Measurement Of The Melting Point Temperature Of Several Lithium-Sodium-Beryllium Fluoride Salt (FLiNaBe) Mixtures

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The molten salt Flibe, a combination of lithium and beryllium flourides, was studied for molten salt fission reactors and has been proposed as a breeder and coolant for the fusion applications. $2LiF\text{-}BeF_2$ melts at 460°C. $LiF\text{-}BeF_2$ melts at a lower temperature, 363°C, but is rather viscous and has less lithium breeder. In the Advanced Power Extraction (APEX) Program, concepts with a free flowing ternary molten salt for the first wall surface and blanket were investigated.[1] The molten salt (FLiNaBe, a ternary mixture of LiF, BeF2 and NaF) salt was selected because a melting temperature below 350°C that would provide an attractive operating temperature window for a reactor application appeared possible. This information came from a Russian binary phase diagram [2] and a US ternary phase diagram [3] in the 1960's that were not wholly consistent. To confirm that a ternary salt with a low melting temperature existed, several combinations of the fluoride salts, LiF, NaF and, BeF_2, were melted in a small stainless steel crucible under vacuum. The proportions of the three salts were selected to yield conglomerate salts with as low a melting temperature as possible. The temperature of the salts and the crucible were recorded during the melting and subsequent re-solidification using a thermocouple directly in the salt pool and two thermocouples embedded in the crucible. One mixture had an apparent melting temperature of 305°C. Particular attention was paid to the cooling curve of the salt temperature to observe evidence of any mixed intermediate phases between the fully liquid and fully solid states. The clarity, texture, and thickness were observed and noted as well. The test system, preparation of the mixtures, and the melting procedure are described. The temperature curves for the melting and cooling of each of the mixtures are presented along with the apparent melting points. Thermal modeling of the salt pool and crucible was also done and is reported in a separate paper.

[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] N.A. Toropov, I.L. Shchetnikova, Modelnye Sistemy – $Na_2BeF_4\text{-}Li_2BeF_4$ I $Ca_2SiO_4\text{-}Mg_2SiO_4$, Zhurnal Neorganische Khimi 2,8 (1957) 1855-1863; phase diagram.

[3] R.E. Moore, C.J. Barton, W.R. Grimes, R.E. Meadows, L.M. Bratcher, G.D. White, T.N. McVay, L.A. Harris, Phase Diagrams of Nuclear Reactor Materials, R.B. Thoma ed., Oak Ridge National Laboratory, ORNL-2548 (1959) 43; phase diagram also in E.M. Levin, C.R. Robbins, H.F. McMurdie (M.K. Reser, ed.), *Phase Diagrams for Ceramists*, American Ceramic Society, (1979) 436.

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