

Design and Fabrication of Prototype Wheel and Low Temperature Parts for Low Pressure Ratio Cryogenic Helium Turbine

Abstract

Problem Definition/Objectives: The aerostatic gas bearing based helium turbine has been considered for the helium refrigerator-cum-liquefier (HRL) plant being developed at IPR. In this project work, design, optimization and fabrication of prototype shaft, wheel, nozzles and other low temperature parts of a helium turbine will be done. The expansion pressure ratio normally considered in the design of the turbines for use in HRL plant are both low pressure ratio and high pressure ratio type. In this design, a low pressure ratio turbine will be considered. The profile and size of blade, wheel and shaft need to be designed for maximum energy transfer from helium gas to the shaft, which in turn will be transferred to the eddy-current brake as heat energy. This is further removed by cooling water. As the rotational speed is few lakhs of RPM and sizes of shaft, wheel and blades are of few mm, the dimensional tolerance in these fabricated parts is of few microns. The 3D complex profile of blades will be made using CNC machine. These parts will be designed for turbine having nominal helium flow rate ~45 g/s with inlet temperature ~35 K & pressure ~14 bar and outlet temperature ~27 K & pressure ~6 bar. Its nominal shaft power is ~1.5 kW at ~2.2 lakhs RPM. The targeted design isentropic efficiency is ~70%.

Works of the project:

1. Study the existing helium turbines of HRL plant at IPR and different design concepts.
2. Study the different operational conditions affecting turbine.
3. Do the design and analysis for the shaft, wheel and other low temperature parts of turbine.
4. Make the drawings and get these fabricated.
5. Check the dimensions of the fabricated parts and check if improvement is required.
6. Make a report on above work.

Project Period: ~9 months

Project outcome: Design method, fabricated parts with report and drawing for shaft, wheel with blades, nozzles and other low temperature parts.

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: 38 Weeks

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

Email to: aksahu@ipr.res.in[Guide's e-mail address] and project_me@ipr.res.in [Academic Project Coordinator's e-mail address]

Phone Number: 079 -2182 [Guide's phone number]