Evaluation of experiments in the AVR with the DALTON–THERMIX coupled code system

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The DALTON–THERMIX coupled code system for pebble-bed high temperature reactors was further validated by simulation of two dynamic experiments in the AVR. The validation included a rapid mass flow reduction experiment and a depressurized loss of forced cooling (DLOFC) experiment. For the mass flow reduction experiment, the rotational speed of the blowers dropped rapidly from 100\% to 50\% in 62 s. In the DLOFC experiment, the long term behavior (100 h) of the reactor was calculated and compared with experiments. Besides the transient calculation, each experiment included a coupled steady state calculation to determine the initial condition for the transient. The calculated results of the new code system agree very well with the experimental ones, from which it is concluded that the code system is very well suited for the design and optimization of future (V)HTR cores.

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1. Introduction

The AVR is an experimental high temperature reactor (HTR), built as an experiment on industrial scale in Jülich, Germany. The reactor had 21 years of successful power operation and was used as a test bed for various fuels and refueling strategies (Bäumer et al., 1990; Ziermann, 1990). Many important experiments to demonstrate the safety features of HTRs were carried out in the AVR (Krüger and Ivens, 1985; Gottaut and Krüger, 1990), such as a simulation of a depressurized loss of forced cooling (DLOFC) experiment. These experiments provide valuable data for validation of computer code systems.

In the frame of OECD/NEA PBMR neutronic/thermal–hydraulic benchmark, international cooperations were initiated to develop and validate new code systems to study PBMR (Reitsma et al., 2008; Tyobeka et al., 2008). A new code system for coupled neutronic and thermal–hydraulic analyses of pebble bed HTRs has been developed and validated at TU-Delft. The code system includes a new 2D/3D time-dependent diffusion code, DALTON, and an existing 2D thermal hydraulics code, THERMIX (Struth, 1995). Until now, the validations mainly focused on 2D neutronics calculations (Boer et al., 2008, in press). In this paper, the code system has further been validated by two experiments of the AVR in the framework of the RAPHAEL project (EURATOM, 2004). The two experiments included a rapid mass flow reduction transient and a DLOFC. In the simula-

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