



Innovative Furnace Technologies

PRODUCT SPECIFICATION

CONTROLLED ATMOSPHERE FURNACE

MODEL: CU 610 H

Specification Number: 201831

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FURNACE

This document specifies the performance and configuration of the CU-series hydrogen furnace.

The furnace system is designed for annealing and brazing operations, thick film and other specialty processes that require precise thermal management in a controlled atmosphere. This series is designed for operation with nitrogen only as well as introduction of hydrogen into each of the furnace infrared heating zones. The nitrogen/hydrogen mixing console allows the user to independently control nitrogen and hydrogen flows to each zone. The sophisticated furnace software receives information from combustible gas detectors, oxygen analyzer and pressure switches; and controls ignitors, sample system ports, warmup, processing and shutdown actions for safe, reliable, and repeatable operation.

1. Furnace Capabilities

- 1.1 The furnace can perform thermal processes requiring a control atmosphere with nitrogen. The maximum temperature of the furnace is 1000°C.
- 1.2 The system operation is left to right as viewed from operator control panel and is clean compatible to class 1000.
- 1.3 Peak Energy and Gas Consumption

Power: 46 Kw
Process Gas: 2600 SCFH Nitrogen
Process Gas: 400 SCFH Hydrogen

2. Mechanical Specification

2.1 Overall Size:

Length: 225 inches
Width: 50 inches
Height: 70 inches
Approximate Weight: TBD

2.2 Transport Specification

Conveyor Width: 10 inches
Conveyor Belt Material: Nichrom V. Compound Balanced Weave
Product Clearance: 4 inch maximum above belt level
Nominal Speed Range: .5 to 10 In/min

3. Furnace Configuration

Furnace Section

Load Station	381 mm	15"
Entrance Baffle	762 mm	30"
Heated Length	1524 mm	60"
Transition Tunnel	762 mm	30"
Cooling Length	1524 mm	60"
Exit Baffle	381 mm	15"
Unload Station	381 mm	15"

4. FURNACE PROCESS SECTIONS:

4.1 The furnace sections reside in a Stainless chamber shell lined with 2" ceramic insulation top, bottom and side for improved thermal efficiency and reduced cabinet temperatures. To insure very good cross belt uniformity, the heated length of IR Lamps overlaps the belt .5" both ends to leave the belt within the uniform radiation field of the elements.

Process gas is introduced thru the zone dividers (Top / Bottom). The gas then passes through the divider where it is heated and enters the process zones at near zone temperature. The control atmosphere within the furnace system the cover gas is nitrogen with the option of Hydrogen. To prevent particles from contaminating the product we provide three exhaust systems, one at the entrance end, and a second one at the transition tunnel after the last heating zone, and the third at the exit end after the water-cooled section. Most of the gas is exhausted at the entrance end, using a dual eduction system to insure good scavenging of contaminants. A small amount of gas is also drawn out the transition tunnel and exit end via a dual exhaust system to keep the front zones free of firing zone contaminants as well.

4.2 Heating is accomplished by IR Lamps located above and below the belt.

Additionally, the entrance, transition & exit baffle trays are located above the chamber for ease of maintenance.

4.3 Cooling is accomplished by a closed atmosphere water-cooled tunnel.

A water cooled heat exchanger surrounds sides, top and bottom of the product to help remove heat mostly carried by the belt. Water flowing through four independently controllable circuits in the heat exchanger removes heat to customer re-circulating chiller system (by others, recommended) or to facility drain. To enhance the water cooling, flow meter controlled process gas (N2) is injected through gas curtains to create stable forced boundary layer cooling flow across both top and bottom of the product. Process gas used for cooling is collected at the exit end of the cooling section and is exhausted through the exit exhaust stack to facility exhaust duct work (by others).

Water Requirements

- Water: 15 - 20°C Inlet water temperature recommended
- Flow: 4 GPM
- Pressure: 60 psi (maximum)

Cooling length is 60 inches long with 2 heat exchangers, one on top and one bottom, including two water flow meters for final adjustment (cooling rate). For controlling the atmosphere for cooling, we provide two flow meters, one top and one for bottom.

