

# Shimadzu Vacuum Furnace

## For safety use

This furnace is for heat-treatment of products.

Heat-treatment involves risk of accident. Please pay attention when use.

Please read the instruction manual carefully and use it correctly.

It should be used only by those who have been educated about the operation method.

### Confirmation and precautions before heat-treatment.

Before starting heat treatment preparation, be sure to check and confirm the following items. If the inspection is not performed correctly, an accident may occur.



#### Warning

When checking, be sure to turn off the main power breaker.  
Touching exposed parts of the battery may cause electric shock and death or serious injury.



#### Caution

If an alarm is generated, check the device and release it. Refer to the instruction manual for details of the alarm display items.



#### Inspection and confirmation

- ① Check water volume, gas pressure and air pressure.
- ② Check the oil level of the rotary pump.
- ③ Check that the heater is not loose.
- ④ Check that the processed material is correctly and stably set within the effective dimensions of the furnace.
- ⑤ Check the door seal.
- ⑥ Check the furnace door is close.

### Treatment when an abnormal alarm occurs

After the operation power is turned on, if there is an error in the device, an alarm screen will be displayed and the error item will light in red.

When the warning is displayed, heat treatment cannot be started.

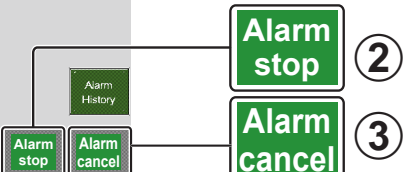
- ① Check the alarm display items.  
Check the equipment and contact our sales office or service agent if necessary.  
Details of the alarm display items are described in the instruction manual.
- ② Press the [Alarm stop] switch.  
→The alarm buzzer stops.
- ③ After confirming that the error has been removed, press the [Alarm cancel] switch.  
→The alarm display disappears.

### Alarm display example

①

Alarm				
Air Pressure Decrease	HW1 Disconnection	Overheating	Upper Thyristor Output Abnormality	Emergency Stop
N2 Pressure Decrease	HW2 Disconnection	Temperature Deviation	Lower Thyristor Output Abnormality	Excess of Gas Introduction Time
Ar Pressure Decrease	HW3 Disconnection	Upper Thyristor Abnormality	Control Panel Cooler Abnormality	Event Abnormality
Power Failure	HW4 Disconnection	Lower Thyristor Abnormality	Power Panel Cooler Abnormality	PTVD Zero Point Abnormality
Shortage of Water (RHU-SHU)	HW5 Disconnection	Upper Heater MCB OFF	VM Valve malfunction	PTVT Zero Point Abnormality
Shortage of Water (RHL-THL)	HW6 Disconnection	Lower Heater MCB OFF	VVB Valve malfunction	PTVI Zero Point Abnormality
Shortage of Water (THL-SHL)	HW7 Disconnection	TPC Abnormality	VD Valve malfunction	PTFD Zero Point Abnormality
Shortage of Water (Front Door Paneling)	HW8 Disconnection	PLC Abnormality	VDB Valve malfunction	PTPI Zero Point Abnormality
Shortage of Water (RHL-THL)	HW9 Disconnection	HW Heater ELB OFF	VO Valve malfunction	PTAO Zero Point Abnormality
Shortage of Water (Front Furnace Flange)	HW10 Disconnection	Door Ring Abnormality	VSL1 Valve malfunction	Excess of G.S.Wait Time
Shortage of Water (Front Furnace)	HW11 Disconnection	Door Lock Pin Abnormality	VSL2 Valve malfunction	
Shortage of Water (Rear Furnace)	HW12 Disconnection	Leakage Valve Malfunction	RP Abnormality	
Shortage of Water (Rear Furnace Flange)	HW13 Disconnection	Output Fuse Broken	MB Abnormality	
Shortage of Water (Rear Door Paneling)	HW14 Disconnection	PLC Battery Decrease	Inverter Abnormality	
Shortage of Water (Rear Door Flange)	HW15 Disconnection	Pipen Abnormality	Overpressure	
Shortage of Water (VIA/Valve)	HW16 Disconnection	Lightning Arrester MCB OFF	Partial Control Upper Limit	
Shortage of Water (FAN-MB-RP)	HW17 Disconnection	Lightning Arrester Abnormality	Decompression Upper Limit	
Shortage of Water (Cooler)		UPS Abnormality	Partial Upper Limit	
		UPS Battery Decrease	Atmospheric Overpressure	
			Pressurized Upper Limit	

Note)  
The alarm screen varies depending on the heat treatment furnace.



