The Viscosimetry of Molten Alkali Metal Fluoborates

PLATINUM COMPONENTS SERVE SUCCESSFULLY UNDER THE ARDUOUS CONDITIONS ENCOUNTERED

The alkali metal fluoborates, well established as brazing fluxes, have been under consideration as heat transfer media for use in molten salt breeder reactors. Recently, a study of the viscosity of these compounds at various temperatures has been carried out at the AERE Harwell Research Laboratories. The viscosimeter employed was of the bob and cup type, where a bob (or spindle) is rotated in a cup containing the fluid under investigation.

A prototype constructed from stainless steel was used for one run to establish that the design and dimensions of the viscosimeter were satisfactory, but the highly corrosive nature of the compounds precluded the use of base metals in any part of the apparatus exposed to the melt during the experimental runs.

The general arrangement of the viscosimeter is shown in Figure 1. To avoid spurious heating effects, the motor drive and the sensor for the bob were located as far from the furnace as practicable. The shape of the final bob design is shown in Figure 2.

At an early stage in the work it was proposed

Variation of Viscosity with Temperature for a $K_2B_3F_5O_3$ Melt

Temperature °C	Viscosity cP	log (cP)
250	23600	4.37
260	9510	3.98
270	4490	3.65
280	2370	3.37
300	854	2.93
320	403	2.61
350	174	2.24
380	102	2.01
410	73	1.86
500	39.3	1.59
575	24.8	1.39
625	17.8	1.25
650	16.6	1.22
700	14.4	1.16

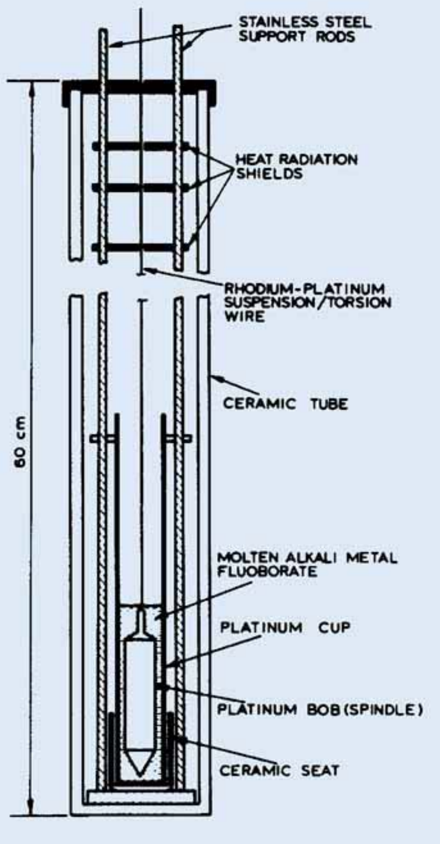

Fig. 1 The viscosimeter cup and spindle were supported in an electrical resistance furnace by means of a stainless steel frame arranged inside a ceramic tube. The remotely located spindle drive and sensor were protected from radiant heat by a series of heat shields

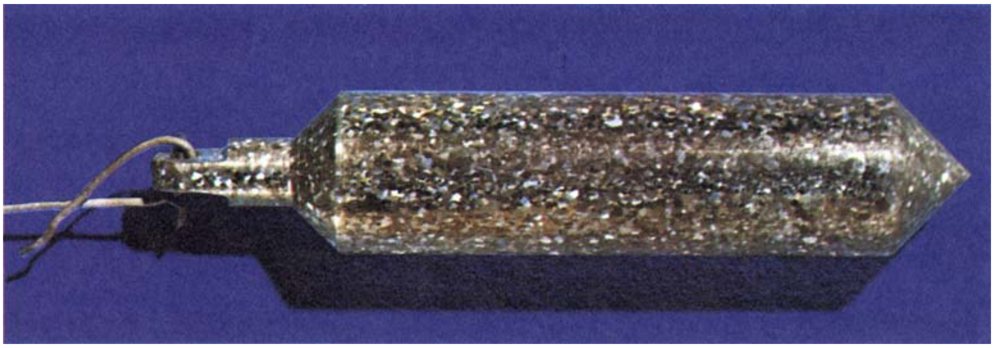

Fig. 2 The viscosimeter spindle, which weighed approximately 60 g, was machined from a solid piece of platinum to a diameter of 1 cm and an overall length of 4.3 cm, while the internal diameter of the cup was 1.25 cm and the depth 12 cm. The finely etched surface texture seen on the platinum resulted from attack by the molten alkali metal fluoborate but it had no effect on the viscosity measurements

to use platinum-coated stainless steel apparatus, and the most suitable method of coating the inside of the cup was considered to be by plasma vapour deposition. However, in practice, this coating was penetrated rapidly by the melt and detached from the steel. For this reason recourse was made to solid platinum.

The bob was machined from rod, while the cup was made by welding a bottom plate onto a seamless platinum tube, and both proved to be entirely satisfactory. After several experimental runs the platinum bob was attacked slightly, revealing the finely etched grain structure which can be seen in Figure 2. However this minor roughening was insufficient to produce any detectable effect on the measured viscosity.

Under the experimental conditions normally employed, it was found that the bob was self-centering in the cup of molten compound. This enabled a thin flexible 13 per cent rhodium-platinum wire to be used to suspend, and provide torsion to, the bob, the high specific mass of which helped rotational stability.

The viscosity of a typical alkali fluoborate, measured over a range of temperatures by means of the apparatus described, is given in the Table.

The ease of fabrication of platinum and its resistance to corrosion at high temperatures has once again made practicable the investigation of an otherwise difficult problem. It is probable that this technique will be of value for the high temperature study of slags, glasses and other aggressive molten salt systems. J.H.F.N.

Spotlight on the Platinum Metals

Continuing its series of major features on the non-ferrous metals, the Metals Society has compiled two lengthy and instructive articles on the platinum group metals and their unique role in modern industry. Part I, by R. J. Dowsing, the Associate Editor, was published in the May issue of *Metals and Materials* and reviews the history of the six metals and their isolation and then details their properties and characteristics. There follows a full review of current practice at Rustenburg Platinum Mines, where the immense deposits of the Merensky Reef are exploited. A flow chart illustrates the treatment of the ore, from initial crushing, ball milling and flotation on to electric smelting, from where the matte is enriched by oxygen blowing in converters, ground and then subjected to magnetic separation, followed by pressure leaching to yield a concentrate.

In Part II of the article, to appear in the July issue of *Metals and Materials*, the complex and lengthy refining processes needed to separate and purify the six metals—platinum, palladium, rhodium, iridium, osmium and ruthenium—in the Johnson Matthey refineries are described, followed by an account of the many industrial uses of the platinum metals and by a discussion of trends in supply and demand.