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Editorial

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Nuclear fuel cycle

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Editorial

The nuclear fuel cycle is also called as nuclear fuel chain, it was the process that progress the nuclear fuel through different stages. In the first stage, fuel is prepared at the steps in the front end. In the second stage, steps in the service period at which the fuel is used during reactor operation. In the final stage, reprocess or dispose of spent nuclear fuel at the steps in the back end which are necessary to safely manage. If spent fuel is not reprocessed, it is referred as open fuel cycle. If spent fuel is reprocessed, it is referred as a closed fuel cycle.

Nuclear fuel cycle begins when uranium is undergoes through various stages such as mining, milling, conversion, enrichment, and fuel fabrication where the nuclear fuel is manufactured, which is delivered to a nuclear power plant. The spent fuel is delivered to a reprocessing plant after using at the power plant. In reprocessing 95% of the spent fuel can be recycled and returned to the nuclear power plant for usage. In mining, uranium ore is mined using open pit and underground methods. It is similar as the methods used for the mining of other minerals. In Milling, mined uranium ores are processed to a uniform particle size and then treating the ore to extract the uranium by chemical leaching. In this process, it yields a dry powder-form material consisting of natural uranium, known as yellow-cake also called as U3O8.

In conversion, (tri-uranium octoxide) is processed into either of two substances depending on the intended use

For use in most reactors, U3O8 is usually converted to uranium hexafluoride (UF6), the input stock for most commercial uranium enrichment facilities.

For use in reactors such as CANDU which do not require enriched fuel, the U3O8 may instead be converted to uranium dioxide (UO2) which can be included in ceramic fuel elements. In enrichment, UF6 produced from natural uranium sources must be enriched to a higher concentration of the fissionable isotope before being used as nuclear fuel in such reactors. The level of enrichment for a particular nuclear fuel order is specified by the customer according to the application they will use it for: light-water reactor fuel normally is enriched to 3.5% U-235, but uranium enriched to lower concentrations is also required. Enrichment is accomplished using any of several methods of isotope separation, gaseous-diffusion, and gas centrifuge. In fabrication, uranium hexafluoride is converted into uranium dioxide (UO2) powder that is then processed into pellet form. The pellets are then fired in a high temperature sintering furnace to create hard ceramic pellets of enriched uranium. The cylindrical pellets then undergo a grinding process to achieve a uniform pellet size. The pellets are stacked, according to each nuclear reactor core's design specifications, into tubes of corrosion-resistant metal alloy. The tubes are sealed to contain the fuel pellets: these tubes are called fuel rods. The finished fuel rods are grouped in special fuel assemblies that are then used to build up the nuclear fuel core of a power reactor.

The alloy used for the tubes depends on the design of the reactor. Stainless steel was used in the past, but most reactors now use a Zirconium alloy. For the most common types of reactors, boiling water reactors (BWR) and Pressurized water reactors (PWR). Transport of radioactive materials

Transport is an integral part of the nuclear fuel cycle. There are nuclear power reactors in operation in several countries, but uranium mining is viable in only a few areas. Also, the course of over forty years of operation by the nuclear industry, the number of specialized facilities have been developed in various locations around the world to provide fuel cycle services and there is a need to transport nuclear materials to and from these facilities. Most transports of nuclear fuel material occur between different stages of the cycle, but occasionally a material may be transported between similar facilities. With some exceptions, nuclear fuel cycle materials are transported in solid form, the exception being uranium hexafluoride (UF6) which is considered a gas. Most of the material used in nuclear fuel is transported several times during the cycle. Transports are frequently international and are often over large distances. Nuclear materials are generally transported by specialized transport companies. Since nuclear materials are radioactive, it is important to ensure that radiation exposure of those involved in the transport of such materials and of the public along transport routes is limited. Packaging for nuclear materials includes, where appropriate, shielding to reduce potential radiation exposures. In the case of some materials, such as fresh uranium fuel assemblies, the radiation levels and no shielding is required. Other materials, such as spent fuel and high-level waste, are highly radioactive and require special handling. To limit the risk in transporting highly radioactive materials, containers known as spent nuclear shipping casks.

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