The Thermal Conductivity of Molten KHF_2

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The thermal conductivity of the molten KHF_2 has been determined by means of a specially developed experimental facility at 250 to 450 °C.

Keywords: Molten KHF_2, Thermal Conductivity

Molten fluorides can be applied as heat carriers. Therefore it is necessary to know their thermophysical properties in a wide range of temperatures.

1. Some Characteristics of KHF_2

KHF_2 transforms from an alpha to a beta phase at 195 °C and has a relatively low melting point (approx. 240 °C) [5]. It is used for the production of elementary fluorine [1]. Part of the phase diagram of the system KF-HF is shown in Figure 1 [2]. Density-measurements have been published in [3, 4].

2. Principle of the Measurements

An apparatus has been developed to measure the thermal conductivity of any molten fluoride. The method uses temperature measurements on the out- and inside of an annular layer of the studied molten salt and simultaneous heater electrical power measurements. The thermal flow penetrates the annular layer of the melt radially. The thermal conductivity of the melt is than computed from the measured data by a Fourier's equation, adjusted to this particular case:

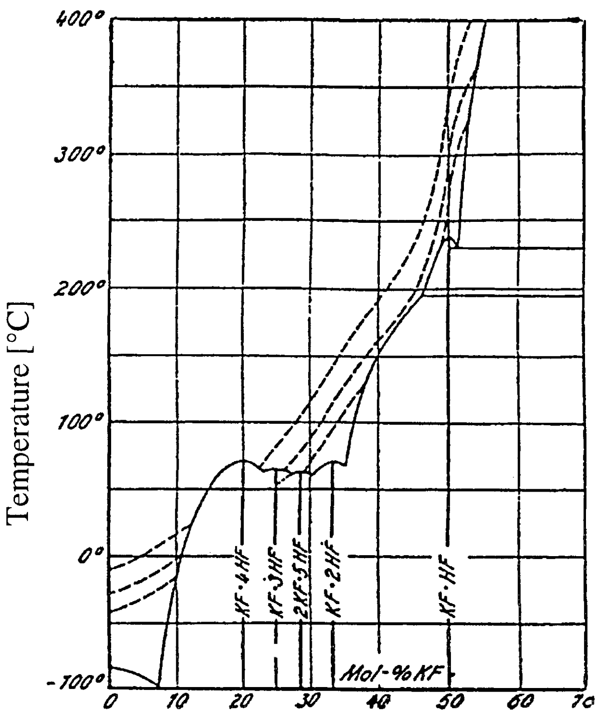

Fig. 1. Phase diagram of KF-HF system.

$$\lambda = \frac{Q\lambda_1 \ln \frac{r_2}{r_1}}{\lambda_1 (T_2 - T_1) 2\pi l - Q\left(\ln \frac{r_1}{r_0} + \ln \frac{r_3}{r_2}\right)} \text{[W/mK]}$$

where
Q = electrical power of the heater [W],
λ_1 = thermal conductivity of the apparatus material [W/m K],
r_i = radius [m], for $i = 0, 1, 2, 3$ cf. Figure 2,
T_2 = temperature on the inside surface [K],
T_1 = temperature on the outside surface [K,]
l = length of the active tube [m], Figure 2.

3. The Apparatus and the Measurement Procedure

The apparatus is shown in Figure 2.

Vacuum and overpressure leak tests of the apparatus were carried out at room- and elevated temperatures. Dry nitrogen was used as testing as well as cover

