IP EUROTRANS: FROM MYRRHA TOWARDS XT-ADS

Background

The integrated project (IP) EUROTRANS (EUROpean Research Programme for the TRANSmutation of High-Level Nuclear Waste in an Accelerator Driven System) has been launched in the Euratom Sixth Framework Programme (FP6) and has officially started in April 2005 for a duration of four years. This project is the logical continuation of several activities worked out within the previous Framework Programme (FP5), namely the ADOPT network, the FUETRA, BASTRA and TESTRA clusters and the PDS-XADS project.

The project is divided into five main sub-projects or domains (DMs). SCK•CEN coordinates the DM1 DESIGN described hereafter. The aim of DM2 ECATS is to provide validated experimental input from relevant coupling experiments of an accelerator, a spallation target and a sub-critical blanket, while the development and demonstration of the associated technologies is devoted to the remaining DMs, DM3 AFTRA (fuels), DM4 DEMETRA (heavy liquid metal technologies) and DM5 NUDATRA (nuclear data).

Objectives

The objective of the DM1 DESIGN of IP EUROTRANS is to proceed by a significant jump towards the demonstration of the industrial transmutation through the ADS route. The strategy of European Transmutation Demonstration (ETD) is carried out with two interconnected activities:

- The first activity is to develop an advanced design file leading to a short-term (i.e. realisation within the next 10 years) experimental demonstration of the technical feasibility of Transmutation (at 50 to 100 MW_{th}) in an Accelerator Driven System (XT-ADS). Liquid lead-bismuth eutectic (LBE) is used as primary coolant and material for the spallation target and the core is designed with standard MOX fuel.
- The second activity is to carry out in parallel a reference conceptual design for a modular EFIT (European Facility for Industrial Transmutation) machine with a power of up to several 100 MW_{th}, as a basis for a cost estimate and safety studies for an ADS-based transmutation system. For the EFIT, liquid lead is used both for the primary coolant and the spallation material. A back-up gas cooling option for EFIT will be studied based on the effort of the PDS-XADS concept, but limited to Minor Actinide (MA) core based EFIT. No primary neither auxiliary systems detailed design works are to be conducted.

The XT-ADS core will be designed in such a way to be able to host a full MA fuel assembly in representative irradiation conditions in terms of dpa and burnup of the EFIT machine. The XT-ADS is intended to be a test bench for the main components and operation scheme for the EFIT and will govern its future design effort. Nonetheless, XT-ADS core performances are also aimed to be typical of a fast spectrum irradiation facility.

