Features of Aircraft Reactors

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A PHYSICAL PROPERTY SUMMARY FOR
ANP FLUORIDE MIXTURES

S. I. Cohen
W. D. Powers
N. D. Greene

OAK RIDGE NATIONAL LABORATORY
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A PHYSICAL PROPERTY SUMMARY FOR ANP FLUORIDE MIXTURES

by

S. I. Cohen
W. D. Powers
N. D. Greene

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For the past five years the Heat Transfer and Physical Properties Section of ORNL has investigated some of the physical properties of fluoride mixtures of specific interest to the ANP Project. Particular attention has been given to the "thermal properties", namely, the density, heat capacity, viscosity, and thermal conductivity, because of the important role that they play in the heat and momentum transfer processes in ANP reactors. A limited study of the electrical conductivity and surface tension of molten fluorides was also conducted.

During the first few years of this research task, a large part of the group effort was directed toward the investigation and evaluation of techniques and devices by which these properties could be measured accurately in the temperature range of about 1000°F to 1800°F. The necessity of operating equipment at such high temperature levels as well as in controlled inert atmospheres often made it impossible to use prosaic property equipment. Consequently many new devices had to be developed.

The earlier summaries of the physical properties measurements for fluorides were presented in the form of ORNL memoranda; some of these data were designated as "preliminary" because measuring techniques were still in the process of being refined and because the chemical purities of fluoride samples were at times inadequate. The experimental data summarized in this report in most cases were obtained by two independent measurement techniques; also, it is believed that most of the samples used were relatively pure. Although much progress has been made in the art and science of making these difficult measurements, further refinements should be and are being made, particularly in the case of thermal conductivity measurements for liquids.
General interpretations and correlations of these physical property data in terms of the known theoretical and semi-theoretical relations have been and are being made for the fluoride measurements. Such studies have already been reported in some of the topical reports on individual properties (see for example, ORNL 1702 and 1956). Additional topical reports on thermal properties are in the process of preparation.

In general, the molten fluorides are good heat transfer media because their thermal conductivities, thermal capacities per unit volume, and densities are high and their viscosities and vapour pressures are reasonable; the following tabulation gives the approximate ranges over which each of the thermal properties varies:

- **thermal conductivity**: 0.5 to 2.6 Btu/hr-ft$^2$-(°F/ft)
- **thermal capacity per unit volume**: 0.7 to 1.3 cal/cm$^3$-°C
- **density**: 2 to 4.5 gm/cc
- **viscosity**: 2 to 12 centipoise

These thermal properties influence the heat and momentum transfer in reactor cores and heat exchangers in more or less complicated ways depending upon the system geometry and the fluid flow regime. Hence, it is not possible to rate a heat transfer fluid on the basis of its properties alone. However, detailed studies of the effectiveness of molten fluorides as reactor coolants and fuels (for a range of system geometries and flow conditions) have been conducted and presented in the ANP literature (see for example references 48 and 49).

Within the last year or two, several external organizations have initiated thermal property research on fluoride mixtures. The National Bureau of Standards and the Naval Research Laboratory have made heat capacity measurements and the
Mound Laboratory has made density and viscosity determinations. The Battelle Memorial Institute and the Mound Laboratory have started thermal conductivity research on these liquids.

The Heat Transfer and Physical Properties Section wishes to acknowledge the cooperation received from two of the Laboratory's Divisions. The former Materials Chemistry Division prepared the many samples which were needed in the study; valuable information on melting temperatures, vapor pressures, and phase diagrams of molten fluoride mixtures were also supplied. The Metallurgy Division performed complicated welding tasks in connection with some of the physical property devices.

[Signature]
H. F. Poppendieck
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SUMMARY

This report presents a summary of certain physical properties that have been determined experimentally on the fluoride mixtures that have been formulated within the ANP program at ORNL (Refs. 1, 2). These properties include the density, enthalpy, heat capacity, heat of fusion, thermal conductivity, viscosity, Prandtl number, electrical conductivity and surface tension. In addition to the experimental data, values have been predicted for the heat capacity and density of the other mixtures from the correlations of these properties. Estimates of the viscosity have also been made for a number of the mixtures on which no experimental data were available.
INTRODUCTION

This report presents a compilation of certain physical properties that have been determined experimentally or predicted from correlations of experimental data for mixtures of fluorides that have been formulated within the ANP program (Ref. 1, 2). Each individual page of the tabulation is devoted to a summary of all of the known properties for a mixture together with the composition in mole and weight percent, the average molecular weight, and the liquidus temperature.

This introductory section will present brief discussions of each of the properties, providing short descriptions of the experimental systems used and statements regarding the accuracy of the data. Also included in this section is a tabulation of the mixture numbers arranged according to chemical system.

A. Density.

Density measurements have been made on sixteen molten fluoride mixtures. In addition, about nine mixtures containing BeF$_2$ have been studied at Mound Laboratory. Measurements were made by the buoyancy principle using a plummet suspended in the molten salt from an analytical balance. An error analysis indicated that the values reported are within $\pm 5\%$ of the true values. The results are reported in gms/cc as a function of °C and in lbs/ft$^3$ as a function of °F.

---

1A large number of fluoride mixtures other than those reported here have been studied at Mound Laboratory. However, the contents of this report will be limited to mixtures which have been assigned composition numbers within the ANP project at this Laboratory.

Work at Mound is being carried out by B. C. Blanke, aided at present by E. N. Bousquet and E. L. Murphy and in the past by L. V. Jones, K. W. Foster and R. E. Vallee. The density (and viscosity) program there at present involves a thorough investigation of systems containing the alkali fluorides with BeF$_2$ and UF$_4$. 

Predicted values are given for all the mixtures for which densities have not been experimentally studied. The values given for non-Be$_2$F$_2$ mixtures are based on an empirical correlation using the experimental data available (Ref. 16). The densities of mixtures containing Be$_2$F$_2$ have been predicted from a similarly developed but slightly different correlation using the experimental data taken on Be$_2$F$_2$-bearing mixtures at Mound Laboratory. These relationships correlate the experimental values to within $\pm 5\%$ and it is felt that the predicted values are of comparable accuracy.

Solid densities at room temperature have been measured for fifteen mixtures. The measurements were made by the buoyancy principle; samples of salt were weighed in air and then in toluene. An error analysis indicated errors of no more than $\pm 5\%$. Solid densities were calculated for the remainder of the mixtures by a simple formula involving the method of mixtures (Ref. 16). These calculated values agreed within $\pm 10\%$ with the experimental values available in most cases; however, a larger deviation was observed in one case which may be attributed to structural complexities.

Values of the volumetric coefficient of liquid expansion, $\beta_L$, were calculated from the experimental or predicted density data using the equation:

$$
\beta_L = -\frac{1}{\rho} \frac{\partial \rho}{\partial T}
$$

where $\frac{\partial \rho}{\partial T}$ is the slope of the density-temperature function. Values have been calculated at 700°C except when specified otherwise.

