Mesh-Belt-Type Successive Annealing Furnace

Operation Manual

Contents

1. Introduction

1-1. Title: Mesh-Belt-Type Successive Annealing Furnace

1-2. Total power: 3ψ 380V 50HZ 95KW

1-3. Temperature range: 750℃ (max. temp); 680~700℃ (normal temp)

1-4. Purpose: annealing treatment of steel tubes

Pipe diameter available: ψ17~ψ40 mm×L3~5M

Normal pipe diameter: ψ21~ψ35 mm×L3.5M

1-5. Furnace size (max.): L31750×W1412×H1785 mm

1-6. Length of load mechanism: L6000 mm

1-7. Length of annealing furnace: L19750 mm

1-8. Length of unload mechanism: L6000 mm

1-9. Conveyer mesh belt: SUS304×W250 mm

1-10. Conveyer speed: 100 mm~400 mm/min; stepless frequency modulator with a speed meter

1-11. Temperature control: JCD-33A temperature controller combined with the stepless S.C.R. electric heating controller and the paperless thermograph for precise temperature control

1-12. Control cabinet installed at the right side of cooling zones

1-13. Alarm devices:

1-13-1 Automatic power-off protection for temperature anomaly

1-13-2 Automatic alarm for the mesh-belt broken and stopped

1-13-3 Alarm function for inverter anomaly

1-13-4 Alarm function for cooling water overheated

1-13-5 Alarm function for gas flow anomaly

1-13-6 Alarm function for N_2 pressure anomaly

2. Pre-operational preparations

2-1. Connections of pipelines/wires to a furnace

2-2. Power supply: 3ψ 380V 95KW

2-3. Switches in the control cabinet; power regulator “OFF”/reset

2-4. Connections between the control cabinet and electric heaters on the furnace; temperature control levels

2-5. Connections of gas lines, e.g., nitrogen (N2), liquefied propane gas (L.P.G.) and compressed air (AIR)

2-6. Installation of conveyer belts

2-7. Connections of cooling water lines

2-8. Installation of thermocouples, connections of compensation circuits and temperature control levels

2-9. Furnace level adjustment

2-10. F.R.L. combination unit of the unload mechanism for compressed air; secondary pressure adjusted at 4 kg/cm^2

3. Operation procedure

3-1 Operation procedure

Name of Operation Unit	Operation Method	Instrument Display
Close all switches, valves and flow meters before operation.		
Valves (cooling zones #1~#4 & cooling water inlet)	OPEN	Inject a small amount of water first. Increase the water flow after N2 is introduced into the furnace.
NFBs (NFB1~NFB7) in the control cabinet	ON	1. Voltmeter “ON” 2. Power indicator “ON” 3. Inverter “ON”
Control circuit switch	ON	1. Temperature controllers (Stage 1~Stage 3) indicate: SV: temperature setting PV: practical temperature inside the furnace 2. Speed meter “ON”
Ball valve (V1) for nitrogen under cooling zone #1	OPEN	
Flow meter panel: Flow meter for nitrogen in the furnace	ON	Nitrogen flow adjusted at 3~5 m^3/hr
Flow meter panel: Flow meter for nitrogen at the high-temperature outlet	ON	Nitrogen flow adjusted at 15~20 m^3/hr
Flow meter panel: Flow meter for nitrogen at an outlet	ON	Nitrogen flow adjusted at 1~2 m^3/hr
P.S: Ball valves (V1~V4) for nitrogen should be enabled rotationally every hour until the furnace temperature reaches 600℃; the ball valve enabled finally should be V1.		
Temperature controllers (Stage 1~Stage3)	SV 200℃	
Electric heater switch (Stage 1~Stage3)	ON	
Power regulator (Stage 1~Stage3)	Power output adjusted at 50%	1. Voltmeter & ammeter for electric heating indicating readings 2. Electric heating indicator “ON” 3. Annealing furnace heated

