

GSL-1700X Series

1700 – 1750°C VACUUM* TUBE FURNACES

OPERATION MANUAL

CE



860 South 19th Street, Richmond, CA 94804, USA
TEL: (510) 525 – 3070 FAX: (510) 525 – 4705
Website: www.mtixtl.com Email: info@mtixtl.com

* Vacuum pressures may be safely used up to 1500°C

TABLE OF CONTENTS

IMPORTANT NOTES 3

GENERAL WARNINGS 3

WARRANTY 3

EQUIPMENT INFORMATION 4

INTRODUCTION: 4

FURNACE STRUCTURE: 4

SPECIFICATIONS: 5

ASSEMBLY INSTRUCTIONS 6

EQUIPMENT INSPECTION: 6

OPERATING ENVIRONMENT: 6

POWER CONNECTION: 6 - 7

AC POWER: 7 - 8

THERMOCOUPLE INSTALLATION: 9 - 10

GENERAL OPERATION: 10 - 13

VACUUM AND GAS FLOW SYSTEMS: 13

SYSTEM LOADING/ UNLOADING PROCEDURES: 13

TEMPERATURE CONTROL INSTRUCTIONS 14

TEMPERATURE CONTROLLER: 14

SETTING THE TEMPERATURE CONTROLLER: 14 - 15

HEATING PROFILE SETTING EXAMPLE: 15 - 17

ILLUSTRATION OF HEATING PROFILE SETTING: 17 - 18

RUNNING THE PROGRAM: 18

HOLDING THE PROGRAM: 18

STOPPING THE PROGRAM/ FURNACE SHUT DOWN: 18

TEMPERATURE CONTROLLER PARAMETERS: 19

FUNCTIONS OF MAIN PARAMETERS: 19 - 21

PARAMETER SETTING: 21

AUTO - TUNE: 21 - 22

MANUAL – TUNE: 22

EQUIPMENT MAINTENANCE & TROUBLESHOOTING 23

MAINTENANCE AND EQUIPMENT CARE: 23

CERAMIC TUBE REPLACEMENT: 24

HEATING ELEMENTS REPLACEMENT: 25

TROUBLESHOOTING FOR TYPICAL PROBLEMS: 26

TROUBLESHOOTING RESOURCES: 26

IMPORTANT NOTES

Thank you for purchasing from Materials Technology International Corporation. This manual contains important operation and safety information prepared for those intending on using the equipment. The prospective user is responsible for carefully reading and understanding the contents of this manual prior to operating the equipment.

MTI reserves the right to update or upgrade the product without informing customers of the data change(s) in this manual. Please visit www.mtixtl.com frequently for the latest information and manual.

GENERAL WARNINGS

MTI will not be responsible for equipment damage, accidents leading to minor or fatal injuries, and etc. caused by the user's negligence or lack of knowledge. Always read the manual fully beforehand and exercise the best judgment when handling the equipment.

To avoid electrical shock:

- Use a properly grounded electrical outlet of correct voltage and current handling capacity.
- Disconnect equipment from the power supply before servicing.
- Always double check the wiring and consult a licensed electrician for installation.

To avoid burns:

- Do not touch the exterior or interior surface of the furnace during operation or after use (cooling time depends on temperature set by the user).

Tube Replacement or Installation:

- Use extreme cautions and be aware of the surroundings when replacing or installing a tube.
- Read the installation instructions listed in the dedicated section prior to installing.

To avoid Physical Injuries:

- Do not put this equipment near flammable or explosive environments and substances.
- Do not leave the internal circuit exposed after disassembly.
- Power should be cut off when performing external maintenance like cleaning.

WARRANTY

MTI Corporation provides one year limited warranty from date the product is shipped out. Any defective part(s) will be replaced free of charge during warranty period. However, the warranty does NOT cover any equipment damage caused by misuse or negligence. After the expiration of warranty, MTI will continue to provide technical support and spare parts at a reasonable cost.