B. Heat Capacity.

The enthalpies, heats of fusion and heat capacities of twenty-one salt mixtures have been determined experimentally by dropping samples at various temperatures into
calorimeters and then measuring the amount of heat liberated. The heat capacity is the slope of the enthalpy-temperature relation thus obtained. Two types of calorimeters have been used. One was an ice calorimeter in which the heat given up by the sample melted ice in an ice-water mixture. The amount of ice melted was proportional to the amount of heat transferred and was determined by the volume change in the ice-water mixture. The other calorimeter was a copper block device. The amount of heat liberated by the sample was measured by the temperature rise of a large mass of copper. From the experimental values obtained for the particular fluorides studied, correlations have been found which enable one to predict the heat capacities of other mixtures (Ref. 4). Hence, estimates have been made of the heat capacities of all the mixtures not studied experimentally. The accuracies of the heat capacities determined experimentally are believed to be within \( \pm 10\% \) of the true values; the predicted values are believed to be in error by no more than \( \pm 20\% \).

The heats of fusion for the fluoride mixtures were obtained directly from the enthalpy-temperature relations.

C. Thermal Conductivity.

Thermal conductivities of seven mixtures in the liquid state have been measured by variable gap devices (Ref. 11). The conductivity is determined by measuring the temperature gradient across a liquid layer as well as the heat flow through it. The layer thickness is varied so that it is possible to eliminate the effect of interface resistances that may exist in the cell. The thermal conductivities of several liquids were determined in a constant gap device. Great difficulty was encountered when using this device because it was difficult to fill the cell completely with the sample liquid. Two methods have been used to measure solid
thermal conductivities; one is a steady state technique in which heat is passed through a slab of the solid salt, and the other is a transient method in which the time-temperature behavior of a solid sphere of the salt is studied.

Error analyses of liquid thermal conductivity measurements indicated that the errors were less than ±25%. It is believed that the solid thermal conductivities are known more accurately than the liquid values. Consequently, liquid conductivities in particular are considered to be of a preliminary nature at this time. Improved conductivity devices are being designed to increase the accuracy. The temperature dependence of the conductivities of fluoride mixtures is currently being studied; the results indicate that the variation is not a large one. Thus, only mean conductivities are reported here.

D. Viscosity.

Viscosity measurements have been made on thirty-eight molten fluoride mixtures. Thirty-two of these were studied at ORNL and nine at Mound Laboratory\(^2\), three being investigated at both laboratories\(^3\). Measurements at ORNL were made with two devices; one of these is a capillary efflux viscometer and the other is a modified Brookfield rotational device. Measurements were made at Mound with a rotational viscometer developed there.

The values are presented in c.g.s. units and in engineering units. Kinematic viscosities are given as well as absolute viscosities. In addition, the viscosity of each salt is presented in terms of the usual exponential formula for viscosity:

\[
\mu = A e^{B/T_0K}
\]

\(^2\)A number of measurements have been made at Mound which are not reported here (see footnote 1, page 4).

\(^3\)The results obtained independently at the two laboratories were in satisfactory agreement; the average values are reported here.
Agreement between the values determined by the two different instruments indicated that the results reported are within ±10% of the true values.

Predicted viscosities are given for a number of salts on which no measurements were made. These estimates were based on measurements on fluorides of similar compositions. These predicted values are probably within ±20% of the actual values.

A blank sheet of graph paper specially prepared for plotting viscosity data is furnished at the end of this report to facilitate interpolation and extrapolation of the values reported.

E. Electrical Conductivity.

The data on electrical conductivity included in this report were primarily obtained by means of a current-potential type cell (Ref. 13). This device measured directly the amount of current flow for a given voltage drop across a molten salt sample. Measurements were made on five molten fluoride mixtures. Since redeterminations of the conductivities of molten LiNO₃, KNO₃, and NaOH were made within ±10% of the values reported in the literature, it was felt that the fluoride measurements were in error by no more than this amount.

F. Surface Tension.

Surface tension measurements were made on one fluoride mixture, Composition 30, using a system consisting of a platinum ring supported from a calibrated wire spring which could be raised and lowered with a vernier (Ref. 21). A thermocouple probe was used to measure the surface temperature of the molten fluoride as accurately as possible.
G. Accuracy Summary.

The following is a summary of the accuracy limits for the properties presented in this report:

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<th>Error Limits for Experimental Measurements</th>
<th>Error Limits for Predicted or Estimated Values</th>
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<tr>
<td>Density (Liquid)</td>
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<td>± 5%</td>
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<tr>
<td>Heat Capacity</td>
<td>±10%</td>
<td>+20%</td>
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<tr>
<td>Thermal Conductivity</td>
<td>+25%</td>
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<tr>
<td>Viscosity</td>
<td>±10%</td>
<td>+20%</td>
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<tr>
<td>Surface Tension</td>
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H. Tabulation of Mixtures According to Chemical System.

The following table lists the mixture numbers arranged according to chemical system.

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<td>NaF-ZrF$_4$-UF$_3$ 27, 30, 33, 38, 39, 40, 41, 42, 44, 46, 70, 99, 108</td>
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<tr>
<td>NaF-BeF$_2$ 35, 77, 113</td>
<td>NaF-BeF$_2$-UF$_4$ 1, 3, 16, 17, 36, 76, 92</td>
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<tr>
<td>LiF-BeF$_2$ 74, 112</td>
<td>LiF-BeF$_2$-UF$_4$ 49</td>
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<td>LiF-NaF 100</td>
<td>LiF-NaF-UF$_4$ 103</td>
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<td>LiF-KF 102</td>
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<td>RbF-BeF$_2$ 115</td>
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<tr>
<td>NaF-LiF-ZrF$_4$ 73, 80, 81</td>
<td>NaF-KF-ZrF$_4$-UF$_4$ 19, 21, 25, 25a, 26, 110</td>
</tr>
<tr>
<td>NaF-LiF-BeF$_2$ 47, 78, 84, 88, 89, 96, 97</td>
<td>NaF-LiF-ZrF$_4$-UF$_4$ 72, 82, 86, 91</td>
</tr>
<tr>
<td></td>
<td>NaF-LiF-BeF$_2$-UF$_4$ 79, 85, 98</td>
</tr>
<tr>
<td></td>
<td>NaF-RbF-BeF$_2$-UF$_4$ 109</td>
</tr>
<tr>
<td></td>
<td>LiF-BeF$_2$-ThF$_4$-UF$_4$ 111</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Binary Fuels System Mixtures</th>
</tr>
</thead>
<tbody>
<tr>
<td>NaF-UF$_4$ 37, 43</td>
</tr>
<tr>
<td>NaF-ThF$_4$ 48</td>
</tr>
</tbody>
</table>
Tabulated Fluoride Property Data

Note: Mixture numbers 50 through 69 have been omitted. These numbers have been reserved by the ANP Chemistry Section for hydroxides (Ref. 1)
<table>
<thead>
<tr>
<th>Mixture</th>
<th>Component</th>
<th>Mol %</th>
<th>Wt. %</th>
<th>Avg. M.W.</th>
<th>Liquidus Temp.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>BeF₂</td>
<td>12</td>
<td>7.50</td>
<td>75.2</td>
<td>514°C (957°F)</td>
</tr>
<tr>
<td></td>
<td>NaF</td>
<td>76</td>
<td>42.41</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>UF₄</td>
<td>12</td>
<td>50.09</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Density**

