Chemistry and transport of fission products

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Objectives

The aim is to experimentally investigate the transport and chemistry of gaseous and particulate fission products in severe nuclear power plant accident conditions. The emphasis is on the phenomena, which are poorly-known or not considered in the current severe accident analysis codes due to the lack of information. The obtained new information will enhance nuclear safety. New fission product transport models will be developed and the existing models will be validated.

Ruthenium and iodine in primary circuit

Internationally, separate effect experiments on ruthenium transport in primary circuit has usually been performed in pure air-steam atmospheres. The effect of (oxidizing) air radiolysis products and aerosols on the formation of ruthenium compounds and transport as gas and particles at 1300 to 1700 K reaction temperatures was investigated. (Nordic NKS-R collaboration with CHALMERS Univ. of Technology.)

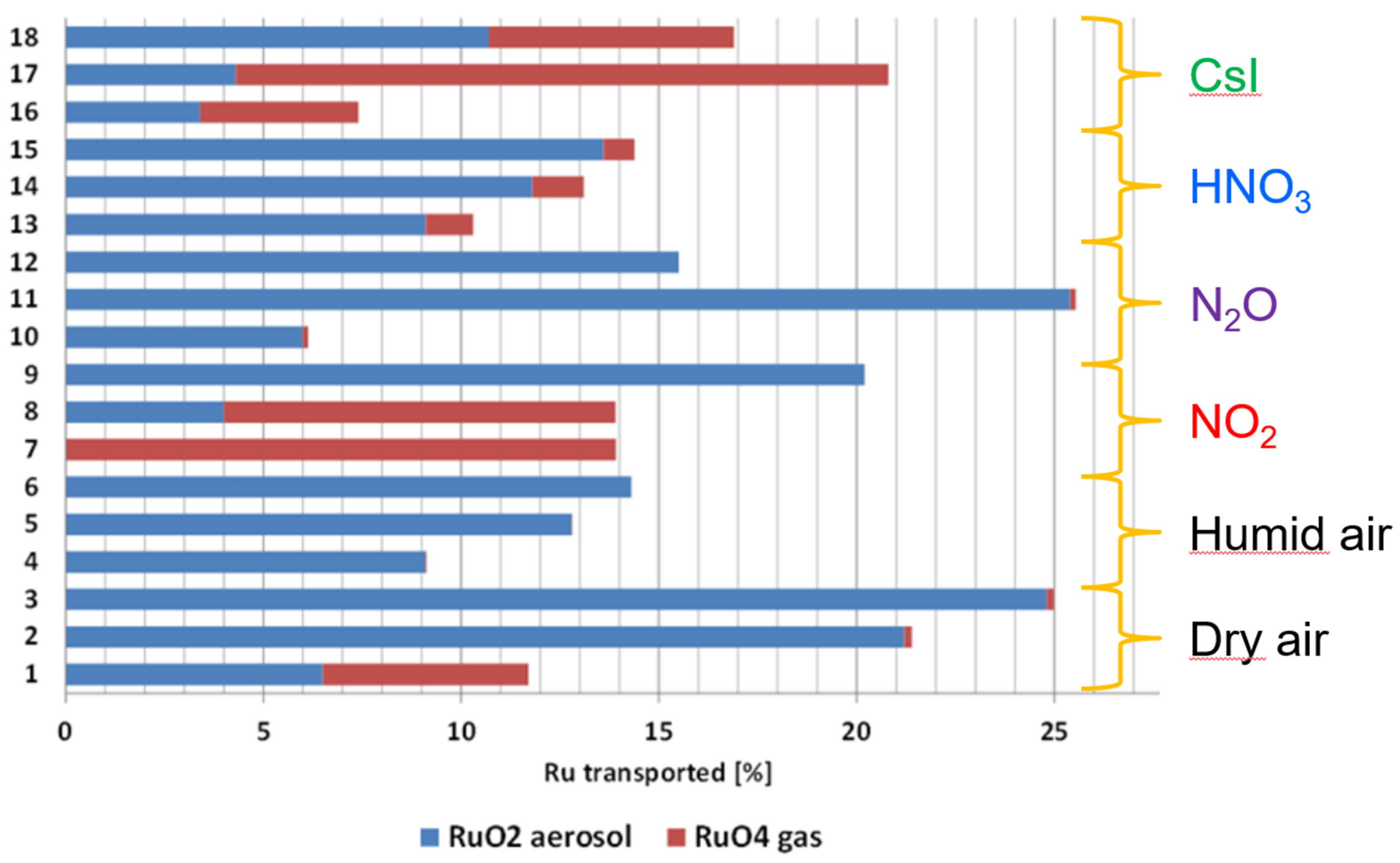

Figure 1. *Transport of ruthenium as gaseous and aerosol compounds. Air radiolysis products may significantly increase the transport of (low volatile) ruthenium as a gaseous compound into the containment building (air ingress conditions). The highest transport of ruthenium as a gaseous compound was observed when CsI reacted with ruthenium oxides.*

