Technology Development

Development of brazing furnace

Design, analysis and manufacturing of a brazing furnace are being carried out. Furnace brazing method is preferred over other joining techniques like TIG brazing, gas brazing, etc. due to more uniform heating, less thermal distortions and better quality brazing joints. The furnace chamber (Fig. 1) is a rectangular box having a layer of insulation on the inner surface of walls. It consists of a few resistive heaters placed close to the job, a number of thermal radiation shields surrounding the job is placed in order to minimize the radiation heat loss from the furnace chamber. The heater power required to maintain the job at desired temperature during brazing was obtained by carrying out detailed analysis using finite element simulation. Heat transfer by radiation was considered for all the surfaces. The inside volume of chamber was assumed to be in vacuum and natural circulation cooling was only considered outside the chamber. The temperature distribution in the structural components of the furnace is shown in Fig. 2. The key parameters of design are given below:

- Design temperature = 900 °C
- Size of chamber (L x B x H) = 1.8 m x 1.2 m x 1.0 m
- Heater power = 6.5 kW
- Number of thermal radiation shields (Stainless Steel) = 5

Manufacturing of the furnace chamber (Fig. 3) and its components is completed. The brazing operations can be carried out both in vacuum or in inert gas atmosphere, as desired, using this furnace.

![Fig. 1: Sectional view of brazing furnace](image-url)
Development of Still for Dilution Fridge

In view of indigenous development of a dilution fridge at VECC, Kolkata; design, fabrication, assembly and commissioning of a $^3$He distillation chamber (Still) of 40 cc volume [see Fig. 2 & 3] is carried out for efficient evaporation of $^3$He from the dilute solution. To ensure the requisite cooling power of the dilution fridge, Manganin wire heater ($\sim$ 400 $\Omega$) is glued to the exterior to the Still body. The Still is made of OFHC copper. To reduce the $^4$He film flow, the diameter of 2.5 mm is used for the exit path in the pump-out line. The estimated Still power is of $\sim$ 0.6 mW. RuO temperature sensor is tightly fitted with the Still in an appropriate boring. A typical circulation rate of 15 $\mu$-mol/s of $^3$He is considered for the fridge (estimated cooling power $\sim$10 $\mu$Watt.
@100 mK). The Still, operating at about 500 mK has performed satisfactorily with the fridge run to achieve a low temperature of about 47 mK in the laboratory.

**Development of a Neon gas target for 22Na production by proton irradiation**

The design and development of a Neon gas target is carried out for the production of $^{22}$Na using a proton beam from the K-130 cyclotron in Variable Energy Cyclotron (VEC) Centre, Kolkata. The target [see Fig.1] design is made to handle a beam power of 85 W (17 MeV, 5μA). The design is based on simulation using the computer code FLUKA [see Fig.2] for the beam dump and CFD-CFX for target cooling [see Fig.3]. The target holds neon gas at 10 atms. pressure for proton irradiation. The target has been successfully used for the production of $^{22}$Na in a 6 day long irradiation run [see Fig.4]. The production yield of $^{22}$Na found to be 0.42μCi/μAh and is satisfactory.
Different types of electromagnets are presently being designed for the low and high energy beam line of VEC cyclotrons. ANURIB, the future mega project of VECC shall also use a number of such electromagnets that require high field quality. These magnets need to be accurately and elaborately mapped before they are placed in the beam line. A precise 3 axis drive system has been designed and developed to move a magnetic field measuring probe (hall sensor/NMR) in a precise manner with accurate positioning in 3D space and measure the magnetic field (Fig. 1). The drive of each axis is given by stepper motor and the position is measured by precision linear encoder system with resolution of 20 micron and accuracy of 50 micron. Each axis has linear guide and ball screw combination to achieve accurate drive. The drive system will have capacity to measure magnetic field in a volume of 1500 mm X 1300 mm X 150 mm for a single setting. The positional accuracy of hall probe or NMR in 3D is better 0.2 mm for the whole volume. This facility can be used for accurate magnetic field mapping of big dipole magnets, solenoids etc. The position of each drive is measured.