QUESA

QUEnch experiment with Steam and Air

OBJECTIVES

During a severe accident in an NPP, air ingress into the vessel will lead to a mixed atmosphere inside core mainly composed of steam and air. Air is a highly oxidizing atmosphere that can lead to an enhanced core oxidation and degradation affecting the release of Fission Products (FP), especially increasing that of ruthenium. This FP is of particular importance because of its high radio-toxicity and its ability to form highly volatile oxides. Oxygen affinity is decreasing between Zircaloy cladding, fuel and ruthenium inclusions in the fuel. It is consequently of great need to understand the phenomena governing cladding oxidation by air as a prerequisite for the source term issues.

Extensive separate-effects tests have been performed recently for better understanding of the mechanisms of air oxidation of zirconium alloys and extraction of corresponding data mainly at IRSN and KIT. The accumulated data have demonstrated that cladding oxidation by air is a remarkably complicated phenomenon governed by numerous processes whose role can depend critically on the oxidizing conditions, the preceding oxidation history and the details of the cladding material specification. A number of air ingress bundle experiments on claddings have been performed under a range of configurations and oxidizing conditions, namely AIT-1, AIT-2, QUENCH-10, PARAMETER SF4 and QUENCH-16.

The QUENCH-10 and QUENCH-16 experiments were performed at KIT with a 21-rod assembly. The target scenario was characterized by: 1) a steam pre-oxidation to reproduce the core uncovery, 2) an air oxidation to reproduce the air ingress into the vessel with a period of oxygen starvation, 3) a reflood initiated at temperatures well below the melting point of the cladding.

Based on the SAFEST (CODEX) and ALISA (QUENCH) calls for proposal, the idea is to define a counterpart of QUENCH-16 but with a mixture of air and steam instead of pure air in order to be more representative of a reactor case.

DESCRIPTION OF WORK

The technical issues would be to extend both phenomenological understanding and the modelling of cladding oxidation under a mixture of air and steam. This project aims at studying and modelling more precisely the way the oxide layer is formed. It would be also an opportunity to know the influence of this kind of atmosphere on hydrogen production, for instance during bundle reflood.

As tests are conducted in the frame of SAFEST and ALISA, this project intends to cover the following aspects of:

1. Definition of the test scenario thanks to experimental support and pre-calculations based on a benchmark thanks to the main severe accidents codes;
2. Post-test calculations in the frame of a benchmark based on the main severe accidents code leading to possible models improvements.

MAIN DELIVERABLES OR RESULTS

Pre-test calculation reports. One per experiment.
Post-test calculation reports. One per experiment.

DURATION

2 years

CONTACTS

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