SOLID AT ROOM TEMPERATURE (gm/cc) 3.77
LIQUID (ρ = gm/cc, T = °C) ρ* = 3.62 - 0.00075T (Ref. 3)
LIQUID (ρ = lbs/ft³, T = °F) ρ* = 226.8 - 0.0260T
MEAN VOLUMETRIC COEFFICIENT OF LIQUID EXPANSION (1/°C x 10⁴) 2.42

**Enthalpy, Heat Capacity and Heat of Fusion**

SOLID (250° - 465°C)
- Enthalpy (cal/gm) \(H_T - H_0\) C° = -5 + 0.219T (Ref. 4)
- Heat Capacity (cal/gm °C) \(c_p\) = 0.22
- Heat Capacity at 300°C (572°F) \(c_p\) = 0.22

LIQUID (520° - 990°C)
- Enthalpy (cal/gm) \(H_T - H_0\) C° = -35 + 0.325T
- Heat Capacity (cal/gm °C) \(c_p\) = 0.32
- Heat Capacity at 700°C (1292°F) \(c_p\) = 0.32

HEAT OF FUSION (cal/gm) \(H_L - H_S\) = 24

**Thermal Conductivity**

K (BTU/hr ft °F)

**Viscosity**

<table>
<thead>
<tr>
<th>°C</th>
<th>(Centipoises)</th>
<th>(Centistokes)</th>
<th>°F</th>
<th>(lb./ft-hr)</th>
<th>ft²/hr</th>
</tr>
</thead>
<tbody>
<tr>
<td>700</td>
<td>7.2* (Ref. 3)</td>
<td>2.33</td>
<td>1300</td>
<td>17.1*</td>
<td>0.0886</td>
</tr>
<tr>
<td>800</td>
<td>4.5*</td>
<td>1.50</td>
<td>1500</td>
<td>10.2*</td>
<td>0.0543</td>
</tr>
</tbody>
</table>

Exponential Form (centipoises)

*Denotes experimental values. Other values given are calculated or estimated.*
Mixture Component Mol % Wt. % Avg. M.W. Liquidus Temp.
2 NaF 46.5 16.14 121.0 530°C (986°F)
KF 26.0 12.49
UF₄ 27.5 71.37

DEN SITY
SOLID AT ROOM TEMPERATURE (gm/cc) 4.7* (Ref. 5)
LIQUID (ρ = gm/cc, T = °C) ρ* = 4.70 - 0.00115T (Ref. 6)
LIQUID (ρ = lbs/ft³, T = °F) ρ* = 294.7 - 0.0399T
MEAN VOLUMETRIC COEFFICIENT OF LIQUID EXPANSION (1/°C x 10⁴) 2.96

ENTHALPY, HEAT CAPACITY AND HEAT OF FUSION
SOLID (240°C-480°C)
Enthalpy (cal/gm) H_T-H₀°C* = -1 + 0.149T (Ref. 4)
Heat Capacity (cal/gm °C) c_p* = 0.15
Heat Capacity at 300°C (572°F) c_p* = 0.15
LIQUID (540°C-1000°C)
Enthalpy (cal/gm) H_T-H₀°C* = -13 + 0.230T
Heat Capacity (cal/gm °C) c_p* = 0.23
Heat Capacity at 700°C (1292°F) c_p* = 0.23
HEAT OF FUSION (cal/gm) H_L-H_S* = 31

THERMAL CONDUCTIVITY
K (BTU/hr ft °F) 0.5 (Liquid) (Ref. 7)

VISCO SITY
°C (Centipoises) (Centistokes) °F (lb./ft-hr) ft²/hr
600 17.3* (Ref. 8) 4.33 1100 43.6* 0.1768
700 9.8* 2.52 1300 23.5* 0.0983
800 6.3* 1.67 1500 14.3* 0.0616
900 4.35* 1.19

Exponential Form (centipoises) μ = 0.0767e⁴³³/T°K

PRANDTL NUMBER 20 at 1100°F, 11 at 1300°F, 6.6 at 1500°F

*Denotes experimental values. Other values given are calculated or estimated.
Mixture | Component | Mol % | Wt. % | Avg. M.W. | Liquidus Temp.
--- | --- | --- | --- | --- | ---
2a | NaF | 48.2 | 17.67 | 114.3 | 558°C (1036°F)
 | KF | 26.8 | 13.65 | | |
 | UF₄ | 25.0 | 68.68 | | |

**DENSITY**

SOLID AT ROOM TEMPERATURE (gm/cc) 4.53
LIQUID (ρ = gm/cc, T = °C) ρ* = 4.54 - 0.0011T (Ref. 15)
LIQUID (ρ = lbs/ft³, T = °F) ρ* = 284.6 - 0.0381T
MEAN VOLUMETRIC COEFFICIENT OF LIQUID EXPANSION (1/°C x 10⁴) 2.92

**ENTHALPY, HEAT CAPACITY AND HEAT OF FUSION**

**SOLID**

\[ H - H_{0°C} = \]

\[ c_p^* = \]

Heat Capacity at 300°C (572°F) \[ c_p = 0.16 \]

**LIQUID**

\[ H - H_{0°C} = \]

\[ c_p^* = \]

Heat Capacity at 700°C (1292°F) \[ c_p = 0.23 \]

**HEAT OF FUSION (cal/gm)** \[ H_{L-H_s} = \]

**THERMAL CONDUCTIVITY**

K (BTU/hr ft °F)

**VISCOSITY**

<table>
<thead>
<tr>
<th>°C</th>
<th>(Centipoises)</th>
<th>(Centistokes)</th>
<th>°F</th>
<th>(lb./ft-hr)</th>
<th>ft²/hr</th>
</tr>
</thead>
<tbody>
<tr>
<td>600</td>
<td>17.3</td>
<td></td>
<td>1100</td>
<td>43.6</td>
<td></td>
</tr>
<tr>
<td>700</td>
<td>9.8</td>
<td></td>
<td>1300</td>
<td>23.5</td>
<td></td>
</tr>
<tr>
<td>800</td>
<td>6.3</td>
<td></td>
<td>1500</td>
<td>14.3</td>
<td></td>
</tr>
<tr>
<td>900</td>
<td>4.35</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Exponential Form (centipoises)

*Denotes experimental values. Other values given are calculated or estimated.*
### Mixture Component

<table>
<thead>
<tr>
<th>Mixture</th>
<th>Component</th>
<th>Mol %</th>
<th>Wt. %</th>
<th>Avg. M.W.</th>
<th>Liquidus Temp.</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>BeF₂</td>
<td>60</td>
<td>32.87</td>
<td>85.8</td>
<td>465°C (869°F)</td>
</tr>
<tr>
<td></td>
<td>NaF</td>
<td>25</td>
<td>12.23</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>UF₄</td>
<td>15</td>
<td>54.90</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Density

