charge with static electricity depending on the specific specimen used, or operating environment or conditions. Implement countermeasures against static electricity such as attaching included earth clips at three positions on the clamp at the connection of the cyclone or attaching an antistatic brush (optional) to the body of the cyclone.

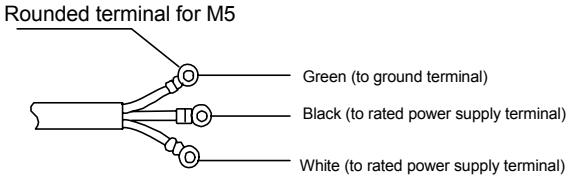
2. Before using this unit

Precautions when installing the unit

⚠ Warning

1. Always ground this unit

- Be sure to connect the earth wire (the green cable of power cord) to the grounding conductor or ground terminal to prevent accidents caused by electric leakage.
- This unit requires a single-phase 220V power supply Ask the nearest electrical contractor for the power including the connecting work. The setting (connecting) work is performed following the related electrical equipment technical standard published by the corresponding country to be used this unit.
- Do not connect the earth wire to gas or water pipes. If not, fire disaster may be caused.
- Do not connect the earth wire to the ground for telephone wire or lightning conductor. If not, fire disaster or electric shock may be caused.



- The power plug is not attached as standard component. Connect the earth correctly adjusting the type of the power equipment of the user.

2. Pay attention to the color of each core wire when connecting the power cord

Be sure to check that the breaker on the power source equipment side is turned "OFF" when connecting power cord without fail. Note that the DL410 does not attach the power plug as standard component. Select the appropriate power plug and terminal matching to the power capacity of the power source equipment to be connected, and connect them.

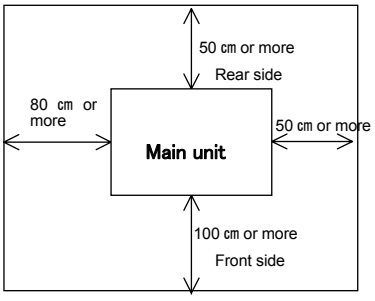
Core Wire Color	In-house Wiring
Black	Voltage Side
White	Voltage Side
Green	Ground Side

3. Choose a proper place for installation

Do not install this unit in a place where:

- Rough or dirty surface.
- Flammable gas or corrosive gas is generated.
- Ambient temperature bellow 5°C or above 30°C.
- Ambient temperature fluctuates violently.
- There is direct sunlight.
- There is excessive humidity and dust.
- There is a constant vibration.
- Place where the water is easy-to-be splashed.

Install this unit on a stable place with the space as shown below.



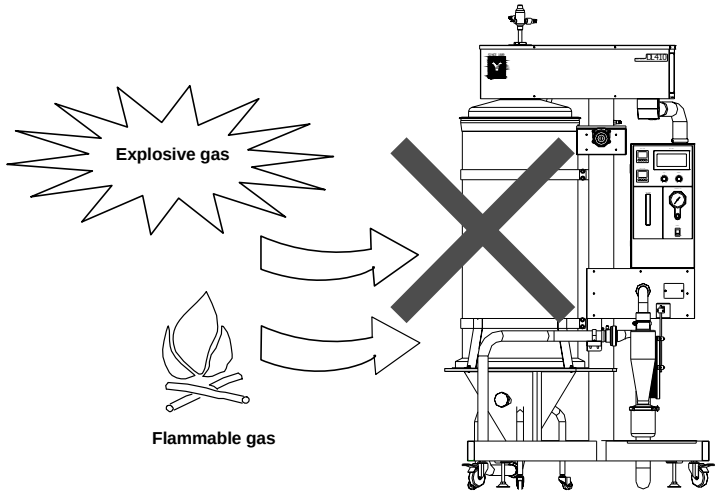
Precautions when installing the unit

⚠ Warning

4. Do not use this unit in an area where there is flammable or explosive gas

- Never use this unit in an area where there is flammable or explosive gas. This unit is not explosion-proof. An arc may be generated when the power switch is turned ON or OFF, and fire/explosion may result.

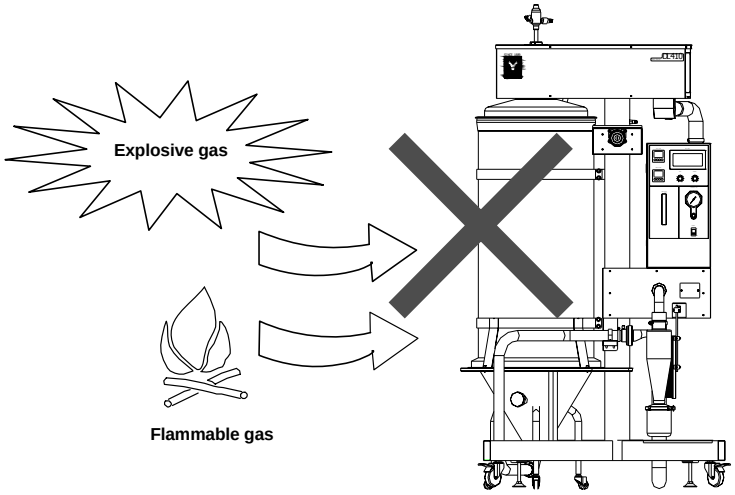
Refer to page 42 “15. List of Dangerous Substances”.



5. Do not use explosive or flammable substances

Never use explosive substances, flammable substances and substances that include explosive or flammable ingredients in this unit. Explosion or fire may occur. **DL410 supports organic solvents by connecting it to the optional GAS410. Carefully read the operation manual of GAS410 and take special care for handling of organic solvents.**

Refer to page 42 “15. List of Dangerous Substances”.



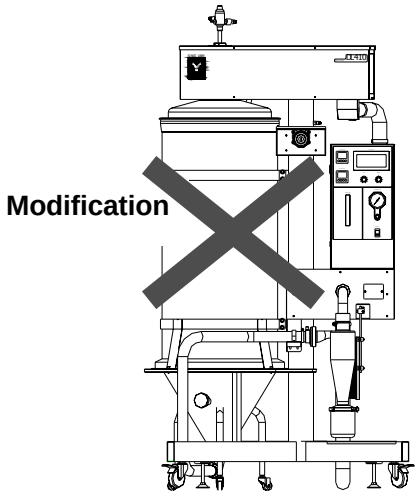
2. Before using this unit

Precautions when installing the unit

⚠ Warning

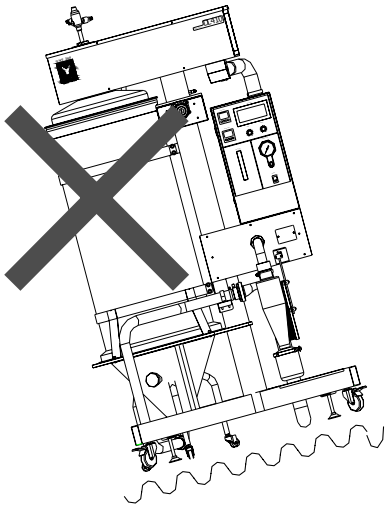
6. Do not modify

Modification of this unit is strictly prohibited. This could cause a failure.



7. Do not topple or tilt this unit

Set this unit to the flattest place. Setting this unit on rough or slope place could cause the vibration or noise, or cause the unrespectable trouble or malfunction.



8. Use specified receptacle for power source

Choose a correct power distribution board or receptacle that meets the unit's rated electric capacity.

Electric capacity: AC220V Single phase 24A

There could be the case that the unit does not run even after turning ON the power. Inspect whether the voltage of the main power is lowered than the specified value, or whether other device(s) uses the same power line of this unit. If the phenomena might be found, change the power line of this unit to the other power line.

For connecting of the device to the power source, ask the dealer that you purchased this unit from or an electrical contractor for safe.

9. Handling of power code

Do not entangle the power cord. This will cause overheating and possibly a fire.

Do not bend or twist the power cord, or apply excessive tension to it. This may cause a fire and electrical shock.

Do not lay the power cord under a desk or chair, and do not allow it to be pinched in order to prevent it from being damaged and to avoid a fire or electrical shock.

Keep the power cord away from any heating equipment such as a room heater. The cord's insulation may melt and cause a fire or electrical shock.

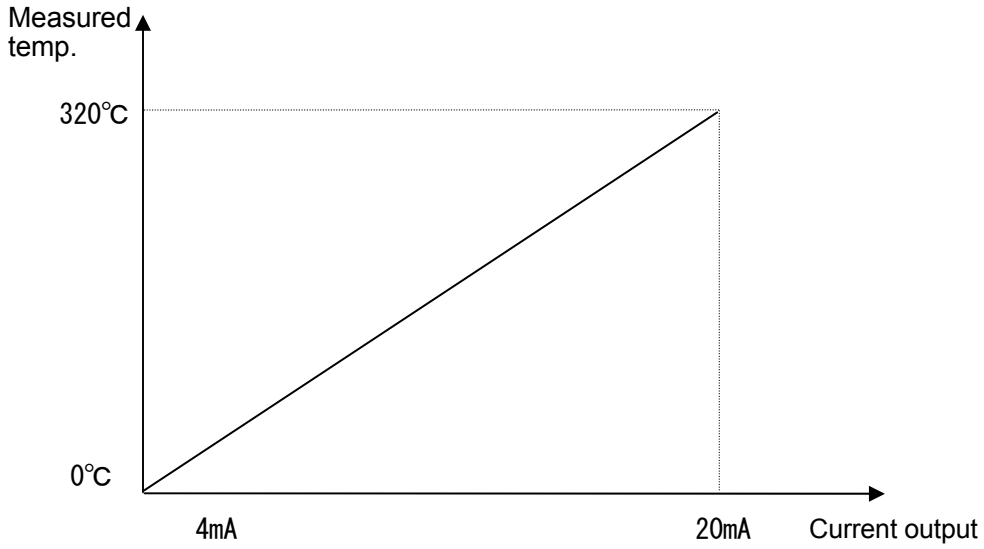
If the power cord becomes damaged (wiring exposed, breakage, etc.), immediately turn off the power at the rear of this unit and shut off the main supply power. Then contact your nearest dealer for replacement of the power cord. Leaving it may cause a fire or electrical shock.

