Fast Reactor development in France

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Fast Reactors (FR) were seen from the beginning as the future of nuclear energy production. The first nuclear electricity was produced in the early 50s by a small experimental fast reactor built on the site of Idaho (USA). Since then, large development programs have been conducted around the world at various speeds according to economical and political situations. The Generation IV initiative and the resulting international cooperation have opened a second step of development with more ambitious criteria and the aim of allowing industrial deployment by the middle of the century.

The basic reason for such a huge effort is simple, fast reactors will allow us to extract a hundred times more energy from uranium than the current light water reactors. In addition they could also help us to simplify the waste management issue by burning long lived products.

In France, the first period of FR development was started in the 50s, and was punctuated by the construction of reactors. First an experimental one (RAPSODIE) a 25 MWth extended to 40 MWth, started in 1967 and shutdown in 1983. Then PHENIX, a 250 MWe prototype operated from 1973 to 2009, a very satisfactory operation with an extensive feedback experience on main issues such as fuel development, in service inspection or minor actinide burning. The industrial prototype, SUPERPHENIX, 1200 MWe, was built in the frame of a European cooperation, started in 1985 but was definitely shutdown in 1998 mainly for political reasons.

The design, construction, start-up and some years of operation of Superphenix have brought a large amount of experience which was first applied for the European Fast Reactor project. This project was ended with the shutdown of Superphenix but considerable progress has already been made in the design and it is still today the most experienced estimate of investment costs for a large size fast reactor.

After a few years of hesitation, a new step of development has been initiated with the aim to pursue the development of fast reactors, both sodium cooled (SFR) and gas cooled (GFR), to reach the criteria of Generation IV systems. In the frame of elaboration of a new law on waste management, it was also decided to put some priority on the possibility of burning actinides and the legislator asked for a demonstration by 2020. Combining both objectives, the French government asked the CEA to prepare a new prototype named ASTRID.

ASTRID will be a SFR power plant prototype, in the range 500-600 MWe aiming to demonstrate technology and design innovations and to provide a step by step demonstration of actinide burning. It should be built on the Marcoule site, close to Phenix location.

According to Gen IV criteria, enhanced safety is a main objective of ASTRID design which will include, from the beginning or in further step, innovations aiming to improve the reliability while reducing the investment cost.

The industry is already participating in the project which is open to international cooperation.

The development of gas cooled fast reactors, which has never been applied in a real application till now, will obviously take more time. R&D is going on and the prospect of building a first experimental reactor is being discussed with several European countries.

Before speaking of MONJU and of the collaboration between France and Japan, let me give a brief view of the situation around the world. As China, India and Korea are represented in this seminar, I shall let their speaker present their program, just congratulating once more China for the start-up of CEFR and mentioning the large prototype near completion in India.

The Russian reactor BN600, started in 1980, is still today the largest fast reactor in operation in the world. The Russian program in this field has also been a long story with many steps, BOR60, BN350, BN600 being the most significant. Original developments were made on fuel fabrication technology with the Vibropak process but the country has not yet industrial experience with MOX fuels.

A new construction, BN800, started nearly 20 years ago, was delayed several times for economic reasons and is now near completion.

Russia has also a specific experience with lead cooled fast reactors (LFR) developed in the frame of naval applications. Many studies for future projects are going on, in particular the BN1200 for SFR and BREST for LFR.

The US were first in the initial step with EBR1 already mentioned and EBR2, an experimental reactor operated for more than 40 years. The program was very intensive with a large industrial project at Clinch River when the US administration decided, at the end of the 70s to stop all developments related to the use of plutonium.

In the 80s, Argonne National Laboratory developed the Integral Fast Reactor concept based upon the use of metallic fuel and pyroprocessing. EBR2 was intensively used for demonstrations but the program was stopped ten years ago.

More recently fast reactors were an important part of the GNEP program which has also been revised and then the Blue Ribbon Commission in charge of making proposals for the national policy on spent fuels and waste management recommends working on the concept of fast reactors for the long term.

Japan and France are cooperating on fast reactor development for a long time. It has started before the construction of the experimental reactor JOYO and has been pursued all along the history of prototypes. Now, the two countries have the most advanced technology with industrial experience and they share the same view on the criteria for Gen IV systems. They play together an important role in the Generation IV International Forum, in particular for the SFR program.

Phenix has been the main tool during the last two decades and now this role should be devoted to Monju before the development could rely, later on, on new prototypes such as Astrid. Both CEA and JAEA have important R&D facilities which could be shared for the necessary demonstration of technology innovations. In my view, it is time for an enhanced collaboration.

In conclusion, fast reactors remain a key step for sustainability of nuclear power. Uranium at low price will not be forever and burying the plutonium is not a good prospect.

Japan has made a large investment in the development of FR. Monju and many R&D facilities are unique tools. The French and the international community hopes this country will continue to contribute to the common goal of future nuclear energy.