**Solid at Room Temperature (gm/cc)**

3.8* (Ref. 5)

**Liquid (ρ = gm/cc, T = °C)**

\[ \rho = 3.43 - 0.00070T \]

**Liquid (ρ = lbs/ft³, T = °F)**

\[ \rho = 209.5 - 0.0243T \]

**Mean Volumetric Coefficient of Liquid Expansion (1/°C \times 10⁴)**

2.37

### Enthalpy, Heat Capacity and Heat of Fusion

**Solid**

<table>
<thead>
<tr>
<th>Property</th>
<th>Formula</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enthalpy (cal/gm)</td>
<td>( H_{T-HO^°C} ) =</td>
</tr>
<tr>
<td>Heat Capacity (cal/gm °C)</td>
<td>( c_p^* = )</td>
</tr>
<tr>
<td>Heat Capacity at 300°C</td>
<td>( c_p = )</td>
</tr>
</tbody>
</table>

**Liquid or Glass (280°-1050°C)**

<table>
<thead>
<tr>
<th>Property</th>
<th>Formula</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enthalpy (cal/gm)</td>
<td>( H_{T-HO^°C} = -43 + 0.315T ) (Ref. 4)</td>
</tr>
<tr>
<td>Heat Capacity (cal/gm °C)</td>
<td>( c_p^* = 0.32 )</td>
</tr>
<tr>
<td>Heat Capacity at 700°C</td>
<td>( c_p = 0.32 )</td>
</tr>
</tbody>
</table>

**Heat of Fusion (cal/gm)**

\( H_{L-HS} = 0 \)

### Thermal Conductivity

\( K \) (BTU/hr ft °F)

### Viscosity

<table>
<thead>
<tr>
<th>°C (Centipoises)</th>
<th>(Centistokes)</th>
<th>°F (lb./ft-hr)</th>
<th>ft²/hr</th>
</tr>
</thead>
</table>

Exponential Form (centipoises)

*Denotes experimental values. Other values given are calculated or estimated.*
NaF 35 8.77 167.6 708°C (1306°F)
KF 20 6.93
UF₄ 45 84.30

DENSITY

SOLID AT ROOM TEMPERATURE (gm/cc) 5.40
LIQUID (\( \rho = \text{gm/cc}, T = \text{°C} \)) \( \rho = 5.60 - 0.00116T \)
LIQUID (\( \rho = \text{lbs/ft}^3, T = \text{°F} \)) \( \rho = 350.9 - 0.0402T \)
MEAN VOLUMETRIC COEFFICIENT OF LIQUID EXPANSION (1/°C x 10⁴) 2.44

ENTHALPY, HEAT CAPACITY AND HEAT OF FUSION

SOLID

Enthalpy (cal/gm) \( H_T-H_0°C^* \)
Heat Capacity (cal/gm °C) \( c_p^* \)
Heat Capacity at 300°C (572°F) \( c_p = 0.14 \)

LIQUID

Enthalpy (cal/gm) \( H_T-H_0°C^* \)
Heat Capacity (cal/gm °C) \( c_p^* \)
Heat Capacity at 700°C (1292°F) \( c_p \)

HEAT OF FUSION (cal/gm) \( H_L-H_S^* \)

THERMAL CONDUCTIVITY

K (BTU/hr ft °F)

VISCOITY

\( °C \) (Centipoises) (Centistokes) \( °F \) (lb./ft-hr) ft²/hr

Exponential Form (centipoises)

*Denotes experimental values. Other values given are calculated or estimated.
### Mixture Component

<table>
<thead>
<tr>
<th>Mixture</th>
<th>Component</th>
<th>Mol %</th>
<th>Wt. %</th>
<th>Avg. M.W.</th>
<th>Liquidus Temp.</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>NaF</td>
<td>60</td>
<td>18.67</td>
<td>135</td>
<td>465°C (869°F)</td>
</tr>
<tr>
<td></td>
<td>PbF$_2$</td>
<td>23</td>
<td>41.78</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>UF$_4$</td>
<td>17</td>
<td>39.55</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### DENSITY

**SOLID AT ROOM TEMPERATURE (gm/cc)**  
5.9* (Ref. 5)

**LIQUID** ($\rho = \text{gm/cc}, T = ^\circ\text{C}$)  
$\rho = 6.01 - 0.00122^\circ\text{C}$

**LIQUID** ($\rho = \text{lps/ft}^3, T = ^\circ\text{F}$)  
$\rho = 376.5 - 0.0423^\circ\text{F}$

**MEAN VOLUMETRIC COEFFICIENT OF LIQUID EXPANSION** ($1^\circ\text{C} \times 10^4$) 2.35

### ENTHALPY, HEAT CAPACITY AND HEAT OF FUSION

**SOLID**

Enthalpy ($\text{cal/gm}$)  
$H_T - H_0^\circ\text{C} = \ldots$

Heat Capacity ($\text{cal/gm} ^\circ\text{C}$)  
$c_p^* = \ldots$

Heat Capacity at 300°C (572°F)  
$c_p = 0.14$

**LIQUID**

Enthalpy ($\text{cal/gm}$)  
$H_T - H_0^\circ\text{C} = \ldots$

Heat Capacity ($\text{cal/gm} ^\circ\text{C}$)  
$c_p^* = \ldots$

Heat Capacity at 700°C (1292°F)  
$c_p = 0.19$

**HEAT OF FUSION** ($\text{cal/gm}$)  
$H_L - H_0^\circ\text{C}^* = \ldots$

### THERMAL CONDUCTIVITY

$K (\text{BTU/hr ft} ^\circ\text{F})$

### VISCOSITY

$^\circ\text{C}$ (Centipoises)  
(Centistokes)  
$^\circ\text{F}$ (lb./ft-hr)  
ft$^2$/hr

Exponential Form (centipoises)

*Denotes experimental values. Other values given are calculated or estimated.*
<table>
<thead>
<tr>
<th>Mixture</th>
<th>Component</th>
<th>Mol %</th>
<th>Wt. %</th>
<th>Avg. M.W.</th>
<th>Liquidus Temp.</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>NaF</td>
<td>30</td>
<td>27.35</td>
<td>46.1</td>
<td>435°C (815°F)</td>
</tr>
<tr>
<td></td>
<td>BeF₂</td>
<td>65</td>
<td>66.33</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>KF</td>
<td>5</td>
<td>6.32</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**DENSITY**

SOLID AT ROOM TEMPERATURE (gm/cc) 2.3* (Ref. 5)
LIQUID (\(\rho = \text{gm/cc}, T = \text{°C}\)) \(\rho = 2.12 - 0.00033T\)
LIQUID (\(\rho = \text{lbs/ft}^3, T = \text{°F}\)) \(\rho = 132.7 - 0.0114T\)