The effect of iodine containing fission product deposits reactions on the primary circuit surface for the formation of gaseous iodine, and the transport as gas and particles, at 400 to 700 °C reaction temperatures was investigated.

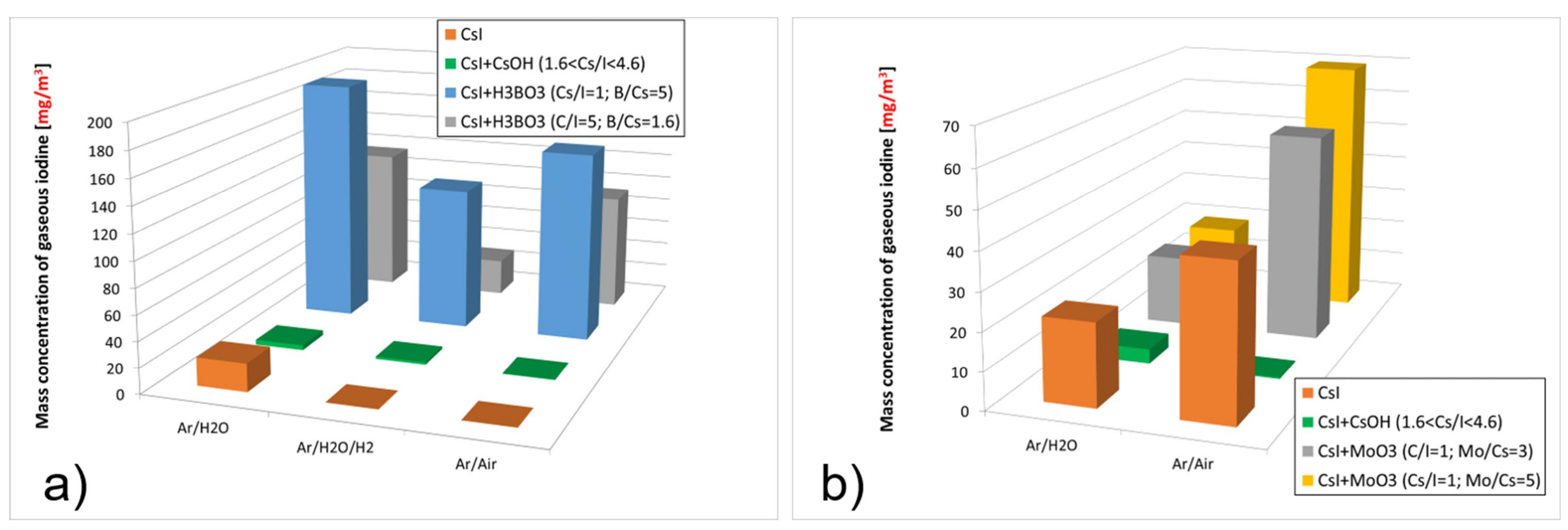

Figure 2. *Transport of iodine as a gaseous compound. a) Boron and b) molybdenum reacted with CsI forming solid caesium-borate and caesium-molybdate, respectively. It resulted in a high formation of gaseous iodine. Oxygen in the atmosphere seemed to enhance the formation of gaseous iodine. Fission product deposits, such as CsI, on the primary circuit surfaces can act as a source of gaseous iodine in a severe accident. The surface deposits could be an important source of gaseous iodine in a long term.*

Pool scrubbing

Both experimental data on gaseous and aerosol compounds retention in the water pools of containment building as well as related model predictions are affected by large uncertainty bands (e.g. at high temperatures and gas flow rates), which make application to reactor cases questionable. Aerosol retention in supression pool conditions at 20 to 100 °C was investigated with experiments (CATFIS project) and subsequent simulations (CASA project) of experiments with ASTEC and MELCOR severe accident analysis codes.