Connect the power plug to the receptacle, which is supplied appropriate power and voltage.

Temperature output terminal

The temperature output signals for the Outlet (outlet temperature) and the Inlet (inlet temperature) are 4-20mA for the measure temperature of 40-320°C.

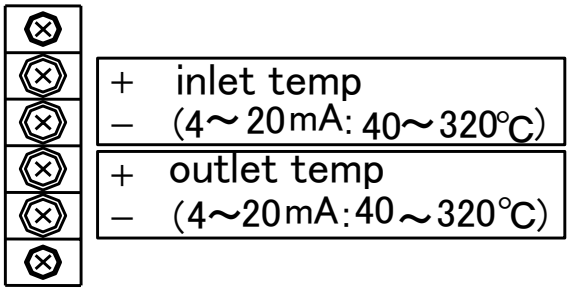
[Current output of 4-20mA: Measured temperature of 40-320°C]



Conversion formula: Current output I (mA) = (0.05x measured temperature T(°C) ＋4)

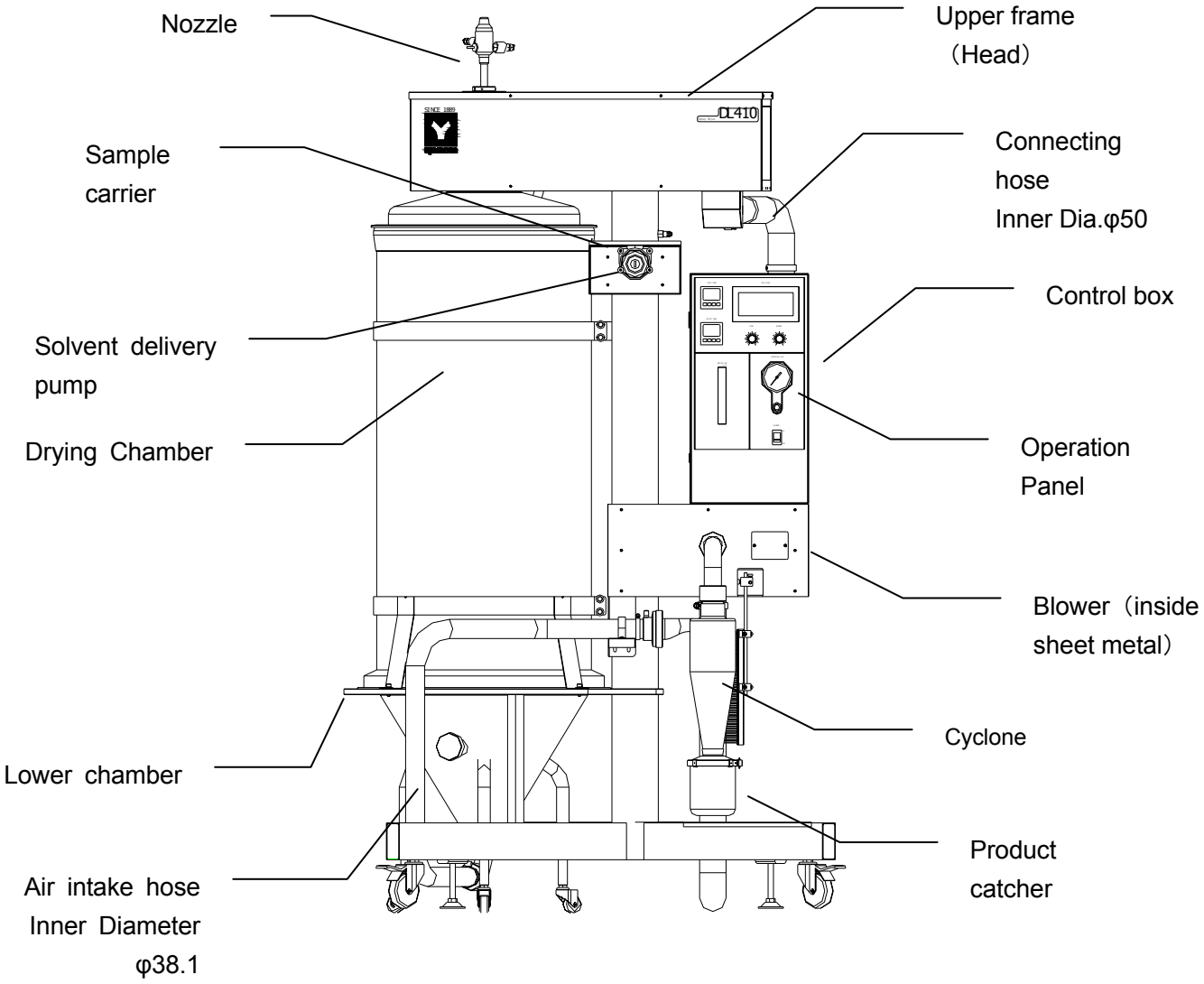
Measured temperature T(°C) =20×current output I (mA)-80

When you connecting to the voltage input of the recorder, connect a fixed resistor (shunt resistor) of 600Ω or lower to the voltage input of the recorder.



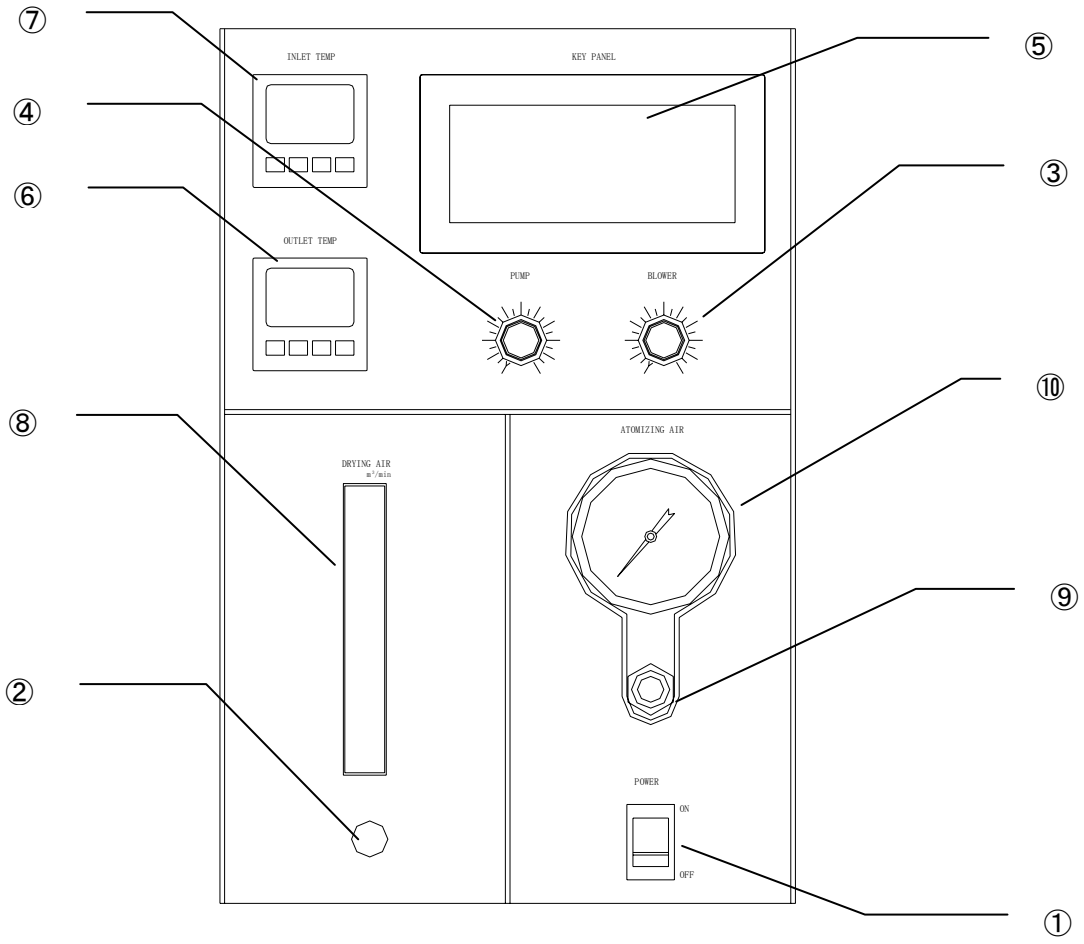
3. Names and Function of each part

Unit body



3. Names of parts and their function

Operation Panel

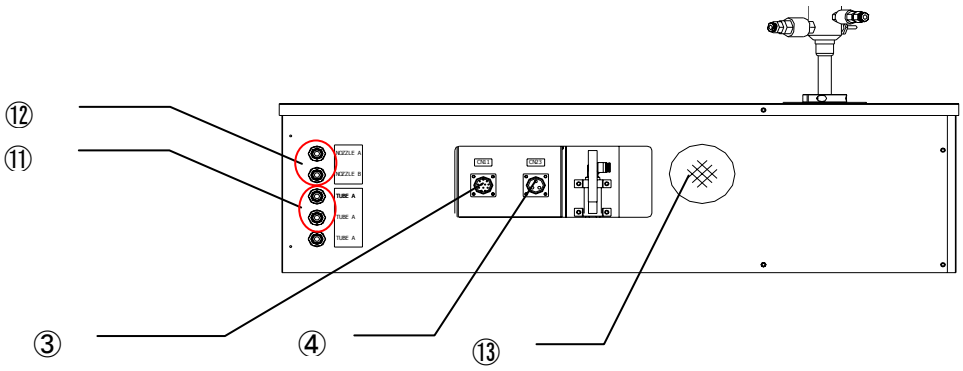


No.	Name	Operation/Action
①	Push button switch	For switching on or switching off the power
②	Connector of outlet temperature sensor	For connecting the temperature sensor
③	Blower adjust plate	For setting the cycle wind volume
④	Adjust plate for solvent delivery speed	For adjusting the flow of solvent delivery pump.
⑤	Operation Key Panel (Touch Panel)	For the following operation and display. HEAD UP/DOWN, Blower ON/OFF, Heater ON/OFF, Solvent delivery pump FWD/REV, NOZZLE BLOW and NEEDLE KNOCKER, When abnormality occurs on the inlet and outlet temperature, ERROR displays.
⑥	Display Outlet Temperature	Display the outlet temperature, to prevent over lifting.
⑦	Setting and displaying inlet temperature	For setting inlet temperature, display measured temperature to prevent over lifting.
⑧	Flow meter	Display the flow of drying air.
⑨	Adjust plate of needle valve	For adjusting the pressure of compressed air.
⑩	Pressure gauge	Display the pressure of compressed air.

