Fabrication and Quality Control of MOX Fuels (FQCMF-2012) : Report of a theme meeting

A theme meeting on “Fabrication and Quality Control of MOX Fuels” was held at AFFF Lecture Hall, BARC, Tarapur on March 16, 2012. The meeting was organized by the Advanced Fuel Fabrication Facility in association with Board of Research in Nuclear Sciences (BRNS), Department of Atomic Energy, Government of India. The meeting was inaugurated by Dr. S. Banerjee, Chairman, Atomic Energy Commission. Dr. Banerjee in his inaugural speech emphasized the need of nuclear energy in our country and the safety of our reactors. He stressed on the importance of fuel fabrication for the forthcoming fast reactor at Kalapakkam. It was followed by presidential address of Dr. R K Sinha, Director, BARC. He conveyed that AFFF has the mandate of fabricating the fuel for the first core and he said that operation of fast reactor with indigenous fuel will be a landmark in Nuclear Power Programme. He also appreciated the safety norms that are being followed during the handling of radioactive materials. Dr. G J Prasad, Director, Nuclear Fuels Group welcomed all the guests and appreciated for the keen interest shown by different groups of DAE for participating in this theme meeting. Dr. Jose P Panakkal, Head, AFFF in his introductory remark mentioned that fabrication of forty thousand pins for PFBR is a challenging task and AFFF is determined to complete this task. In the past also, it has fabricated fuels for different types of reactors and all of them have been irradiated successfully. Md. Afzal, Plant Superintendent, AFFF was instrumental in comparing the inaugural session with other Senior officers of BARC at the inaugural event.
and proposed a vote of thanks. Among the other dignitaries present on the dais was Shri S Basu, Chief Executive, Nuclear Recycle Board.

The meeting was divided in two sessions. The Session-I began with the key note address by Dr. Jose P Panakkal on MOX fuel programme in India. In his presentation, he covered the fabrication procedure followed for fabrication and quality control of MOX fuel, new techniques developed for fabrication, process, quality control and characterization of fuels.

The key note address was followed by invited talks. Dr. K L Ramakumar briefed about the chemical quality control measurements for MOX fuel. He explained to the participants how analytical chemistry is indispensable and plays an important role in the entire nuclear fuel cycle activities starting from ore refining, conversion, nuclear fuel fabrication, reactor operation, nuclear fuel reprocessing to waste management. Since India is fabricating fuels for various types of reactors, a number of analytical parameters need to be determined as a part of chemical quality control of nuclear materials. Chemical quality control provides a means to ensure that the quality of the fabricated fuel conforms to the chemical specifications for the fuel laid down by the fuel designer. His talk covered analytical methodology for chemical quality control measurements, criteria for selection of analytical techniques and statistical treatment required to express the analytical results.

The next talk was delivered by Shri Arun Kumar, Associate Director, NFG. His talk was on evolution of MOX fuel for thermal reactors. He explained that though plutonium is more suitable to fast reactors due to its neutronic characteristics, recycling of plutonium in thermal reactors is in use due to various factors like reduction in demand of natural uranium, increasing the design burn up of fuel and disposition of plutonium of military origin. Starting form explaining the use of MOX in thermal reactors worldwide, he narrated the works carried out in Indian scenario. He conveyed to the audience that the MOX fuel fabrication for thermal reactors has led to the development of various novel technology and techniques which has given a strong base for fabrication of \( (U\text{-Pu})O_2 \) MOX fuel on industrial scale for our fast reactor programme.

The first session was chaired by Dr. A K Suri, Director, Materials Group.

The Second session started with the presentation of Dr. T Jayakumar, Director, Metallurgy and Materials Group, IGCAR on performance evaluation of mixed carbide and mixed oxide fuels irradiated in FBTR. He told that systematic performance evaluation of the fuel through Post Irradiation Examination (PIE) at different burn ups has enabled understanding the behavior of plutonium rich carbide fuel and provided the confidence in increasing the burn up in stages to a maximum of 165 Gwd/t well beyond the initial burn up limit. He also explained how the beginning of life gap closure behavior was evaluated using an experimental PFBR MOX fuel pin having the fuel composition \( (U_{0.71}\text{-Pu}_{0.29})O_2 \). The feedback from the PIE on the MOX fuel performance will be useful for the designers to arrive at the optimum fuel specifications.

Shri S. Anantraman, Head, PIED delivered a talk on the Post irradiation studies on Mixed oxide fuels. He briefed that Post irradiation examination is an integral part of any fuel development programme. His paper provided a brief review of results of the examination and explained the difference between the irradiation performance of urania - plutonia MOX fuels from that of thoria - plutonia MOX fuels.

Md. Afzal, Plant Superintendent, AFFF discussed the experience in the fabrication of MOX fuel. His presentation was detailed deliberation of glove box design, process equipment design and automation system for plutonium based fuel fabrication. He explained how the design of glove box, process equipment and the automation system should take into account the three constraints of the availability of space, occupancy and geometry of the fabrication.
equipment, visibility and approachability in the glove box. Implementation of the interlinked design as a whole overcomes the constraints imposed by the glove box.

Shri G V S Hemanth Rao, DCE, Nuclear Fuel Complex presented the fabrication of fuel subassemblies for fast reactors. He informed that manufacturing capability of Indian industry was used effectively for precision components. Special purpose machines required for variety of assembly operation were developed indigenously. Fabrication operations were mastered including optimization of process parameters and quality control techniques. Welding operations typical to FBTR and PFBR component fabrication were developed in house successfully with the help of fixtures and tooling specifically developed for this purpose.

Shri D Mukherjee, Head, MES, QAD talked on quality surveillance of MOX fuels. Quality surveillance of nuclear fuels include all the technical and management aspects of fuel quality and safety during the entire manufacturing process. Well structured quality assurance programme is adopted and incorporated in the quality control plan made based on approved specification for a specific MOX fuel type used in a specific reactor (BWR, PHWR, PFBR).

The second session was chaired by Dr. G J Prasad, Director, Nuclear Fuels Group.