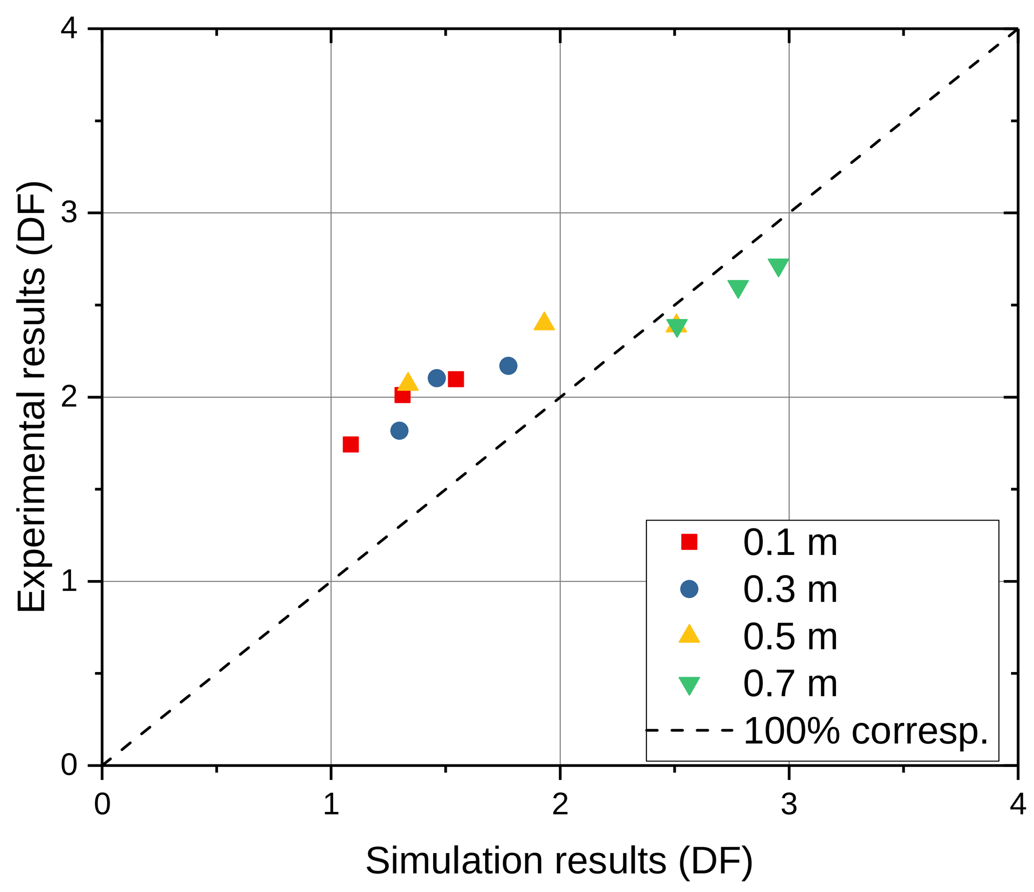

Figure 3. *Comparison of experimental and simulated (ASTEC) decontamination factor (DF) results. Experiments were performed with CsI aerosol at 20 °C varying the pool depth from 0.1 to 0.7 m and non-condensable N_2 flow rate through the pool from 8, 14 to 27 l/min.*

Conclusions

- **Air radiolysis products have an effect on the speciation of fission products.**
- **Surface deposits of fission products are an important source of volatile radionuclides.**
- **Pool scrubbing models are not covering all accident conditions.**
- **New information on fission products behaviour in severe accident conditions to enhance nuclear safety was produced.**
- **International connections were wide and it included collaboration in EU, NUGENIA, OECD, NKS and JAEA projects.**

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