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C3Or4C-03: ITER Roughing Pump System Cryogenic System Overview

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The ITER cryogenic system will be the largest concentrated cryogenic system in the world serving multiple client system (superconducting magnets, plasma fueling and vacuum pumping). Cryogenic technology will be extensively used at ITER to create and maintain low-temperature conditions for vacuum pumping. US ITER is responsible for the design, fabrication, and delivery of the roughing pump system (RPS) Cryogenic System which among other things, regenerates the torus and neutral beam cryogenic pumps of the ITER tokamak. In the process exhaust gas stream, common gases (nitrogen, air, helium, etc.) can be found, as well as hydrogen isotopes (H2, D2, T2, and combinations of). The RPS Cryogenic System separates the hydrogen isotopes, allowing processing of the exhaust gas stream. The RPS Cryogenic System consists of Cryogenic Viscous-flow Compressors (CVC), Condensable Vapor Devices (CVD), Cryogenic Distribution Boxes (CDB), and the Cryogenic Transfer Lines (CTL). The Cryogenic Forevacuum Exhaust System is backed by roots pumps while the Cryogenic Forevacuum Roughing Train consists of scroll pumps. Gaseous helium (GHe) and super critical helium (SCHe) are supplied via the CTLs to the CDB. The GHe is distributed to the CVD and CVC, while the SCHe is processed through a liquid helium (LHe) bath to achieve a temperature range of 3.5K to 4.2K. The GHe supplied to the CVD is used to freeze water within the process gas stream, protecting the CVC from accumulating water. GHe is supplied to the CVCs to create a thermal shield and to precool the incoming exhaust stream. The SCHe is sent to the CVC condenser, and the hydrogen isotopes are separated from the process gas stream using helical tubes that direct the flow radially towards the cold tube walls and back to the center. This avoids radial gradients in the flow and is required for the complete phase change of the hydrogen isotopes. The process gas stream exiting the CVC is sent for processing, while the CVC continues to collect hydrogen isotopes. During regeneration of the CVC, the CDB will send a mixture of 80K GHe and ScHE to the condenser to warm up the hydrogen isotopes to allow a controlled release, which will then be processed. In total, the RPS Cryogenic System will allow ITER to engage in the critical science of developing sustainable burning plasma operations to facilitate the design and construction of commercial fusion power plants.

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