

Thermal Modeling of the Sandia Flinabe (LiF-BeF₂-NaF) Melt Experiment

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An experiment at Sandia National Laboratories confirmed that a ternary salt salt (Flinabe, a ternary mixture of LiF, BeF₂ and NaF) had a sufficiently low melting temperature (~305°C) to be useful for first wall and blanket applications using flowing molten salts that were investigated in the Advanced Power Extraction (APEX) Program.[1] In the experiment, the salt pool was contained in a stainless steel crucible under vacuum. One thermocouple was placed in the salt and two others were embedded in the crucible. The results and observations from the experiment are reported in the companion paper.[2] The paper presented here will cover a 3-D finite element thermal analysis of the salt pool and crucible. The analysis was done to evaluate the thermal gradients in the salt pool and crucible and to compare the temperatures of the three thermocouples. One salt mixture appeared to melt and to solidify as a eutectic with a visible plateau in the cooling curve (i. e, time versus temperature for the thermocouple in the salt pool). This behavior was reproduced with the thermal model. Cases were run with several values of the thermal conductivity and latent heat of fusion to see the parametric effects of these changes on the respective cooling curves. The crucible was heated by an electrical heater in an inverted well at the base of the crucible. It lost heat primarily by radiation from the outer surfaces of the crucible and the top surface of the salt. The primary independent factors in the model were the emissivity of the crucible (and of the salt) and the fraction of the heater power coupled into the crucible. The model was “calibrated” using (thermocouple) data and heating power from runs in which the crucible contained no salt.

[1] R.E. Nygren et al., A Fusion Reactor Design with a Liquid First Wall and Divertor, to be published in a special issue of Fusion Engineering and Design

[2] T. J. Lutz, T. J. Tanaka,,J.M. McDonald R.E. Nygren, K. P. Troncusa, T.J. Boyle, and M.A. Ulrickson, Measurement of the Melting Point Temperature of Several Lithium-sodium-beryllium Flouride Salt (Flinabe) Mixtures, this conference

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