A.5: Development of aluminium plate fin heat exchangers for cryogenic application

To acquire core cryogenic engineering aspects of a helium liquefier, indigenous efforts were initiated for its development earlier. In this effort, the first fully indigenously developed helium liquefier was commissioned during September 2010. In its initial trails, its liquefaction rate was 6 lit/ hr. Based on the experimental observations, cryogenic process parameters were optimized. Improvements were done to reduce pressure fluctuations during operation. In addition, position and size of cold absorbers inside the cold box was changed to improve their performance. With these improvements the liquefaction rate of this liquefier increased to 12 lit/ hr. Further improvements were carried out by adding liquid nitrogen pre-cooler in the process circuit. Inlet and outlet headers of heat exchangers were also modified to improve gas flow in the multi-stream heat exchangers. With these modifications the liquefaction rate of indigenous helium liquefier touched 20 lit/hr.

After this, design efforts were started to develop indigenous helium liquefier with liquefaction capacity of 35-50 lit/ hr. To produce the targeted quantity of liquid helium, gas flow rate through the process circuit will increase many folds as compared to the present machine. Suitable heat exchangers are necessary which can handle this higher flow rates with minimum pressure drop, simultaneously keeping required heat transfer between the two gas streams. Aluminium plate fin heat exchangers are better suited for this or higher size of helium liquefiers. Our present liquefier is based on laboratory made, spirally wound finned copper tube in shell, type heat exchangers. An aluminium plate fin heat exchanger was designed with constrains of available facilities at local vendors. The designed heat exchanger has been successfully made through an Indian vendor. It has a rating of 67 kW for operating temperature between 300K to 80K. Figure A.5.1 below shows the developed heat exchanger.

Fig.A.5.1: Aluminium Plate Fin Heat Exchanger developed for Cryogenics Application

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A.6: Enhancement of helium gas recovery facility for liquid helium experiments

Large quantity of liquid helium will be required to test superconducting RF cavities at 2K. To meet this demand helium gas recovery facility has been enhanced. Three large cylinder banks have been installed. Each cylinder bank is consisting of eight large cylinders. Each cylinder is equivalent to 50 conventional cylinders. Now, Helium gas evaporated from 10,000 liters of liquid helium can be stored in these cylinder banks at 140 bar.

A Helium gas recovery compressor is also installed to fill these cylinder banks. For comparison, this compressor takes only 1 ½ minutes to fill a regular cylinder up to 140 bar. Additionally, it is also capable of compressing helium gas, recovered when a cooling power of 250 W at 2K is being produced by pumping over liquid helium. Both the above items are made and supplied by Indian Companies.

Fig. A.6.1: Jumbo Cylinder banks

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