MEAN VOLUMETRIC COEFFICIENT OF LIQUID EXPANSION (1/°C x 10⁴) 1.74

**ENTHALPY, HEAT CAPACITY AND HEAT OF FUSION**

**SOLID**

<table>
<thead>
<tr>
<th>Enthalpy (cal/gm)</th>
<th>(H_{T-H_{0}O^\circ C}^*)</th>
<th>Heat Capacity (cal/gm °C)</th>
<th>(c_p^*)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heat Capacity at 300°C (572°F)</td>
<td>(c_p) = 0.39</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**LIQUID**

<table>
<thead>
<tr>
<th>Enthalpy (cal/gm)</th>
<th>(H_{T-H_{0}O^\circ C}^*)</th>
<th>Heat Capacity (cal/gm °C)</th>
<th>(c_p^*)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heat Capacity at 700°C (1292°F)</td>
<td>(c_p) = 0.54</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**HEAT OF FUSION (cal/gm)**

\(H_{L-H_\circ B}^* = \)

**THERMAL CONDUCTIVITY**

\(K (\text{BTU/hr ft °F})\)

**VISCOITY**

\(\text{°C} \quad \text{(Centipoises)} \quad \text{(Centistokes)} \quad \text{°F} \quad (\text{lb./ft-hr}) \quad \text{ft}^2/\text{hr}\)

Exponential Form (centipoises)

*Denotes experimental values. Other values given are calculated or estimated.
<table>
<thead>
<tr>
<th>Mixture</th>
<th>Component</th>
<th>Mol %</th>
<th>Wt. %</th>
<th>Avg. M.W.</th>
<th>Liquidus Temp.</th>
</tr>
</thead>
<tbody>
<tr>
<td>7</td>
<td>NaF</td>
<td>50</td>
<td>16.55</td>
<td>126.8</td>
<td>575°C (1067°F)</td>
</tr>
<tr>
<td></td>
<td>KF</td>
<td>20</td>
<td>9.16</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>UF₄</td>
<td>30</td>
<td>74.28</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**DENSITY**

SOLID AT ROOM TEMPERATURE (gm/cc) 5.1* (Ref. 5)
LIQUID ($\rho = gm/cc, T = ^\circ C$) $\rho = 4.78 - 0.00104T$
LIQUID ($\rho = lbs/ft^3, T = ^\circ F$) $\rho = 299.5 - 0.0361T$

MEAN VOLUMETRIC COEFFICIENT OF LIQUID EXPANSION ($1/^\circ C \times 10^4$) 2.57

**ENTHALPY, HEAT CAPACITY AND HEAT OF FUSION**

**SOLID**

Enthalpy (cal/gm) $H_T - H_{0C}^* =$
Heat Capacity (cal/gm °C) $c_p^* =$
Heat Capacity at 300°C (572°F) $c_p = 0.15$

**LIQUID**

Enthalpy (cal/gm) $H_T - H_{0C}^* =$
Heat Capacity (cal/gm °C) $c_p^* =$
Heat Capacity at 700°C (1292°F) $c_p = 0.22$

**HEAT OF FUSION (cal/gm)** $H_L - H_S^* =$

**THERMAL CONDUCTIVITY**

$K (BTU/hr ft ^\circ F)$

**VISCOITY**

<table>
<thead>
<tr>
<th>°C</th>
<th>(Centipoises)</th>
<th>(Centistokes)</th>
<th>°F</th>
<th>(lb./ft-hr)</th>
<th>ft²/hr</th>
</tr>
</thead>
<tbody>
<tr>
<td>700</td>
<td>10.0</td>
<td></td>
<td>1300</td>
<td>23.7</td>
<td></td>
</tr>
<tr>
<td>800</td>
<td>6.65</td>
<td></td>
<td>1500</td>
<td>15.3</td>
<td></td>
</tr>
<tr>
<td>900</td>
<td>4.75</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Exponential Form (centipoises)

*Denotes experimental values. Other values given are calculated or estimated.*
<table>
<thead>
<tr>
<th>Mixture</th>
<th>Component</th>
<th>Mol %</th>
<th>Wt. %</th>
<th>Avg. M.W.</th>
<th>Liquidus Temp.</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>NaF</td>
<td>100</td>
<td>100</td>
<td>42</td>
<td>995°C (1823°F)</td>
</tr>
</tbody>
</table>

**DENSITY**

SOLID AT ROOM TEMPERATURE (gm/cc) 2.79* (Ref. 9)

LIQUID (ρ = gm/cc, T = °C)

LIQUID (ρ = lbs/ft³, T = °F)

MEAN VOLUMETRIC COEFFICIENT OF LIQUID EXPANSION (1/°C x 10⁴)

**ENTHALPY, HEAT CAPACITY AND HEAT OF FUSION**

SOLID (25° - 992°C)

Enthalpy (cal/gm) \( H_{T-H_0} * = 0.2593T + 5.36 \times 10^{-5}T^2 \) (Ref. 46)

Heat Capacity (cal/gm °C) \( c_p * = 0.2593 + 10.72 \times 10^{-5}T \)

Heat Capacity at 300°C (572°F) \( c_p * = 0.291 \)

LIQUID (992° - 1027°C)

Enthalpy (cal/gm) \( H_{T-H_0} * = 117.24 + 0.3810T \)

Heat Capacity (cal/gm °C) \( c_p * = 0.381 \)

Heat Capacity at 700°C (1292°F) \( c_p * = \)

HEAT OF FUSION (cal/gm) \( H_{L-H_0} * = 185.2 \)

**THERMAL CONDUCTIVITY**

K (BTU/hr ft °F)

**VISCOILITY**

<table>
<thead>
<tr>
<th>°C (Centipoises)</th>
<th>(Centistokes)</th>
<th>°F (lb./ft-hr)</th>
<th>ft²/hr</th>
</tr>
</thead>
</table>

Exponential Form (centipoises)

*Denotes experimental values. Other values given are calculated or estimated.
<table>
<thead>
<tr>
<th>Mixture</th>
<th>Component</th>
<th>Mol %</th>
<th>Wt. %</th>
<th>Avg. M.W.</th>
<th>Liquidus Temp.</th>
</tr>
</thead>
<tbody>
<tr>
<td>9</td>
<td>BeF₂</td>
<td>100</td>
<td>100</td>
<td>47</td>
<td>543°C (1009°F)</td>
</tr>
</tbody>
</table>

**DENSIY**

SOLID AT ROOM TEMPERATURE (gm/cc) 1.98* (Ref. 9, 10)
LIQUID (ρ = gm/cc, T = °C)
LIQUID (ρ = lbs/ft³, T = °F)

MEAN VOLUMETRIC COEFFICIENT OF LIQUID EXPANSION (1/°C x 10⁴)

**ENTHALPY, HEAT CAPACITY AND HEAT OF FUSION**

SOLID
- Enthalpy (cal/gm): $H_T - H_{O{C}^*}$
- Heat Capacity (cal/gm °C): $c_p^*$
- Heat Capacity at 300°C (572°F): $c_p$

LIQUID
- Enthalpy (cal/gm): $H_T - H_{O{C}^*}$
- Heat Capacity (cal/gm °C): $c_p^*$
- Heat Capacity at 700°C (1292°F): $c_p$

