Seminar

Institute for Plasma Research

Title: Thermo-Hydraulic Analysis to Find Safe Operating Parameters for Turbine Start-Ups in Helium Liquefier Plant

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Abstract

The indigenous helium refrigerator-cum-liquefier (HRL) plant of capacity 200 W at 4.5 K has been developed, operated and tested successfully in Mar-2023. The indigenously developed cold box of this plant has three helium turbines, seven plate-fin heat exchangers and one helium purifier at 80 K. It uses LN2-precooling. Turbines are normally designed for a particular nominal flow parameters to get the best efficiency at the design state point of operation. Three turbines of this indigenous helium plant have nominal operating inlet temperatures of helium as 33, 15, and 7 K, respectively. As per design, these turbines can also be operated safely with a room-temperature helium gas flow, provided a controlled flow is maintained. During start-ups of the plant and turbines, it becomes unavoidable to operate these turbines with room temperature helium flow. Later, gradually, it cools down to low temperature flow. In the past, there have been many events, where helium turbines failed during start-ups of the plant possibly due to operation at a speed beyond the safe limit. Hence it was necessary to understand what should be the controlled flow rate at different off-nominal temperature and pressures for safe operation of turbines. It is required to find, how much, the inlet control valve for the turbine should be opened with respect to inlet pressure and temperature, so that, flow through turbine will not lead to over-speed and damage of turbine. The details of this analysis and control strategies including a cooldown sequence used for safe operations will be discussed in this paper.

Key Words: Operation, commissioning, helium refrigerator, tokamak, up-gradation