Experiences Revitalizing and Advancing Molten Salt Technology

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Abstract:

Over fifty years ago an 8 MW thermal test reactor called the Molten Salt Reactor Experiment (MSRE) began its operation at Oak Ridge National Laboratory. The nuclear reactor was unique in that it used fuel dissolved within a molten fluoride salt to generate heat at temperatures in excess of 600°C and pressures around an atmosphere; these features give way to many safety and cost improvements as compared to a light water reactor. Over its four year operation, the MSRE accrued more than 15,000 full power hours and demonstrated the feasibility of high temperature nuclear operation with molten salts. Out of many accomplishments, the most notable may be the complete removal of $^{235}UF_4$ from the fuel salt via fluorination and the subsequent introduction of $^{233}UF_4$, making it the first reactor in the world to use ^{233}U as the singular fissile material. Despite the success of the MSRE, the program was canceled in 1969 and its documentation was preserved for future generations.

Fifty years later, proactive citizens are searching for a baseload power source with minimal carbon emissions. At the same time, energy companies are looking for a cheaper alternative to light water reactors which can hedge against the volatile price of natural gas. A molten salt reactor may satisfy these requirements. While MSRE staff documented their exploits in great detail, recreating and advancing their work is a challenge. Purification of salt, a necessary step in high quality research, is non-intuitive and can involve exotic chemical processes. Designing basic equipment requires knowledge of suitable alloys capable of withstanding salt exposure. Pumps, flanges, valves, and instrumentation, necessary for larger equipment, must be tested for their robustness in salt environments. Even working with molten salts, which melt from 200-800°C depending on the composition, requires working by an unusual set of rules. This talk aims to explore these basic issues which must be solved before a molten salt reactor can be constructed, as well as some of the solutions and successes.

Bio:

Brian Kelleher is currently a research engineer at TerraPower tasked with investigating the high temperature corrosion of alloys in flowing molten chloride salts. Molten salts are potential heat transfer fluids for high temperature processes and may find application in thermal storage, solar thermal power plants, or next generation nuclear reactors. In addition to his corrosion studies, he also explores molten salt electrochemistry, purification, and component testing. Prior to TerraPower, he received his doctorate in Nuclear Engineering from the University of Wisconsin – Madison where he purified and chemically qualified Li_2BeF_4 --- commonly known as flibe --- for molten salt reactor applications. On sunny weekends Brian enjoys spending time alpine climbing, skiing, camping, and hiking in the Cascade Range.