Fuel Reprocessing - The Initial Years

***Shri N. Srinivasan** pioneered the development of the reprocessing programme in our country. He was responsible for the design and construction as well as commissioning of the Plutonium Plant at Trombay. He was also the Project Engineer of the Reprocessing Plant PREFRE, at Tarapur. He took charge as the Project Director of Indira Gandhi Centre for Atomic Research (then Reactor Research Centre [RRC]), in 1971 and was responsible for initiating the fast reactor programme in our country. He was the Director of RRC till 1982. Subsequently, he held the positions of the Chief Executive of the Heavy Water Board and member of the Atomic Energy Commission. Shri Srinivasan presently lives at Chennai and he continues to follow and actively support the nuclear pgorammes in our country. Shri Srinivasan is a Fellow of the Indian National Academy of Engineering, Indian Institute of Chemical Engineers and Institution of Engineers.*

The only naturally occurring source of nuclear energy is ^{235}U, accounting for less than one percent of the natural uranium. Thus the extent of occurrence of uranium in nature would have set the limit for growth of this source of energy as is the case with the other natural fuel materials like coal and oil. It is the formation of plutonium and ^{233}U that practically removes the limitation. These manmade fissile materials are produced in fuel irradiated in nuclear reactors. Plutonium recovered from reprocessing of irradiated fuel from thermal reactors can be used in thermal or fast reactors. Reprocessing is of relevance even to systems using enriched uranium since the fuel discharged contains more fissile isotope than natural uranium. Thus reprocessing of irradiated fuel is an important element of any long term nuclear power programme.

Historically, nuclear power exploded into human consciousness with Hiroshima and Nagasaki. Hence discussions on nuclear power have transcended pure techno-economic considerations. Proliferation aspects have clouded the issue. It is also relevant to remember that the few countries who had reprocessing capabilities had established them for military purposes in the first instance. It is however clear that reprocessing irradiated fuel for recovery of plutonium and utilisation of plutonium in second generation reactors are inescapable, if nuclear power programmes have to be meaningful in the long term perspective. For countries like India and Brazil the scope for utilisation of the vast resources of thorium makes reprocessing even more imperative.

To reprocess or not to reprocess irradiated fuel has often been debated on economic as well as safety considerations. The value of recovered plutonium depends on the use it is put to whether within a system or traded to another system. There could be a situation when even recycle in thermal reactors could be worthwhile. Economic and other pressures on the availability of natural uranium would be a major factor influencing decisions regarding reprocessing.

Right in the beginning of the Indian nuclear programme it was realised that indigenous resources of uranium would be limited and there was a need for India to establish capability to be self-sufficient in fuel sources if nuclear power was to make any contribution to the country's economic development. It is a tribute to the foresightedness of the Father of the programme Dr. Homi Bhabha that he decided that India will embark on a reprocessing programme as one of its first major activities.

While Canada India Reactor (CIR) was still under construction the formal order regarding the decision to set up a plant to reprocess irradiated fuel from it was issued. This was dated December 31, 1958. Apart from the historic nature of the decision it conveyed, the modalities set out for the implementation detailed in it were a veritable model for implementation of such path-breaking, scientifically challenging projects in a country which

had been independent for only a decade. The freedom and flexibility in action allowed to the project management ultimately made it possible to complete the project within the sanctioned cost and the committed time schedule.

There was not much detailed information available on the design of such a plant nor was there any experience in the country in handling systems with lot of radioactive material in a loose fluid form. The team was assembled out of very young engineers the oldest of them being twenty five. All the background they had was the course in the (BARC) Training School, which itself was in the formative stage. The plant was designed literally from the first principles of chemistry and chemical engineering. In the absence of experience in the industry for the specifications called for, fabrication of equipment was taken up in-house to ensure effective quality control and also to improvise as it progressed. The availability of engineers and craftsman trained in the construction of CIR was a useful input. As the design phase was nearing completion, some of the design engineers took up supervision of installation literally learning on the job as it went along. Ultimately the plant went 'hot' in August 1964. Help from the Radiochemistry Division, BARC was valuable in establishing the analytical procedures for this plant.

Many were the mistakes and mishaps that occurred during the earlier days, fortunately none resulting in any health hazard to personnel or environment, thanks to the commitment and devotion to the cause on the part of all personnel. The first grammes of plutonium oxide had been produced when the plant was formally inaugurated in Jan. 65. It was the first such facility outside the nuclear club set up under civilian aegis.

Neutron sources based on plutonium-beryllium, until then, were being imported involving agreements through IAEA regarding peaceful use. With the availability of plutonium, production of these sources by personnel of the Isotope Division was the first application-oriented activity. The first button of plutonium metal was produced in August 65. There was a sense of fulfillment among the personnel involved, little realising at that time that this would pave the way for the later "experiment" at Pokhran.

With a few years of experience of reprocessing CIRUS fuel the next logical step was taken, namely the setting up of a plant for reprocessing Tarapur and Rajasthan reactor fuels. This was a big step not only technologically but due to the non-technoeconomic considerations involved. It must however be conceded that at that point of time, the countries involved were not too fussy about safeguards procedures; learning along the way was an acceptable approach.

Now it is history that reprocessing has come of age in this country and experience has been gained in the fabrication of different types of fuel containing plutonium. When FBTR needed carbide fuel it was just one more challenge to be met and it was met successfully.

The really long term prospect of utilising thorium had also been provided for when in 1968 ^{233}U was successfully separated from thorium irradiated in CIRUS and ^{233}U was used in reactor systems.

When the nuclear power programme gets back on its feet, availability of reprocessing capability will not be a constraint. This was indeed the dream of the founders of the programme.