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Thermal and mechanical analysis of the Wendelstein7-X cryo-vacuum pump plug-in

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The function of the cryo-vacuum pump (CVP) system is basically the control of the plasma density by condensing undesirable gases together with a set of turbo molecular pumps. One CVP will be installed under each of the 10 units of the actively cooled divertor in Wendelstein7-X for the long pulse operation up to 30 minute duration scheduled in 2020. The 10 CVPs are independent and each one is operated with supercritical Helium (ScHe) at 3.5K and liquid nitrogen at 77K fed by a plug-in, which is installed inside a dedicated W7-X port of the plasma chamber. The plug-in made of stainless steel provides for the vacuum boundary between the plasma chamber and the torus hall atmosphere. The outer dimensions of the plug-in are: ~ 2 m long and ~ 90 mm. 4 pipes (12 x 1 mm) are positioned inside the plug-in: 2 for the inlet/outlet of ScHe and 2 for the inlet/outlet of nitrogen, respectively. On the supply interface side, the pipes are equipped with bellows to compensate the thermal elongation during operation. The connection to the CVP is equipped with flexible hoses to allow compensating of assembly tolerances and to accommodate the displacement of the plasma chamber during operation. The design needs to guarantee the feeding at the specified temperature of ScHe and nitrogen while minimizing thermal losses and thermal interactions between pipes. Inside the plug-in the vacuum level is 10^-3Pa at RT and 10^-5 Pa during operation. The pipes of the ScHe are shielded with a multi-layer super-insulation. In addition the cryogenic feed lines are protected with a cryo-shield against thermal loads in the port as well as in the plasma vessel. During baking, the relative displacement due to thermal expansion and mechanical load between the port and the cryostat could damage the plug-in and endanger the CVP feeding. This paper presents the thermal and mechanical analysis performed with ANSYS to check the selected design of the plug-in of the CVP.

Eligible for student paper award?

No

Author: Dr WANG, Zhongwei

Co-authors: Mr EHRKE, Gunnar; Mr MENDELEVITCH, Boris; Dr BOSCARY, Jean; Mr STADLER, Reinhold; Mr W7-X TEAM

Presenter: Dr WANG, Zhongwei

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