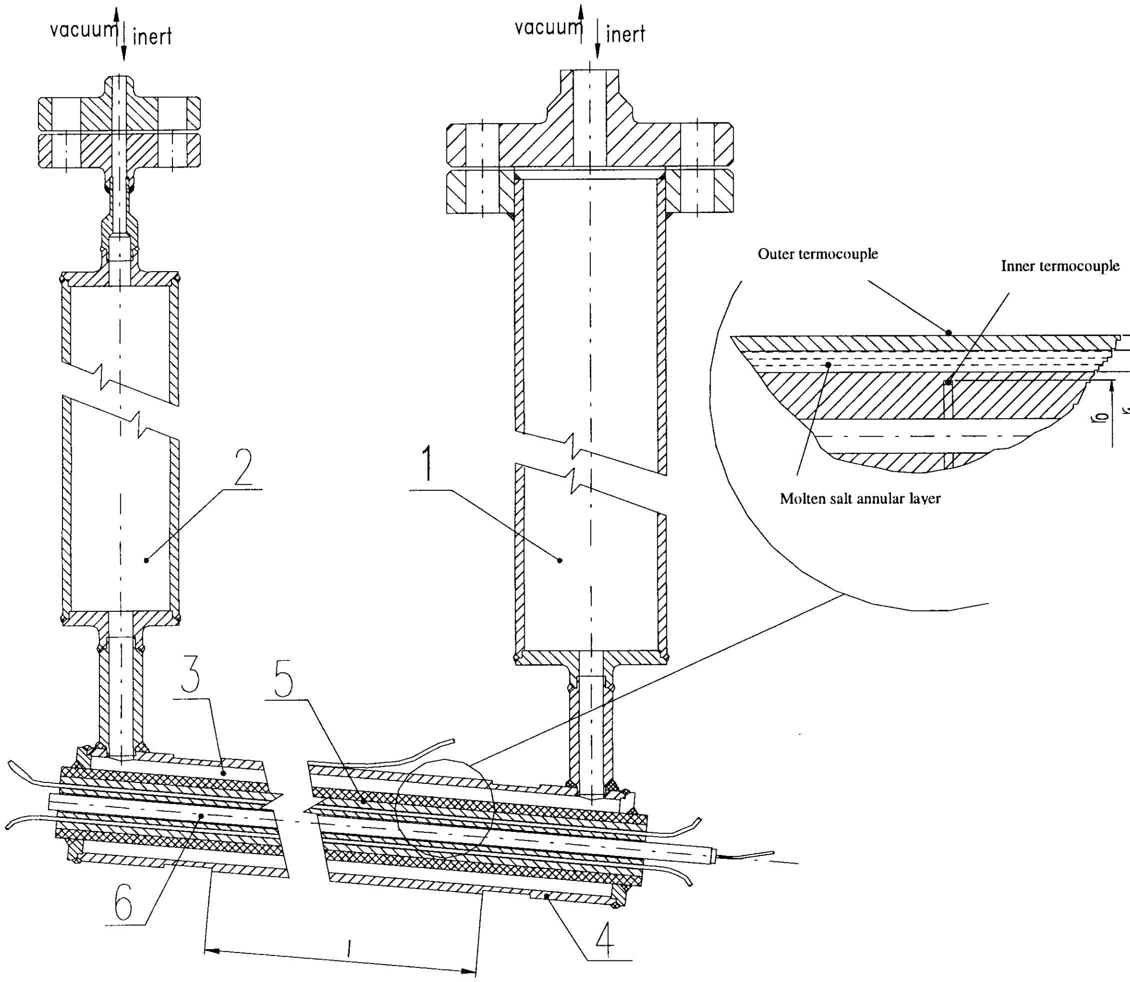

Fig. 2. Apparatus for the measurements.
1 – storage chamber
2 – expansion chamber
3 – annular layer of molten fluoride salts
4 – outside tube
5 – inside tube

gas. The storage and expansion chambers were connected to the cover gas and vacuum system, Figure 2.

Both chambers were equipped with auxiliary external heaters, thermocouples and thermal insulation. During the measurements the molten salt temperature in chambers was kept in equilibrium with the average temperature in the annular layer .

The temperatures and electrical power rates were measured and stored by an EMS 2000 system [6] supported by an XMEAS system [7].

A sample of KHF_2 was inserted into the storage chamber, and the apparatus was sealed and heated to approximately 120 °C. The sample was dewatered by the vacuum system for a few hours.

The following steps were heating over the salts melting point, temperature stabilization, and reading and recording of the temperature and electric power data (pos. 6, Fig. 2) at the constant temperature.

The calculation of the thermal conductivity from the measured data was done by the FEM method [4].

4. Results

The obtained thermal conductivity in the range 525 – 730 K, shown in Figure 3, has been approximated by the polynomial

$$\lambda = (0{,}00948T - 2{,}577 - 6{,}42 \cdot 10^{-6}\, T^2)\ \mathrm{W/m\ K},$$

where T is the temperature in K. The accuracy of λ is within $\pm 8.5\%$.

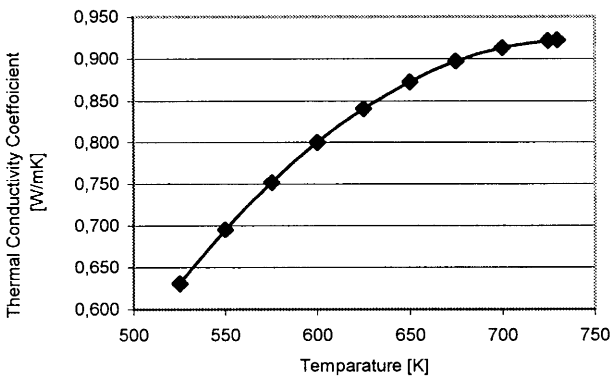

Fig. 3. Thermal conductivity of KHF_2 vs. temperature.

Acknowledgement

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