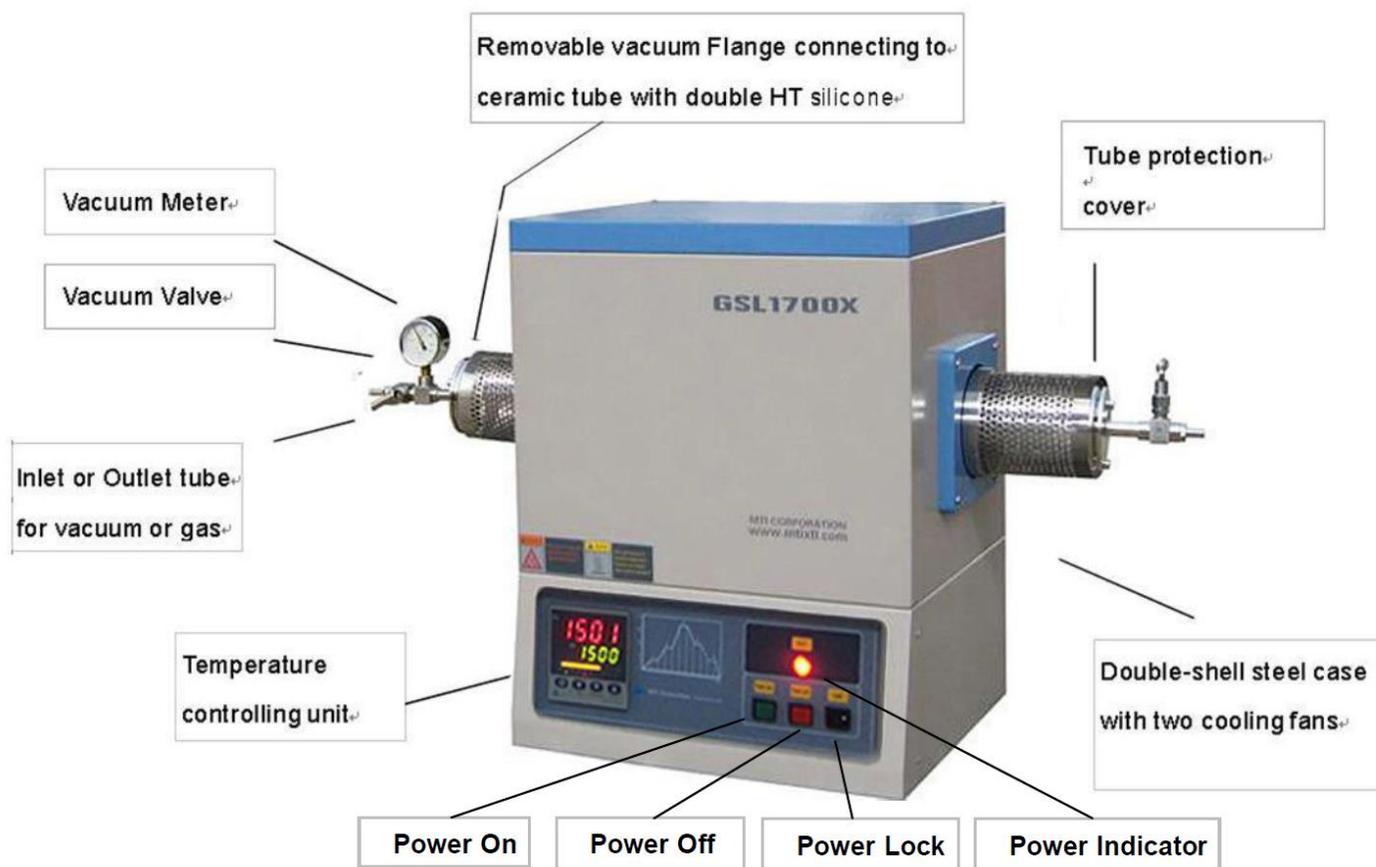
EQUIPMENT INFORMATION

INTRODUCTION

EQ-GSL-1700X single-zone series furnace use high-powered electric Molybdenum Disilicide (MoSi₂) or Kanthal Super HT Heating elements to achieve faster heating and cooling rates. Stainless steel vacuum flanges with valves, vacuum gauge and high purity ceramic tube are included for immediate use. This configuration allows for heating samples in vacuum or flowing gas. Precision temperature controller provides up to 30 segments of heating and cooling steps with ± 1 °C accuracy.

These types of furnaces are ideal for use in material & chemical researching labs to sinter all types of novel materials under vacuum and other gas conditions

FURNACE STRUCTURE



SPECIFICATIONS

1700°C Series Heating Element: Super 1800°C MoSi2 Heating Elements			
Model	Power Requirement	Size	Heating Zone / Constant Temp. Zone
GSL-1700X-S60	AC 208-240 V, 50/60 Hz, 3KW 30A fuse required	Tube size: 2" alumina tube: OD: 54mm x ID:60 mm Length: 790 mm L Heating element size: 30mm x 270mm Dimensions: 445mmx380mmx615mm (W x L x H)	12"(300 mm) (single zone)/ 3" (75mm) (+/-1°C)
GSL-1700X-80	AC 208-240 V, 50/60 Hz 5KW 40A fuse required	Tube size: 3" alumina tube: OD: 72mm x ID:80 mm Length:1000mm L Heating element size: 30mm x 330mm Dimensions: 590mmx490mmx760mm (W x L x H)	18"(457 mm) (single zone)/ 5.9" (150mm) (+/-1°C)
GSL-1700X-4	AC 208-240 V, 50/60 Hz 5KW 40A fuse required	Tube size: 4" alumina tube: OD:101.6mm x ID:92 mm Length:1000mm L Heating element size: 30mm x 330mm Dimensions: 590mmx490mmx760mm (W x L x H)	18"(457 mm) (single zone)/ 5.9" (150mm) (+/-1°C)
1750°C Series Heating Element: Kanthal Super HT 1800°C MoSi2 Heating Elements			
GSL-1700X-KS60	AC 208-240 V, 50/60 Hz, 3KW 30A fuse required	Tube size: 2" alumina tube: OD: 54mm x ID:60 mm Length: 790 mm L Heating element size: 30mm x 270mm Dimensions: 590mmx490mmx760mm (W x L x H)	12"(300 mm) (single zone)/ 3" (75mm) (+/-1°C)
GSL-1700X- KS80	AC 208-240 V, 50/60 Hz 5KW 40A fuse required	Tube size: 3" alumina tube: OD: 72mm x ID:80 mm Length:1000mm L Heating element size: 30mm x 330mm Dimensions: 590mmx490mmx760mm (W x L x H)	18"(457 mm) (single zone)/ 5.9" (150mm) (+/-1°C)
GSL-1700X- KS100	AC 208-240 V, 50/60 Hz 5KW 40A fuse required	Tube size: 4" alumina tube: OD:101.6mm x ID:92 mm Length:1000mm L Heating element size: 30mm x 330mm Dimensions: 590mmx490mmx760mm (W x L x H)	18"(457 mm) (single zone)/ 5.9" (150mm) (+/-1°C)

ASSEMBLY INSTRUCTIONS

EQUIPMENT INSPECTION

Once receiving the furnace, please inspect the equipment and all accessories for damage incurred from shipping and check the packing list for missing items. If anything is damaged or missing, please inform us at info@mtixtl.com.

WARNING:

Prior to connecting power to the furnace, please open up the top lid of the furnace and remove the shock absorbent foam covering the heating elements. Put the top lid back in place afterwards.



OPERATING ENVIRONMENT

The operating environment information listed below may be helpful for safely operating the instrument:

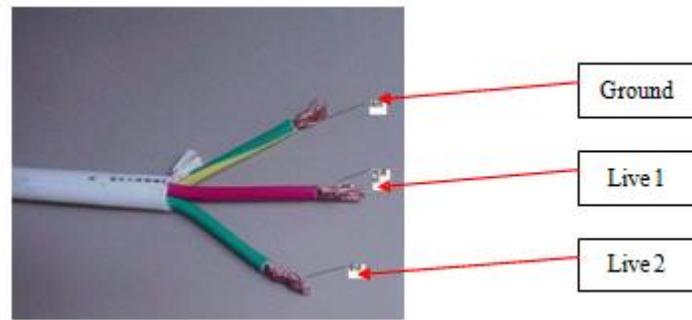
- The furnace should be placed on a dry, hard and flat surface
- Use should be limited to indoor only with adequate ventilation and away from direct sunlight
- Environment should be dust-free and without explosive and corrosive gases
- Relative humidity (non-condensing): 10% ~ 85%
- Circumstance temperature: -10~75 °C

WARNING:

To reduce the possibility of heat-related injuries or of overheating the instrument, do not place the instrument too close to the side wall or obstruct the air vents. Keep the instrument at least 1 meter in distance from the side wall.

POWER CONNECTION

Please make sure that the power source in your lab is sufficient to meet the power requirement listed for the equipment. The following picture shows the three wires of the power cable: Ground, Live 1, and Live 2. **We strongly suggest consulting a professional or licensed electrician to perform the power connections.** For more information, please refer to the “AC Power” section below.



AC POWER

For power connection, a licensed electrician should be consulted to meet and comply with the local electrical codes and requirements. Proper electrical power handling and knowledge are crucial for both safety and thorough application of the equipment.

