Analysis and Optimization of Process Parameters of Heat Exchangers and Compressors for HR Plant of 1 kW at 4.5 K

Abstract

Problem Definition and Objective: The main components of a helium refrigerator (HR), which determine the performance of the HR for given turbines are: Heat exchangers and compressors. IPR has recently successfully tested the indigenously developed HR plant of cooling power 200 W at 4.5 K. In this, the turbines used were originally designed for HR of ~1 kW at 4.5 K. Hence, this indigenous HR can be upgraded up to a cooling power ~1 kW at 4.5 K. Plate-fin heat exchangers and compressors are main components which will be required to upgrade. As per the chosen modified Claude thermodynamic cycle, the cold box of the indigenous HR, developed at IPR, has 7 vacuum-brazed aluminum plate-fin HEs and 3 turbines. In this project work, requirement of sizes of different heat exchangers of the cold box will be analyzed and optimized. Various practical factors, like, external heat load, pressure losses and inefficiencies in different components and piping will be included in the analysis to get realistic cooling power of HR. Effect of different helium flow rates and pressures supplied by compressor will be analyzed to find optimum flow parameters of compressors.

Works of this project:

1. Study different thermodynamic configurations used in HR plant and different operational requirements.
2. Study and analyze different practical factors and inefficiencies affecting the performance of plant.
3. Find a method to analyze the given thermodynamic cycle to find refrigeration capacity.
4. Analysis and finding the optimum process parameters of heat exchangers and compressor.
5. Make a report for the above work.

Project period: About 9 months
Project outcome: Optimization method, Optimized parameters and a report for helium plant of refrigeration power 1 kW at 4.5 K.

Academic Project Requirements:

1) Required No. of student(s) for academic project: 1

2) Name of course with branch/discipline: M.E./M.Tech Mechanical Engineering

3) Academic Project duration:

(a) Total academic project duration: 36 Weeks
(b) Student's presence at IPR for academic project work: 3 Full working Days per week

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