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P2.230 Thermal-hydraulic modeling and analyses of the water-cooled EU DEMO using RELAP5 system code

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The current conceptual design of the Primary Heat Transfer System (PHTS) of the water-cooled EU DEMO foresees two independent cooling circuits, the breeding zone PHTS and the first wall PHTS. During the pulse (120 minutes) the first delivers thermal power to the turbine, the latter delivers thermal power to the Intermediate Heat Transfer System (IHTS) equipped by an Energy Storage System (ESS). The IHTS delivers partially thermal power to the turbine in pulse so that to accumulate a suitable amount of energy in ESS to operate the turbine during the dwell time (10 minutes) at almost constant load, despite the EU DEMO pulsation of the generated thermal power.

A dynamic model of the primary systems of water-cooled EU DEMO is developed using RELAP5 system code, capable to perform steady state and transient simulations. The model includes the primary and secondary side of the breeding zone; first wall primary system and the intermediate and energy storage systems are included too. A detailed nodalization is carried out for in-vessel components (i.e. breeding blanket), where higher accuracy is required. The ex-vessel components are modeled maintaining real geometries (i.e. main collectors, hot and cold legs) or adopting equivalent components (i.e. heat exchangers and steam generators tubes). Heat structures are used to model the heat transfer between primary and secondary side. Preliminary assessments of the nodalization have been carried out, in particular checking pressure drops along the systems and heat exchanger performances. The system analyses are performed to investigate postulated operation of EU DEMO power plant (i.e. pulse to dwell transient) and to evaluate advantages and key issues of the adopted configuration of the primary system and power conversion system.

Presenter: MARTELLI, Emanuela (Dipartimento di Ingegneria Astronautica Elettrica ed Energetica Sapienza University of Rome)

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