I.5: Installation and commissioning of advanced laboratory furnace

A fully integrated computer controlled 40 kW advanced laboratory furnace with state of art dynamic argon (Ar) partial pressure system was installed and commissioned in Ultra-High Vacuum (UHV) lab (Figure I.5.1).The laboratory furnace is used for conducting brazing experiments either in vacuum or Ar partial pressure atmosphere for optimizing brazing process parameters (filler material, joint design, electroplating requirements, brazing temperature, soaking time and partial pressure of Ar) for development of recipe of UHV compatible brazed joints involving advanced materials such as Oxygen Free Electronic (OFE) Cu, Oxide Dispersion Strengthened (ODS) Cu, Be-Cu, Be, Nb, SS, Ti and Ti alloys and high purity alumina ceramics used for particle accelerators.

Salient features of the laboratory furnace are given in Table I.5.1. The furnace is designed to operate in hydrocarbon free high vacuum (ultimate Pr~2×10^{-7} mbar before start of heating) as well as argon (1×10^{-3} to 1.1 mbar) atmosphere. The furnace consists of Ar purifier system which provides dew point <-65 ºC, to facilitate enhancement of brazeability of metals by minimizing the oxide formation due to water vapor.

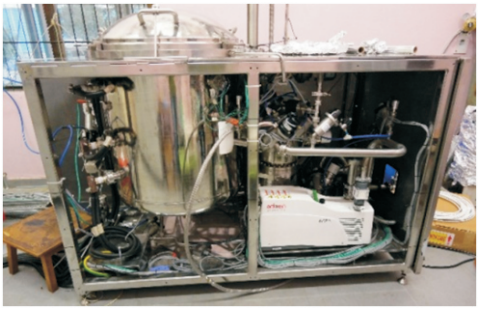

Fig. I.5.1: Fully assembled laboratory furnace.

The vacuum pumping system of furnace consists of two Turbo Molecular Pumps (TMP) of 1250 lps and 260 lps capacity, respectively, connected in series and backed by one multistage roots pump of 37 m^3/hr capacity for dry roughing and backing. This combination offers pump downtime of less than 30 minutes from atmosphere to $5x10^{-6}$ mbar and helps in early start of heating and reducing the brazing cycle time.

Design, construction, testing, installation and commissioning of the lab furnace was based on "NFPA-86D Standard for Industrial Furnaces using Vacuum as an Atmosphere 1999 Edition". Temperature uniformity survey of the furnace was carried out conforming to AMS 2750D standard.

The laboratory furnace is equipped with state of art SCADA control system architecture that uses HMI, GUI for high-level multi process supervisory control. It is equipped with Programmable Logic Controller (PLC) and discrete safety and PID standalone controllers to interface with various pressure, flow rate, level, vacuum and temperature parameters. The control panel (Figure I.5.2) is equipped with panel AC for reliable operation.

Fig. I.5.2: View of the control panel.

During commissioning, one Glidcop® to OFE Cu joint was successfully brazed at 790 ºC x 1 min using BVAg-8 alloy under Ar partial pr of (5×10^{-3} mbar). Helium leak tightness of the brazed joint was found better than $2x10^{-10}$mbar.l/s, which confirmed the compatibility of brazed joint for UHV application.

Table I.5.1: Salient features of lab furnace.

1. Furnace Configuration • Vertical , top loading with table-top configuration.
2. Furnace Chamber • Double walled water cooled cylindrical chamber • Design Std: ASME B&PV Code Sec VIII-Div-1 • Material: SS316L
3. Hot zone a. Usable hot zone size: Dia 300 mm × 450 mm height b. Operating temperature : 600 ºC to 1200 ºC c. Heating rate: 1 ºC to max 5 ºC per minute d. Maximum charge weight: 40 kg e. Temperature uniformity (spatial): ± 5 ºC f. Temperature stability (temporal) : ± 1 ºC for 8 hr g. Heating element : Lanthanum doped molybdenum h. Hearth assembly :TZM material
4. Thermocouples : a. Control thermocouple : Moly sheathed 'S' Type b. Over temperature thermocouple: Moly sheathed 'S' type. c. Job Thermocouple: MI sheathed 'N' type:05 Nos

This furnace was built by an Indian industry based on the furnace configuration and specification for design and manufacturing provided by RRCAT.

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