

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

## **Abstract**

Problem Definition/Objectives: The Helium Refrigerator/Liquefier (HRL) needs helium turbines as expansion machines to produce cooling effect which is further used for production of liquid helium. These turbines are significantly smaller in size but rotation speed is high, about few lakhs of rpm and hence these have contactless gas bearings. Here, an aerostatic gas bearing based turbine is considered for the HRL plant being developed at IPR. In this project work, design, optimization and fabrication of prototype (full scale) shaft and wheel 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 high pressure ratio turbine will be considered. Considering flow dynamics in the blades of the expansion wheel, normally these have geometry of 3-dimensional complex profile. Here, the nozzles are designed for fixed angle of gas injection in the expander wheel. The profile and size of blade, wheel and shaft need to be designed for maximization of energy transfer from helium gas to the shaft of the wheel 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 needed in these fabricated parts are 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 ~15 K & pressure ~6 bar and outlet temperature ~10 K & pressure ~1.3 bar. Its nominal shaft power is ~1 kW at ~1.6 lakhs RPM. The targeted design isentropic efficiency is ~70%.

## **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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