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Refined Multiphysics Analysis of W7-X Cryopumps

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Ten identical cryopumps (CVP) are to be installed in corresponding divertor volumes of Wendelstein 7-X (W7-X) stellarator before commencing the steady state phase of operation (OP 2). Each CVP is typically made of two units connected by a transfer line and is fed with a dedicated plug-in. The units consist of water baffle, liquid nitrogen (LN2) baffle, helium panel and LN2 cooled housing. All components are expected to be well cooled with the available cooling capacity during long pulse plasma operation in order to maintain the helium panel at about 4 K and hence ensure the desired absorption rate. The LN2 cooled housing has to minimize both the effect of electron-cyclotron resonance heating (ECRH) and the thermal radiation from backside of in-vessel components on the CVP 80 K shield and 4 K elements. Moreover, the ECRH is unevenly distributed in W7-X which requires analyses of several cases and sophisticated cooling scheme as described. The paper presents thermal behavior of CVP components and is followed by the discussion of several important issues for the assessment. In addition, eddy current and electromagnetic (EM) forces on CVP copper components are analyzed for the events of fast discharge of main superconducting coils, plasma current decay, alternative current in control coils and fast discharge of trim coils. Moreover, sharing of eddy currents between plasma vessel shell and attached CVP is estimated. Structural analysis taking temperature gradients and EM forces into account finalizes the study with some conclusions and recommendations.

Eligible for student paper award?

No

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