

Design and fabrication of a prototype Aerostatic Bearing for High Pressure Ratio Cryogenic Helium Turbine

Abstract

Project definition/objectives: The cryogenic helium turbine based on aerostatic bearing will be used in the helium refrigerator-cum-liquefier (HRL) plant, being developed at IPR, Gandhinagar. In this design a high pressure ratio turbine will be considered. The shaft in the bearing will be vertical and clearance between shaft and its housing will be of few tens of microns. Through very fine holes, made in the housing parts, gas comes out and hits the shaft and its collar and a pressure is created. There will be many holes, distributed peripherally and axially in the housing. These will be designed in such a way that, all these pressure thrusts on the shaft and collar will make the shaft float and shaft can rotate without any contact in the housing. The gas which will be used for this aerostatic bearing is helium gas at 10 bar and at room temperature. This project work involves the design, analysis and optimization of aerostatic bearing and its housing. A prototype of full scale will be manufactured with tolerance of about few microns using CNC machine. These parts will be designed for turbine having process flow condition of ~45 g/s helium flow rate with inlet temperature ~15 K at 6 bar pressure and outlet temperature ~10 K at pressure ~1.3 bar. Its nominal shaft power is ~1 kW at ~1.6 lakhs RPM. Mass of the shaft with wheel is few hundreds of grams.

Scope of Work:

1. Study the aerostatic bearing of turbines of HRL plant of IPR and different operational conditions.
2. Develop the design method for different parts of bearing and do the design optimization.
3. Make drawings, get the parts fabricated using CNC, assemble all parts.
4. Do the tests with air to check if shaft is floating while there is shaft rotation and check if improvements in design and fabrication are needed.
5. Make a report on above work.

Project Period: About 9 months

Project outcome: Design methodology, optimized dimensions, drawings, fabricated parts, and design report.

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

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