Name of Operation Unit	Operation Method	Instrument Display
Abnormity switch	ON	The abnormal conditions such as high/low temperature during electric heating, cooling water overheated, inverter trouble, gas flow low or nitrogen pressure low will enable alarm buzzers and indicators.
Thermograph switch	ON	The temperatures for all stages inside the furnace are recorded in the thermograph.
Method to turn on a thermograph: 1. Press a black cover on the lower right gap. 2. Press a gray power switch at the left-hand side to enable the thermograph for recording temperatures.		
Temperature controllers (Stage 1~Stage 3)	PV: 200℃	Keep the temperature for 4 hours.
Conveyer switch for heating zones	"Forward" position	1. The operating frequency is indicated on the inverter. 2. The conveyer belt is activated and the speed is indicated on the speed meter. 3. The conveyer belt stopped incorrectly will enable the alarm buzzer and indicators.
Temperature controllers (Stage 1~Stage 3)	SV: 400℃	
Power regulator (Stage 1~Stage 6) adjusted at 70%		
Temperature controllers (Stage 1~Stage 3)	PV: 400℃	Keep the temperature for 4 hours.
Temperature controllers (Stage 1~Stage 3)	SV: 700℃	
Power regulator (Stage 1~Stage 3) adjusted at 100%		
Temperature controllers (Stage 1~Stage 3)	PV: 700℃	Keep the temperature for 4 hours.

Name of Operation Unit	Operation Method	Instrument Display
Switches to activate driving wheels at loading and unloading tables	"Forward" position	1. The operating frequency is indicated on the inverter. 2. Driving wheels are activated; speeds are indicated on speed meters. 3. The driving wheel stopped incorrectly will enable the alarm buzzers and indicators.
The speeds of driving mechanisms for loading/unloading tables and conveyer belts in heating zones should be adjusted at a constant speed which is indicated on speed meters.		
Arrange steel tubes on the loading table.		
P.S.: The front ends of all steel tubes to be transmitted into the furnace should be aligned. A batch of steel tubes should be separated from the next batch by at least 300mm; otherwise, the short distance between two batches of steel tubes may cause problems in the course of unloading steel tubes.		
The full procedure of steel tubes annealed in a furnace includes different stages such as loading table, preheating, heating, cooling, furnace outlet, unloading table, and baffles (3-second delay for a steel tube contacting the rear end of the unloading table).		
Pneumatic cylinder at the unloading table	UP	Steel tubes on the unloading table are transferred to unloading racks automatically.
Pneumatic cylinder at the unloading table for 3-second delay	DOWN	
P.S: 1. The time of the pneumatic cylinder "UP" or "DOWN" at the unloading table may depend on on-site conditions. (TM5/TM6: timer inside the control cabinet for setup of UP/DOWN delay time) 2. An operator confronting emergent status may press the emergency stop button to disable the driving mechanism of the loading table, a heating zone or the unloading table. 3. An operator can press and hold a speed button at the loading/unloading table to increase the operating speed to 1065 mm/min which will be reduced to the normal speed with the button released. 4. The first unloading handspike from the unloading table outlet must be removed if a steel tube to be annealed is 3.5 meters long. Otherwise, the 3.5-meter-long steel tube will be a problem in the course of unloading.		

3-2 Furnace shutdown and heat preservation for running in the next day

Name of Operation Unit	Operation Method	Instrument Display
Inlet and outlet gates	CLOSE	
Abnormity switch	OFF	
Temperature controllers (Stage 1~Stage 3)	400℃	Indicators for temperature anomaly (Stage 1~Stage 3) "ON"
Flow meter panel: Flow meter for nitrogen in the furnace	Adjusted	Nitrogen flow adjusted at 3 m^3/hr
Flow meter panel: Flow meter for high-temperature nitrogen	Adjusted	Nitrogen flow adjusted at 7 m^3/hr
Flow meter panel: Flow meter for nitrogen at an outlet	OFF	Nitrogen flow adjusted at 0 m^3/hr
Switches to activate driving wheels at load and unloading tables	OFF	
Cooling water (circulating constantly)	Low level	
Temperature in the annealing furnace is kept at 400℃.		