HEAT OF FUSION (cal/gm): $H_L - H_S^*$

**THERMAL CONDUCTIVITY**

$K$ (BTU/hr ft °F)

**VISCOSITY**

<table>
<thead>
<tr>
<th>°C</th>
<th>(Centipoises)</th>
<th>(Centistokes)</th>
<th>°F</th>
<th>(lb./ft·hr)</th>
<th>ft²/hr</th>
</tr>
</thead>
</table>

Exponential Form (centipoises)

*Denotes experimental values. Other values given are calculated or estimated.*
<table>
<thead>
<tr>
<th>Mixture</th>
<th>Composition</th>
<th>Mol %</th>
<th>Wt. %</th>
<th>Avg. M.W.</th>
<th>Liquidus Temp.</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>LiF</td>
<td>100</td>
<td>100</td>
<td>25.9</td>
<td>848°C (1558°F)</td>
</tr>
</tbody>
</table>

**Density**

SOLID AT ROOM TEMPERATURE (gm/cc) 2.64*(Ref. 9)

**Enthalpy, Heat Capacity and Heat of Fusion**

**SOLID (0°C-848°C)**

Enthalpy (cal/gm)

\[ H_T - H_{0^0C} = 0.54240T + 2.0624 \times 10^{-5}T^2 - 2.4217 \times 10^{-8}T^3 + 0.40261 \times 10^{-10}T^4 - 108.00 \log_{10}(T + 273.16/273.16) \]  
(Ref. 47)

Heat Capacity (cal/gm °C)

\[ c_p^* = \begin{cases} 0.371 & \text{at } 0°C \\ 0.450 & \text{at } 200°C \\ 0.488 & \text{at } 400°C \\ 0.522 & \text{at } 600°C \\ 0.568 & \text{at } 800°C \end{cases} \]

**LIQUID (848°C-900°C)**

Enthalpy (cal/gm)

\[ H_T - H_{0^0C} = 157.14 + 0.59777T \]

Heat Capacity (cal/gm °C)

\[ c_p^* = 0.598 \]

**Heat of Fusion** (cal/gm)

\[ H_L - H_S^* = 249.4 \]

*Denotes experimental values. Other values given are calculated or estimated.*
Mixture Component Mol % Wt. % Avg. M.W. Liquidus Temp.
KF 100 100 58.1 86°C (157°F)

Density

SOLID AT ROOM TEMPERATURE (gm/cc) 2.51 (Ref. 9)
LIQUID (ρ = gm/cc, T = °C)
LIQUID (ρ = lbs/ft³, T = °F)
MEAN VOLUMETRIC COEFFICIENT OF LIQUID EXPANSION (1/°C x 10⁴)

Enthalpy, Heat Capacity and Heat of Fusion

SOLID (25°C-857°C)
Enthalpy (cal/gm) \( H_{T=0°C} = 0.2044T + 2.69 \times 10^{-5}T^2 \) (Ref. 46)
Heat Capacity (cal/gm °C) \( c_p = 0.2044 + 5.38 \times 10^{-5}T \)
Heat Capacity at 300°C (572°F) \( c_p = 0.221 \)
LIQUID (857°C-927°C)
Enthalpy (cal/gm) \( H_{T=0°C} = 75.02 + 0.2754T \)
Heat Capacity (cal/gm °C) \( c_p = 0.2754 \)
Heat Capacity at 700°C (1292°F) \( c_p = \)
Heat of Fusion (cal/gm) \( H_{L-H_S} = 116.1 \)

Thermal Conductivity

K (BTU/hr ft ⁰F)

Viscosity

°C (Centipoises) (Centistokes) ⁰F (lb./ft-hr) ft²/hr

Exponential Form (centipoises)

*Denotes experimental values. Other values given are calculated or estimated.
Mixture | Component | Mol % | Wt. % | Avg. M.W. | Liquidus Temp.
--- | --- | --- | --- | --- | ---
12 | NaF | 11.5 | 11.70 | 41.2 | 454°C (849°F)
K | F | 42.0 | 59.09 | | |
LiF | 46.5 | 29.21 | |

DENSITY

SOLID AT ROOM TEMPERATURE (gm/cc) 2.6* (Ref. 5)
LIQUID (\( \rho = \text{gm/cc}, T = ^\circ C \)) \( \rho^* = 2.53 - 0.00073T \) (Ref. 16)
LIQUID (\( \rho = \text{lbs/ft}^3, T = ^\circ F \)) \( \rho^* = 158.7 - 0.0253T \)
MEAN VOLUMETRIC COEFFICIENT OF LIQUID EXPANSION (1/°C x 10\(^4\)) 3.61

ENTHALPY, HEAT CAPACITY AND HEAT OF FUSION

SOLID (60°C-454°C)
Enthalpy (cal/gm) \( H_T-H_0^\circ C^* = -2.6 + 0.271T + 9.8 \times 10^{-5}T^2 \) (Ref. 4)
Heat Capacity (cal/gm °C) \( c_p^* = 0.27 + 19.6 \times 10^{-5}T \)
Heat Capacity at 300°C (572°F) \( c_p^* = 0.33 \)
LIQUID (475°C-875°C)
Enthalpy (cal/gm) \( H_T-H_0^\circ C^* = 30.3 + 0.453T \)
Heat Capacity (cal/gm °C) \( c_p^* = 0.45 \)
Heat Capacity at 700°C (1292°F) \( c_p^* = 0.45 \)

HEAT OF FUSION (cal/gm) \( H_L-H_S^* = 95 \)

THERMAL CONDUCTIVITY

\( K (\text{BTU/hr ft } ^\circ F) \)
2.6 (Liquid) (Ref. 11)
2.7 (Solid sphere) (Ref. 45)

VISCOITY

\( \mu = 0.04000e^{170/T^\circ K} \)

FRANDTIL NUMBER 2.1 at 1100°F, 1.2 at 1300°F, 0.76 at 1500°F

ELECTRICAL CONDUCTIVITY (ohm-cm)-1 1.34 at 1100°F, 1.58 at 1300°F, 1.80 at 1500°F (Ref. 13)

*Denotes experimental values. Other values given are calculated or estimated.
<table>
<thead>
<tr>
<th>Mixture</th>
<th>Component</th>
<th>Mol %</th>
<th>Wt. %</th>
<th>Avg. M.W.</th>
<th>Liquidus Temp.</th>
</tr>
</thead>
<tbody>
<tr>
<td>13</td>
<td>NaF</td>
<td>53</td>
<td>17.40</td>
<td>128</td>
<td>490°C (914°F)</td>
</tr>
<tr>
<td></td>
<td>RbF</td>
<td>20</td>
<td>16.53</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>UF₄</td>
<td>27</td>
<td>66.27</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**DENSITY**

SOLID AT ROOM TEMPERATURE (gm/cc) 5.02
LIQUID (ρ = gm/cc, T = °C) ρ = 5.05 - 0.00108T
LIQUID (ρ = lbs/ft³, T = °F) ρ = 316.4 - 0.0374T
MEAN VOLUMETRIC COEFFICIENT OF LIQUID EXPANSION (1/°C x 10⁴) 2.53

