A CASE STUDY
ON THE AVAILABILITY OF MODELLING TO PREDICT TRITIUM RELEASES

THE TRANSAT PROJECT

FOCUSES ON HOW TO PREDICT & HELP MITIGATE TRITIUM RELEASES IN FUSION & FISSION PLANTS

The evaluation of tritium inventory and migration within different kinds of nuclear reactors or processes is one major challenge in controlling the potential releases and personal dosimetry in nominal operating conditions.

In the framework of TRANSAT, a benchmarking activity between two calculation tools developed for either fusion (EcosimPro developed between CIEMAT and EAI) or for fission reactors (Kutim developed by CEA) took place to improve the evaluation of tritium and hydrogen balances in complex systems such as nuclear reactors.

A first application to a conceptual Sodium Fast Reactor was carried out. The two modelling tools are based on different mathematical and computational implementations of the physical models to be used for the simulation of all transfers in the reactor.

CALCULATION TOOLS

EcosimPro

In this multi-domain simulation platform, tritium generation, 1D diffusion model through materials and coolants, different surface phenomena, and system modules were simulated.

Kutim

In this 0D and steady state modelling tool, equilibrium concentrations were calculated by solving the two equation systems of both tritium/hydrogen isotopes, built with the material balance calculated in each circuit with different transfer contributions such as permeation through metallic walls, concentration partition by liquid-gas equilibrium, and co-crystallisation in purification systems.

KEY RESULTS

Two kinds of tritium releases were evaluated in the frame of the benchmark activity: tritium in gaseous form (HT, T_2) due to permeation through circuit walls and liquid form (HTO) released from pressurised (water/steam) tertiary circuit. Tritium releases evaluated are very limited (less than 6% of the tritium source transferred into primary sodium). A sensitivity study was also carried out on the influence of permeation level through IHX, between primary and secondary circuits, since the effective value of metallic wall permeability is subject to potential uncertainty.

A very good coherence of both codes' results (discrepancies were lower than 15% and only for particular transfer terms) was observed despite the different calculation approaches. Due to the modularity and adaptability of these tools, this important result is also an indicator of their robustness for potential application to the simulation of fission and fusion systems.

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