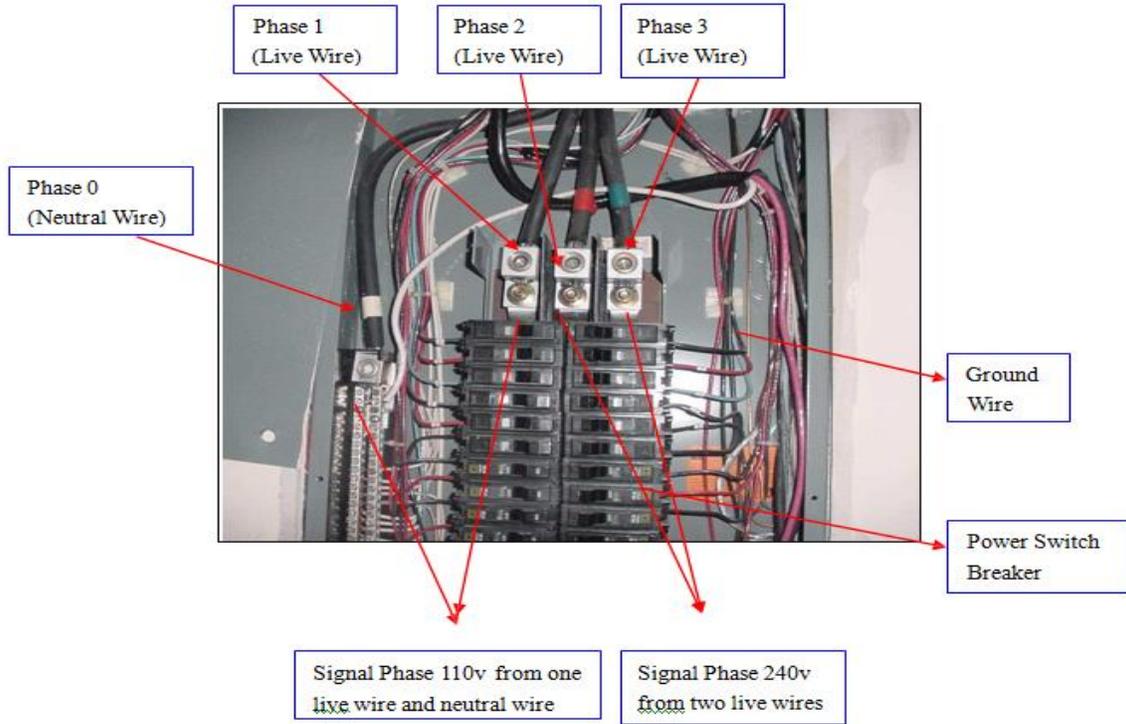
 **Attention:**

For countries that use 220V, the furnace's power supply is already configured to work with this input voltage. However, in countries that use 110V, a 208~240V single phase AC power line needs to be setup.

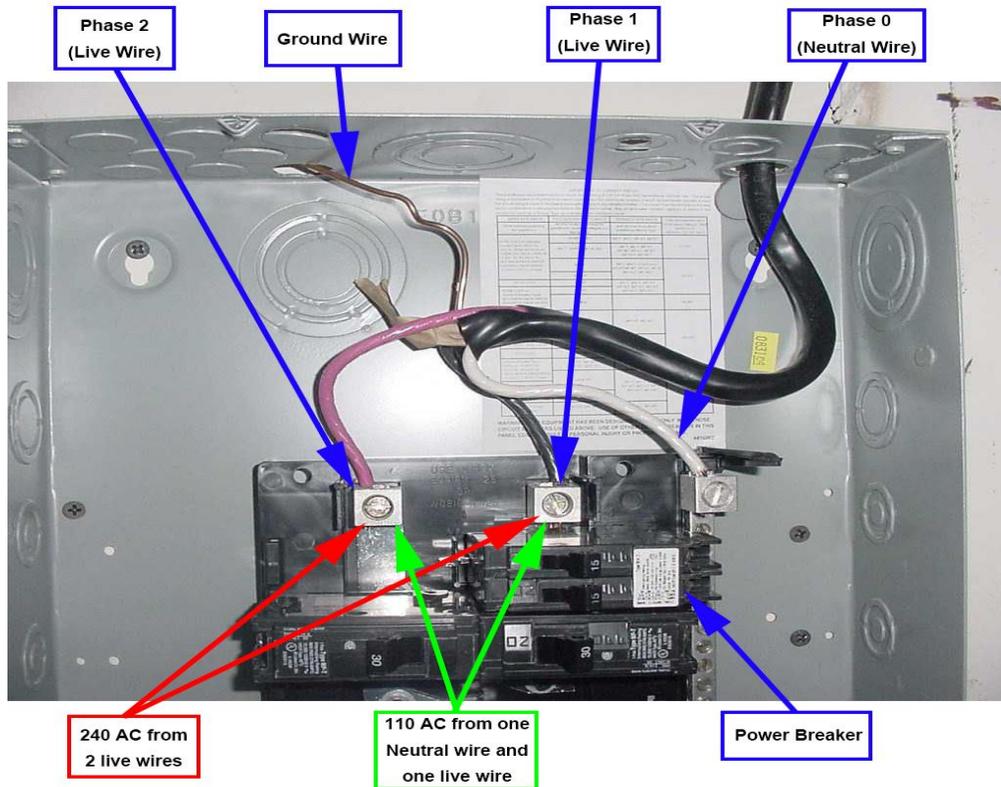
The following knowledge may be useful for configuring a single phase 208~240V power line from various electrical panels. A three phase 240V AC electrical panel generally found in most laboratories can be configured to output a single phase 208~240V power line. To do this, two of the three live wires from the panel need to be configured with the neutral wire. Please refer to the illustrations below to get an idea of the connections for the three phase and as well as the single phase 208~240V AC.

 **Attention:**

MTI Corporation will not be responsible for any equipment or property damage that results from improper or incorrect power connections.



Typical Three Phases AC Power in US



Typical Single Phase AC Power In US

THERMOCOUPLE INSTALLATION

The thermocouple has been tested on the furnace to ensure proper function prior to shipping. However, some furnaces have special thermocouples that had to be removed prior to shipping to protect against damage. If your furnace does not come with the thermocouple already being installed, please use the following instructions to install it.

- Insert the thermocouple (ceramic tube) from the backside of the furnace and make sure that the tip of the thermocouple is fully protruded in the chamber for accurate temperature readings.

 **Attention:**

A clearance of 1mm (millimeter) between tip of the thermocouple and the tube surface should be given to prevent damage to the thermocouple.

- Tighten screw to fix the thermocouple in position.
- Connect the wires coming out from the furnace to the terminals on the thermocouple block according to the labels and markings. It is very important that the positive and negative polarities are connected correctly or else the thermocouple will not work. Please refer to pictures C and D for more details.