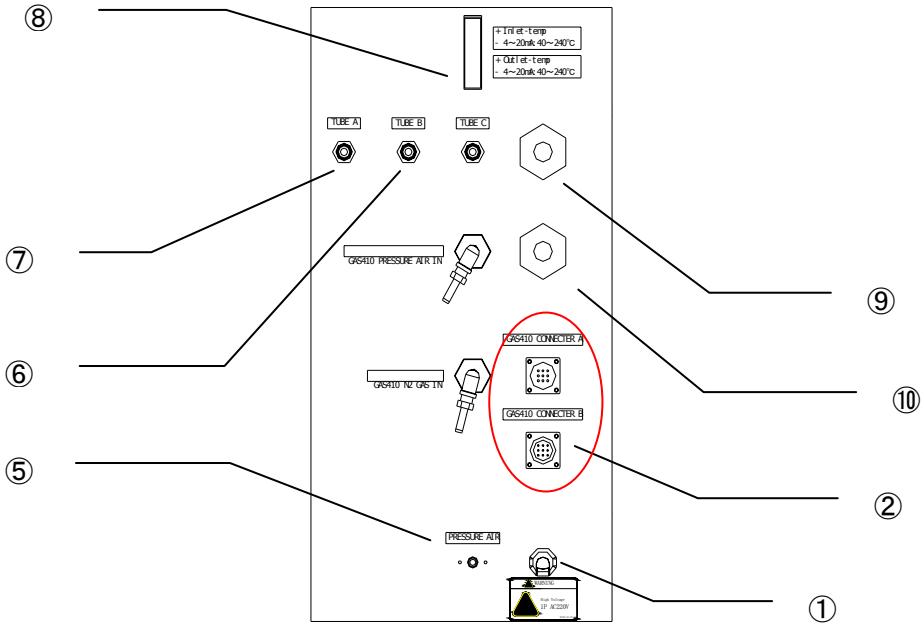
3. Names of parts and their function

Upper frame and control box

Backside of upper frame (Head)



Backside of control box:



No.	Name	Operation
①	Power cord	For supplying power to the unit
②	connector	For connect with GAS410
③	Signal relay connector CN21(12p)	For the temperature sensor on the HEAD and battery valve to connect each other.
④	Heater reply connector CN22(3p)	For connecting to the Head heater.
⑤	Air supply Inlet AIR IN	For supplying air into the unit
⑥	TUBE B	For connecting the air pose with the Head
⑦	TUBE A	For connecting the air pose with the Head
⑧	Temperature output terminal	Current output terminal of inlet, outlet temperature(4-20mA:0-320°C)
⑨	Signal cable(12p)	To connect with CN21 of control box
⑩	Heater cable(3p)	To connect with CN22 of control box
⑪	TUBE A, TUBE B	Connect Hose A and B of the control box
⑫	NOZZLE A, NOZZLE B	Connect the hose to the nozzle
⑬	Cold air adjusting valve(manual valve)	For adjusting the cold air which goes into the container.

4. Operation procedures

Preparations before operation

(1) Place the stand on a flat surface, fixed with caster stopper.
(2) Disassemble the upper container and firm band which is fixed at the stand and the support, and take out the corrugated carton.
(3) Connect the cable from the backside of the upper frame (Head) with the connector on the backside of the control box.
(4) Make sure the power cord is single phased, and the power source should be above AC200V, 30A.
(5) Make sure the cable is grounded.
(6) Use the attached pressure hose to connect the nipple Air in at the back side of the control box, as well as the compressors and compressed air unit, then fix with hose band. To remove the water and oil in the exhausted air, the air filters are installed on the compressor; Pressure reducing valve is needed to keep the pressure at stable value.(set pressure of the pressure reducing valve:0.4 MPa)
(7) Insert the hose connector TUBE A, TUBE B at the backside of control box and the head part into the nylon tube (O.D. 6mm, length 1m).
(8) Insert the nozzle through the nozzle mesh on the upper frame.
(9) Use Tube A to connect the nipple AIR of the nozzle with tube connector NOZZLE A on the backside of the upper frame (Head). Likewise, use Tube B to connect the nipple CYL with the NOZZLE B at the backside of the upper frame (Head).
(10) Start compressed air unit such as compressor to supply compressed air into the unit.
(11) Switch on the leakage current reply breaker at the backside of the control box, and then turn on the power switch. At this moment the initial page of the touch panel displays for 4 sec. before it jump to the standby page. Press down the setting button to go to the Head Set page. Press down HEAD button to lift the upper frame. (The head will rotate by 90°when it lifted by 5cm), at this moment, please help it lift by hand.
(12) Open the package, take out the drying chamber (which is made of super-hard glass, with 457I.D. and 975cm height), then place it on the stand. The chamber is made of glass, and of 40 kg weight, you'll need at least 2 persons to carry it.
(13) Fix the up and bottom firm band on the support and stand.
(14) Insert silica sealing rings in the groove of the upper and lower container. Please note the length of the sealing rings are different (the sealing rings for the upper container will be longer).
(15) Lower the upper container by your hand, to make the upper container return to the upper position of the drying chamber, and then press down the HEAD switch for the drying chamber and upper container to be connected together.
(16) As there are springs installed in the castor, please press down the upper container while you move it, until the container move into the lower part of the stand. Please ensure the sealing ring of the lower container contact with the glass flange of the drying chamber.
(17) Install blowers on the elbow pipe under the control box.
(18) Connect the tube (which is made of silica with 38mm inner dia. and 1 mm length, red color, with joints installed at both side) on the lower container and blower. First of all, install fastening nut on the arm of the blower, install springs, close the Teflon surface of the joints with the glass flange, and fasten with screws finally. Next, connect the other side of the connecting tube on the lower chamber. Special care should be taken during operation, as the blower is made of glass.
(19) The O ring of the blower should be tightly jointed with the flange face of the product catcher, so that there will not be any leakage. Please fasten it with fasten band. (You may start blower first, and fasten it when the chamber is attached to blower, this will be easier for operation.)

（20） Install the outlet temperature sensor on the nipple of the connecting pipe joint. Insert the plug into the connector「Outlet Temp Sensor」in front of the control box.

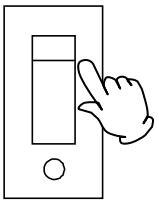
（21） Install the sample tube on the liquid delivery pump, and then connect it to the nipple of the nozzle.

（22） To solve the hot wind or particles caused by the blower, you can install the attached exhaust duct at the vent of the blower. (inner dia. 50mm, length 3m, with cuffs on each side), so that it can exhaust air through the ventilated containers.

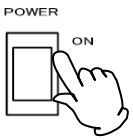
4. Operation procedures

Operation method- Setting of drying chamber

Leakage current breaker

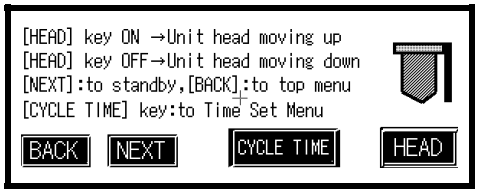


(1) Turn on the leakage protection switch on the backside of the control box.

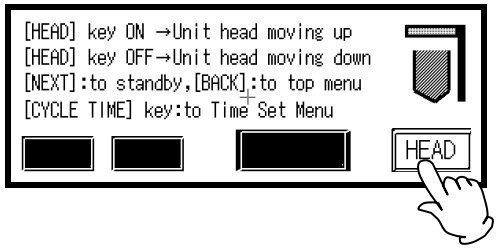


(2) Turn on the POWER switch on the operation panel.
The Temperature adjuster and keystroke displays.
After the power is on, the initial page of the touch panel displays for 4 seconds, and then shift to standby page.
Press the Setting button to enter into the set page of HEAD.

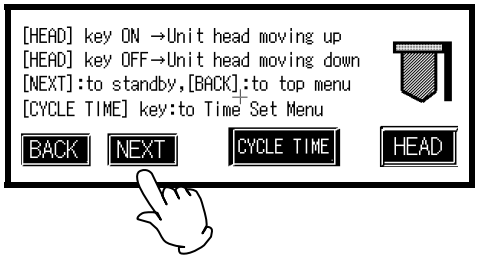
(3) Press HEAD button to make the upper frame moving upward.
(Head lifts by 5cm, and rotated by 90°)
At this moment, lift the Head by using your hand.123



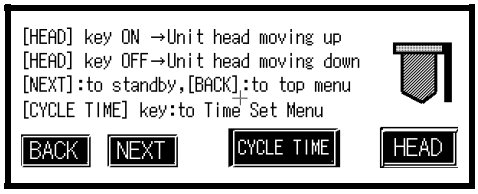
※When the HEAD button is ON, the HEAD indicator light flickers .
The HEAD button light is on.
After setting the drying chamber, help its upper chamber to rotate, and then return to the upper position of the drying chamber. Press down the HEAD button for the drying chamber and the upper part of the chamber to be closely connected.
The Head indicator light goes out.
The HEAD button light goes out also.



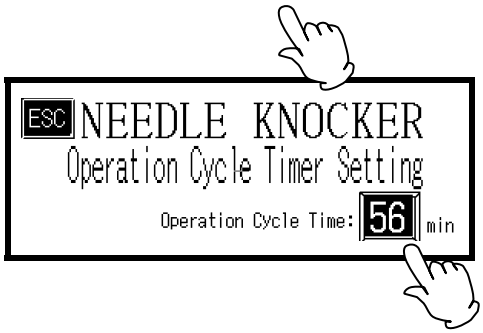
※After the drying chamber is set, press down the NEXT button to jump to next page.
When the BACK button is pressed down, it will return to the standby page.



