Summary of Physical Properties for Lithium, Pb-17Li, and $(LiF)_n \bullet BeF_2$ Coolants

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The attached figures and data sheets summarize the properties of liquid lithium, lead-lithium (Pb-17%Li), and $(LiF)_n \bullet BeF_2$ (Flibe) coolants. The vapor pressure of Pb-Li was taken to be equal to that of pure Pb, due to the low activity of Li in Pb-17Li. The surface tension of Pb-Li was estimated using the procedure outlined by Buxbaum.

Physical Properties of Molten Natural Li (temperature in degrees Kelvin)
Valid for T = 455-1500 K

Melting Temperature: 454 K

Density [1]

ρ (kg/m^3) = 278.5 - 0.04657 • T + 274.6 (1-T/3500)$^{0.467}$

Specific heat [1; see also 2]

C_p (J/kg-K) = 4754 - 0.925 • T + 2.91 $\times$ 10^{-4} • T^2

Thermal conductivity [1]

K_{th} (W/m-K) = 22.28 + 0.0500 • T - 1.243 $\times$ 10^{-5} • T^2

Electrical resistivity [1]

ρ_e (nΩ-m) = -64.9 + 1.064 • T - 1.035 $\times$ 10^{-3} T^2 + 5.33 $\times$ 10^{-7} T^3 - 9.23 $\times$ 10^{-12} T^4

Surface tension [1]

γ (N/m) = 0.398 - 0.147 $\times$ 10^{-3} • T

Dynamic viscosity [1] note: $\eta = \rho\upsilon$ where υ = kinematic viscosity (m^2/s)

ln η (Pa - s) = -4.164 - 0.6374 ln T + 292.1/T

Vapor pressure [1]

ln P (Pa) = 26.89 - 18880/T - 0.4942 ln T

References:

[1] R.W. Ohse (Ed.) Handbook of Thermodynamic and Transport Properties of Alkali Metals, Intern. Union of Pure and Applied Chemistry Chemical Data Series No. 30. Oxford: Blackwell Scientific Publ., 1985, pp. 987.

[2] C.B. Alcock, M.W. Chase, V.P. Itkin, J. Phys. Chem. Ref. Data 23 (1994) 385.

Physical Properties of Pb-17Li

Melting Temperature: T_M = 507 K

Density [1]

ρ (kg/m^3) = 10.45 $\times$ 10^{-3} (1 - 161 $\times$ 10^{-6} T) 508-625 K

Specific heat [1]

C_p [J/kg-K] = 195 - 9.116 $\times$ 10^{-3} T 508-800 K

Thermal Conductivity [1]

K_{th} (W/m-K) = 1.95 + 0.0195 T 508-625 K

Electrical resistivity [1]

ρ_e (nΩ-m) = 10.23 + 0.00426 T 508-933 K

Surface tension [2,3]

γ(N/m) =0.52 - 0.11$\times$ 10^{-3} T 520-1000 K

Dynamic viscosity [1]

η (Pa - s) = 0.187 $\times$ 10^{-3} exp [1400./T] 521-900 K

Vapor pressure [2-4]

P (Pa) = 1.5 $\times$ 10^{10} exp (-22900/T) 550-1000 K

References:

[1] B. Schulz, Fusion Eng. Design 14 (1991) 199.

[2] H.E.J. Schins, Liquid Metals for Heat Pipes, Properties, Plots and Data Sheets, JRC-Ispra (1967)

[3] R.E. Buxbaum, J. Less-Common Metals 97 (1984) 27.

[4] H. Feuerstein et al., Fusion Eng. Design 17 (1991) 203.

Physical Properties of Molten Flibe $(LiF)_n \bullet (BeF_2)$

Melting temperature [1]

$T_M(K) = 636$ K n=0.88 (T_M=653 K for n=1)

$T_M(K) = 742$ K n=2

Density [2]

ρ (kg/m^3) =2319 - 424 • T n = 1 930-1130 K

ρ (kg/m^3) =2413 - 488 • T n = 2 800-1080 K

Specific heat [3]

C_p (J/kg-K) $\approx$ 2380 n=2 600-1200 K ?

Thermal conductivity [3]

K_{th} (W/m-K) = 1.0 n=2 600-1200 K ?

