

Performance Evaluation of 1.3 kW at 4.5 K Helium Refrigerator/ Liquefier (HRL) at IPR

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At IPR, 1350 W at 4.5 K helium cryo plant is dedicated to facilitate the cooling requirements of SST-1 machine. Since 2004, helium refrigerator / liquefier (HRL) (Make: M/s. Air Liquide, France) is operational in mixed mode equivalent to 650 W (refrigeration power) and 200 lh-1 (liquefaction capacity) at 4.5 K. The HRL can be operated in two phase (1.3 –1.5 bar (a) at 4.5 K –4.7 K) as well as single phase supercritical helium (at 4 bar (a) and 4.5 K with nominal mass flow rate of 300 gs-1) modes of operation. The refrigeration capacity of the HRL is 650 W at 4.5 K used to make TF and PF coils superconducting whereas the remaining capacity of 200 lh-1 is utilized for powering the vapor cooled current leads system of SST-1 at rated current of 10 kA.

To ensure the availability of the HRL and its best performance as per the needs of long duration SST-1 experiments, we carry out preventive maintenance of the different cryogenic components and subsystems as per defined schedule. These activities result in increasing the life span of the HRL as well as ensure its maximum availability during SST-1 operation. M/s. Air Liquide envisaged to carry out every five years preventive maintenance of the HRL for all the sub-systems and components. After major maintenance, it is desirable to have performance test on the HRL. We have carried out major preventive maintenance of the HRL and measure the HRL capacity during 2009-2010.

Recently, we have further carried out the maintenance ourselves and carried out the performance test. The equivalent cold power of HRL found to be 1160 W (in pure refrigeration mode), 10.7 gs-1 (in pure liquefaction mode) and 1300 W equivalent (in mixed mode) at 4.5 K. These values matches with our last experimental measurements during HRL maintenance performed in 2010 and as expected considering the operational hours of HRL after thirteen years of operation. These results are quite satisfactory from the HRL performance point of view. The HRL capacity strictly depends on the different modes of operations. In this paper, we report the performance evaluation of cold capacity of HRL at IPR since it commissioning to till date.

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