4.4 The Furnace chambers are divided into zones as follows:

Module	Length
Entrance Baffle	30"
Zone 1	10"
Zone 2	20"
Zone 3	20"
Zone 4	10"
Transition Tunnel	30"
Cooling	60"
Exit Baffle	15"

5. ELECTRICAL SPECIFICATIONS

5.1 Input Service: 480 Volts, 3 Phases, 60 Hz.

5.2 Peak Instantaneous Power Consumption 46 KW

The electrical system as manufactured by TPS will meet the following U.S Electrical codes:

NFPA 70 – 2008 “The National Electrical Code”
 UL-508 “Industrial Control Equipment”
 NFPA 79 – 2008 “Electrical Standard for Industrial Machinery”
 CE compliance to machinery directive:
 Annex 1. 89/392/EEC and Safety of machinery
 Electrical Equipment of Machines; Part 1-EN60204-1
 SEMI S2-93

6. CONTROL ATMOSPHERE REQUIREMENTS:

Atmosphere control is accomplished with the following flow meters:

FLOW METER	Range	Units
<u>Nitrogen Flow Meters</u>		
Entrance Exhaust	0-100	SCFH
Entrance Baffle	0-200	SCFH
Zone 1	0-200	SCFH
Zone 2	0-200	SCFH
Zones 3	0-200	SCFH
Zones 4	0-200	SCFH
Transition Tunnel	0-400	SCFH
Transition Exhaust	0-100	SCFH
Cooling Top	0-200	SCFH
Cooling Bottom	0-200	SCFH
Plenums	0-200	SCFH
Exit Baffle	0-200	SCFH
Exit Exhaust	0-200	SCFH

Hydrogen Flow Meters

Zone 1	0-100	SCFH
Zone 2	0-100	SCFH
Zone 3	0-100	SCFH
Zone 4	0-100	SCFH

Water Flow Meters

Cooling 1 Top	2	GPM
Cooling 2 Bottom	2	GPM

7 The Hydrogen Gas Panel will allow the furnace to run H₂, at user's option, by adjusting. H₂ and N₂ gas in Zones 1 – 4. To operate in this mode, first adjust flow meters (Nitrogen) if necessary to control the atmosphere and balance the furnace zones. Once system is stable (low ppm) the software will allow the hydrogen into the zones, the operator can start adjusting flow rate of Hydrogen into the zones.

7.1 The following safety precautions will be added to the furnace:

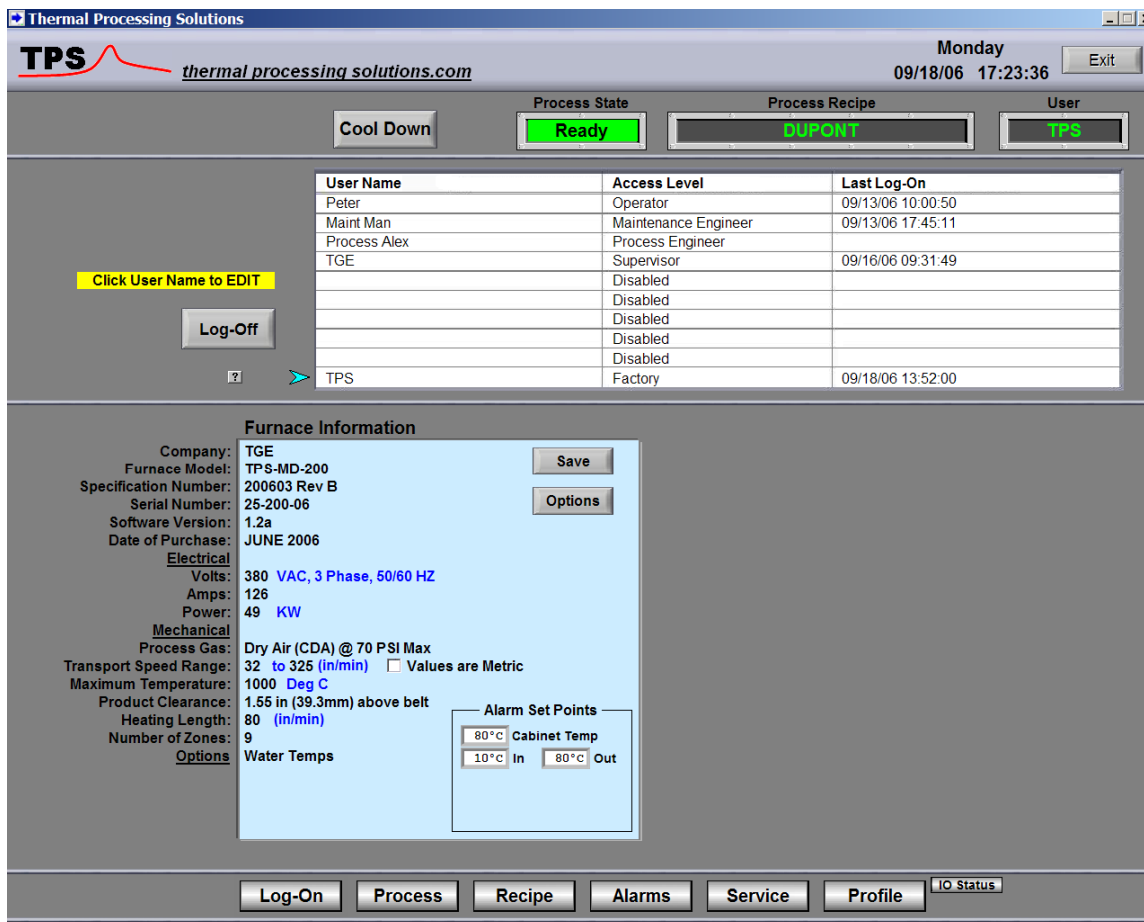
- a) Sealing clamps will be added to outside of heating chamber to prevent H₂ escaping into room during operation. These clamps may be loosened to allow full access to heated furnace interior during maintenance using the Motorized Chamber Lift system.
- b) Igniters shall be installed on all exhaust stacks.