② Alarm stop

③ Alarm cancel

# ! Note here

The precautions for use are classified by color and symbol for each work.

● Installation and preparation

◆ During heat treatment / After heat treatment

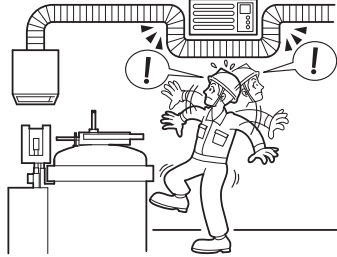
⊙ Maintenance

## ● Attached equipment (exhaust duct shape and capacity)

Install it with due consideration for the shape and capacity of the attached equipment.

Depending on the shape of the exhaust duct, combustible gas may not be exhausted properly.

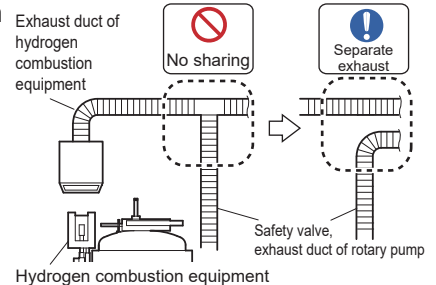
Improper installation may cause some accident such as an explosion of combustible gas.



## ● Instruction of hydrogen combustion equipment

Be careful when handling the hydrogen combustion device. Do not install the exhaust duct of the hydrogen combustion device in common with other exhaust ducts.

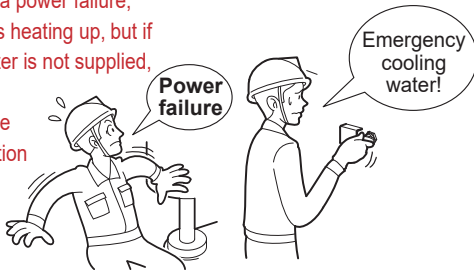
Hydrogen may explode in the exhaust duct, causing a fire.



## ● Emergency cooling water supply

Even if the cooling water pump stops in the event of a power failure, ensure that the emergency cooling water volume is supplied.

In the event of a power failure, the heater stops heating up, but if the cooling water is not supplied, the furnace will become hot due to heat dissipation from the processed material.



## ◆ Caught in (when opening and closing doors, press furnace pusher head, etc.)

Be careful not to be caught your body, clothing sleeves, or hair when closing the door.

There is a risk of injury.



## ◆ High pressure (uses pressurized furnace and HIP furnace)

At the end of operation, be sure to confirm that the pressure in the furnace has dropped, and then open the lid.

Opening the lid when the pressure inside the furnace is high may cause injury or damage the furnace.

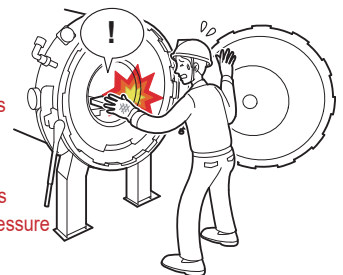


## ◆ Setting and removal of processed materials

When opening the furnace lid to remove the processed material, check the temperature and pressure inside the furnace.

When the temperature or pressure is high in opening the door, there is a risk of injury.

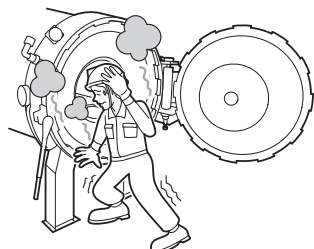
Furnace temperature: 60 °C or less  
Furnace pressure: atmospheric pressure



## ◆ Oxygen deficiency (precautions when opening the door / operation in the furnace)

When inspecting the inside of the furnace, be sure to air purge and ventilate and check that the oxygen concentration is 18 % or more.

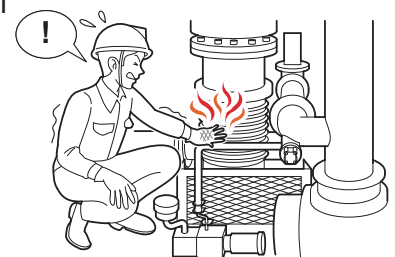
Inhaling air with low oxygen concentration may result in death.