Electrical resistivity [2]

ρ_e (Ω-m) = 0.960×10^{-4} exp (3982/T) n=1 680-790 K

ρ_e (Ω-m) = 3.030×10^{-4} exp (2364/T) n-2 750-920 K

Surface tension [2,4]

γ (N/m) = $0.2978 - 0.12 \times 10^{-3} \bullet T$ n = 1 830-1070 K

γ (N/m) = $0.2958 - 0.12 \times 10^{-3} \bullet T$ n = 2 770-1070 K

Dynamic viscosity [2]

η(Pa - s) = 6.27×10^{-6} exp (7780/T) n = 1 680-840 K

η(Pa - s) = 5.94×10^{-6} exp (4605/T) n = 2 740-860 K

Vapor pressure [3]

P (Pa) = 1.5×10^{11} exp (-24200/T) n = 2 770-970 K

References:

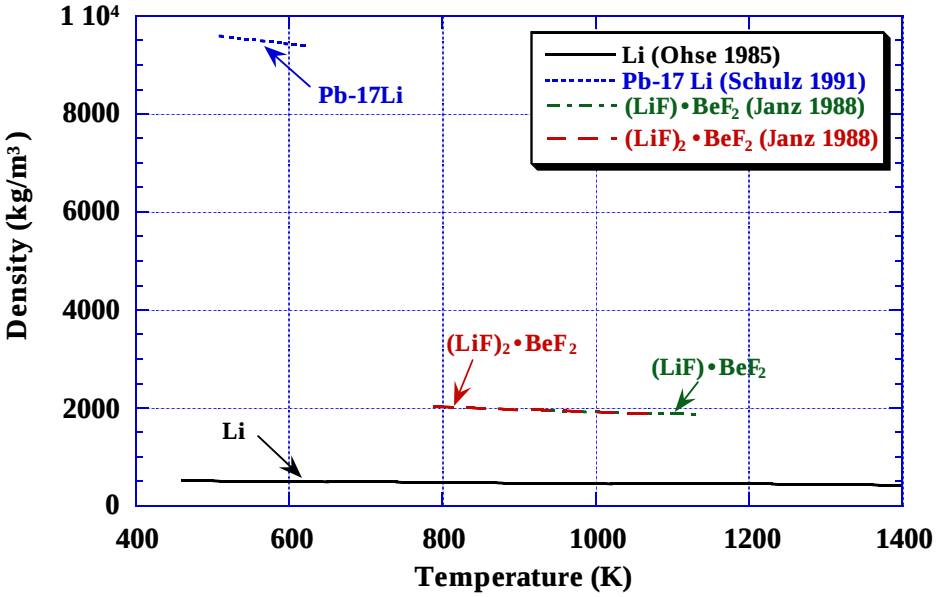
[1] K.A. Romberger, J. Braunstein, R.E. Thoma, J. Phys. Chem. 76 (1972) 1154.

[2] G.J. Janz, Thermodynamic and Transport Properties for Molten Salts: Correlation equations for critically evaluated density, surface tension, electrical conductance, and viscosity data, J. Phys. Chem. Ref. Data 17, Supplement 2 (1988) 1.

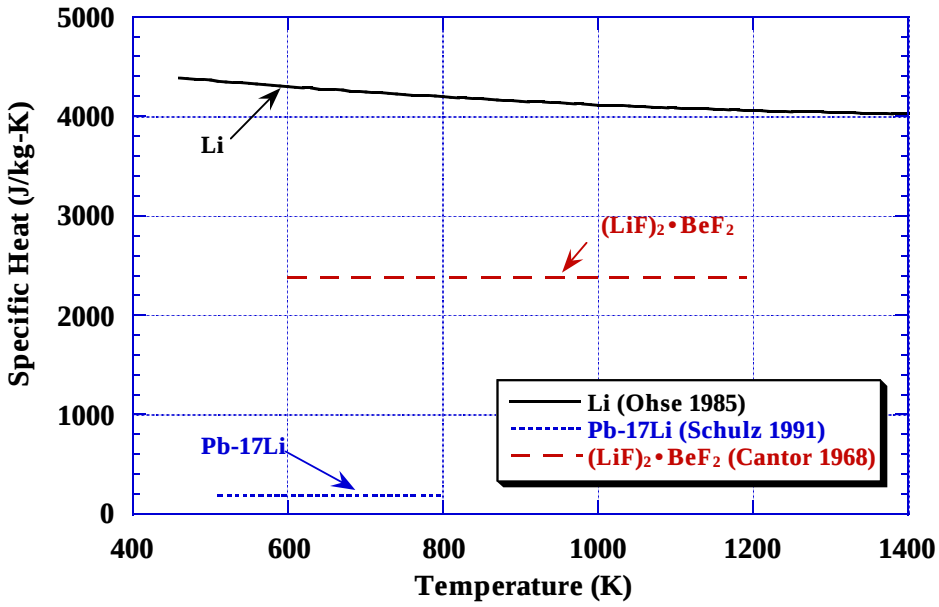
[3] S. Cantor et al., Physical Properties of Molten-Salt Reactor Fuel, Coolant and Flush-Salts, ORNL-TM-2316 (August 1968).