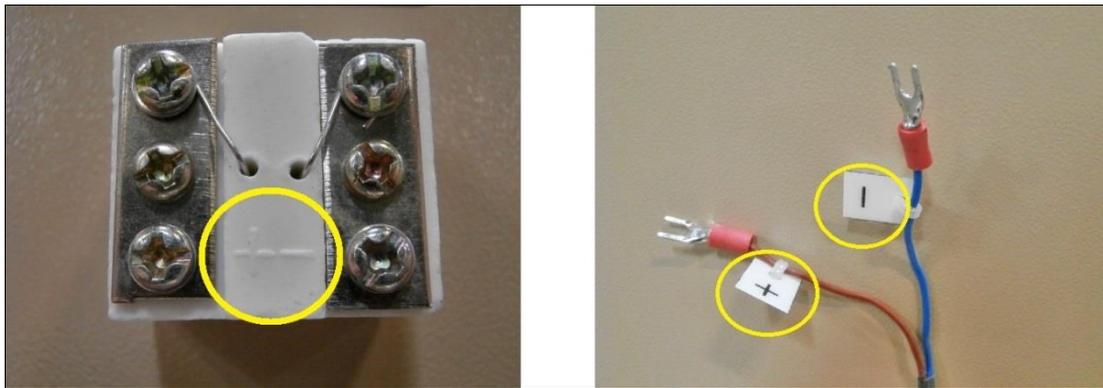


Figure C

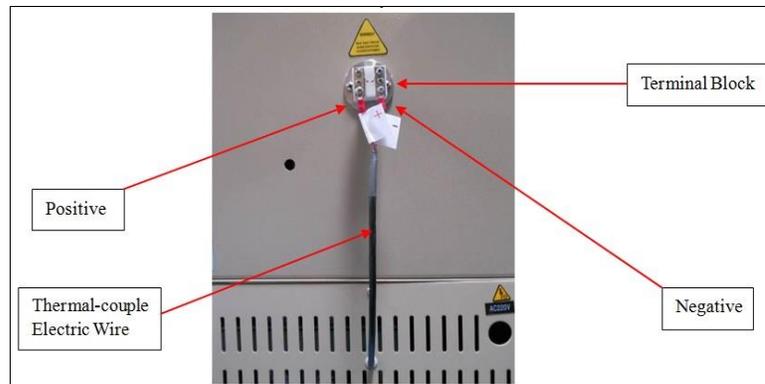


Figure D

 **Attention:**

Once the furnace setup is finished, we strongly recommend reading the handbook and follow the instructions listed in the “HEATING PROFILE SETTING EXAMPLE” section to perform a quick test and check the heating condition of the furnace.

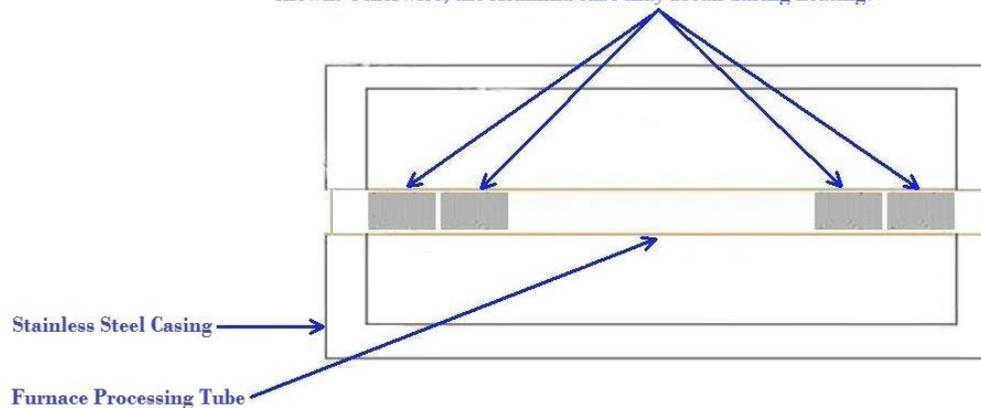
GENERAL OPERATION

If the furnace is being used for the first time (or use again after a long period of inactivity), please pre-heat the furnace to 300°C for at least 2 hours for removing moisture inside the chamber to prevent cracking of the furnace refractory ceramics.

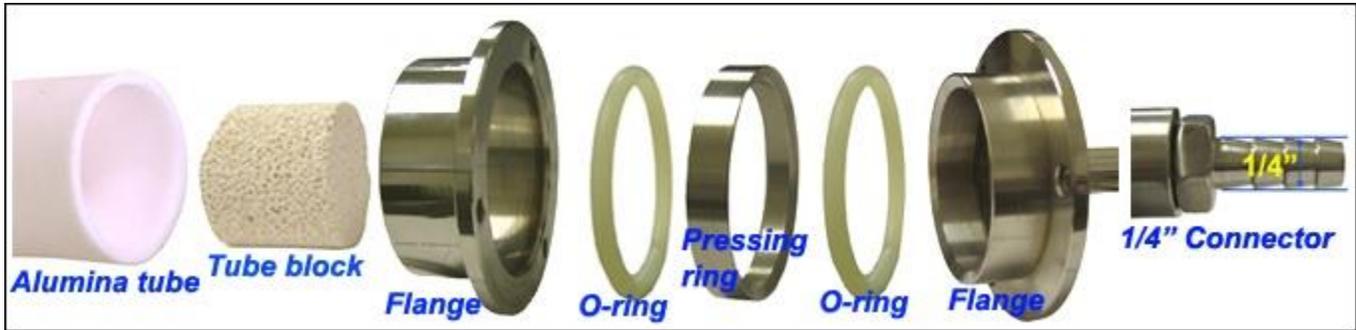
Properly setting up the tube and vacuum flanges prior to heating will ensure the furnace to work under the most ideal conditions. This will insulate the heat from the flanges while simultaneously preventing the dissipation of heat from the furnace chamber. The insulation of heat stabilizes the heating zone which in turn expends less energy and places less wear on the heating elements.

- Place the test sample inside the tube chamber (crucibles or boats may be used as material containers, please visit: <http://www.mtixtl.com/ceramiccrucibles.aspx>) to order.
- Before operating the furnace, thermal insulation blocks must be placed inside the tube chamber at the positions below (note the position of block placements).

NOTE: 4 porous refractory tube blocks must be inserted into both ends of the tube at the positions shown. Otherwise, the Alumina tube may break during heating.



- Install the vacuum sealing flanges on each side of the tube using the picture below as reference. Seal the flanges by tightening the screws to finish the assembly.



- Limit the pressure regulator attached to the gas tank to below 1.1 atm before filling the tube with gas. Keep the vacuum valve(s) open during gas filling to avoid high pressure from building up inside tube.
- When the installation is finished, please do a test for gas leaks to check if the sealing parts were assembled well.
- If your system has a big gas leaking rate, you may locate the leaking part(s) by using soap suds and apply vacuum grease on the part(s):



- Please order it at:
<http://www.mtixtl.com/highvacuumsiliconegreaseforsealingloveboxeq-gb-vg.aspx>

 **WARNING:**

- Tube furnaces are designed to be used under vacuum with low pressure gases. **NEVER** inject gas into the tube with pressure higher than 1.1 atm. Pressure build up inside the tube may cause the flange(s) to be catapulted which may cause injury or death.
- Use of vacuum on alumina tubes at temperatures over 1500 °C is strictly prohibited as the tube materials will become too soft to withstand vacuum.
- Also, do not pour any liquid or molten substances into the tube to keep its interiors clean.
- After an inspection has been performed to make sure there are no gas leaks, power on the instrument by turning the “**Power Lock**” to the right and the temperature control LCD will start to blink.
- Press the “**Turn On**” button and a “clunk” sound should be heard. This switch activates the relay switch inside the furnace to establish power connection to the heating elements. If the sound is not heard, please do not proceed with operating the furnace. The furnace must be powered down and get inspected.
- Please refer to the “TEMPERATURE CONTROL INSTRUCTIONS” sections to learn how to setup and run the heating profile.