- c) Combustible gas detectors shall be installed on all at-risk points.
- d) A gas collector shall be installed at the entrance opening of the furnace above the belt.
- e) Furnace software limits hydrogen operation until all safety and process provisions are met.

7.2 Oxygen Analyzer: An O₂ analyzer and on-line 4-port gas sampling system will be provided and integrated with the control system. Using the furnace HMI, user can select a port to allow the O₂ analyzer to monitor O₂ levels in Zone 1, Zone 3, and Zone 4 & Source. Levels out of tolerance will display visual warning and sound audible alarm on HMI screen of furnace and log warning to the event file on hard drive, so that situation can be remedied.

7. CONTROLS:

7.1 The TPS furnace is controlled by a 32 bit, industrial controller (PLC) that uses an Industrial rack mount PC for user interface.



Log-On Screen

Security is provided by passwords allowing different users levels of access and Control rights. For communication the system uses an Ethernet link between the PC, Controller and I/O points. All inputs and outputs are optically isolated to insure stable, noise free data transfers. All operational software, recipes and profiles are stored on the hard drive. A removable hard drive is also provided for back up. For troubleshooting we provided two methods: Via modem and via Internet. We are able to connect to the furnace remotely by one of these protocols for factory diagnostic support.

7.2 Conveyor speed is regulated by a closed loop, stand alone motor speed controller which accepts commands from the interface. (PC)

Description	1	2	3	4	5	6	7	8	9
High Alarm	320	320	320	600	440	420	20	1010	1010
High Alert	310	310	310	590	430	410	10	1000	1000
SetPoint (°C)	300	300	300	580	420	400	0	990	990
Low Alert	290	290	290	570	410	390	-10	980	980
Low Alarm	280	280	280	560	400	380	-20	970	970
Top Power %	50	50	50	60	50	50	50	67	73
Bottom Power %	0	0	0	0	0	0	0	55	70
P	10	10	10	10	10	10	10	10	10
I	12	12	12	10	10	10	10	12	20
D	0	0	0	0	0	0	0	0	0

Recipe Screen

7.3 The controller (PLC) accomplishes temperature control via closed loop PID control; Zone temperature set points are established by one of two methods that you have the option to choose as follows:

- 1) CLOSED LOOP CONTROL BY TEMPERATURE SETTING: User may set temperature, maximum power and PID settings throughout the zones of the furnace. Type K thermocouples are used to measure the temperature of the zones. Actual power being output to the lamps is displayed on- screen. Lamp power is controlled by SCR single phase firing modules, controlled individually.