[4] K. Yajima, H. Moriyama, J. Oishi, Y. Tominaga, J. Phys. Chem. 86 (1982) 4193.

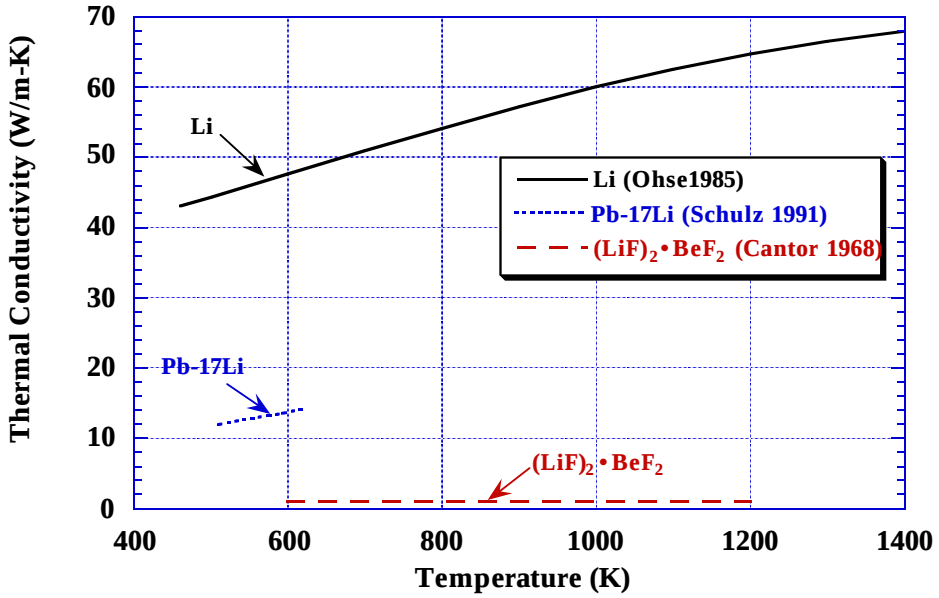
COMPARISON OF THE DENSITY OF LIQUID COOLANTS



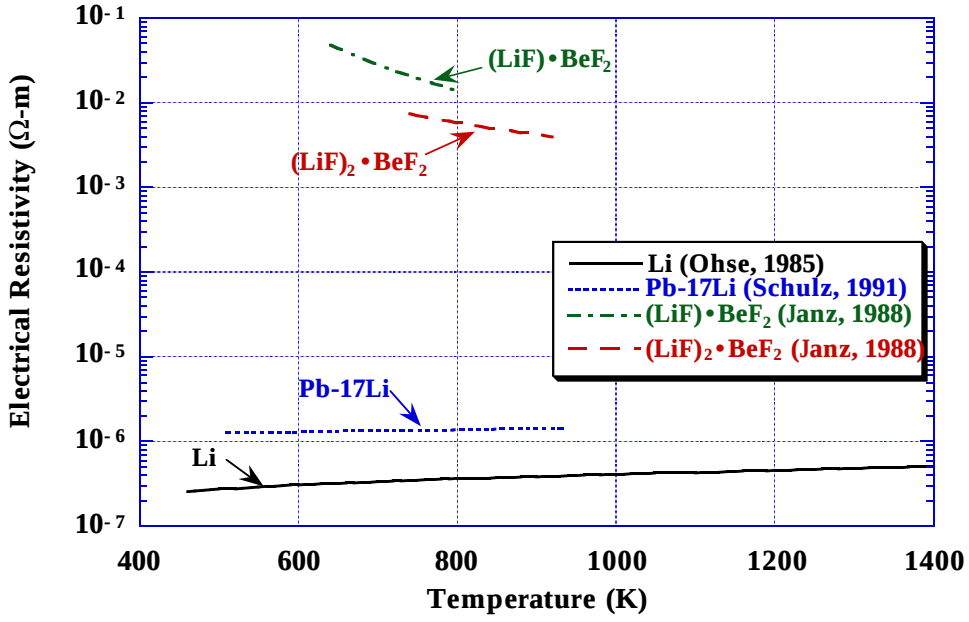
COMPARISON OF THE SPECIFIC HEAT OF LIQUID COOLANTS