⚠ Attention:

A small to medium heating rate with a small temperature difference between the adjacent segments should be set when the furnace is being heated up from room temperature. Please take the characteristics of the material being sintered into consideration when setting the heating rate.

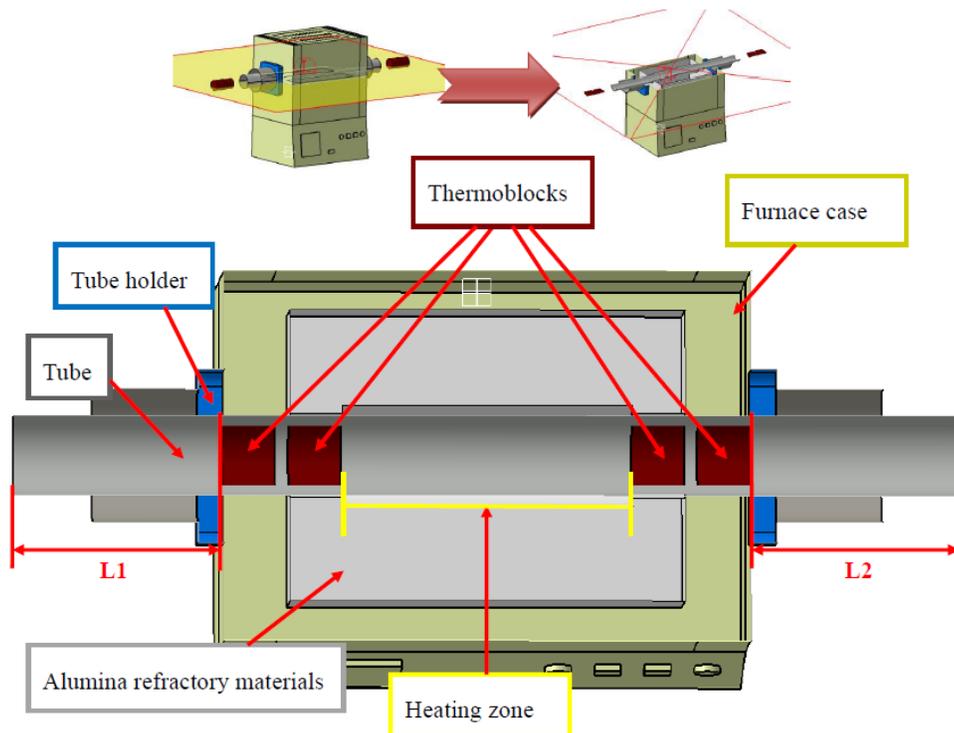
Also, please avoid using rapid heating and cooling rates as doing so will render shock and damage to the heating elements. Using the heating or cooling rates listed in the specifications is recommended.

⚠ WARNING:

- The Alumina Tube could be subjected to thermal shock and crack when the furnace is heated to high temperatures. Furnace casing and other surrounding parts will also be tarnished as a result of the tube crack.



- For minimizing the possibilities of the phenomenon above, **TWO** tube blocks must be used and placed on each side of the tube at the positions depicted below:



1. Two tube blocks are required on each side of the tube. Before inserting the blocks, please measure 'L1' and 'L2' and make sure they are of equal length. This will keep the processing tube centered in the furnace.
2. When placing the tube blocks, make sure the insertion depths (distance between the edge of the tube and outside edge of the outer tube block) on both sides equal to L1 or L2.

VACUUM AND GAS FLOW SYSTEMS

When used in conjunction with vacuum pumps, vacuum furnaces can heat samples with a cleaner environment that greatly reduces oxidation and contamination of materials or samples.

The flanges on MTI furnaces can be readily configured to accept various fittings for vacuum pump connections. Typically, connection to the pump is made by securing stainless steel bellows to either side of the flange by quick locking clamps. For medium vacuum ($25\sim 10^{-3}$ Torr), the **EQ-YTP550** vacuum pump is an ideal option. Turbo-molecular pumps such as the **EQ-PV-HVS** or **EQ-MT-HVS** are ideal for achieving high vacuum levels ($10^{-3}\sim 10^{-5}$ Torr).

Gas mixing/ delivery systems allow for mixing of various reactive gases for inducing chemical reactions as well delivering inert gases into the chamber for sample treatment. For making the connections to these systems, the flanges regularly come standard with barbed hose fittings to accept gas tubes bridging the gas source and furnace. Moreover, this fitting can easily be removed and re-configured to more secured gas connections or for adding gas flow meters to monitor gas flow rates.

All of the components mentioned above can be found at the *Furnace Accessories* section below:

<http://mtixtl.com/furnaceaccessories.aspx>

WARNING:

- For safety concerns, never charge any noxious, explosive or flammable gas into ceramic tubes. Please remember that pressures > 0.12 Mpa (absolute pressure value) inside the tube chamber are strictly forbidden at high temperatures when using quartz or corundum tubes.

SAMPLE LOADING / UNLOADING PROCEDURES

Loading/unloading materials:

- 1) Place the unprocessed materials in a container such as: alumina crucible, quartz boat or other containers at <http://www.mtixtl.com/ceramiccrucibles.aspx>
- 2) Then push the container to the middle of the tube before heating up the furnace.
- 3) Turn on the water chiller to provide cooling to the flanges.
- 4) Turn on any vacuum pump and gas mixer (if necessary) at this point.
- 5) Once the heating is finished, use a hook to pull out the container and the processed materials.