(4)Please switch on the cold air valve(manual valve)
(cold air valve(manual valve) is located at the center of the backside of the HEAD)



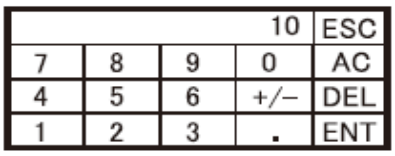
(5) After the CYCLE TIME button is pressed, it will shift to the automatic operation setup page of the NEEDLE KNOCKER.

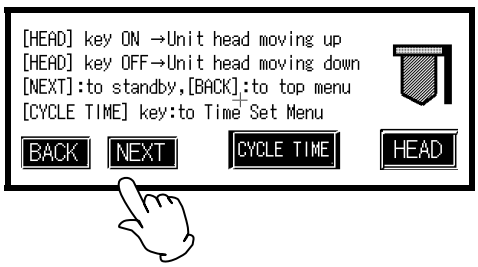


After the Time Setting button is press, the

Please input figures within the set range(1~60min), then press ENT to confirm

If the ESC key is pressed, it will automatically jumps from the setup page.。

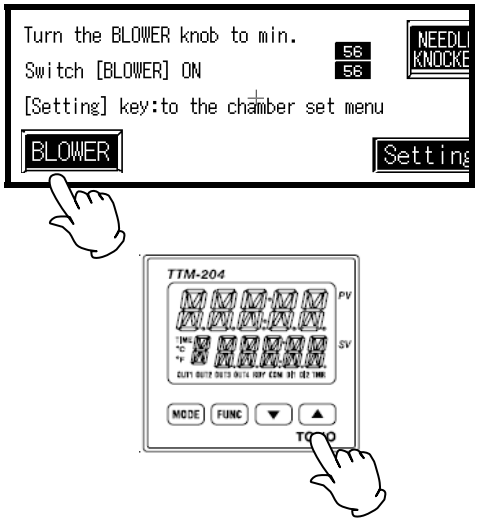




※ After the automatic operation period of NEEDLE KNOCKER has been set up.

Press NEXT to jump to next setup page.

Press BACK to return to the standby page.



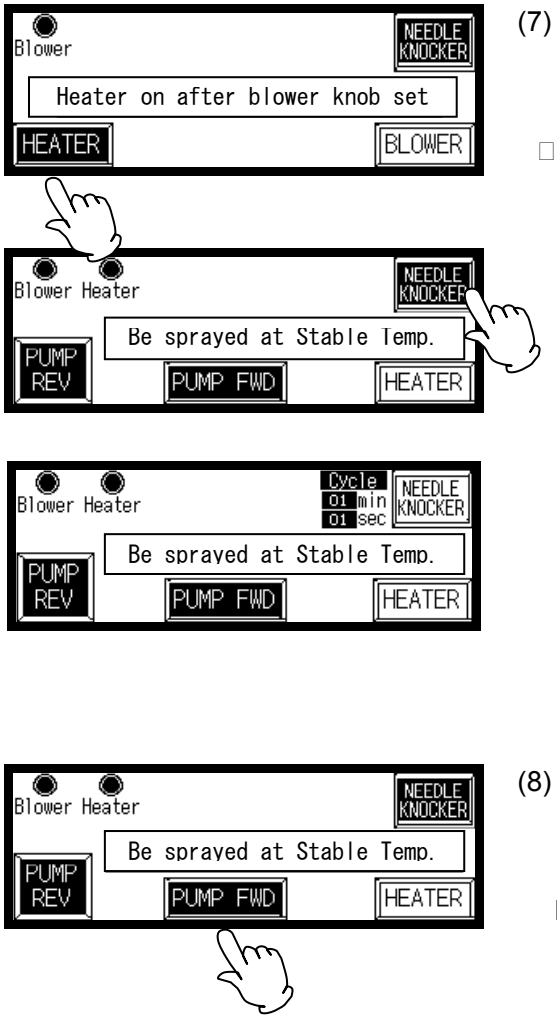
(6) Adjust the wind rate to the lowest limit, press BLOWER button, start the blower.
Please use the gears to set the wind rate.
Please use the gears to set the wind rate。
During operation, the indicator light of the blower is constantly on.

E.g. Wind rate 0.8m3/min

□Please select ▲,▼button to set INLET TEMP (Temperature of the drying chamber inlet)

E.g. INELT TEMP: 300°C

OUTLET TEMP (temperature of drying chamber) will only be displayed, the outlet temperature will not be set and the temperature will not be controlled.



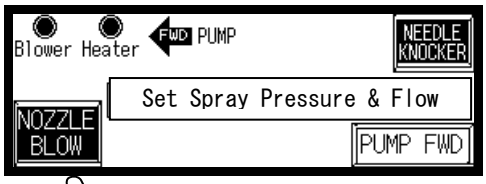
(7) Press down HEATER button, turn on the heater.
During operation, the Heater indicator light is always on.

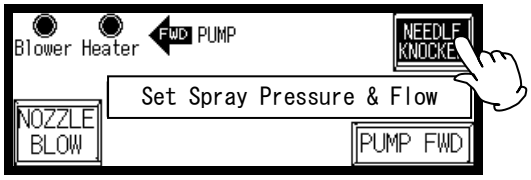
□ Adjust the INLET TEMP through the ▲.▼button.
E.g. INELT TEMP:200°C

When pressing the NEEDLE KNOCKER button, the needle in front of the spray nozzle will appear on the mesh automatically. If the front side of the spray nozzle is clogged, it will affect the spraying. So please use this function. Press on the automatic operation, the problem will be solved.

(8) Adjust the aspirator hose; fasten with knurled screw when the aspirator hose has been pressed flat by the pump stand.

E.g. . . . Sample Distilled water
Wait until the OUTLET TEMP stable at the expected temperature.





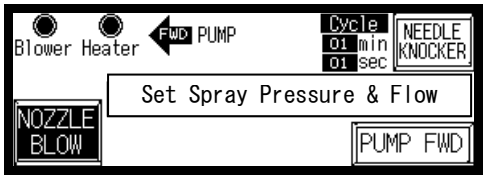
(9) After the inlet and outlet temperature has reached the expected temperature, please set the spraying pressure. Switch the pump FWD to ON, and then infuse distilled water

E. g. When the outlet temperature has reached around 90°C, set the spraying pressure to 0.1MPa. the infusion speed should be adjusted so that the inlet temperature is lower than 85 °C

□During operation, in case there are powder attached on the nozzle head and the spraying direction has changed, please turn on NOZZLE BLOW switch to blow away the attachments with compressed air.

(10) Readjust the drying air volume, spraying pressure, and solvent delivery speed to set the inlet and outlet temperature to be stabled at the expected temperature.

E. g. Adjust the infuse speed so that the outlet temperature is lowthan85



□When pressing the NEEDLE KNOCKER button, the needle in front of the spray nozzle will appear on the mesh automatically. If the front side of the spray nozzle is clogged, it will affect the spraying. So please use this function. Press on the automatic operation, the problem will be solved.

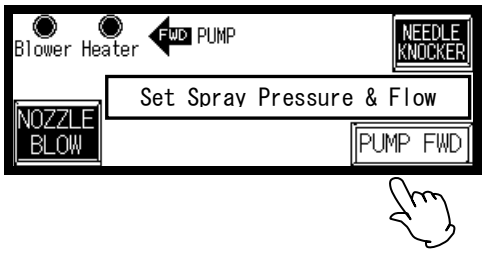
～Little Tips～

When the inlet temperature is the same, all setting has the following influence on the outlet temperature.

Sample infuse volume → small: Outlet Temp. →High
Draying Chamber air volume → high: 〃 →high
Sample Concentration (external factors)→high 〃→high
In addition, the droplet diameter variation which gushed from the nozzle is as follows:
Sample infuse volume → big: Diameter of Spraying droplet diameter → large
Spaying air pressure → high: 〃→small
Sample concentration、viscosity (external factor) → high: 〃 →large

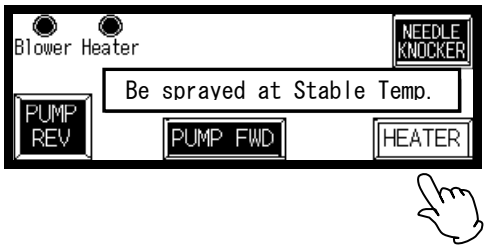
- If the spraying pressure is increased, the droplets will particulate.
- When the distilled water has changed into actual samples, the outlet temperature will be somewhat higher as there are non-evaporated parts (solid parts).

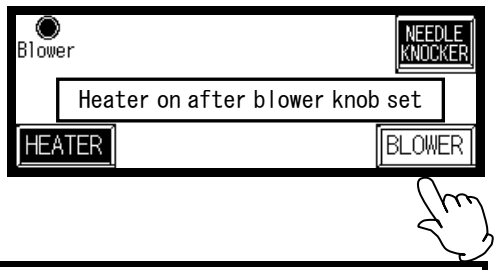
(11) After the outlet temperature is stabled, please change the sample to actual samples. At this moment, the outlet temperature will be changed, adjust the infuse speed if necessary.



~Finished operation~

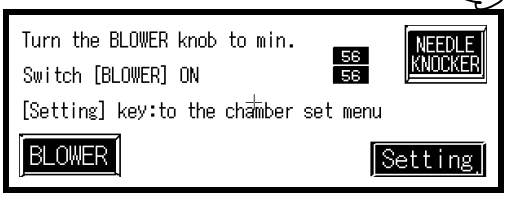
(12) After the sample infusion is finished, add distilled water to clean the nozzle. Switch the pump FWD switch to OFF, adjust the spraying pressure to 0.



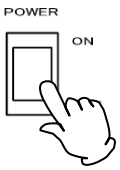


(13) Turn OFF the heater, when the inlet temperature is below 45°C, switch of the wind volume. Turn OFF the Blower.