Thermal Processing Solutions
Monday 09/18/06 17:24:56
Exit

Cool Down
Ready

Process Recipe
DUPONT

User
TPS

SetPoints

Tuning

Legend: Temp Set Point Power

Voltage Control Active on this Zone

Gain

Integral

Derivative

Pwr Limit

Select Zone

1 2 3 4 5 6 7 8 9

Set Point

Feedback

Output %

Not Used

Belt Speed

Calibrate

in/min
 in/min
 in/min
 cm/min

Gain

Offset

Integrator

Control Volts

Feedback Volts

Belt Hours

Design Max Speed in/min

Calc'd Max Speed in/min

SCR's

Lamp Hours

Test

Power

Click to Apply Power

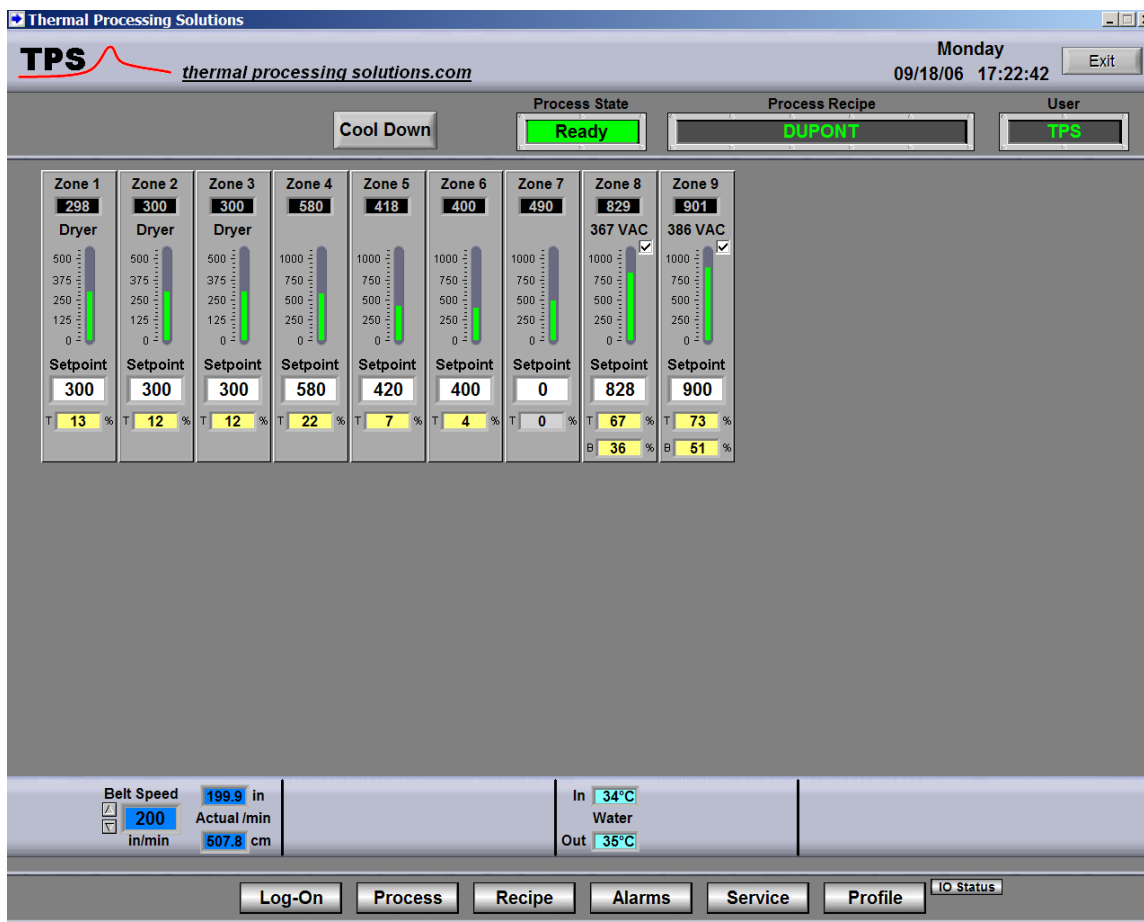
Zone

Auto Sequence

Close

Log-On
Process
Recipe
Alarms
Service
Profile
IO Status

Service Screen



Process Screen

8. DOCUMENTATION:

TPS shall provide a web-based owner’s manual including operating instructions and recommended maintenance procedures.