※ Conditions for heat preservation on control panels in the control cabinet:

1. SV: 400℃ entered in temperature controllers (Stage 1~Stage 3)
2. Switch to activate conveyer belts of the annealing furnace placed at "Forward"; operating frequency indicated on the speed meter; conveyor speed kept at the low level
3. Readings of voltage and current for electric heating (Stage 1~Stage 3) indicated

3-3 Method to turn on a furnace which was shut down and kept warm

Name of Operation Unit	Operation Method	Instrument Display
Temperature controllers (Stage 1~Stage 3)	SV: 700℃	
Flow meter panel: Flow meter for nitrogen in the furnace	ON	Nitrogen flow adjusted at 3~5 m^3/hr
Flow meter panel: Flow meter for high-temperature nitrogen	ON	Nitrogen flow adjusted at 15~20 m^3/hr
Flow meter panel: Flow meter for nitrogen at an outlet	ON	Nitrogen flow adjusted at 1~2 m^3/hr
Temperature controllers (Stage 1~Stage 3)	PV: 700℃	Keep the temperature for 30 minutes.
Switches to activate driving wheels at load and unloading tables	"Forward" position	1. The operating frequency is indicated on the inverter. 2. Driving wheels are activated; speeds are indicated on speed meters. 3. The driving wheels stopped incorrectly will enable the alarm buzzers and indicators automatically.
The speeds of driving mechanisms for loading/unloading tables and conveyer belts in heating zones should be adjusted at a constant speed which is indicated on speed meters.		
Arrange steel tubes on the loading table.		

3-4 Method for furnace shutdown (furnace unused for a long term)

Name of Operation Unit	Operation Method	Instrument Display
Abnormity switch	OFF	
Switches to activate driving wheels at load and unloading tables	OFF	
Temperature controllers (Stage 1~Stage 3)	400℃	Indicators for temperature anomaly (Stage 1~Stage 3) "ON"
Method to turn off a thermograph: 1. Press a black cover on the lower right gap. 2. Turn off the thermograph and verify shutdown. 3. Press a gray power switch at the left-hand side to disable the thermograph display.		
Thermograph switch	OFF	
Temperature controllers (Stage 1~Stage 3)	400℃	
Flow meter panel: Flow meter for nitrogen in the furnace	OFF	Nitrogen flow adjusted at 0 m^3/hr
Flow meter panel: Flow meter for high-temperature nitrogen	OFF	Nitrogen flow adjusted at 0 m^3/hr
Flow meter panel: Flow meter for nitrogen at an outlet	OFF	Nitrogen flow adjusted at 0 m^3/hr
Switches to activate conveyer belts at heating zones	OFF	
Control circuit switch	OFF	
NFBs (NFB1~NFB7) in the control cabinet	OFF	
Cooling water inlet valve	CLOSE	

4. Fault, root cause and troubleshooting

Situation	Possible Causes	Actions
Power regulator (SCR)		
Green light “OFF”	No power supplied	1. Check NFB is enabled. 2. Check the green light is overheated.
Power OK; green light “OFF”	PCB fault	Repair
Green light “ON”; red light “OFF”	1. No input signal 2. Internal settings wrong 3. External power regulator (PR) not configured 4. PCB fault 5. Fuse burned-out 6. SCR fault	1. Check input signals. 2. Check internal settings. 3. Check VR. 4. Replace PCB. 5. Check fuses. 6. Repair SCR.
Red light “OFF”; current not controlled	SCR breakdown or PCB fault	Repair
Green light flashing	Cooling fin overheated; temperature switch activated	1. Check any overload. 2. Check ambient temperature and ventilation.
Control cabinet		
Temperature anomaly inducing the indicator “ON” and alarms	1. SCR fault 2. Temperature output wrong	Repair
Control circuit switch turned on but no power supplied to the control cabinet	Short circuit inducing NFB tripped or fuse burned-out	Repair
PV for a circuit in the temperature controller decreasing incorrectly; no current for the circuit (reading=0)	1. NFB for the circuit tripped 2. Fuses in the SCR machine burned-out or the SCR machine fault 3. Wire for electric heating disconnected	1. Check NFB for the circuit; switch NFB to “OFF” and “ON” once. 2. Check fuses and the SCR machine. Replace the faulty component with a spare part, if necessary 3. Check the electric heating wire.

