

## **Development of a test facility and measurement of performance of cryogenic helium purifier using N<sub>2</sub> and O<sub>2</sub> impurities**

### **Abstract**

The Helium Refrigerator/Liquefier (HRL) plant being developed at IPR, needs helium purifiers at temperatures about 80 K and 20 K to remove different gas impurities from helium gas before liquefaction. The purifier operating at ~80 K will be installed inside the cold box of the helium plant for removal of mainly O<sub>2</sub> & N<sub>2</sub> and little bit Ar impurities from helium gas. This purification process is based on charcoal adsorption concept. This purifier has been designed by IPR and manufactured by the Indian industry. An indigenous system is being developed at IPR to provide 80 K He circulation at different pressure between 5 to 14 bar. A purifier test facility will be developed indigenously using this 80 K helium circulation system. In this circulation system, provision will be incorporated to feed N<sub>2</sub> and O<sub>2</sub> gases as impurity in helium gas in controlled and measured quantity in the range of few hundreds of PPM (parts per million by volume). These impurities will then get adsorbed in the 80 K purifier which will be a part of the circulation loop. Continuous feeding of such impure gas will be done and continuous monitoring of impurity level at inlet and outlet of purifier will be done to find when purifier bed is getting saturated. This will provide adsorption capacity of adsorber bed. And such measurements will be done for different impurity concentrations in helium gas.

This will involve different instrumentations, thermal, hydraulic and mechanical aspects. Required insulation has to be designed to minimize the external heat leaks to the cryogenic components, which, otherwise can lead to significant error in performance measurement. Provision will be there to vary temperature and pressure also. Following works will be involved in this project.

1. Study the literatures related to the purifier test facility for cryogenic purifier based on adsorption capacity.
2. Study the 80 K helium circulation facility being developed at IPR.
3. Study the instruments and component requirements and make the PFD and PID of the test facility.
4. Do the design and analysis for incorporation of purifier in the 80 K circulation loop.
5. Generate details of piping, insulation, instrumentation requirements considering pressure drop, heat load, thermal stresses and maintenance requirements.
6. Do the purification test at ~80 K using N<sub>2</sub> and O<sub>2</sub>.
7. Do analysis of test data to find the performance of purifier and make a comparison with theoretical values.
8. Make the report for the above work.

### **Academic Project Requirements:**

- 1) **Required No. of student(s) for academic project: 1**
- 2) **Name of course with branch/discipline: PG (thermal/cryogenic engg. field)**
- 3) **Academic Project duration:**

- (a) **Total academic project duration: ~8 Months**
- (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 –2396-2182 [Guide's phone number]**