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The Conditioning and Chemistry Programme for MYRRHA

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In 2010 the Chemistry and Conditioning Programme (CCP) was established to provide R&D support for the engineering and licensing of the MYRRHA nuclear system under development at the Belgian Nuclear Research Centre (SCK-CEN). MYRRHA is an accelerator-driven subcritical nuclear reactor with fast neutron spectrum, using liquid lead-bismuth eutectic (LBE) as spallation target material and coolant. The CCP team studies various chemistry-related aspects of the LBE which are important for safety, operation and decommissioning of MYRRHA. In this paper we present an overview of our activities and achievements.

One of the programme's main goals is to develop methods for accurate measurement and control of dissolved oxygen in the LBE coolant. Oxygen control is needed to reduce corrosion of reactor components exposed to LBE and to avoid precipitation of lead oxide in the primary circuit. Our achievements in this domain include the development of new oxygen sensors that measure reliably down to 200 ℃ in both loop and pool configuration, several advanced designs of lead-oxide based solid mass exchangers for oxygen supply to LBE and a new electrochemical oxygen pumping system to precisely regulate dissolved oxygen. Accurate oxygen control on pilot scale has been recently demonstrated in the LBE chemistry loop MEXICO. Experimental studies on oxygen control are supported by various theoretical calculations. Thermochemical calculations have been successful in predicting the influence of temperature and impurities such as corrosion products on oxygen control. Detailed CFD calculations coupled with chemical reactions are used to assess oxygen distribution and transport in the complex geometries of the primary system of MYRRHA.

A second priority is the study of evaporation of several safety-critical radionuclides from LBE. These radionuclides are formed in the LBE by activation of the coolant (polonium), by spallation (mercury, ⋯) or may be released into the LBE through leaking fuel pins (fission products such as iodine). For the experimental study of polonium release, considered to be one of the most important safety issues of LBE-cooled reactors, a dedicated polonium lab has been set up. The evaporation of other elements is typically studied using stable isotopes. In close collaboration with colleagues from especially the Swiss Paul Scherrer institute, we have discovered several physicochemical mechanisms by which polonium can be released from LBE and we have performed studies on methods to capture especially volatile gaseous Po molecules.

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Belgian Nuclear Research Centre

Primary author: Dr AERTS, Alexander (Belgian Nuclear Research Centre)

Co-authors: Dr MARINO, Alessandro (SCK-CEN); Dr GONZALEZ PRIETO, Borja (SCK-CEN); Mr MANFREDI, Gabriele (SCK-CEN); Dr LIM, Jun (Belgian Nuclear Research Centre (SCK-CEN)); Dr ROSSEEL, Kris (SCK--CEN); Mr GLADINEZ, Kristof (SCK-CEN)

Presenter: Dr AERTS, Alexander (Belgian Nuclear Research Centre)

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