Sustainable Energy Through Recycling Used Nuclear Fuel

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Recycle of used nuclear fuel is central to the successful deployment of sustainable nuclear energy systems. Argonne National Laboratory is developing and demonstrating cost-effective, commercially viable fuel recycling technologies that integrate easily with the fuel manufacturing process. These technologies are designed to recover actinides for recycle in a manner that meets the non-proliferation objectives of the United States and encapsulate the unusable fission products in durable waste forms for disposal in an environmentally responsible manner. Two recycle technologies are currently under development – aqueous and pyrochemical. Aqueous process development activities are focused on designing and demonstrating simplified separations processes that directly yield mixtures of actinides suitable for recycle to power systems. For example, a single process is being developed to replace two processes to separate transuranic elements from fission products. The fundamental kinetic and transport data needed for process development are being collected using innovative microfluidic systems. Optimization of centrifugal contactors, which are efficient mixer – separators used in solvent extraction processes, is also being pursued to further improve process efficiency and reduce process waste. Other aqueous research includes modeling of solvent extraction and used fuel dissolution processes, and implementation of on-line systems for process monitoring and safeguards. Pyrochemical process development focuses on designing and demonstrating electrochemical methods to extract actinides from used nuclear fuel. This approach is ideally suited for treating metallic fuels but with a head-end conversion process can be used to treat oxide fuels. Process development activities include recovering actinides from molten salt solutions by electrochemical co-deposition, evaluating a bottom-pour system designed for separating actinide metals from molten salt, and demonstrating electroanalytical techniques for process monitoring and safeguards. This presentation will provide a brief survey of both treatment technologies including a discussion of significant development activities.