## ◆ High temperature (DP, electrode cover, door flange, furnace wall, etc.)

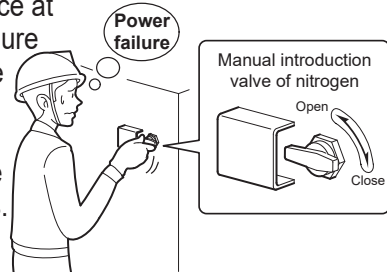
The inside of the furnace is hot during the operation or immediately after shutdown. Do not touch until the temperature drops.

Touching the equipments when the furnace is hot may cause burns.



## ◆ Power failure

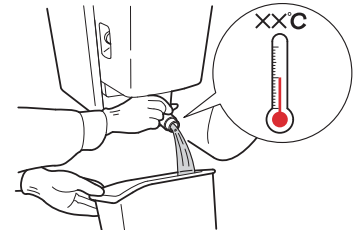
If a power failure occurs while using hydrogen, open the manual introduction valve of nitrogen and maintain the furnace at atmospheric pressure so that the furnace does not become depressurized even if the furnace temperature drops.



## ◎ Oil change

Change oil when confirming that the temperature of the pump body has dropped to room temperature after 3 to 4 hours or more have elapsed after the heat treatment.

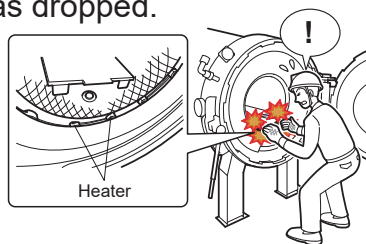
If the oil is changed while the main unit is still hot, the oil may blow out and cause injury or burns.



## ◎ Replacement of heater

Replace the heater after the main power is turned off and the heater body temperature has dropped.

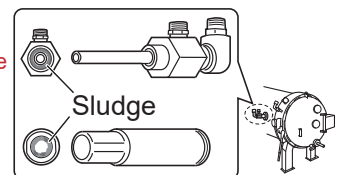
May cause burns or electric shock.



## ◎ Cleanse furnace bodies and electrode of cooling sludge.

Depending on the quality of the cooling water, the sediment accumulates when used for a long time, and water doesn't flow smoothly. Periodically check the furnace body, door, and water cooling jacket of the electrode, and clean up any sludge.

If the cooling water does not flow smoothly, the temperature will rise, which may damage the O-ring and crack the weld.

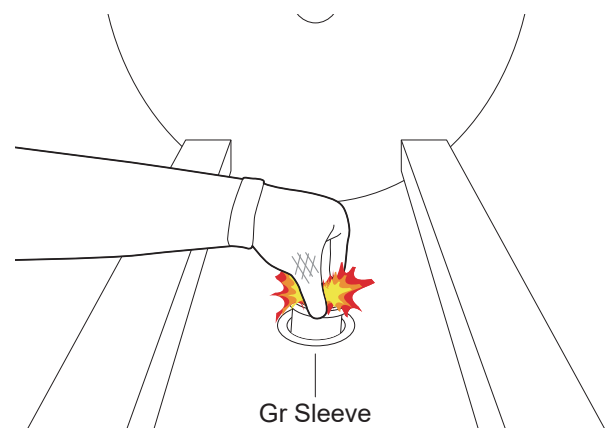


# Examples of accident

## 1 Burns from ignition of vacuum furnace

- When a new setter (alumina) with a lot of impurities was baked in vacuum at 1500 °C, they evaporated and reattached to the cool points inside the Gr sleeve.
- There were more than 900 burned setters, and the amount of impurities evaporated was large.
- When the Gr sleeve was pulled out, the impurities reacted with oxygen and moisture in the atmosphere and ignited and burned.

Impurities contained in setters or processed materials may evaporate under vacuum or reduced pressure even if they do not evaporate at atmospheric pressure. Use the setter with less impurities and consider the amount of impurities when baking. Be careful when cleaning as there is a risk of fire.