To avoid any trouble, please do not stop the blower when the outlet temperature is above 45°C.



(14) Please turn off the power switch.



(15) Untie the container fasten ribbon, take out product catcher. At this moment, please note there is also powder attached inside the cyclone cover.

(16) Please follow the cleaning method (P24.「On clearance after use」to clean up the container)

When using the metal corrosive samples such as sodium chloride, please be sure to clean it carefully after disassembling.

4. Operation procedures

KEY PANEL Indicator light instruction

As for the operation inside the KEY PANEL, the indicator light can work as a confirmation to check weather the switch is working or not.

Each indicator light is on at the upper right corner of KEY PANEL.

	Means time setting, used when setting the operation period of the NEEDLE KNOCKER
	Display the operation period of NEELDE KNOCKER
	When this indicator light is on, it means the blower is working.
	When this indicator light is on, it means the heater is working.
	When this indicator light is on, it means the solvent delivery pump is working in the forward direction.
	When this indicator light is on, it means the solvent delivery pump is working in the reversed direction

When the nozzle is clogged, and when you want to stop the sampling process.

In the case the nozzle is clogged when you want to stop the sampling process, please follow the operation of the finished operation (P18 (8) ~ (12)), and stop delivery the solvent.

Moreover, when you want to process the other samples; please take out the products in the product catcher, follow the method in (P24.「on the cleaning after use」), then proceed with other samples.

5. Handling Precautions

⚠ Warning

1. Substances that cannot be used

Never use an explosive, a flammable, or a substance that contains them. Otherwise, an explosion or a fire may result.**ADL311S supports organic solvents by connecting it to the optional GAS410. Carefully read the operation manual of GAS410 and take special care for handling of organic solvents.**

See P.42 "15. List of Dangerous Substances ".

2. If a problem occurs

If a smoke or strange odor should come out of this unit for some reason, turn off the power key right away, and then turn off the circuit breaker and the main power. Immediately contact a service technician for inspection. If this procedure is not followed, fire or electrical shock may result. Never perform repair work yourself, since it is dangerous and not recommended.

3. Do not touch the part with high temperature

The chamber, cyclone, and peripheral part become high temperature during and just after operation. Do not touch these parts, for there may be caused heat injury.

⚠ Caution

1. Do not put anything on this unit。

Do not put anything on this unit. It will cause injury if fall.

2. During a thunder storm

During a thunderstorm, turn off the power key immediately, then turn off the circuit breaker and the main power. If this procedure is not followed, fire or electrical shock may be caused.

5. Recovering after power failure

When the power is supplied after a power failure, the device automatically starts operation again with the same state as just before the power failure.

6. After installing

It may cause injury to a person if this unit falls down or moves by the earthquake and the impact, etc... To prevent, take measures that the unit cannot fall down.

5. Handling Precautions

Maintenance method

(1) To disassemble the unit; please follow the step contrary to the installation procedure of outlet temperature sensor, connecting tube, and blower. Clean with water or by the other proper method.

(2) Disassemble the sample tube on the nozzle.

(3) Turn the HEAD switch to UP side, lift the upper frame by hand.

If the samples are placed on the pump, they are like to contact with connecting pipe, and damage may result. Therefore special care should be taken on this.

Clean the wall of the drying chamber by using tap-water, brushes from the open part of the drying chamber. Please do not disassemble the container from the stand as damages might occur.

If there were no drain tank available nearby the unit, please put a basin under the lower chamber during cleaning.

While washing the inner wall of the drying chamber, if there were water leakage in the joint part with the lower chamber, please use a container to catch the water.

(4) Press down the lower chamber as it moves horizontally, take out the chamber from the stand then clean with tap water.

(5) There are some powder attached on some part as the hot wind from the upper frame, please wipe it properly.

(6) Lower the upper chamber by hand, after the upper chamber has return to the upper position of the drying chamber, turn the HEAD switch to DOWN so that the drying chamber and the upper chamber can be closely attached.

(7) To clean the sample tube, please turn the PUMP switch to FORWARD, fill with purified water to clean up the tube.

(8) Disassemble the nozzle tube A, B, the remove the spray nozzle.

Be sure to close the needle valve when disassemble the nozzle tube A. When disassembling tube B, if the power switch is at ON position, please stop the rotation of NEEDLE KNOCKER.

Use supersonic or other ways to clean the spay head. Use water to clean the other part. Dissemble the parts for cleaning if there were serious dirtiness inside. The head of the needle valve are very thin and fragile, therefore special care must be taken during operation

The sprayer can not work properly if there were dirt inside, so make sure it is thoroughly cleansed.

5. Handling Precautions

Drying method under proper condition

（1） Different drying sample ask for different drying condition. Spray drying method is not workable for all samples. Normally, this method is not applicable for the substance with thermo plasticity (such as low melting, thermo softening substance: sugar, fat etc.). Therefore, when using this unit for drying these substances, its recovery rate will be significantly lower.

（2） Spray drying method is very suitable for some substance. After drying, there is almost no powder attached on the blower. As to the reason why there are always some powder attached on the blower, besides the above mentioned characteristics of the substances, the reason is that the solvent can not be evaporated. Increase the heat can reduce the water in the powder. So this problem can be solved by increase the inlet temperature or increase the flow of dry air, also it can improved by reduce the sample delivery volume. If the problem is caused by the substance itself, it can be adjusted by adding some special additive to the sample.

（3） If the powder attachment phenomenon is very serious in the drying chamber, generally it is caused by the following reason: sample concentration too high; inlet temperature too low; sample delivery quantity too high; Spray air pressure too high or too low etc. After drying, 70-85% of samples will be recycled to the product catcher, the remaining 15-30% samples will be attached to the drying chamber. If there are serious problems on the chamber, please adjust following the above instructions.

（4） If the hygroscopicity of the sample is high, it will leave wet powder inside the product catcher. In this case you can follow the instruction in (2) to improve its drying condition, and can increase the temperature to operate for the product catcher.

（5） After drying, there are some small particles (under μ) which can not be caught by the blower; these powders will be discharged outside. If the powder is too much, please lower the dry air flow or decrease spray air pressure to solve the problem. The lower the sample concentration, the small the particle diameter is. The sample concentrations can be adjusted when necessary.

（6） During operation, when the sample attached to the head of the spray nozzle, the spray direction may change. In this case, please turn on the NOZZLE BLOW switch, use compressed air to blow away the attachments on the nozzle head. If dirtiness still exists, disassemble the nozzle; wipe the nozzle head with wet tissue.

（7） Some samples will cause static electricity on the blower. In this case, remove the static electricity by applying proper methods. Sometimes you can install wires on the glass to connect to the ground. If this still can not solve the problem, you can remove the static electricity and direct contacts the cyclone.

5. Handling Precautions

Matters to consider during operation

(1) The outlet temperature should be above 100°C otherwise may result in bad performance of the blower.

(2) Do not use substance containing flammable organic solvent as the sampling solvent.

(3) When the heater is opened do not leave the spray nozzle inlet and the installation part of the product catcher open for long time. Make sure the heater is ventilated.

(4) Should there be some leakage problem between product catcher and lower metal part, the dry powder might accumulated in the lower part of the blower and will not fall into the product catcher. Therefore please pay special attention when installing the product catcher.

(5) The content of product catcher is 750ml. In normal cases, some 200~250g powder will almost account for 80% of its capacity. Under this cases, to continue operation may result in lower powder catch rate. Therefore, please stop the operation, and take out the powders which are already in the catcher.

(6) When the samples are not gushed out any more, it means the mesh of spray nozzle might be clogged. In this case please turn on NEEDLE KNOCKER to remove the clogs. Every time you press the switch, the needle will enter into the mesh for 1 second. The needle will go out and in inside the mesh automatically if the button was hold for 3 seconds. In the case when the clog problem is too serious for the NEEDLE KNOCKER to clean up, please remove the nozzle, and clean it. During operation, if you want to disassemble the nozzle tube B, please stop the automatic operation of NEEDLE KNOCKER first. To remove the nozzle tube A, please switch off the needle valve first.

(7) The nozzle mesh is around 0.7mm. When the sample is severely clogged, please use our parts to remove the clog, this part has a bigger diameter than the mesh.

(8) If the sample does not deliver from the liquid delivery pump, this might be caused by one of the following reasons: the sample tube was crushed flat by the roller of pump; the inner wall of the tube was attached together; clogged nozzle; sample viscosity too high, etc. Please confirm these one by one, and start operation until it resume to normal condition. In addition, based on the performance of the pump and nozzle, the sample viscosity is normally as 300~400cp as the upper limit.

(9) The sample tube is made of silicone rubber; it might expand and split after attached by halogen solvent or acid solvent. Please pay more attention during operation.

(10) There should be someone guarded during operation. Special attention should be paid on the samples in the nozzle which are easily clogged. To continue operation with a clogged nozzle, the sample tube will come off from the nozzle, and the samples will flow out. Unexpected accidents may result.

(11) To maintain the unit, when the HEAD switch is at UP position, please do not put beaker or samples on the pump stand. The reason is the upper frame will turn around by 90°which might touch the connection pipe. When lowering the upper frame, please do it manually until the frame has return to the upper position of the drying chamber, and then turn the HEAD switch down.

6. Maintenance Method

Daily Inspection and Maintenance

⚠ Warning

- Disconnect the power cable from the power source when doing an inspection or maintenance unless needed.
- Perform the daily inspection and maintenance after returning the temperature of this unit to the normal one.
- Do not disassemble this unit.

⚠ Caution

- Use a well-drained soft cloth to wipe dirt on this unit. Do not use benzene, thinner or cleanser for wiping. Do not scrub this unit. Deformation, deterioration or color change may result in.