Situation	Possible Causes	Actions
PV for a used circuit in the temperature controller increasing incorrectly and the warning indicator “ON”	1. SCR machine for the circuit fault 2. Temperature controller fault 3. Electric heating wire grounded	1. Reset the power regulator for SCR; check the ammeter indicates “0”. (The ammeter indicates other number in case of the SCR machine fault.) 2. Check the temperature controller. 3. Check the electric heating wire.
“0” ampere indicated on the ammeter for a used circuit	Circuit for electric heating disconnected (open)	Check the circuit for electric heating. Shut down the furnace and replace a disconnected electric heating wire with a new one.
PV for a used circuit in the temperature controller indicating ————	Thermocouple and compensation circuit open or contacting poorly; controller fault	Tighten screws. If it does not work, pull out and check the thermocouple or replace the temperature controller with another one for cross check.
Loading table not running correctly	1. Motor inverter tripped 2. Conveyer belt broken 3. Sensor fault	1. Check the motor. 2. The inverter fails. 3. Check and reset the inverter. 4. Check the sensor.
Conveyer belt at the heating zone not running correctly	1. Conveyer motor inverter tripped 2. Conveyer belt broken 3. Conveyer in the furnace fault	1. Check the motor. 2. The inverter fails. 3. Check and reset the inverter. 4. Check the conveyer belt is broken in the furnace.
Unloading table not running correctly	1. Motor inverter tripped 2. Conveyer belt broken 3. Sensor fault	1. Check the motor. 2. The inverter fails. 3. Check and reset the inverter. 4. Check the sensor
Cooling water overheated	1. Valve not opened or opened incompletely 2. Temperature switch fault	1. Check the cooling water valve. 2. Check the temperature switch.
Gas flow incorrect	Nitrogen flow low	1. Check the gas source. 2. Press the reset button.

Situation	Possible Causes	Actions
Nitrogen pressure incorrect	1. Nitrogen pressure low 2. Pressure switch fault	1. Check pressure of the nitrogen source. 2. Check or replace the pressure switch.
Conveyer belts at the loading table and heating zones and the unloading motor not running; E.S. indicated on the inverter	Emergency stop button not released	Check and reset the emergency stop button; re-start conveyer belts at the loading table and heating zones and the unloading motor.
Mechanism at the unloading table not lifted	1. Compressed air pressure low 2. Photo sensor (at the rear end of an unloading table) fault	1. Check pressure of compressed air. 2. Check the photo sensor.

5. Precautions for maintenance:

5-1. The first unloading handspike from the outlet of unloading table must be removed if a steel tube to be annealed is 3.5 meters long. Otherwise, the 3.5-meter-long steel tube will be a problem in the course of unloading.

5-2. A steel tube to be delivered into a furnace must be cleaned in advance for minimal soot and no quality issue.

5-3. Check thermocouples once every year and replace them every two or two and a half years.

5-4. The terminal of the first thermocouple to be inserted should be separated from the top of the furnace core by 15 mm; the heights of the second and third thermocouples to be inserted should refer to that of the first thermocouple.

5-5. Verify (+)/(-) on an installed thermocouple.

5-6. Remove dust on the control cabinet once every three months.

5-7. Check the wiring board for electric heating wires once every year.

5-8. Clean cooling pipes once every three months.

5-9. Remove oil dirt accumulated in the inlet tube and the preheating tube once every three months.

5-10. Apply grease on bevel gears and chain pitch wheels which drive loading and unloading tables.

5-11. Lubricate the F.R.L. combination unit of the unloading table for compressed air once every three months.

5-12. Check the oil level of the reducer once every three months; replace oil (multi-functional gear oil 80W/90) once every half a year.

5-13. Lubricate all bearings once every three months.

5-14. The time to reheat a furnace which had been shut down for over half a year should continue at least 5 to 6 hours or more at a constant temperature.

5-15. The gas flow for an activated annealing furnace should be kept stable with no air drawn in the furnace and adversely influencing any workpiece.

5-16. Notice and keep the level of the gas flow inside an activated annealing furnace.

5-17. Do not touch the baffles at the rear end of an activated unloading table.

5-18. Keep the body away from driving mechanisms and bevel gears of loading and unloading tables.

5-19. Check and clean the inside of a furnace once every two years.