**ENTHALPY, HEAT CAPACITY AND HEAT OF FUSION**

**SOLID**

Enthalpy (cal/gm) \( H_T-H_{0°C} \)
Heat Capacity (cal/gm °C) \( c_p \)
Heat Capacity at 300°C (572°F) \( c_p = 0.15 \)

**LIQUID**

Enthalpy (cal/gm) \( H_T-H_{0°C} \)
Heat Capacity (cal/gm °C) \( c_p \)
Heat Capacity at 700°C (1292°F) \( c_p = 0.21 \)

HEAT OF FUSION (cal/gm) \( H_L-H_S \)

**THERMAL CONDUCTIVITY**

K (BTU/hr ft °F)

**VISCOITY**

°C (Centipoises) (Centistokes) °F (lb./ft·hr) ft²/hr

Exponential Form (centipoises)

*Denotes experimental values. Other values given are calculated or estimated.*
### Mixture Component Mol % Wt. % Avg. M.W. Liquidus Temp.

<table>
<thead>
<tr>
<th>Mixture</th>
<th>Component</th>
<th>Mol %</th>
<th>Wt. %</th>
<th>Avg. M.W.</th>
<th>Liquidus Temp.</th>
</tr>
</thead>
<tbody>
<tr>
<td>14</td>
<td>NaF</td>
<td>10.9</td>
<td>10.21</td>
<td>44.9</td>
<td>452°C (846°F)</td>
</tr>
<tr>
<td></td>
<td>KF</td>
<td>43.5</td>
<td></td>
<td>56.34</td>
<td></td>
</tr>
<tr>
<td></td>
<td>LiF</td>
<td>44.5</td>
<td></td>
<td>25.73</td>
<td></td>
</tr>
<tr>
<td></td>
<td>UF₄</td>
<td>1.1</td>
<td></td>
<td>7.71</td>
<td></td>
</tr>
</tbody>
</table>

### DENSITY

- **SOLID AT ROOM TEMPERATURE (gm/cc)**: 2.7* (Ref. 5)
- **LIQUID (ρ = gm/cc, T = °C)**: \( \rho^* = 2.65 - 0.00090T \) (Ref. 17)
- **LIQUID (ρ = lbs/ft³, T = °F)**: \( \rho^* = 166.4 - 0.0312T \)

**MEAN VOLUMETRIC COEFFICIENT OF LIQUID EXPANSION \( (1/°C \times 10^4) \)**: 4.46

### ENTHALPY, HEAT CAPACITY AND HEAT OF FUSION

**SOLID (90°-450°C)**

- **Enthalpy (cal/gm)**: \( H_T - H_{O°C}^* = -9 + 0.310T \) (Ref. 4)
- **Heat Capacity (cal/gm °C)**: \( c_p^* = 0.31 \)
- **Heat Capacity at 300°C (572°F)**: \( c_p^* = 0.31 \)

**LIQUID (500°-1000°C)**

- **Enthalpy (cal/gm)**: \( H_T - H_{O°C}^* = 21 + 0.437T \)
- **Heat Capacity (cal/gm °C)**: \( c_p^* = 0.44 \)
- **Heat Capacity at 700°C (1292°F)**: \( c_p^* = 0.44 \)

**HEAT OF FUSION (cal/gm)**: \( H_L - H_S^* = 87 \)

### THERMAL CONDUCTIVITY

- **K (BTU/hr ft °F)**: 2.3 (Liquid) (Ref. 14)
- **2.0 (Solid sphere) (Ref. 45)**

### VISCOSITY

<table>
<thead>
<tr>
<th>°C</th>
<th>(Centipoises)</th>
<th>(Centistokes)</th>
<th>°F</th>
<th>(lb./ft-hr)</th>
<th>ft²/hr</th>
</tr>
</thead>
<tbody>
<tr>
<td>500</td>
<td>8.8* (Ref. 12)</td>
<td>4.00</td>
<td>1100</td>
<td>11.6*</td>
<td>0.0876</td>
</tr>
<tr>
<td>600</td>
<td>4.6*</td>
<td>2.18</td>
<td>1300</td>
<td>6.6*</td>
<td>0.0525</td>
</tr>
<tr>
<td>700</td>
<td>2.75*</td>
<td>1.36</td>
<td>1500</td>
<td>4.2*</td>
<td>0.0351</td>
</tr>
<tr>
<td>800</td>
<td>1.85*</td>
<td>0.96</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Exponential Form (centipoises)**: \( \mu = 0.0348e^{4265/T} \)

**PRANDTL NUMBER**

- 2.2 at 1100°F; 1.3 at 1300°F; 0.80 at 1500°F

*Denotes experimental values. Other values given are calculated or estimated.*
<table>
<thead>
<tr>
<th>Mixture</th>
<th>Component</th>
<th>Mol %</th>
<th>Wt. %</th>
<th>Avg. M.W.</th>
<th>Liquidus Temp.</th>
</tr>
</thead>
<tbody>
<tr>
<td>15</td>
<td>NaF</td>
<td>29.5</td>
<td>24.60</td>
<td>50.3</td>
<td>433°C (811°F)</td>
</tr>
<tr>
<td></td>
<td>BeF₂</td>
<td>84.0</td>
<td>59.75</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>KF</td>
<td>4.9</td>
<td>5.66</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>UF₄</td>
<td>1.6</td>
<td>9.99</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**DENSITY**

SOLID AT ROOM TEMPERATURE (gm/cc) 2.5* (Ref. 5)

LIQUID (ρ = gm/cc, T = °C) ρ = 2.26 - 0.00036T

LIQUID (ρ = lbs/ft³, T = °F) ρ = 141.5 - 0.0125T

MEAN VOLUMETRIC COEFFICIENT OF LIQUID EXPANSION (1/°C x 10⁴) 1.80

**ENTHALPY, HEAT CAPACITY AND HEAT OF FUSION**

**SOLID**

- Enthalpy (cal/gm) \( H_{T-H_0}^{°C} \star = \)
- Heat Capacity (cal/gm °C) \( c_p^\star = \)
- Heat Capacity at 300°C (572°F) \( c_p = 0.36 \)

**LIQUID**

- Enthalpy (cal/gm) \( H_{T-H_0}^{°C} \star = \)
- Heat Capacity (cal/gm °C) \( c_p^\star = \)
- Heat Capacity at 700°C (1292°F) \( c_p = 0.51 \)

**HEAT OF FUSION (cal/gm)** \( H_{L-H_S}^{°C} \star = \)

**THERMAL CONDUCTIVITY**

K (BTU/hr ft °F)

**VISCOSITY**

\( ^\circ C \) (Centipoises) (Centistokes) \( ^\circ F \) (lb./ft-hr) ft²/hr

Exponential Form (centipoises)