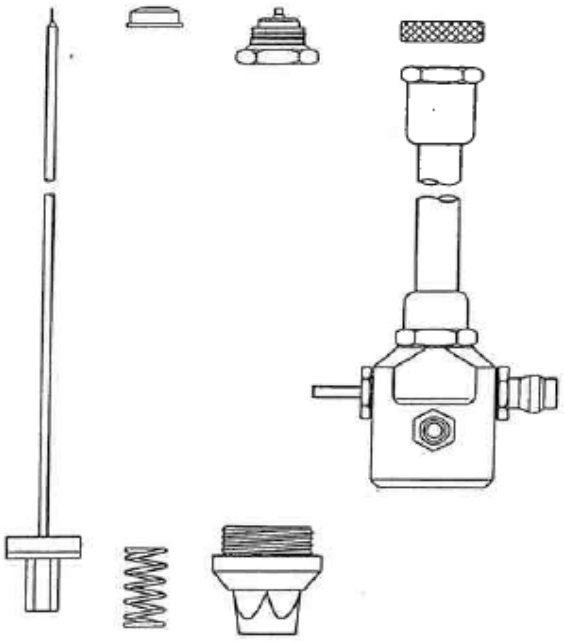
Cleaning After Using

(1) After completing the operation, remove the attachments following the process “Preparations" on P.11 in reverse order.

(2) Clean the portion of attachment to which the powder is adhered.

(3) Flow the distilled water into the sample tube by pressing the pump switch, and remove the contaminant attached to the inner of the part.

(4) Remove the spray air tube and sample tube from the spray nozzle, and disassemble the nozzle as shown in the Photo 1. After disassembling, clean it using the supersonic cleaner. Remaining the contaminant to the inner of the part may cause the insufficient spray. Therefore, clean it completely.



Spray nozzle exploded drawing

6. Maintenance Method

Filter Cleaning

- Clean up the filter in blower periodically.

1) Open the door at the bottom of the front surface of the unit, and disconnect the hose from the blower.
2) Open the front cover by removing the two fastening plates for the cover from the upper surface of the blower, and open the front cover, and take the filter out.
3) The followings are the cleaning procedures of the filter.
   ① Wash the filter pressing in the water repeatedly, and air-dry it.
   ② Compressed air blowing.
   ③ Vacuum cleaning with a cleaner.
   ④ Press washing the filter after being immersed into the solvent that hot water (approx. 40 Celsius degree) and neutral detergent are mixed at a rate of 5:95 one whole day and night, then rinse it with water and air-dry it.
4) When assembling, reversely execute the above procedure. Turn the soft surface of the filter to windward when installing the filter.

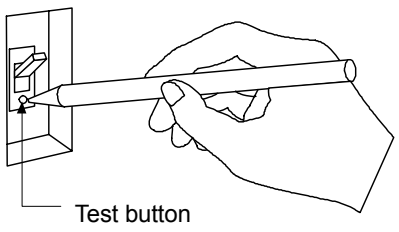
- Suction filter

  Regularly clean the suction filter.

  1. The suction filter is stored in the suction filter case at the rear of the main unit.
  2. Clean the suction filter with the same procedures of number 3.

Monthly maintenance

- Check the earth leakage breaker function.
  - Connect the power cord.
  - Turn the breaker on.
  - Push the red test switch by a ballpoint pen etc. If there is no problem, the earth leakage breaker will be turned off.



7. Long storage and disposal

When the unit is not used for long term / When disposing

⚠ Caution	⚠ Warning
When the unit is not used for long term… ● Turn off the earth leakage breaker and original power source for safety without fail. Also, store the glass unit after removing it from the main unit. When the glass unit is in contact to the external, it may cause the breakage.	**When disposing…** ● Keep out of reach of children. ● Remove the power cord.

Matters to consider when disposing of the unit

Environmental protection should be considered

・ We request you to disassemble this unit as possible and recycle the reusable parts considering to the environmental protection. The feature components of this unit and materials used are listed below.

Component Name	Material
Parts of Main Unit	
Casing	Bonderizing steel plate baked with melamine resin coating, Stainless steel
Insulating material	Ceramic Felton
Specimen bed	Stainless steel
Production plates	Polyethylene (PET) resin film
Tube	Silicon rubber, Teflon
Electrical Parts	
Heater	Stainless steel and others
Motor	Iron, Aluminum, Copper wire and others
Circuit boards	Composites with board, condenser, resister and transformer
Power cord & wiring materials and others	Synthetic rubber, resins
Sensor	Stainless steel and others

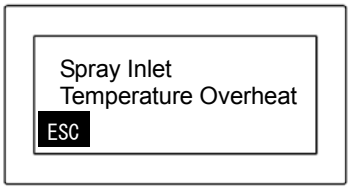
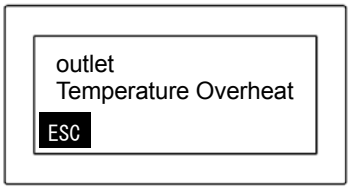
8. When a trouble occurs

Safety unit and error indications

The table shows possible causes of activation of the safety unit and solutions.

[Error indication]

When an abnormality occurs to the inlet temperature controller or the outlet temperature controller, the touch panel at the operation panel displays the error screen. When an abnormality occurred, confirm description of the error and implement appropriate solutions.

Display	Possible causes	Solutions
	① Disconnection of the thermocouple sensor ② When the displayed inlet temperature is at 320°C or over ③ Malfunction of the blower	① Replacement of the thermocouple sensor ② Lower the set temperature or adjust air amount. ③ Replacement of the blower
	① Disconnection of the thermocouple sensor ② When the displayed outlet temperature is at 110°C or over ③ Malfunction of the blower	

* When the measured temperature exceeds the set upper limit (upper limit of inlet temperature: 320°C; upper limit of outlet temperature: 110°C), "Over Heat" will appear, the heater output will stop and when that status continues for one minute, the temperature error above will be displayed. The safety unit will perform automatic REV operation for five seconds when a temperature error occurred while the blower is ON, the heater is OFF, or the liquid sending pump was in operation and then shift to the stop mode.

The same process as shown above will take place when the disconnection of the temperature sensor occurred. The temperature controller will indicate "-----".

Pressing "ESC" key will release the error screen and the status will return to the "BLOWER ON" and "HEATER OFF" status.

8. In the Event of Failure…

Trouble Shooting

Symptoms	Possible causes	Countermeasures
The POWER would not turn ON.	● ELB is turned OFF ● Malfunction of the power supply ● The wire ire short-circuited. ● Malfunction of power switch	● Turn the ELB ON ● Check the power supply circuit ● Replace the cord ● Replace the power switch
Blower does not activate.	● Incorrect connecting of the connector of blower ● Breaking of blower input cord ● Blower switch failure ● Blower motor failure ● Blower motor brush failure ● Blower circuit failure and wiring failure	● Connect correctly. ● Replace the cart. ● Replace the touch panel, sequencer or thermo regulator. ● Replace the motor or motor substrate ● Replace the brush ● Maintain or replace the part
Heater does not activate.	● Incorrect connecting of the connector of heater ● Activated the protection circuit caused by the failure of the other device (displayed error) ● Activated the protection circuit without turning on the blower switch ● Heater disconnection ● Heater switch failure ● Heater circuit failure and wiring failure	● Connect correctly. ● Solve the problem, and turn ON the switch. ● Turn ON the blower, and then turn ON the heater switch. ● Replace the part. ● Replace the touch panel or sequencer ● Maintain the part or replace the thermo regulator.
Feeding pump does not activate	● The indicator of the pump adjusting dial is at "0" ● Pump switch failure ● Pump motor failure ● Pump circuit failure and wiring failure ● Imperfect nozzle attachment	● Adjust the dial. ● Replace the touch panel or sequencer ● Replace the motor or driver ● Maintain the part ● Check and adjustment of attachment status of the nozzle
Pulse jet does not activate	● Failure of pressuring air source ● Connecting failure of tube ● Solenoid valve failure ● Pulse jet switch failure ● Pulse jet circuit failure and wiring failure	● Make arrangement aiming for appropriate status. ● Maintain or replace the part. ● Replace the part. ● Replace the touch panel or sequencer ● Maintain the part

8. In the Event of Failure…

Trouble Shooting

Problem	Possible Cause	Solution
Thermo regulator failure	● Defective display function ● Sensor failure ● Activated overheating protection function	● Maintain or replace the part. ● Replace the part. ● Lower the temperature setting
Adjusting dial (Not activated blower and pump)	● Adjusting circuit failure and wiring failure ● Lack of capacity of heater due to excessive drying airflow	● Maintain the part or replace the thermo regulator. ● No error. For operating this unit with high temperature, decrease the flow rate of the drying air or increase the setting value.
HEAD lifting failure	● Compressed air supply deficiency ● Air tank failure ● Magnetic valve failure for Head lifting	● Set the pressure of the pressure reducing valve to 0.4 Mpa, lift the Head part by hand. ● Replace the part. ● Replace the part.

In case of an error other than listed above occurred, turn off the power switch and primary power source immediately. Contact the shop where you purchased or nearest Yamato Scientific Service Office.

9. After Service and Warranty

When requesting a repair

If any trouble occurs, immediately stop operation, turn the power switch off, pull out the power plug and contact your dealer, our sales office or our customer service center.

Information necessary for requesting a repair

- Model name of the product
- Serial number
- Date (y/m/d) of purchase

} See the warranty card or the nameplate on the unit.
See the section “3.Names of parts and their function” on page 9.

- Description of trouble (as in detail as possible)

Be sure to indicate the warranty card to our service representative.

Warranty card (attached separately)

- Warranty card is given by your dealer or one of our sales offices and please fill in your dealer, date of purchase and other information and send it to our customer service center by Facsimile (03-3231-6523). Then, store it securely.

- Warranty period is one full year from the date of purchase. Repair service for free is available according to the conditions written on the warranty card.

- For repairs after the warranty period consult your dealer, one of our sales offices or our customer service center.
  Paid repair service is available on your request when the product’s functionality can be maintained by repair.

Minimum holding period of repair parts

The minimum holding period of repair parts for this product is seven years after end of production.
Repair parts here refer to parts necessary for maintaining performance of the product.

