DEVELOPMENT OF A TWO-DIMENSIONAL NUCLEAR-THERMAL-COUPLED ANALYSIS CODE FOR DEMO REACTOR BLANKET DESIGN

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For DEMO reactor blanket design, a two-dimensional (2-D) nuclear-thermal-coupled analysis code, DOHEAT, has been developed. Use of the code has showed outstanding usefulness in the blanket design where detailed evaluation of neutron flux, nuclear heating rate, tritium breeding ratio (TBR) and the temperature of materials is required for various blanket concepts and trial-and-error-basis iteration is sometimes necessary.

Previously, one-dimensional (1-D) nuclear-thermal-coupled analysis code, ANIHEAT, was used in the early stage of blanket design. However, it is a problem that the model can be sometimes too simplified to rely on the evaluated result of the TBR and temperature profile, because the blanket must be expressed by a 1-D model (that is, slab model)

DOHEAT can replace the actual blanket structure by a more realistic model including cooling tubes, multipliers and breeders. In DOHEAT, the neutron flux is calculated by a 2-D transport code, DOT3.5 [1], with the nuclear data library, FUSION-40, and the nuclear heating rate and the local TBR profile of blanket are calculated using the 2-D neutronics calculation code, APPLE-3. Figure 1 shows the structure of the DOHEAT code. The 2-D steady heat conduction analysis module provides the temperature profile in the blanket based on the nuclear heating rate profile. Figure 2 shows an example of 2-D blanket model and the resulting temperature profile. A validation calculation indicates that DOHEAT provides reasonable results on the temperature profile.

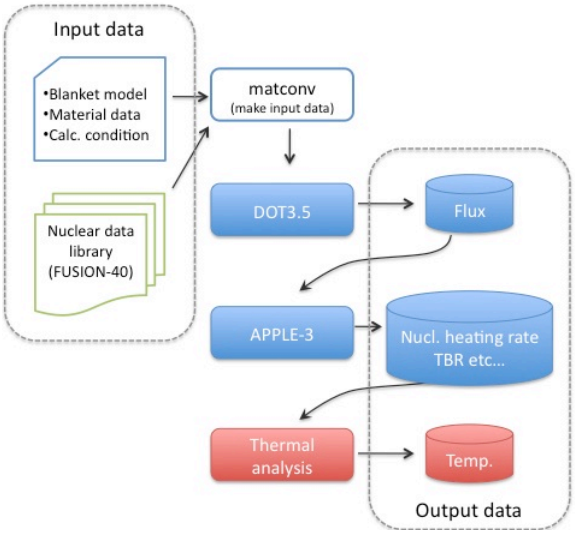
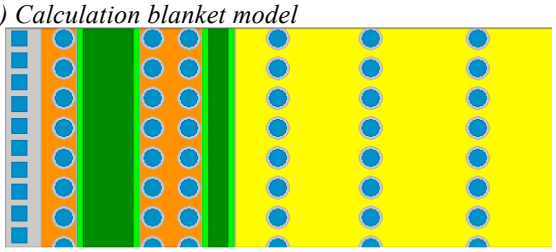


Figure 1: Structure of DOHEAT

(a) Calculation blanket model



(b) Temperature profile from DOHEAT

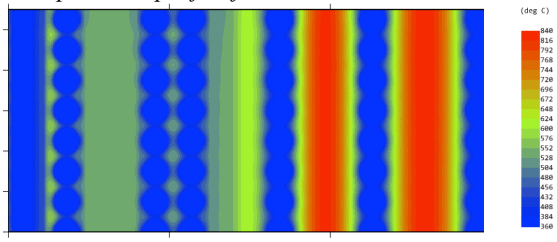


Figure 2: Calculation model and temperature profile from DOHEAT

[1] W. A. Rhoades and F. R. Mynatt, ORNL/RSIC/CCC-276, 1975