

A.3: Development of heat exchangers for helium refrigerator / liquefier

Work has been going on at RRCAT in the design and development of medium capacity helium refrigerator / liquefier. Development of helium refrigerator/liquefier requires very high effectiveness (>95%) heat exchangers. The cross-counter flow coiled finned tube heat exchangers are one of the choices for these cryogenic systems. These heat exchangers are one of the important components of the system and play very influential role in total thermal management of the cycle. The effective heat exchange in each of heat exchanger is a vital issue for achieving high performance of the refrigerator/liquefier. These heat exchangers present the largest challenges in terms of realizing the compact design with fairly high net effectiveness and low pressure drops in fluid streams. Moreover, the most basic engineering challenges are to design and fabricate these heat exchangers in proper sizes subject to minimum weight and space constraints.

Cryogenics Section of RRCAT has successfully developed cross-counter flow coiled finned tube heat exchangers using complete indigenous resources. Coiled finned tube heat exchangers developed at RRCAT have high effectiveness (>95%) and low pressure drops (<0.2 bar) with minimum weight constraint. Complete design and fabrication procedures of these heat exchangers have been developed. Fig. A.3.1 shows a photograph taken during fabrication of a heat exchanger. Fig. A.3.2 shows heat exchangers mounted during thermal testing in the test circuit. Exhaustive theoretical and experimental work has also been carried out in order to establish the accurate design methodologies. Correlations for calculations of pressure drop and heat transfer coefficients have been developed. Fig. A.3.3 shows comparison of overall heat transfer coefficients between developed correlation and experimental values obtained from our test set-up. Similarly Fig. A.3.4 shows different calculated and test results of tube side pressure drop of these heat exchangers.



Fig. A. 3.1: Winding of finned-tubes over the inner shell of heat exchanger for 300 - 80 K temperature range.

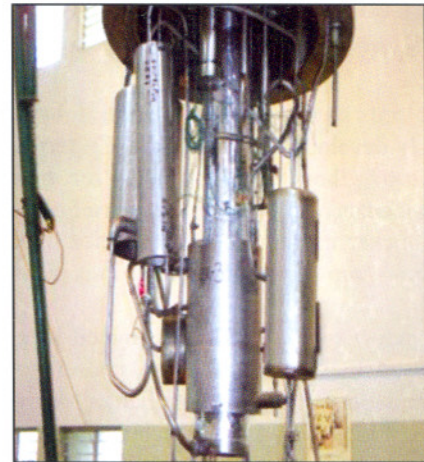


Fig. A. 3.2: Picture showing heat exchangers in test circuit.

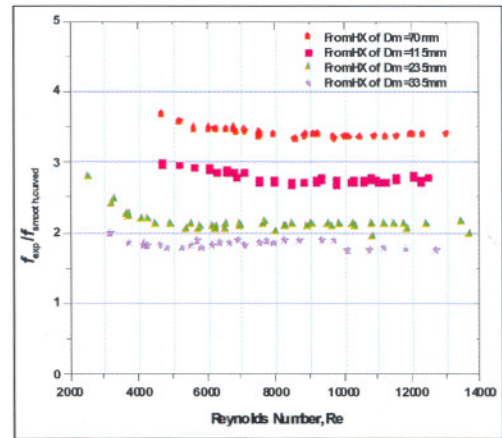


Fig. A.3.3: Comparison of overall heat transfer coefficients between developed correlation and experimental values obtained from the test set-up, for different clearance values.

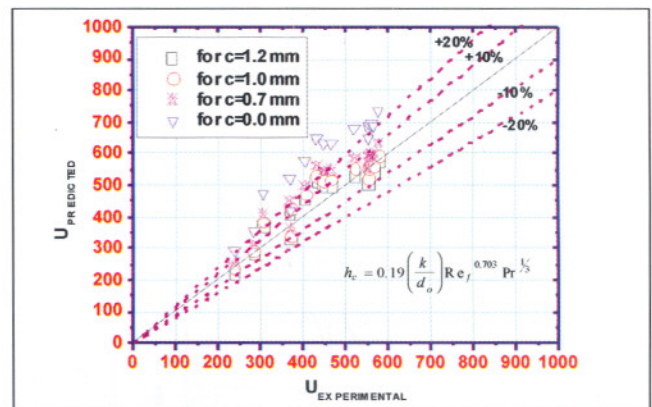


Fig. A.3.4: Comparison between experimental values of finned-tube pressure drop and calculated values of pressure drop of smooth tube.

Reported by:
Prabhat K. Gupta (prabhat@rrcat.gov.in)