Impact of the Nuclear Fuel Cycle on the Environment

R.C. EWING[1]

[1]Nulcear Eng. & Radiological Sciences and Geological Sciences, University of Michigan, Ann Arbor, MI, 48109, USA (rodewing@umich.edu)

The nuclear fuel cycle impacts two types of geochemical cycles: **Carbon cycle**: reduced emissions of carbon to the atmosphere as nuclear power plants replace carbon-based sources of energy. **Radionuclide cycles**: increased production of technogenic radionuclides in spent nuclear fuel (SNF). Depending on national policy, the SNF is considered a waste product, or fissile nuclides, such as ^{235}U and ^{239}Pu, can be recycled for further energy production, However, most fission products and the "minor" actinides (Cm, Am, Np) are generally considered waste. Unlike other energy producing systems, the by-product, fissile nuclides, can be diverted for weapons production. This paper analyzes the global impact of increased utilization of the nuclear fuel cycle.

Carbon Cycle: In Kyoto, a Framework Convention on Climate Change proposed a reduction of greenhouse-gas emissions of industrialized countries by 5 percent below 1990 levels, over the next ten to fifteen years. However, energy demands world-wide are increasing and are expected to at least double over the next fifty years. The amount of energy supplied by carbon-free sources must grow by a factor of ten to twenty by 2050 (Fetter, 2000). At present, the use of nuclear power plants avoids carbon dioxide emissions of an estimated 600 million metric tons per year. However, in order to impact carbon emissions in a significant way by 2050, electrical power production by nuclear plants would have to reach 3,300 gigawatt-years (a single GW-year is the output of a large electric power plant) (Sailor et al., 2000). Even if the installed capacity of nuclear power plants only reaches 1,000 GW, there is the potential to avoid the emission of 6 billion metric tons of CO_2. Although this number is large, it has to be evaluated in the context of carbon exchange fluxes and sinks between the atmosphere, land and oceans.

Radionuclide Cycles: Although the use of nuclear power plants to produce electricity will reduce CO_2 emissions, there will also be a concomitant increase in the production of SNF and high-level nuclear waste. In 2002, approximately 150,000 metric tons of SNF have already accumulated. One of the principal concerns is the production of technogenic radionuclides, such as the transuranium elements, particularly Pu. There is presently a global inventory of over 1,400 metric tons of Pu. At present, the annual production of spent nuclear fuel is on the order of 10,000 metric tons (containing approximately 100 metric tons of fissile Pu). A ten-fold increase in nuclear power plants will yield substantial quantities of spent nuclear fuel, approximately 100,000 metric tons per year (for comparison, the legislated capacity for the proposed geologic repository at Yucca Mountain is 70,000 metric tons of SNF).

References

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