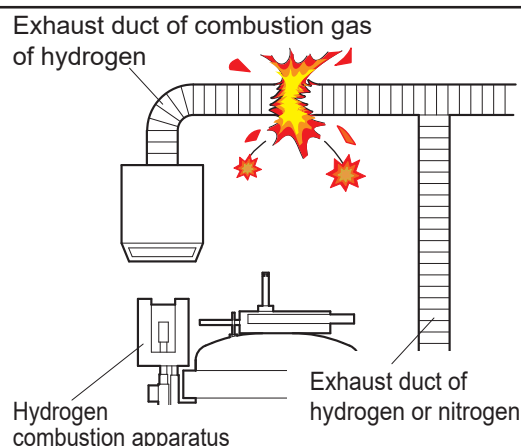


# Examples of accident

## 2 Hydrogen explosion in the exhaust duct

- During atmospheric pressure flow operation with hydrogen in a vacuum furnace, a power failure occurred for 10 minutes, and a small explosion occurred in the exhaust duct set by the customer after power recovery.
- In this vacuum furnace, nitrogen was automatically introduced into the furnace at the time of power failure, and a mixed gas of hydrogen and nitrogen was released from the self-weighted safety valve installed in the furnace body.
- The exhaust duct from which hydrogen is released was not single piping but also connected to the exhaust duct of the hydrogen combustion apparatus.
- Furthermore, because the forced exhaust system that was prepared by the customer did not have an automatic return function after power recovery, the forced exhaust system did not operate after the power recovery, and when the hydrogen combustion apparatus took fire the hydrogen remaining in the duct ignited and a small explosion occurred.

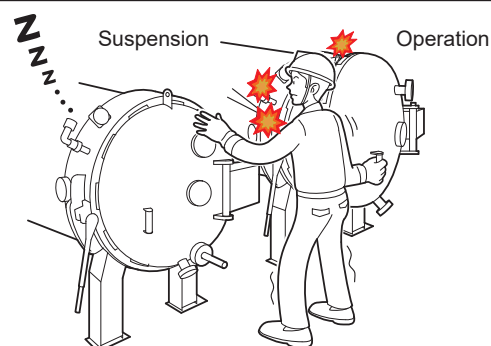
The exhaust duct from which hydrogen gas is released must be a single pipe.  
If a forced exhaust system is used in the exhaust duct, make sure that the system is activated when the heat treatment furnace is in operation.



## 3 Fire due to opening of furnace door during operation using hydrogen in vacuum sintering twin furnaces

- Usually when one side of twin furnaces is in operation, the other side is stop and allowing treatments to be set.
- When the operator intended to open the left furnace door while the display showed not suspension, he wrongly opened the right furnace door which was during the hydrogen flow operation and the fire broke out.

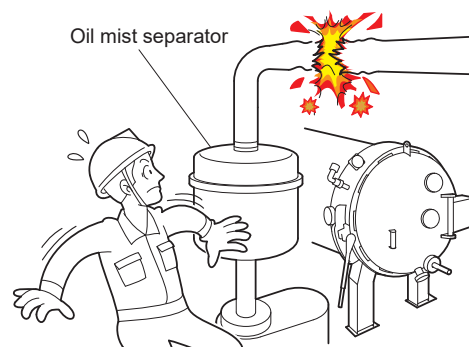
In twin furnaces, a lock mechanism is provided on any place like the door handle to ensure distinction between operation and suspension.



## 4 Explosion in the exhaust pipe of a vacuum furnace

- During operation with hydrogen pressure control, a furnace alarm occurred and the furnace stopped. The hydrogen in the furnace was evacuated manually.
- When the furnace was exhausted again for heat treatment, a few seconds later, an explosion occurred in the vicinity of the oil mist separator exhaust just above the rotary pump, and aluminum duct hose was broken and scattered.
- The cause is considered to be that hydrogen staying in the vicinity of the exhaust port of the oil mist separator mixed with air (oxygen) due to the exhaust, and the static electricity near the duct became an ignition source and exploded.

The exhaust duct shall be metal piping and grounded to prevent static electricity.  
Do not share the exhaust duct and use a single pipe.



## 5 Smoke by opening the door without checking the displayed temperature of the vacuum furnace

- During vacuum heating, smoke was emitted from the furnace because the furnace door was opened after the manual leak valve was opened to atmospheric pressure while the furnace was near the maximum temperature.
- The operator assumed that the temperature inside the furnace was at room temperature even though the temperature displayed on the temperature controller was close to the maximum temperature, opened the manual leak valve to atmospheric pressure, and opened the furnace door.

Check the displayed temperature and pressure before opening the furnace door.