TEMPERATURE CONTROL INSTRUCTIONS

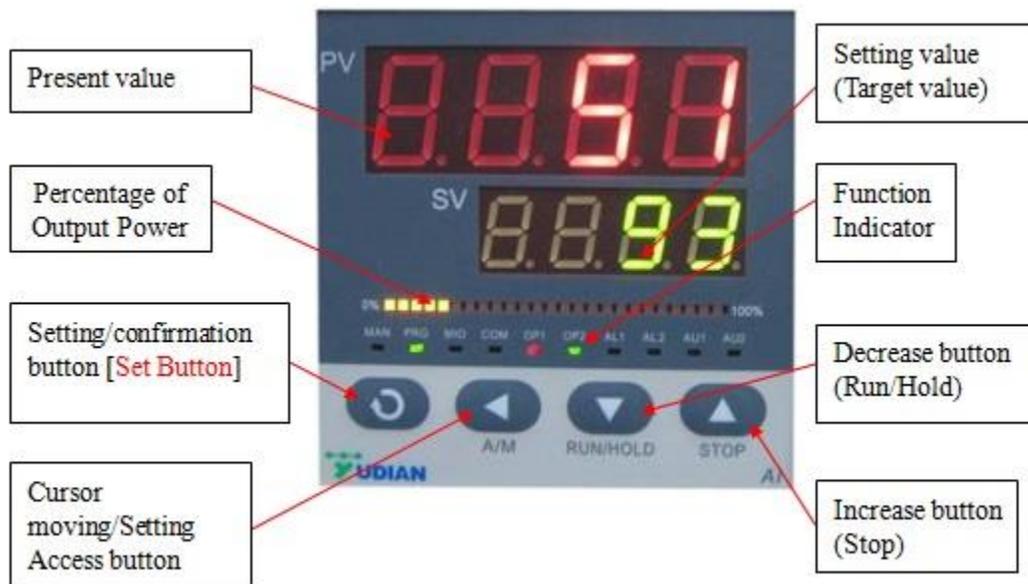
TEMPERATURE CONTROLLER

1. Specification

- Compatible Thermocouple: K, S, R, E, J, T, N;
- Measurement Accuracy: 0.3;
- Power Input: Single phase 220V AC ($\pm 10\%$) / 50~60Hz;
- Power: $\leq 5W$;
- 30 Programmable Segments.

f. MET Certified 

2. Structure



SETTING THE TEMPERATURE CONTROLLER

Start Up State

When starting the device, the meter type and program version will display for a few seconds, and then enter the normal state. Blinking "stop" indicates the program is in "normal state".

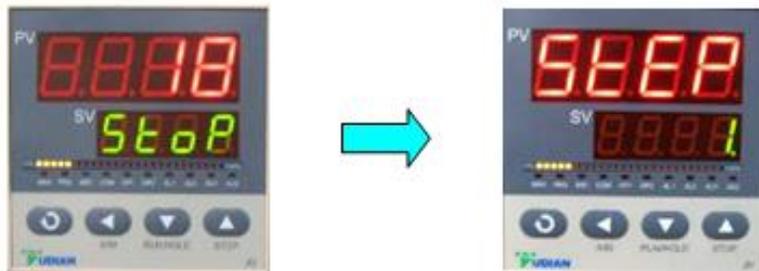


Meter type & Program version

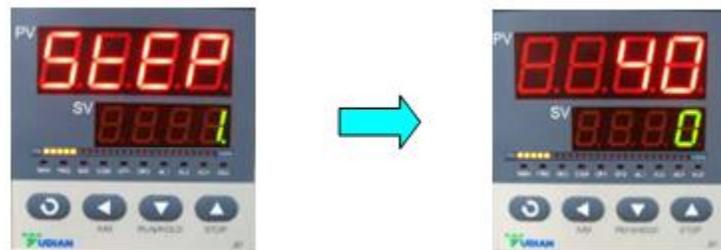
Normal state

Displaying Switch

- a. In the “normal state” or “program running state”, press “SET” key (Button 2) for 1 second to switch to “executing program segment” (Set executing segment or display the ongoing temperature segment).



- b. Press “SET” key (Button 2) again for 1 second to switch to “running time state” (Display the total running time PV xxxx min. and the elapsed time SV xxxx min.)
- c. Press “SET” key again (Button 2) for 1 second to go back to “normal state”.

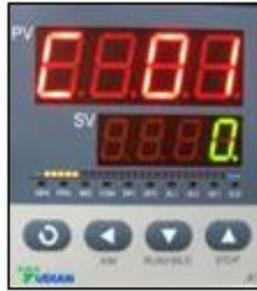


HEATING PROFILE SETTING EXAMPLE

LTDE programmable smart instrumentation auto-controller allows you to set the temperature profile up to 30 segments. To process this function, follow these steps:

- Power on the furnace, blinking “STOP” on the SV window indicates the Normal State;

- Press “←” once to display “C01” on PV window;
- Set initial temperature to 0 °C by using Keystrokes :“←”, “↑” or “↓” ;



- Press “Set” to display “t01” on PV window;



- Set heat-up time (Usually beyond 30 minutes for this segment in case of temperature overshooting) from initial temperature to target temperature by using Keystrokes :“←”, “↑” or “↓” ;
- Press “Set” to display “C02” on PV window; Set the actual working temperature for the second segment by using Keystrokes :“←”, “↑” or “↓” ;



- Press “Set” to display “t02” on PV window; Set heat-up time from initial temperature to target temperature by using Keystrokes :“←”, “↑” or “↓”;
- By pressing “Set”, you can get into the following segments (C03&t03;C04&t04;C05&t05...) for temperature and time setting;
- Press “Set” to display “Cxx” on PV window (xx could be any values among 01~30);
- Press“←”, “↑” or “↓” to set “-121” in the last segment in order to shut down the furnace;

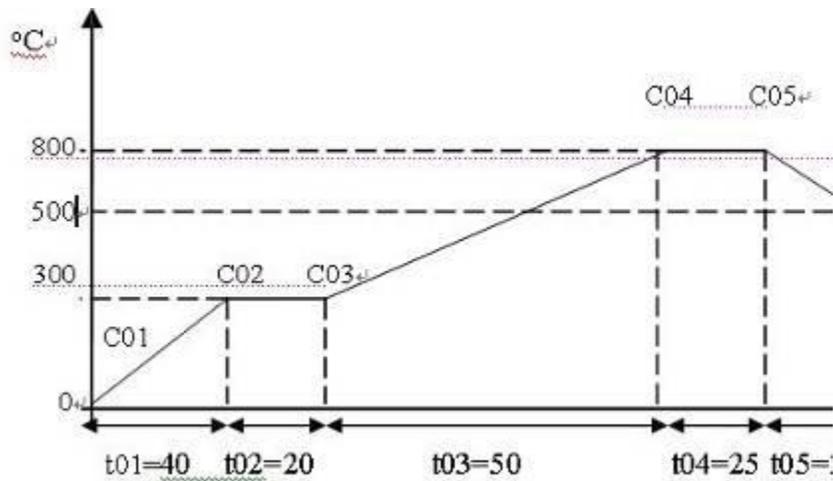


⚠ Attention:

When finish all the segments you need, please end the last segment with -121

ILLUSTRATION OF HEATING PROFILE SETTING

Setting Example: Temperature Control Program with 6-segments



According to figure I above, all segments were recorded in the following:

Prompt	Input Data	Description
C01	0	Initial Temperature
T01	40	Heat-up time 40 minutes from 0-300 °C in the first segment
C02	300	Target temperature of the first heat-up stage
T02	20	Keep 20 minutes at 300 °C in the second segment
C03	300	Target temperature of the third stage
T03	50	Heat-up time 50 minutes from 300-800°C in the third segment
C04	800	Target temperature of the fourth stage

T04	25	Keep 25 minutes at 800°C in the fourth segment
C05	800	Target temperature of the fifth cooling stage
T05	60	Cooling time 60 minutes from 800-500°C
C06	500	Beginning temperature of the sixth stage
T06	-121	Program end, Out-put power off. Furnace cooling down naturally. (t06 = -121 is an order to stop running)

RUNNING THE PROGRAM

- When all the data is input into the temperature program, press both “Set” and “←” together, and “STOP” will show on SV window again as indication of entering “Normal State”. Then press “↓” and hold for two seconds to display “Run” on SV window;



- Furnace will run segment by segment automatically according to the program setting;
- PV window displays present temperature inside the chamber;

HOLDING THE PROGRAM

- If you need to hold the furnace at certain temperature **when the program is running**, press “↓” for 2 sec to hold the program and press it again to continue.
- You can stop the program either from the running or holding states by pressing “↑” for 2 seconds.

