A multi-physics integrated approach to breeding blanket modelling and design

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Abstract

Often, for the design of a component, several kinds of analyses are needed. Even more frequently, the different fields of study, to be taken into account for the design verification, have to be examined minutely until the final results are satisfying. Furthermore, when geometry modifications are required, for instance to fulfill the component functions, the analyses cycle has to be restarted and an iterative process has to be carried out. This procedure may be time-consuming and herald of errors, in particular if it is demanded to the human activity. Therefore, it is more convenient for the scientific community to adopt a numerical tool that can combine various computational codes. On the base of these considerations, one of the greatest and important challenges for the new design tools is to demonstrate the capability for performing multi-physics analysis in an integrated way. This is a prerequisite, above all, when the component is part of a fusion utility like the Breeding Blanket (BB) in European Demonstration Fusion Power Reactor (DEMO). Indeed, for its design, several fields of analysis are involved such as the neutronics, thermal-hydraulics and the thermo-mechanics. The present work outlines a procedure for their coupling. The main characteristics of this new multi-physics integrated approach are (i) the use of the well-known commercial software, widely employed in the BB design, as well as (ii) the employment of the same geometry definition for all the phenomena studied. An effective application of the aforementioned approach to the pre-conceptual design of the Helium Cooled Pebble Bed (HCPB) and of the Water Cooled Lithium Lead (WCLL) is also provided in this paper. Finally, the achieved results are herewith reported and critically discussed.

Keywords: **multi-physics, coupling, breeding blanket, HCPB, WCLL**