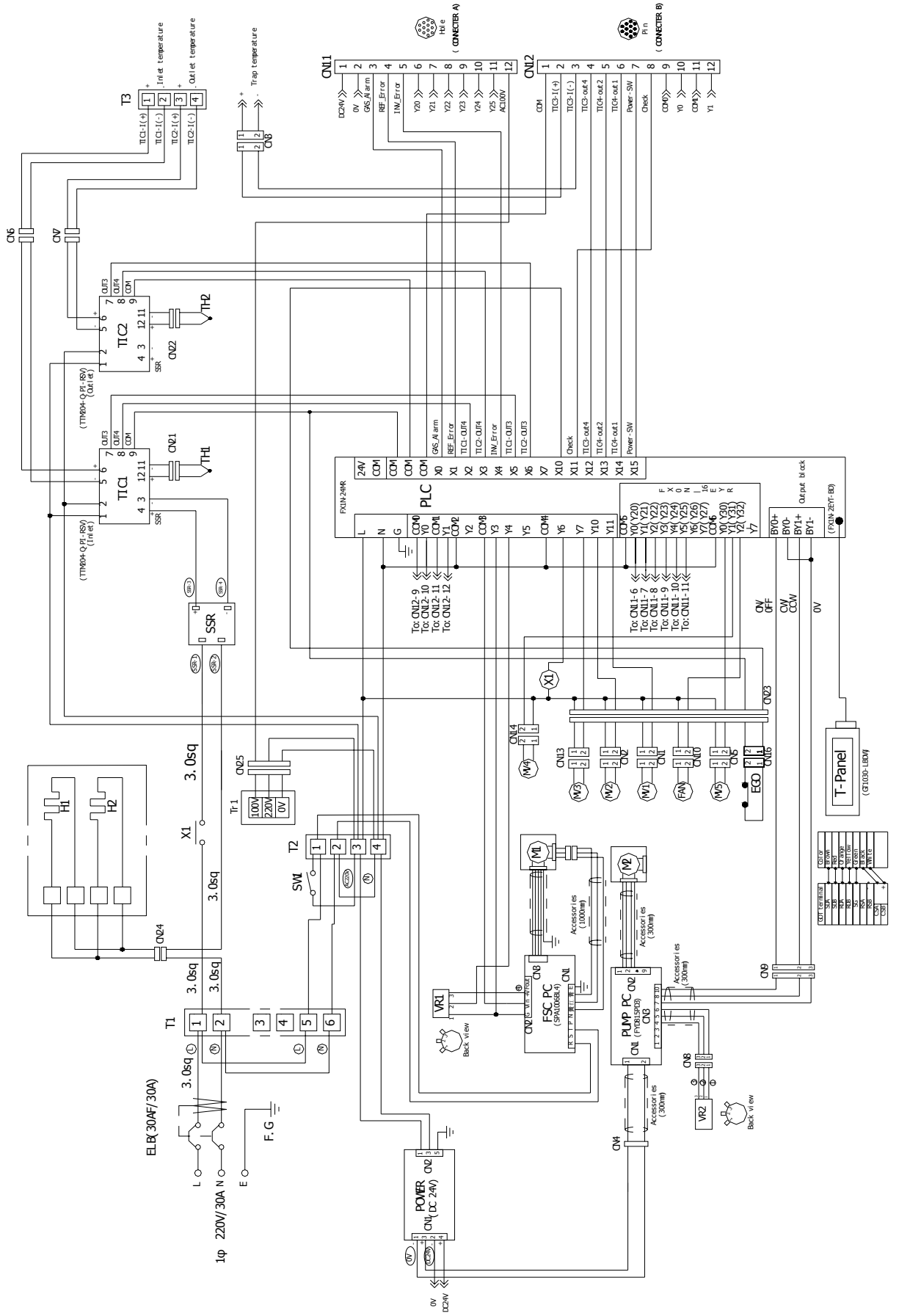
10. Specification

Machine specification

Model	DL410	
Spraying mode	Two fluid Nozzle method (Mesh diameter about Φ 0.7)	
Contact method of spray, hot wind	Cocurrent flow method of lower spray	
Moisture Evaporation	Around 3L/Hr highest	
Temperature adjuster	PID Digital Temperature adjuster	
Heater	2kW＋2KW Stainless tube heater	
Cyclone	Brushless Motor (Blast volume at 1m^3/min adjustable)	
Liquid delivery pump	Ration Perista pump (Flow volume at 80ml/min adjustable)	
Temperature adjusting range	40~300°C	
Temperature adjustment precision	±1°C	
Temperature indication	Inlet temperature, Outlet temperature digital display [0-320°C] (resistance thermometer bulb K thermo couple)	
Dry air blast volume meter	Float-type flow meter (mesh distributary method) Measuring range 0.3~1.2m^3/min	
Spray air pressure gauge	Bourdon (tube pressure) gauge Measuring range:0~0.6MPa	
NEEDLE KNOCKER	Use the needle inside the nozzle to clean the mesh automatically (Drive the air tank inside the nozzle through magnetic valve, electric timer, and compressed air)	
Nozzle Blower	Blow away the powder attached on the nozzle head (Use magnetic valve, Compressed air)	
Head lifting mechanism	Automatic UP, DOWN of Head (where the hot wind blown out) (Drive the air tank inside the upper frame by using magnetic valve and compressed air)	
Power supply	AC220V single-phase 50/60Hz 24A	
Size of O.D.(㎜) (W×D×H)	1060×880×1750	
Weight	About 180kg	
Attachments	･sample tube made of silica gel I.D.Φ3.2 ㎜×O.D.Φ6.4 ㎜×2m	2
	･connecting tube made of chlorethylene I.D.Φ50mm×Length0.8m (with cuffs at each side)	1
	･exhaust duct made of chlorethylene I.D.Φ50mm×Length3m (with cuffs at one side)	1
	･connecting tube made of silica gel I.D.Φ38 ㎜× O.D. Φ42 ㎜ (with coupling at each side)	1
	･Outlet temperature sensor K thermo couple	1
	･Nozzle Tube A made of Nylon 11 I.D.Φ4×O.D.Φ6 (with coupling)	1
	･Nozzle tube B made of Nylon 11 I.D.Φ4×O.D.Φ6 (with coupling)	1
	･Connection pipe A made of Nylon 11 I.D.Φ4×O.D.Φ6	1
	･Connection pipe B made of Nylon 11 I.D.Φ4×O.D.Φ6	1
	･Pressure hose I.D. Φ 7.9mm × Length 3m	1
	･Instruction Manual	1
	･Warranty	1

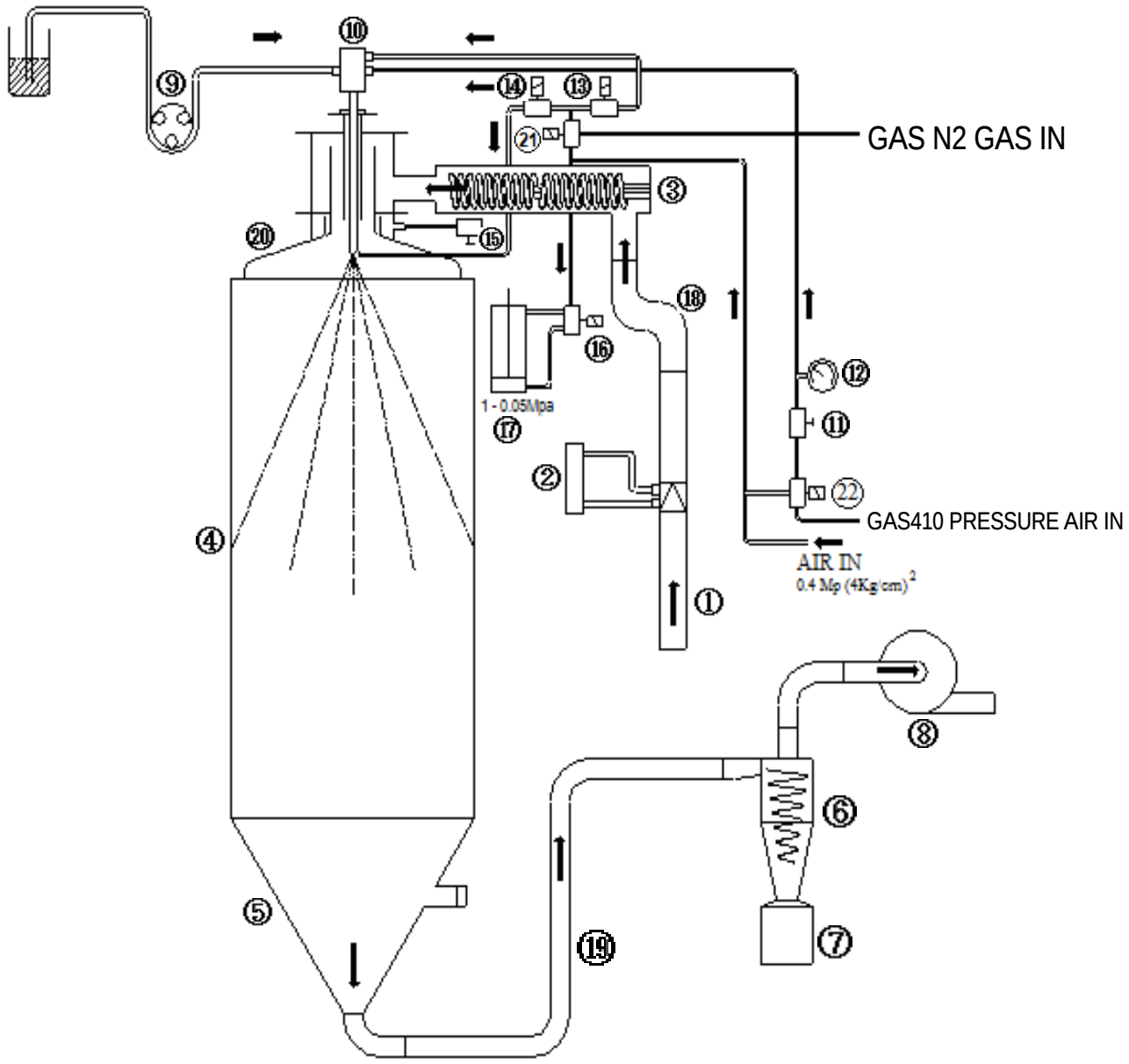
11. Wiring diagram

DL410 Wiring diagram



12. System Chart

System Chart



① Mesh tube	⑨ Liquid delivery pump	⑰ Air tank
② Dry air flow meter	⑩ Spray nozzle	⑱ Connecting tube
③ Heater	⑪ Spray air needle valve	⑲ Connecting hose
④ Drying chamber	⑫ Spray air pressure gauge	⑳ Upper chamber
⑤ Lower chamber	⑬ NEEDLE KNOCKER for magnetic valve	㉑ Conversion solenoid valve
⑥ Cyclone	⑭ nozzle, Blower use magnetic valve	㉒ Conversion solenoid valve
⑦ product catcher	⑮ Cold wind adjusting valve (Manual valve)	
⑧ Blower	⑯ use magnetic valve for Head lifting and descending	

13. Operating principle

Operating principle

12. Please refer to system diagram。

Use containers to deliver the solvent to the spray nozzle ⑩ through the solvent delivery pump ⑨. The compressed air generated from the compressors goes through the needle valve⑪and adjusted into proper pressure, then deliver to the spray nozzle. Blended with the samples at the top of nozzle, and then spray the samples into the drying chamber ④.