Attention:

It is not suggested to modify any parameters during the execution if the operator is not familiar with the furnace operations. If it is absolutely necessary, please first stop the program first and then do the modification.

STOPPING THE PROGRAM/ FURNACE SHUT DOWN

- Push key “↑” to make sure the controller is at its “STOP “ state
- Touch Red “ Turn-Off” butto to shut down furnace power
- Turn lock to close position to cut off power to control panel
- If possible, close power switch from cable

TEMPERATURE CONTROLLER PARAMETERS

Introduction of Main Parameters

Parameter Name	Parameter Function	Setting Range	Unit
M5	Maintain parameter	1 – 9999	° C or definable unit
P	Speed	1 – 9999	
t	Delay time	1 – 2000	second
Ctrl	Control type	2, 3	
LOC	Parameter lock	0 or 808	

 **Attention:**

Whenever you want to change the parameters referred below, please firstly change the value of parameter “Loc” to “808” in order to unlock the parameter settings.



FUNCTIONS OF MAIN PARAMETERS

Maintain parameter M5:

Like integral time of PID calibration, this parameter is mainly in charge of the integral work during the adjustment process. For instance, the smaller the M5 is set, the stronger the system integral effect is, vice versa. When M5=0, the system will cancel integral and intelligent adjustment, leave only proportion and differential (PD) function.



Speed parameter P:

Parameter P has nothing to do with integral function. The bigger the P value is, the stronger the proportion and differential function are, vice versa.



Delay time t:

It is defined as the time spent when the heating rate reaches to 63.5% of the maximum value with assumption that there is no heat dissipation. Remember, this parameter affects the three functions such as integral, proportion and differential, the smaller t is, the stronger proportion and integral function are but weaker differential, after all, the system feedback is promoted, vice versa. If $t \leq 1$, the differential function will be off.



Control type CtrlL:

(Do follow the default setting, or the system may be unable to work)

When CtrlL=2, startup auto-tune function, after that, system will go to 3.

When CtrlL=3, adopts advanced AI adjustment. After auto-tune, the system goes to this setting mode. Note that in this mode, you cannot startup auto-tune function from the panel by holding button, for a protection of repeating auto-tune.



Parameters lock LOC:

Please set LOC to “808” in order to unlock the parameter settings. Otherwise, please keep it as default: “0”.



PARAMETER SETTING

- In the “normal state”, press “SET” key for 2 seconds, you will see parameter “M5” pops up and press “←”, “↑” or “↓” to modify the parameter.
- Press “SET” key for 1 second to go to next parameter and press “←” for 2 seconds to back to preceding parameter.
- Press “←” and then press “SET” key to back up to “normal state”. Without any operation on the keys for about 30 minutes, the meter will automatically exit from “parameter setting state”.

AUTO - TUNE

In order to obtain precise temperature control, customers should pay more attention to the parameters of M5, P and t. Actually, MTI’s engineers have already made a strict high temperature pre-heating test (rate: 5°C/min) and fine-tuned on these three parameters according to each furnace’ condition before shipping it out. Therefore, we have a confidence of satisfying over 95% customers.

However, the diversity of environment and the distinction in manufacturing for each customer, may seriously affect the operation, so, using auto-tune function to decide these parameters for a perfect result **when the temperature is not stable and the error is large**:

- Run the program and wait until the furnace temperature reaches to 80% of your desired temperature. For example, if your desired target temperature was set to 800C, the Auto-tune should be started when the chamber temperature reaches 640C
- Press and hold the “SET” key for 2 seconds to enter the parameter setting menu
- Press the “SET” key repeatedly until “Ctrl” appears on the PV screen
- Set the “Ctrl” to 2 and then press “←” and “SET” key simultaneously to switch back to “Running State”

- You will see the SV screen flashes with “AT”, which indicates that the controller has entered the “auto-tune state”. Then, system begins to oscillate 2-3 times and the controller automatically analyzes the furnace’s heating behavior and yields the optimal parameters of M5, P and t.
- Press and hold “←” for 2 seconds to stop Auto-tune at any time you need
- Due to different temperature, the time spent for “auto-tune” may vary

Note: the parameter ‘Ctrl’ will be set as 3 by the system after “auto-tune”. So, if customer needs more “auto-tune” operation for the furnace, please reset the ‘Ctrl’ to 2.

MANUAL - TUNE

- Short oscillating period, you can decrease P (priority), increase M5 and t.
- Long oscillating period, you can increase P (priority) as well as M5 and t.
- No oscillating but offset is large, decrease M5 (priority), increase P.
- Stable controlling but time-consume is too long, decrease t (priority) as well as M5, increase P.

Increase (or decrease) one of the three parameters by 30%-50%, if the controlling becomes better, continue increasing (or decreasing), otherwise, decrease (or increase) it till get the qualified adjustment. Commonly, M5 poses a priority, if not enough, try P and t.

EQUIPMENT MAINTENANCE & TROUBLESHOOTING

MAINTENANCE AND EQUIPMENT CARE

- If the furnace is being used for the first time (or use again after a long period of inactivity), please pre-heat the furnace to 300 °C for at least 2 hours for removing moisture inside the chamber to prevent cracking of the furnace refractory ceramics. Do not pour any liquid or molten substances onto the furnace heating chamber to keep it clean.
- A small to medium heating rate with a small temperature difference between the adjacent segments should be set when the furnace is being heated up from room temperature. Please take the characteristics of the material being sintered into consideration when setting the heating rate.
- Avoid using rapid heating and cooling rates as doing so will render shock and damage to the heating elements. A 10 °C/min heating or cooling rate is suggested.
- Please refer to parameters “M5, P and t” if the temperature offset cannot be eliminated and the difference between PV and SV increases at 300 °C.
- When powering the furnace on, do not continue to operate if you cannot hear the sound from cooling fans. Shut down the furnace and check or replace the cooling fans.
- While furnace is running, please do not touch furnace to avoid burns from high temperature.
- Do not open the furnace when it is being heated above 300 °C to prevent its insulation materials from cracking.
- MTI furnaces are only suitable for using with air or inert gas environments. Other flammable or toxic gases, such as H₂, Cl₂ and SO₂, will cause damage to the heating elements. Customer should use them at their own risk.
- If the vacuum performance starts to decline drastically, please replace the silicon rubber O-rings inside the flanges and then reassemble the flanges and the vacuum system.
- Please always keep inside chamber clean to avoid contamination to your sample. Furnace must be used in an environment without vibration and conductible dust, explosive, flammable and corrosive gases.
- Please check heating elements for every three months to see if they are in good connection. If connection gets loose, please open case and tighten them properly.
- Ceramic tubes made of Al₂O₃ need to be handled with care. Do NOT rapidly heat up or cool down the tube furnace from a temperature range of 800 - 1000 °C. Doing so may cause the ceramic tube (not covered by warranty) to crack. The suggested heating or cooling rate is 5 °C / min.