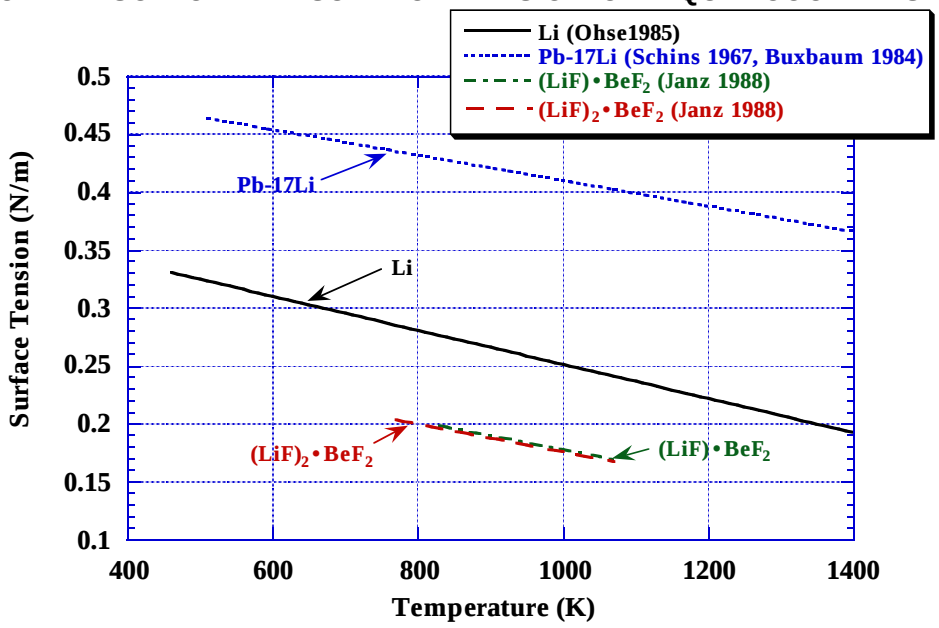
COMPARISON OF THE THERMAL CONDUCTIVITY OF LIQUID COOLANTS



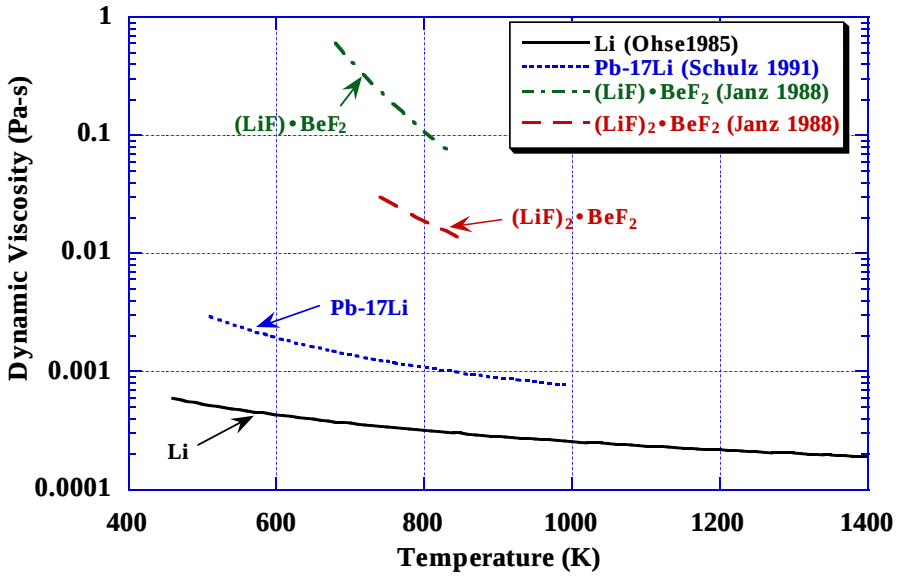
COMPARISON OF THE ELECTRICAL RESISTIVITY OF LIQUID COOLANTS



COMPARISON OF THE SURFACE TENSION OF LIQUID COOLANTS



COMPARISON OF THE DYNAMIC VISCOSITY OF LIQUID COOLANTS



COMPARISON OF THE VAPOR PRESSURE OF LIQUID COOLANTS