

innovation integrity quality



contents

0. Technical Data	4
1. Introduction	6
2. Technical Description	7
2.1 Furnace Vessel	7
2.2 Pumping Group	7
2.3 Thermal Chamber	8
2.4 Gas Cooling System	8
2.5 Power & Control	9
2.6 Water Cooling System (option)	9
2.7 Safeties	10
2.8 Documentation	10
3. European Standards	10
4. Acceptance Test Procedure	11
4.1 Acceptance at TAV	11
4.2 Acceptance at Customer Site	11
A. Scope of Supply & Prices	12
B. Terms	13
B.1 Terms of Prices	13
B.2 Payments	13
B.3 Delivery	13
B.4 Warranty	13
B.5 Validity of the Proposal	13
C. TAV General Terms of Sales	14



0.0 Technical Data

0.1 Useful Dimensions

- width 400 mm
- height 400 mm
- depth 600 mm
- volume 96 dm³

0.2 Charge

- max. gross charge 200 kg

0.3 Temperature

- max. temperature 1400 °C
- max. operating temperature 1350 °C
- max. operating temperature
with convection heating 750 °C
- temperature uniformity with convection
(350 < T < 750 °C) ± 5 °C
- temperature uniformity in vacuum
(T > 600 °C) ± 5 °C

0.4 Vacuum & Partial Pressure

- ultimate vacuum level ¹ 1E-2 mbar, 1E-3 mbar (range)
- operating vacuum 1E-1 mbar, 1E-2 mbar (range)
- partial pressure (N₂) 0.1 – 10 mbar
- leak rate ¹ < 5E-3 mbar l s⁻¹

¹ empty, clean and cold furnace

0.5 Gas

- convection heating gas N₂
- max. pressure 2 bar abs
- cooling gas N₂
- max. pressure 12 bar abs
- gas consumption per cycle
(@ max. pressure) approx. 36 Nm³
- gas purity 99.999 %

0.6 Power

- heating power 80 kW
- pumping group approx. 10 kW
- connected load 110 kVA
- power supply 400 V, 50 Hz
- max. admissible voltage fluctuations $\pm 5\%$

0.7 Water

- water pressure at inlet (min. – max.) 2.5 – 3.0 bar
- water pressure at outlet (min. - max.) 0 – 0.5 bar
- water flow requirement
furnace 200 l min⁻¹
- extra water flow requirement
during cooling 300 l min⁻¹
- max. water temperature at inlet
furnace 30 °C
- max. water hardness 150 ppm CaCO₃

0.8 Furnace Performances (empty furnace)

- pumping time to 1E-1 mbar range < 20 min
- heating time from RT to 1200 °C < 50 min
- cooling time from 1200 °C to 200 °C < 5 min

0.9 Weight

- plant gross weight approx. 10 ton

0.10 Colour

- RAL colour white 9003 and blue 5013



1.0 Introduction

Vacuum Furnace **TAV H4** offers an advanced solution for high pressure – fast quenching vacuum heat treatment processes.

A large pumping group, inclusive of rotary vane pump, Roots blower and oil diffusion pump allows rapid evacuation of the chamber and high operating vacuum levels.

The high power installed, the wide surfaces of the heating elements and the possibility to heat up the load with **auxiliary convection** at lower temperatures, allow fast and uniform heating ramps and shorter cycles.

A closed loop gas cooling system combines high flow capacity, high pressure and **multi-directional** gas flow distribution to guarantee fast and uniform cooling of the load. A variable frequency inverter allows a fine regulation of the cooling speed.

A **SCADA system** provides comprehensive monitoring and control of the furnace and it includes **OEE and Performance Measurement Functions**.

The furnace vessel remains at room temperature and can be installed in an air conditioned area without altering room temperature.

The system consumes electric energy only when needed and does not pollute air nor water.

Max furnace dimensions : 3400 mm width x 4000mm depth x 2800mm height , including vacuum pumps.



2.0 Technical Description

2.1 Furnace Vessel

The sealed vessel separates the outside environment from the inside where the thermal chamber, the heat exchanger, the gas fan and the cooling motor are placed.

The vessel develops along an **horizontal axis** and it is cambered at both ends. The **front door** opens - from right to left - turning on solid hinges to allow loading and unloading of the charge as well as inspection and maintenance of the thermal chamber. No. 2 clamps, activated by hydraulic cylinders, lock the furnace door. A safety system, complete with pneumatic cylinder, prevents the opening of the clamps when the vessel is pressurized.

The vessel is provided with a set of vacuum sealed flanges (**water cooled**) for connection to :

- pumping group
- power supply (**water cooled feed-throughs**)
- gas cooling system
- pneumatic pistons
- temperature/pressure gauges
- gas inlet/discharge valves
- blind flange for diffusion pump
- safety valve.

Nozzles are also water cooled.

A bell type chamber is flanged at the back of the vessel. It contains the cooling motor. The flanges are vacuum sealed with "O"-rings suitable for high temperature and high vacuum operation. The front door is sealed with a **double lip seal**, suitable for high temperature operation under high vacuum and under high pressure.

The vessel is fitted with No. 4 legs.

The vessel is in mild steel and it is cooled by water flow through a double wall jacket. The inner wall is sprayed with a high temperature resisting coating to prevent oxidation.