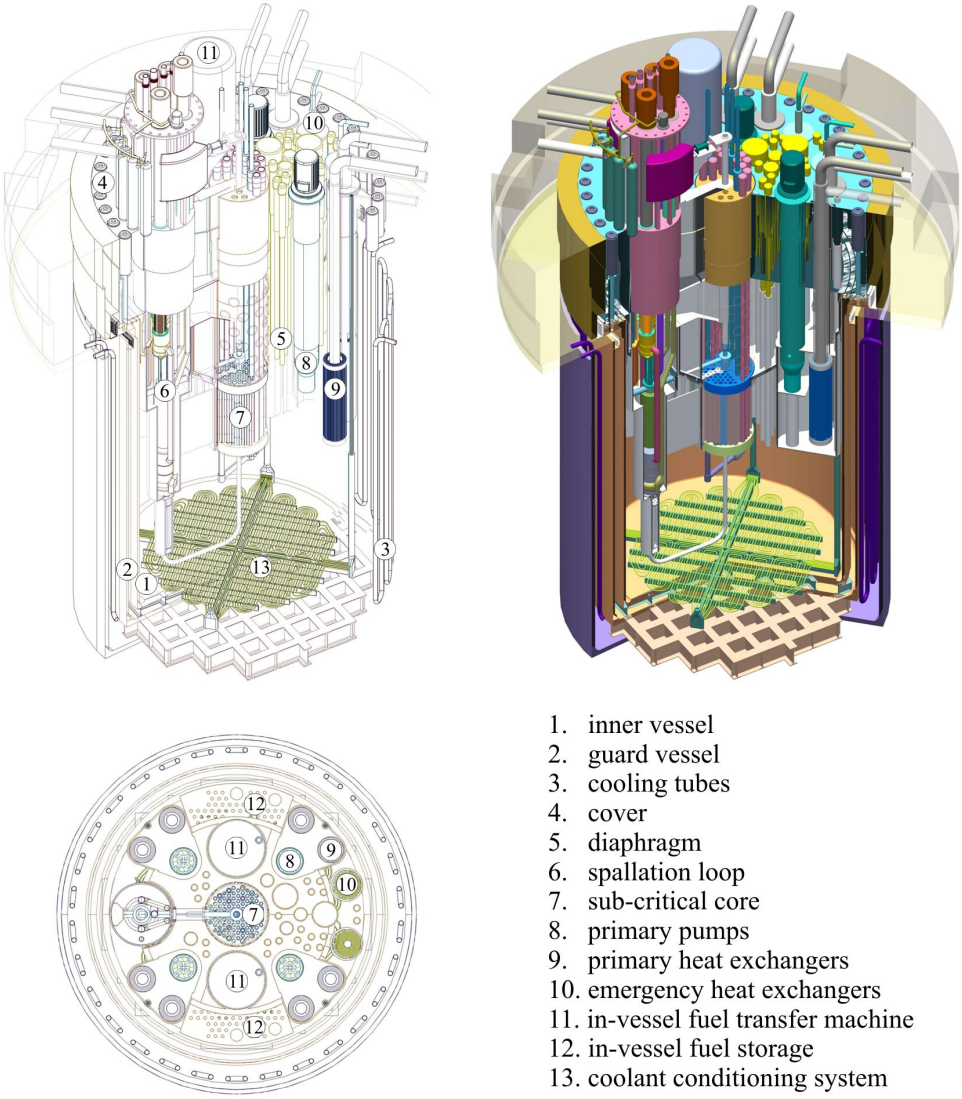
The size and power of EFIT, a first-of-a-kind ETD, should be carefully selected based on the experience gained when introducing the LWR- and FBR-technology in Europe. It should be compatible with the state of science and technology at the end of FP6 to guarantee realisation of an EFIT without a too high risk of failure.

Principal results

During the first months of IP EUROTRANS, SCK•CEN proposed to use MYRRHA (see the figure below) as starting point for the XT-ADS design work. The DM1 partners have approved this proposal. In order to better meet the objectives of XT-ADS, we agree to revisit some options of MYRRHA, mainly:

- investigate the feasibility of core loading from top in order to gain visibility (after a certain amount of LBE has been pumped out) in case of fuel manipulation difficulties without jeopardizing the easy and flexible access to the core for In-Pile sections (IPS) manipulation; this should also enhance the natural circulation for decay heat removal since the distance between cold (emergency heat exchangers) and hot (core) sources might be increased;
- to reduce the pressure in the core by revisiting the P/D ratio of the fuel assemblies;
- to optimise the number of irradiation positions to minimise the number of IPS in the core and the number of penetrations through the diaphragm;
- to re-assess the choice of the proton beam parameters (E_p and I_p) and
- to revisit the diaphragm design taking into account the modifications listed above and the representativity of EFIT.

Having in mind that EFIT is intended as an industrial-scale transmutation facility, the characteristics of EFIT have been defined bearing in mind the efficiency of transmutation, the easiness of operation & maintenance and the high level of availability in order to achieve an economical transmutation.



Overview of the present-day MYRRHA concept

Future work

Besides the mechanical design work that is required to revisit the original MYRRHA options (see above), several other aspects of the XT-ADS can now be further worked out, due to the decision to use MYRRHA as a starting point, namely:

- designing the MOX fuel core, in order to reach acceptable levels of fast and thermal fluxes;
- designing the spallation loop, similar to the MYRRHA loop, but to be integrated in a larger core;
- a first iteration from MYRRHA to XT-ADS on plant layout and remote handling operation;
- and for safety considerations, determining the approach and the acceptance criteria for both XT-ADS and EFIT machines; the safety calculations can only be performed later, when a preliminary design would be available.

Main contact person

Didier De Bruyn didier.de.bruyn@sckcen.be

Main reference

D. De Bruyn & J.U. Knebel (2005) *"The Integrated Project EUROTRANS: EUROpean Research Programme for the TRANSmutation of High Level Nuclear Waste in an Accelerator Driven System (ADS)",* 38th annual meeting of the IAEA Technical Working Group on Fast Reactors & Accelerator Driven Systems, Sao Paolo & Rio de Janeiro (Brazil), May 23 – 27