Meanwhile, use the blower ⑧ to intake air into the unit. The heater ③ reaches the set temperature. After the hot wind intake into the drying chamber, it contacts with the sample liquids, then dry the samples immediately.

The particles and dried samples will be dried further, and then it will be delivered to the cyclone ⑥. Inside the cyclone it was separated with evaporated part, then goes into the product catcher ⑦.

The evaporated water will exhausted to outside through the blower.

And then, the intake outside air will go through the wall of upper chamber ⑳ by cold wind valve (manual valve) ⑮. This can prevent the powder from attaching to the upper chamber.

The temperature condition for testing displays on the temperature adjuster through the inlet temperature sensor and outlet temperature sensor. The temperature can be recorded by installing a temperature recorder on the temperature output terminal. In addition, the air flow of the dry samples can be displayed through the by-pass dry air flow meter ② which was generated from the mesh tube ①.

When the mesh of the nozzle head is clogged, please operate the NEEDLE KNOCKER switch on the touch panel, start the magnetic valve ⑬, the needle inside the nozzle moves up and down to remove the clogs in the mesh. Moreover, when there are serious powders attachments on the nozzle head; operate the nozzle blower switch, start magnetic ⑭, so that the compressed air blows to the nozzle head to clean away the attachments.

In addition, after the test has finished, please operate the head switch, start the magnetic valve ⑯, lift the upper frame through the air tank to open the upper part of the drying chamber for cleaning.

14. List of replaced parts

Symbol	Component Name	Specification	Manufacturer	Code №
	Drying chamber	DL410-30431	YSC	KM11062401
	Cyclone	DL410-30610	YSC	2127080165
	Product catcher	DL410-41251	YSC	DL41041251
	Spray nozzle type 1	6123SS-12-B1/4 JAUSS	YSJ	SJA08060
	Liquid nozzle for spraying	PF2850-SS	YSJ	SJA07986
	Gas nozzle for spraying	PA64-5-SS	YSJ	SJA08061
	Armored heater	DL410C_01_03-06 Stainless steel Sheath heater	YSJ	SJA21112
TIC1-I	Inlet temperature sensor	DL410C_03_01-01	YSJ	SJA07960
TIC2-I	Outlet temperature sensor	DL410C_03_01-02	YSJ	SJA07961
	Solenoid valve (for head lifting and descending)	4KA210-06-AC200V	YSJ	SJA06836
	Solenoid valve (for NEEDLE KNOCKER, nozzle Blower)	3PA210-06-2	YSJ	SJA06835
	pressure gauge	DU-1/4-60-6	YSC	D0070001
	Needle valve	2412T-B-7 Φ4·30 50L/min	YSC	R0070040
	Dry air flow meter	O-186-FB	YSC	LT00034057
	Gears	LRA25 20S-B10K	YSC	A101A045S0
	Brushless motor	BBW1006BL2E Blower	YSC	LT00029635
FSC PC	Drive	SPA1006BL4 Blower	YSC	LT00029636
M2	Motor	FY8PF15ND3 for solvent delivery	YSC	LT00027675
PUMP PC	Drive circuit board	FYD815SD3 for solvent delivery	YSC	LT00027693
	Gear head	8H30FBN100 for solvent delivery	YSC	LT00027684
	Liquid feed pump head	7016-21Cole Parmer32S	YSC	D0020090
	Axle Bearing (IKO)	NAG4900UU	YSC	D0040023
	PLC connecting cable	GT10-C10-R4-8P	YSJ	SJA24366
T-panel	Touch screen	GT1030-LBD-C	YSJ	SJA07721
PLC	PLC basic unit	FX1N-24MR-001	YSJ	SJA07722
	PLC input Expansion module	FX2N-16EYR	YSJ	SJA07927
	Transistor output board	FX1N-2EYT-BD	YSJ	SJA24369
TIC	Temperature adjuster	TTM204-Q-PI-RSV TOHO	YSC	LT00027709
SSR	SSR	XBPE4025C	YSJ	SJA13073
ELB	ELB	KD-LS2123 30A 30mA	YSJ	SJA04529
X	AC Relay	HF116F-2/220AL1HSTFW	YSJ	SJA06060

14. List of replaced parts

	Symbol	Component Name	Specification	Manufacturer	Code №
	POWER	power supply of switch	HF60W-SL-24(24V 2.5A)	YSJ	SJA04731
	FAN	Axial flow fan	SJ8025HA2BAT	YSJ	SJA07962
	SW2	Push button switch	HLS-112A-G	YSC	A0020175
	T1	Terminal block	T3052-6-6P-CLO	YSJ	SJA24363
	T2	Terminal block	T3052-6-4P-CLO	YSJ	SJA24362
※		hose	32SL	YSC	W0010020
※		Lower chamber sealing ring	(DL-41)212708-193-1	YSC	B081999035
※		Suction hose	ϕ34*ϕ42 1M	YSC	2127080224
		Spring A (For Connecting hose, elbow tube)	(DL-41)212708-151	YSC	B050232010
		Spring B (for Cyclone)	(DL-41)212708-149	YSC	B050232009
		Tube connector (straight)	GWS6-8	YSJ	SJA06842
		Tube connector (straight)	GWS6-6	YSJ	SJA06841
		Tube connector(joint of bended tube)	GWL6-8	YSJ	SJA06840
		Tube connector(joint of long & bended tube)	GWL6-8-L	YSJ	SJA06839
		D type Tube connector (Shunt circuit T)	GWT6-6-D	YSJ	SJA07544
		D type tube connector (Shunt circuit T)	GWT6-8-D	YSJ	SJA06838
		Bulkhead push-in fitting (Isolation coupling)	GWS6-0-X	YSJ	SJA06843
		TSP connector (for tube nozzle A)	2TSF BS	YSC	R0150004
		TSP connector (for tube nozzle B)	1TSF BS	YSC	R0150002
		internal thread ball valve (Manual valve)	SUS304 1/4	YSJ	SJA24379
		Suction filter	DL410-40540 For air intake	YSC	LG00000394

Remarks: The item with ※ symbol means it is a consumable.

15. List of Dangerous Substances

Never use explosive substances, flammable substances and substances that include explosive or flammable ingredients in this unit. Otherwise explosion or fire may result

DL410 supports organic solvents by connecting it to the optional GAS410. Carefully read the operation manual of GAS410 and take special care for handling of organic solvents.

Explosive substance	Explosive substance	①Nitroglycol, glycerine trinitrate, cellulose nitrate and other explosive nitrate esters
		②Trinitrobenzen, trinitrotoluene, picric acid and other explosive nitro compounds
		③Acetyl hydroperoxide, methyl ethyl ketone peroxide, benzoyl peroxide and other organic peroxides
Flammable substances	Explosive substances	Metal “lithium”, metal “potassium”, metal “natrium”, yellow phosphorus, phosphorus sulfide, red phosphorus, celluloids, calcium carbide (a.k.a, carbide), lime phosphide, magnesium powder, aluminum powder, metal powder other than magnesium and aluminum powder, sodium dithionous acid (a.k.a., hydrosulphite)
	Oxidizing substances	①Potassium chlorate, sodium chlorate, ammonium chlorate, and other chlorates
		②Potassium perchlorate, sodium perchlorate, ammonium perchlorate, and other perchlorates
		③Potassium peroxide, sodium peroxide, barium peroxide, and other inorganic peroxides
		④Potassium nitrate, sodium nitrate, ammonium nitrate, and other nitrates
		⑤Sodium chlorite and other chlorites
		⑥Calcium hypochlorite and other hypochlorites
	Flammable substances	①Ethyl ether, gasoline, acetaldehyde, propylene chloride, carbon disulfide, and other substances with ignition point at a degree 30 or more degrees below zero.
		②n-hexane, ethylene oxide, acetone, benzene, methyl ethyl ketone and other substances with ignition point between 30 degrees below zero and less than zero.
		③Methanol, ethanol, xylene, pentyl acetate, (a.k.a.amyl acetate) and other substances with ignition point between zero and less than 30 degrees.
		④Kerosene, light oil, terebinth oil, isopenthyl alcohol(a.k.a. Isoamyl alcohol), acetic acid and other substances with ignition point between 30 degrees and less than 65 degrees.
	Combustible gas	Hydrogen, acetylene, ethylene, methane, ethane, propane, butane and other gases combustible at 15°C at one air pressure.

(Quoted from the separate table 1 in Article 6, the enforcement order of the Industrial Safety and Health Law)

Responsibility

Please follow the instructions in this document when using this unit. Yamato Scientific has no responsibility for the accidents or breakdown of device if it is used with a failure to comply.

Never conduct what this document forbids. Unexpected accidents or breakdown may result in.

Note

- ◆ The contents of this document may be changed in future without notice.
- ◆ Any books with missing pages or disorderly binding may be replaced.

Instruction Manual
Spray Dryer
DL410
Version Feb. 25 ,2009
Revision September 28, 2012

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