The vessel is designed and manufactured according to PED (Pressure Equipment Directive) requirements and it is **PED certified – 12 bar abs.**

2.2 Pumping Group

The pumping group is composed of :

- No. 1 mechanical - Leybold SV300
- No. 1 Roots pump – Leybold Ruvac WA501
- foreline butterfly valves
- partial pressure needle valve
- piping.

The valves are pneumatically operated.

The pumping group is interlocked and automatically sequenced to provide safe operation of its components.

2.3 Thermal Chamber

The thermal chamber provides the insulated area within the vessel, where the charge can be placed to be heated and processed.

It has a **square section** and it consists of a horizontal steel frame, that supports the insulation and the heating elements.

The insulation is provided by rigid graphite boards covered by **CFC** that protects them from the flow of the cooling gas during quench.

The insulation panels are fixed to the steel frame by molybdenum pins.

The heating elements are rigid graphite bars placed at the **bottom, top and lateral sides** of the thermal chamber. They are connected to each other by rigid graphite junctions bolted with **CFC screws and nuts** and they are supported to the frame by molybdenum studs, electrically insulated by high purity ceramics. The heating elements can be disconnected without removing the thermal chamber from the vessel.

Bungs open during quench to allow the flow of the cooling gas through the charge. The bungs are operated by pneumatic pistons.

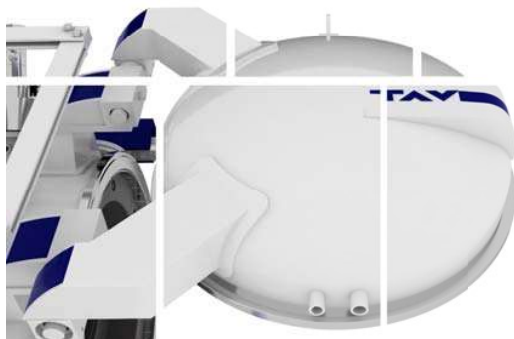
At the bottom of the chamber, No. 3 graphite rails provide a flat support to the charge. High purity ceramic inserts separate the graphite rails from the load.

The thermal chamber is placed on supports that allow easy extraction in case of maintenance operation.

2.4 Gas Cooling System

The gas cooling system allows to cool the thermal chamber and the load from operating temperature to room temperature.

It includes a centrifugal cooling fan, an asynchronous electric motor and a fin-and-tube **copper** heat exchanger.



The system allows for **multi-directional gas flows** :

- from bottom to top
- from top to bottom
- alternating these directions
- from top and bottom with exit at the sides
- from side to side
- alternating these directions
- from top with exit at the 3 sides
- from bottom with exit at the 3 sides.

The electric motor is driven by a variable frequency inverter for **fine regulation** of the cooling speed and for interrupted quench feature.

The gas pressure can be set and regulated from 0.9 up to 11.5 bar abs.

2.5 Power & Control

The heating power is provided to the heating elements by water cooled copper current feed-throughs connected by copper/aluminium bars to No. 1 3-phase transformer placed close to the furnace vessel. The transformer is driven by No. 1 3-phase thyristor controller, placed within the control cabinet.

The control cabinet is free standing, full opening, front door, ventilated and it houses the control instrumentation.

The communication between the field instrumentation (TC's, pressure and vacuum gauges, limit switches, etc.) and the PLC is through **AS-i** (Actuator Sensor Interface) protocol.

The control instrumentation includes :

- SCADA system
No. 1 industrial PC, complete with LCD touch screen, UPS.
TAV software allows :
 - real time furnace status display
 - display of all process details
 - batch data storage
 - display and storage of alarms
 - **OEE (Overall Equipment Efficiency)**.
- PLC - Siemens Simatic S7
it provides the control of the furnace components and of the cycle.
It receives the analogue signals from No. 1 control/record thermocouple (type S), from an internal socket for the connection of No. 9 load thermocouples (type N) and from the vacuum gauges (Pfeiffer).
- **Safety PLC**
- over-temperature controller
it receives the signal from No. 1 thermocouple (type S) and stops the cycles providing an alarm in case of over-temperature within the thermal chamber.

The control system can be remotely monitored by TAV engineers via internet connection.

2.6 Water Cooling System (option)

A closed loop water cooling system provides water to the furnace.

It includes :

- No. 1 air cooler
- No. 1 water tank (2,5 m3)
- No. 2 pumping group (one for inside loop and one for outside loop)
- No. 1 heat exchanger
- valves, flow indicators, interconnecting pipes (customer supply)
- control panel
- No. 1 emergency pump provide water flow if a lack of electricity occurs.

2.7 Safeties

The furnace operations are inter-locked for a safe functioning of the system.

Acoustic/visual alarms occur in the event of :

- lack of cooling water
- low pressure in the pneumatic system
- low pressure in the process gas supply
- over-temperature within the thermal chamber or at the inner wall of the vessel
- loss of operating vacuum level
- failure of a thermocouple.

2.8 Documentation

The furnace is supplied complete with No. 1 digital copy + No. 1 paper copy of the following documents :

- Operator & Maintenance Manual
- electrical schematics
- components data manual
- spare parts list.

