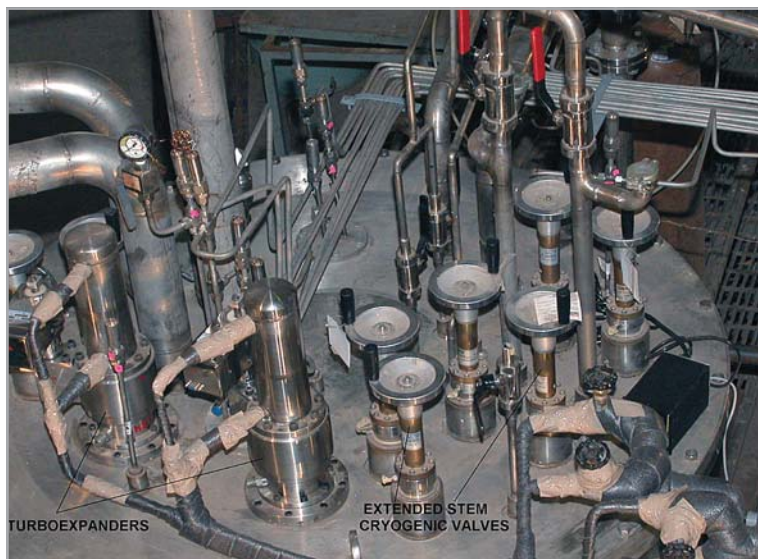


## 11.1 CRYOGENIC SYSTEM DEVELOPMENT

### ■ Helium Gas based Cryogenic Refrigerator (1kW at 20 K).

The Cryo Technology Division has developed a cryogenic refrigerator for 1kW of refrigeration at 20 K with helium gas as the refrigerant and installed at Engineering Hall no. 8, BARC, Trombay. This refrigerator can be used for cryo-distillation of hydrogen isotopes and has undergone operational tests. The plant is based on reversed Brayton cycle with two-stage turbine-based expansion. The system, in effect, consists of a cold box housing components such as turboexpanders, brazed plate and fin heat exchangers, gas purifiers and piping with cryogenic extended stem valves together with temperature sensors, pressure transducers and vibration monitoring instrumentation for the turboexpanders.



A close-up of the prototype refrigeration system showing turboexpanders, extended stem valves and external piping mounted on the top cover of the cold box



The prototype 1kW at 20K Cryogenic Refrigeration system developed and installed at BARC.

The operational tests revolve around measuring cool down time, lowest temperature reached, turbine speeds, vibration and overall system reliability. Preliminary tests conducted have enabled us to reach a lowest temperature of 14.9 K without any refrigeration load. The cryogenic system has been tested with a refrigeration load of 200 W at 16.5 K. The turboexpanders reached an operational efficiency of about 60% during loading.

### ■ Test Set-up

A test set-up has been built to test the efficiency and vibration levels of turboexpanders, efficacy of vacuum system, cryogenic insulation, indigenous temperature sensors and overall system performance and reliability. These apart, air screw compressors modified for helium service are being used to provide first hand data regarding the viability of using such compressors in larger plants in the future. Currently, the test set-up can accommodate a single turboexpander and a temperature of about 170 K is achieved. A second cold-box when incorporated with the facility would allow to simulate plant conditions in laboratory with a full two-staged expansion.



Laboratory test set-up built to test the performance of turboexpanders, efficacy of vacuum system, cryogenic insulation, indigenous temperature sensors and overall system performance and reliability



Turboexpander mounted on the test bench



Air compressors modified for helium service are being used for laboratory test set-up