9. FINISH

All exposed parts will be powder coated: Standard color is grey.

10. ACCEPTANCE CRITERIA

The furnace, as described in this document, and meeting the requirements herein, will be certified and documented by TPS Quality Assurance before customer acceptance testing begins. A customer acceptance criterion is to be mutually agreed upon and be in writing prior to furnace in-plant acceptance. Upon acceptance of the furnace by TPS, QC, (with or without customer present), TPS will have fulfilled its obligation of in-plant acceptance and will ready the furnace for shipment.

11. Standard Features & Options

11.1 Air Purification System: Provides an air dryer and filtering system which removes moisture, oil and particulate contamination from air.

11.2 On Screen Profiling: Up to five traveling thermocouple outputs can be plotted simultaneously.

11.3 Over Temperature shut down: This option provides a secondary scanner to monitor each zone and respond to over temperature conditions. The redundancy in the sensors is designed to provide shutdown of the heat even in the event of multiple component failures.

11.4 Uninterruptible Power Supply: This option adds an uninterruptible power supply which keeps the belt, fans and control system operating for at least 20 minutes during a power outage.

11.5 Dimpled Mesh Belt: This option provides an alternate conveyor belt that includes one row of low mass inverted “V” stand-offs that are provided to support wafers above the mesh belt. This option provides the ability to achieve the highest heating and cooling rates. (Contact factory for stand-off pattern and dimensions.

11.6 Scrubber/Water Cooled Condenser System: Located at entrance exhaust dryer section is ducted to a water cooled condenser unit. The unit traps condensed organic paste material and vents the remaining dryer exhaust to the facility exhaust duct. A drain is also provided at the bottom of the reservoir. The drain may be serviced while the dryer is in operation.

11.7 Light Tower: This option provides a three stage alarm status light tower. The status system has three solid state relay outputs, and activates a three lamps alarm light, located above the upper frame, as follows;

Red Indicator: Alert/Alarm Condition

Yellow Indicator: Process Not Ready, No Alarms / Alerts

Green Indicator: Process Ready, No Alarms

11.8 Interface Rollers: This option is designed for integration with automation equipment with conveyor extensions. Load 600mm / Unload 1000mm sections.

12.9 Process flow Monitor: This option will add circuitry (flow sensor) and special programming to sense failed flow gas through the process zones. The failure displays on screen, allowing the operator to quickly adjust the minimum required flow before the process is compromised.

11.10 Exhaust system Monitor: This option will add circuitry (flow sensor) and special programming to sense failed exhaust flow. The failure displays on screen, allowing the operator to quickly adjust exhaust flow necessary to evacuate organic paste material from the process chamber before the process is compromised.

11.11 Element Monitor: This option will add circuitry and special programming to sense failed heating elements, fans thru out the cooling system. The current in each element/fans is monitored continuously and the operator receives audible and visual alerts should a failure occur.

11.12 Spare Parts: These options provide two parts kits that may be commonly used within two or four years of operation.

11.13 Main Breaker: These options provide main power off switch; this is located at the entrance end of the furnace.

11.14. WATER REQUIREMENTS (for water-cooled systems only)

Water: 20°C Inlet water temperature recommended

Flow: 4 gpm (Typical) Clean, PH 6.8-7.2, No organics.

Pressure: 60 psi (maximum)

11.15 Oxygen Analyzer: An O₂ analyzer and on-line 4-port gas sampling system will be provided and integrated with the control system. Using the furnace HMI, user can select a port to allow the O₂ analyzer to monitor O₂ levels in one of three zones. Levels out of tolerance will display visual warning and sound audible alarm on HMI screen of furnace and log warning to the event file on hard drive, so that situation can be remedied.

11.16 Motorized Chamber Lift: A powered system that raises the top furnace sections above the bottom section for inspection, maintenance and removal of any debris or parts that may be deposited inside the furnace. The system can be powered by local facility 117 V power when 3-phase main power is disconnected from the furnace. Hydrogen furnaces and other specialty equipment may require removal of special clamps before the top and bottom sections can be separated.