480c Determination of Bubble Size Distribution in an Oxide Reduction Electrochemical Cell

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The electrometallurgical treatment of spent nuclear fuel in a metal form has been demonstrated and is currently in operation at the Idaho National Laboratory (formerly Argonne National Laboratory – West). This treatment is based on the anodic dissolution of an irradiated metal fuel in a molten salt electrolyte and the simultaneous deposition and recovery of uranium metal. The fission products are separated from the fuel in the process and are subsequently sequestered in engineered waste forms. In order to extend the electrometallurgical treatment technology to oxide-based fuels, a head-end operation is required to first reduce an oxide fuel to metal. Such a head-end process is referred to as oxide reduction and is being developed at the Idaho National Laboratory. In the oxide reduction process uranium oxide is converted to uranium metal (cathode) and to oxygen gas (anode) by electrolytic means within a molten salt electrolyte (LiCl) at 650 ºC.

Despite extensive research and development of the oxide reduction process, there is still a concern regarding the generation of oxygen bubbles around the anode which potentially lowers the cell efficiency. This issue has not been thoroughly investigated and therefore provides the motivation to study the effect of physical properties and device geometry on bubble size distribution for gas-liquid interaction in this electrolytic reduction process.

To theoretically predict and experimentally assess this problem, a fundamental mock-up study for this process has been designed to focus on the effect of continuous phase viscosity on the bubble size distribution. To vary this parameter, bubbles are generated using an electrochemical technique in glycerol, water, and glycerol/water solutions. The reasons for choosing these liquid mediums relate to the physical properties of actual LiCl used in pyrochemical operations. Data were acquired using a high-speed imaging system with interchangeable macro-lens and automated image analysis software. Results will be given and discussed along with a qualitative explanation.