

TRITIUM ANALYSIS FOR THE EUROPEAN HCPB TBM MODULE IN ITER

R. Meyder⁽¹⁾, L. V. Boccaccini⁽¹⁾, N. Bekris⁽²⁾

Association Euratom-Forschungszentrum Karlsruhe, Postfach 3640, D-76021
Karlsruhe

⁽¹⁾ Institut für Reaktorsicherheit, ⁽²⁾ Hauptabteilung Versuchstechnik - Tritium Labor
meyder@irs.fzk.de

The Forschungszentrum Karlsruhe is designing the Helium Cooled Pebble Bed (HCPB) Test Blanket Modules (TBM) for ITER. Analyses of tritium inventory in TBM and tritium permeation into the Helium Coolant System (HCS) are of primary importance for the safe operation of the TBM and for the planning of the tests. Different phases have been foreseen for the operation of TBM. These are, the Electromagnetic (EM), the Neutronic (NT), the Thermo-mechanical (TM) and the Plant Integration (PI) phases. In particular for the NT-TBM tritium is recovered in a batch-wise process. During the TM and PI phases tritium is extracted continuously at high temperature. Each case needs to be modelled by computation, analysing uncertainties in the data and determining the ranges of operational conditions for safety and test purposes.

The tritium analysis in a TBM has to consider two aspects. One is the release of the tritium from the ceramic pebbles and the other is the permeation of the tritium from the breeding zone into the coolant. The release rate from the pebbles is important to estimate the tritium amount being stored in the module and to predict the tritium released during the different operational phases of the TBM. The permeation rate of tritium into the coolant is also important to predict the likely release rate of tritium which potentially will be released into the environment during the cooling operation.

As the length of ITER pulses is much lower than the time constant associated to the tritium processes, a model of tritium release needs to be implemented in the calculations to allow transient analyses. The tritium release rate from the pebbles is a function of the local tritium inventory and the local temperature. The detailed design available now and the transient thermal analysis of the beds is used for a more realistic prediction of the time dependent tritium inventory and release.

For the permeation, surface effects, diffusion constants, hydrogen swamping ratio and surface status play important roles. Essentially, the model used considers HT transport in the pebble beds and tritium diffusion through the steel. With this model the effects mentioned are investigated in terms of influence on the permeation rate.