In-vessel LOCA analysis including 1D PHTS model

Introduction

The EU DEMO tokamak fusion reactor is a proposed design of demonstration fusion power plant, and it will be the first fusion facility to include a Breeding Blanket (BB) aimed at producing more tritium than that consumed by the fusion reactions. Consequently, one of the major challenges of the EU DEMO project is the design of the BB, for which several concepts are being investigated; the two most promising technologies are the Helium-Cooled Pebble Bed (HCPB) and the Water-Cooled Lithium-Lead (WCLL).

For the design of the BB, both nominal transients and accidental scenarios are to be simulated via numerical tools. The GETTHEM code [1][2] (see Figure 1), developed at Politecnico di Torino, is one of the codes employed to this task within the EUROfusion Consortium; it has been applied in the past to both operating and off-normal condition analyses, in particular focusing on Loss-Of-Coolant Accidents. Such analyses are generally carried out with simplified models, where e.g. the Primary Heat Transfer System (PHTS) is lumped in a single volume.

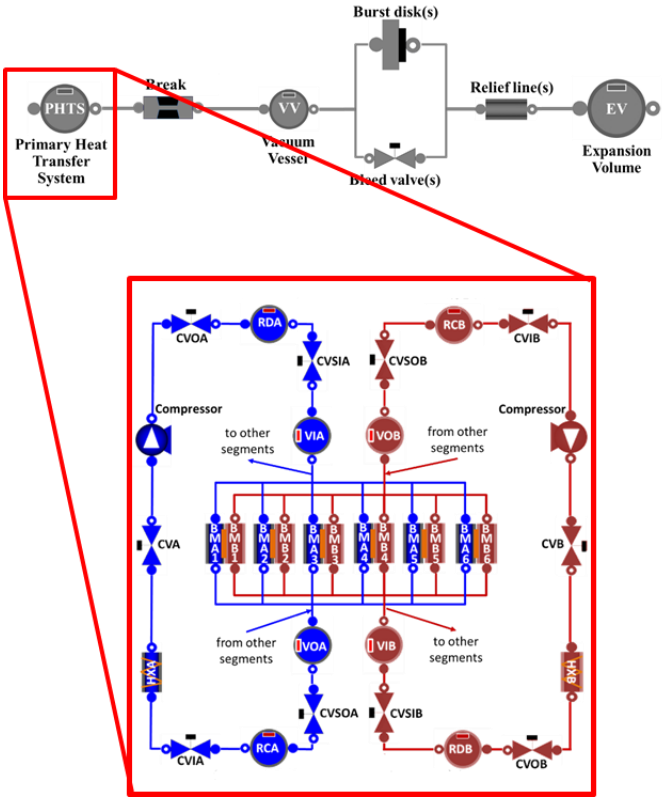

Figure 1: Scheme of the GETTHEM model of the HCPB cooling system.

Aim of the work

Within the GETTHEM code, two different modules exits, for the accidental and nominal operation analyses: in the first, all components are modelled as single volumes, losing local information inside the PHTS, whereas in the latter all channels are modelled separately. To allow modelling all the (several thousands of) cooling channels in the PHTS, the model in the latter module is simplified, e.g. linearizing the equations around the operating point, so the two models cannot be connected directly. The aim of this work is to develop a communication strategy to connect the two, heterogeneous

models together. The full model could then be used to analyze the effect of a LOCA on the PHTS, e.g. to investigate overheating of the structures.

Contact person

Antonio Froio

References

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[2] A. Froio, F. Casella, F. Cismondi, A. Del Nevo, L. Savoldi, R. Zanino, "Dynamic thermal-hydraulic modelling of the EU DEMO WCLL breeding blanket cooling loops," Fusion Engineering and Design 124:887-891, 2017.