CERAMIC TUBE REPLACEMENT

- 1) Remove the tube from the furnace after disassembling the vacuum sealing flanges from the tube (refer to Fig. 20).
- 2) Carefully insert a new ceramic tube into furnace while keeping the tube straight to avoid breaking heating elements inside the furnace.
- 3) Keep equal lengths on both ends of the ceramic tube protruding out of the furnace casing. The ceramic tube should be able to be rotated by hand after insertion; otherwise, the ceramic tube may crack during heating due to lack of clearance for thermal expansion.
- 4) Install the vacuum sealing flanges back onto the tube using the following procedures (refer to Fig. 20 again if necessary).
 - i. Put the Tighten Cover though the tube and let tube be exposed a little.
 - ii. Put Sealing Gasket 1 in, then the Press ring, and Sealing Gasket 2 thereafter.
 - iii. Seal the tube with the Sealing Cover and tighten the Hexangular Screws.
 - iv. Follow the same steps above to install the vacuum sealing flange on the other side of the tube.

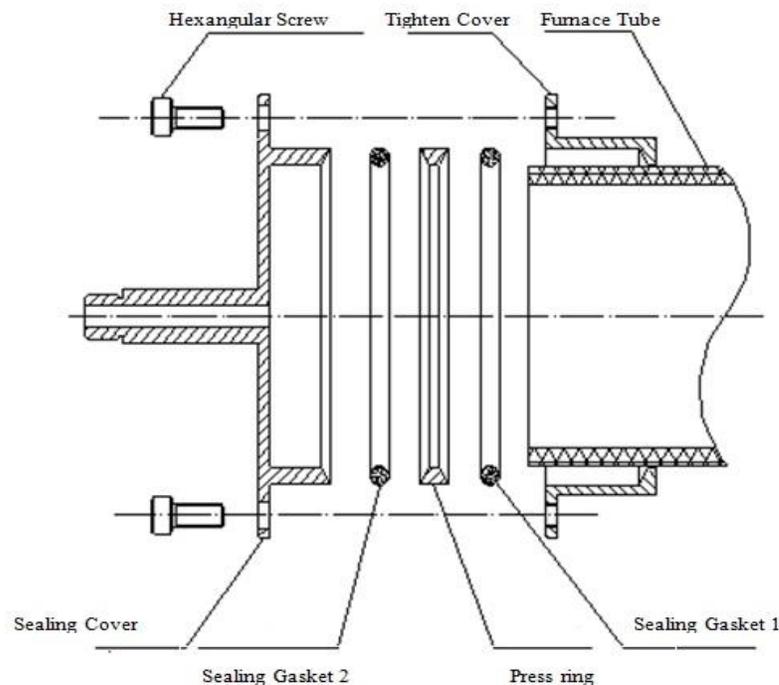


Fig. 20

 **WARNING:**

The air sealing must be inspected by vacuum or filled inert gas before running the furnace again.

HEATING ELEMENTS REPLACEMENT

- 1) Remove the 4 screws on top of furnace, and then open the cover as shown in Fig. 1
- 2) Take off the screws on the clips for heating elements as shown in Fig. 2
- 3) Disassemble the aluminum plates connecting the heating elements as shown in Fig. 3



Fig. 1



Fig. 2



Fig. 3

- 4) Unfasten the screws on the metal clips used for fixing the ceramic blocks as shown in Fig. 4
- 5) Remove the ceramic block between rods of U type heating elements as shown in Fig. 5
- 6) Take out the U type heating elements that need to be replaced as shown in Fig. 6
- 7) Insert a new heating element together with the ceramic block positioned in between the heating rods as shown in Fig. 7



Fig. 4



Fig. 5



Fig. 6



Fig. 7

- 8) When tighten the screw of metal clip for heating element, please make sure the bottom of the U heating element does not touch the bottom of furnace chamber. Usually the bottom of the U element shall rise 5 mm high from the bottom of furnace chamber
- 9) Then, follow the procedure 4, 3, 2, 1 to tighten the screws and finish the exchange of heating elements

Attention:

Heating elements are brittle and need to be handled with care at all times.

To avoid breaking, do NOT over-tighten the aluminum connecting plates between the rods of heating elements. However, a loose connection could cause a higher contact resistivity and increase the temperature on the top of furnace dramatically.

If the temperature on top of furnace is too high during heating, please shut down the power and remove the cover to further tighten the screws between heating element rods and aluminum plates.

TROUBLESHOOTING FOR TYPICAL PROBLEMS

Problems	Reason	Solution
Open Power Lock, no power indication	Fuse (4A) in control panel is broken	Check control panel, and replace fuse
Green Power indicator is off, but Red open circuit indicator is On	Fuse in main power circuit is broken	Open the cover of front panel and replace the fuse
No current shows in meter, but has Max. Voltage	Broken Heating Element(s)	Find broken heating rod, and replace it
Controller display panel SV shows “ OraL”	Thermal Couples broken	Replace Thermal couples (B type)
Controller display panel SV shows “ HI AL”	Furnace temperature > 1750°C, Protection from Alarm	Cool furnace down, and find reason why temperature is so high (program setting may be wrong)
Power and heating element are OK, but furnace cannot be controlled by program.	Controller or related circuit may be damaged	Check controller. If not, please inform manufacturer to check what the real problem is
Program running, but furnace cannot be heated, or real temperature is far behind the setting value	oPL or oPH value is too low due to lower local voltage or frequency difference	Increase oPL and oPH value till current meter shows “0 and 100” respectively
During heating below 300°C, the temperature value (PV) is not stable, and does not match with setting program (SV)	It is normal because the furnace comes with a high temperature thermocouple, which is not sensitive at temperature below 300°C.	Let the furnace heat to 300°C, then thermocouple will function stably with program. If the PV value at 300°C is still less than that of SV, you may need to increase OPL value a little.

TROUBLESHOOTING RESOURCES

- Visit MTI web site link: WWW.MTIXTL.COM for additional information about the instrument through Help and Support
- Contact us by Tel: 510-525-3070 or email: info@mtixtl.com