IP EUROTRANS: A EUROPEAN RESEARCH PROGRAMME FOR THE TRANSMUTATION OF HIGH LEVEL NUCLEAR WASTE IN AN ACCELERATOR DRIVEN SYSTEM

Joachim U. Knebel (FZK)**, Hamid Aït Abderrahim** (SCK-CEN)**, Gianluca Benamati** (ENEA)**, Pierre D'hondt** (SCK-CEN)**, Concetta Fazio** (FZK)**, Enrique Gonzalez** (CIEMAT)**, Stefano Monti** (ENEA)**, Sylvie Pillon** (CEA)**, Dominique Warin** (CEA)

Motivation

Among the prior research and development topics of EURATOM 6th Framework Programme is the management of high-level nuclear wastes. In particular, the development of technical solutions of nuclear waste management is considered important.

Presently, several European associations which are headed by CEA, ENEA, FZK, and SCK-CEN, are preparing the Integrated Project IP EUROTRANS for the WP04 of the EURATOM 6th Framework Programme in the Thematic Priority Area "Management of Radioactive Waste: Transmutation". The focus of this Thematic Priority Area is the evaluation of the industrial practicability of transmutation of high-level nuclear waste in an Accelerator Driven System (ADS) together with the development of the basic knowledge and technologies needed.

Basically, the implementation of partitioning and transmutation of a large part of the high level nuclear wastes in Europe needs the demonstration of the feasibility of several installations at an "engineering" level. The respective research and development activities could be arranged in four so called "building blocks":

1. Demonstration of the capability to process a sizable amount of spent fuel from commercial power plants (i.e. LWR) in order to separate Pu and MA.

2. Demonstration of the capability to fabricate at semi-industrial level the dedicated fuel needed to load a dedicated transmuter.

3. Availability of one or more dedicated transmuters.

4. Realisation of a specific installation for processing of the dedicated fuel unloaded from the transmuter, which can be of a different type than the one used to process the original spent fuel unloaded from the commercial power plants (i.e. LWR), and fabrication of new dedicated fuel.

The number and the size of the installations of each of these building blocks quoted above will depend on the strategy and objectives of a specific policy of nuclear power development. However, a common objective of all strategies using partitioning and transmutation is to reduce the burden on a long-term waste management, in terms of radiotoxicity, volume and heat load of high-level nuclear waste which has to be put into final repositories. Possible strategies can range from using dedicated transmuters in a separate fuel cycle stratum in a stable or expanding nuclear energy scenario, in order to reduce drastically the amount of MA sent to the repository, up to the scenario of a nuclear phase-out.

IP EUROTRANS is dealing with the third building block, being the transmuter.

Objectives of IP EUROTRANS

The IP EUROTRANS concentrates on the development of a dedicated transmuter. Consequently, the objectives of IP EUROTRANS are:

- To develop a reference design for a European Facility for Industrial Transmutation (EFIT) with a power of up to several 100s MW(th).
- To experimentally demonstrate the stable operation and dynamic behaviour of an ADS at power.
- To develop and demonstrate the necessary associated technologies.
- To prove its overall technical feasibility.
- To perform an economic assessment.

The European Facility for Industrial Transmutation (EFIT) is an industrial-scale prototype of a waste burner of about 200 to 300 MW(th). In a first step, this system could be loaded with standard fuel and operated at low power; in a consequent second step its capability has to evolve to the transmutation of high-level waste, such as Minor Actinides, from existing nuclear reactors.

The comprehensive study of a transmutation system during FP6 will provide, together with the results of the FP5 projects in the area of partitioning and transmutation and especially the PDS-XADS project, and the IP EUROPART of FP6, a more consistent and complete feasibility assessment and a cost estimate, which will be then an essential element for decision makers.

Work Programme of IP EUROTRANS

The paper will give an overview of the objectives and the work programme of IP EUROTRANS.

The work programme is organised in five Domains (DM), the major objectives of which are:

1. DM1 DESIGN: Development of a reference design for a European Facility for Industrial Transmutation (EFIT) with a power of up to several 100s MW(th). The coolant for the reference design of the core and the spallation target is a heavy liquid metal (Pb-Bi), but Pb and gas cooling are to be considered as back-up solutions for the core as well. A complementary and consistent objective is to undergo a more detailed design activity leading to a short-term eXperimental demonstration of the technical feasibility of Transmutation in an Accelerator Driven sub-critical System (XT-ADS); i.e. demonstration starting at the least within the next 10 years. The latter facility is representing the first-of-a-kind of the EFIT system.

2. DM2 TRADE-PLUS: Realisation and operation of the experimental facility TRADE to demonstrate the coupling between proton accelerator, spallation target and subcritical blanket at sizeable power (several 100 kWs) in presence of thermal reactor feedback effects. The expected outcomes of this Domain – in terms of proof of stable operability, dynamic behaviour and definition of licensing issues of an ADS – are crucial for and give input to the future realisation of the EFIT and XT-ADS (see DM1 DESIGN).

3. DM3 AFTRA: Design, development and qualification in representative conditions of a U-free fuel concept for the EFIT, compatible with the reference design studied in T1 DESIGN. Ranking of different fuel concepts according to a set of criteria (reprocessability, fabricability, in-pile behaviour according to normal and transient conditions, safety performance in accidental conditions) at the end of the project. Recommendations about fuel design and fuel performance of the most promising fuel candidate(s). Setup of roadmap for fuel licensing. Assessment of the technological feasibility and the time schedule for implementing facilities for the fabrication of the first U-free core. Assessment of facilities to separate the requested americium quantity from spent fuel and to store the curium.

4. DM4 DEMETRA: Improvement and assessment of the Heavy Liquid Metal (HLM) technologies and thermal-hydraulics for application in ADS, and in particular to EFIT and XT-ADS, where the HLM could act both as spallation material and primary coolant; characterisation of the reference structural materials in representative conditions in order to provide the data base needed for design purposes (fuel claddings, in-vessel components and instrumentation, target container, primary vessel, and beam window, etc.).

5. DM5 NUDATRA: Completion of evaluated nuclear data libraries and reaction models for materials in transmutation fuels, coolants, spallation targets, internal structures, and reactor and accelerator shielding, relevant for the design and optimisation of a transmuter.