*Denotes experimental values. Other values given are calculated or estimated.
<table>
<thead>
<tr>
<th>Mixture</th>
<th>Component</th>
<th>Mol %</th>
<th>Wt. %</th>
<th>Avg. M.W.</th>
<th>Liquidus Temp.</th>
</tr>
</thead>
<tbody>
<tr>
<td>16</td>
<td>NaF</td>
<td>34.0</td>
<td>21.00</td>
<td>68.0</td>
<td>550°C (1022°F)</td>
</tr>
<tr>
<td></td>
<td>BeF₂</td>
<td>57.5</td>
<td>39.7₂</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>UF₄</td>
<td>8.5</td>
<td>39.26</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Density**

SOLID AT ROOM TEMPERATURE (gm/cc) 2.99
LIQUID (ρ = gm/cc, T = °C) ρ = 2.90 - 0.00054T
LIQUID (ρ = lbs/ft³, T = °F) ρ = 181.6 - 0.0187T

MEAN VOLUMETRIC COEFFICIENT OF LIQUID EXPANSION (1/°C x 10⁻⁴) 2.14

**Enthalpy, Heat Capacity and Heat of Fusion**

**Solid**

Enthalpy (cal/gm) \( H_T - H_{0°C} \)
Heat Capacity (cal/gm °C) \( c_p \)
Heat Capacity at 300°C (572°F) \( c_p = 0.28 \)

**Liquid**

Enthalpy (cal/gm) \( H_T - H_{0°C} \)
Heat Capacity (cal/gm °C) \( c_p \)
Heat Capacity at 700°C (1292°F) \( c_p = 0.39 \)

**Heat of Fusion** (cal/gm) \( H_L - H_S \)

**Thermal Conductivity**

K (BTU/hr ft °F)

**Viscosity**

\( ^°C \) (Centipoises) (Centistokes) \( ^°F \) (lb./ft-hr) ft²/hr

Exponential Form (centipoises)

*Denotes experimental values. Other values given are calculated or estimated.*
Mixture Component Mol % Wt % Avg. M.W. Liquidus Temp.
    NaF  47  39.48  50.0  395°C (743°F)
    BeF₂  51  47.96  
    UF₄  2  12.56  

DENSITY

SOLID AT ROOM TEMPERATURE (gm/cc) 2.6* (Ref. 5)
LIQUID (ρ = gm/cc, T = °C) ρ = 2.39 - 0.0040T
LIQUID (ρ = lbs/ft³, T = °F) ρ = 149.6 - 0.0139T
MEAN VOLUMETRIC COEFFICIENT OF LIQUID EXPANSION (1/°C x 10⁴) 1.89

ENTHALPY, HEAT CAPACITY AND HEAT OF FUSION

SOLID

Enthalpy (cal/gm) Hₜ-Hₒ °C*
Heat Capacity (cal/gm °C) c * = c
Heat Capacity at 300°C (572°F) c p = 0.35

LIQUID

Enthalpy (cal/gm) Hₜ-Hₒ °C*
Heat Capacity (cal/gm °C) c * = c
Heat Capacity at 700°C (1292°F) c p = 0.49

HEAT OF FUSION (cal/gm) Hₗ-Hₛ*

THERMAL CONDUCTIVITY

K (BTU/hr ft °F)

VISCOSEITY

<table>
<thead>
<tr>
<th>°C</th>
<th>(Centipoises)</th>
<th>(Centistokes)</th>
<th>°F</th>
<th>(lb./ft·hr)</th>
<th>ft²/hr</th>
</tr>
</thead>
<tbody>
<tr>
<td>600</td>
<td>16.5</td>
<td></td>
<td></td>
<td>1100</td>
<td>42.4</td>
</tr>
<tr>
<td>700</td>
<td>8.0</td>
<td></td>
<td>1300</td>
<td>18.9</td>
<td></td>
</tr>
<tr>
<td>800</td>
<td>4.4</td>
<td></td>
<td>1500</td>
<td>9.8</td>
<td></td>
</tr>
</tbody>
</table>

Exponential Form (centipoises)

*Denotes experimental values. Other values given are calculated or estimated.
Mixture Component     Mol % Wt. % Avg. M.W. Liquidus Temp.
18    NaF           45    19.57    96.5    506°C (943°F)
      LiF           33    8.87
      UF₄           22    71.56

DENSITY
Solid at Room Temperature (gm/cc) 5.0* (Ref. 5)
Liquid (ρ = gm/cc, T = °C) ρ = 4.54 - 0.00101T
Liquid (ρ = lbs/ft³, T = °F) ρ = 284.5 - 0.035T
Mean Volumetric Coefficient of Liquid Expansion (1°C x 10⁴) 2.64

ENTHALPY, HEAT CAPACITY AND HEAT OF FUSION

SOLID
Enthalpy (cal/gm) H_T-H_{0°C}*
Heat Capacity (cal/gm °C) c_p*
Heat Capacity at 300°C (572°F) c_p = 0.19

LIQUID
Enthalpy (cal/gm) H_T-H_{0°C}*
Heat Capacity (cal/gm °C) c_p*
Heat Capacity at 700°C (1292°F) c_p = 0.26

HEAT OF FUSION (cal/gm) H_L-H_{S*}

THERMAL CONDUCTIVITY
K (BTU/hr ft °F)

VISCOSITY
°C (Centipoises) (Centistokes) °F (lb./ft-hr) ft²/hr

Exponential Form (centipoises)

*Denotes experimental values. Other values given are calculated or estimated.
<table>
<thead>
<tr>
<th>Mixture</th>
<th>Component</th>
<th>Mol %</th>
<th>Wt. %</th>
<th>Avg. M.W.</th>
<th>Liquidus Temp.</th>
</tr>
</thead>
<tbody>
<tr>
<td>19</td>
<td>NaF</td>
<td>5</td>
<td>1.94</td>
<td>108.2</td>
<td>405°C (761°F)</td>
</tr>
<tr>
<td></td>
<td>KF</td>
<td>51</td>
<td>27.38</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>ZrF₄</td>
<td>42</td>
<td>64.88</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>UF₄</td>
<td>2</td>
<td>5.80</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Density**

SOLID AT ROOM TEMPERATURE (gm/cc) 3.67

LIQUID (ρ = gm/cc, T = °C)

\[ ρ^* = 3.78 - 0.00109T \] (Ref. 18)

LIQUID (ρ = lbs/ft³, T = °F)

\[ ρ^* = 237.2 - 0.0378T \]

MEAN VOLUMETRIC COEFFICIENT OF LIQUID EXPANSION \([1/°C \times 10^4]\) 3.48 (600°C)

**Enthalpy, Heat Capacity and Heat of Fusion**

**SOLID**

Enthalpy (cal/gm)

\[ H_T - H_{0°C}^* \]

Heat Capacity (cal/gm °C)

\[ c_p^* \]

Heat Capacity at 300°C (572°F)

\[ c_p = 0.18 \]

**LIQUID**

Enthalpy (cal/gm)

\[ H_T - H_{0°C}^* \]

Heat Capacity (cal/gm °C)

\[ c_p^* \]

Heat Capacity at 700°C (1292°F)

\[ c_p = 0.25 \]

**Heat of Fusion (cal/gm)**

\[ H_L - H_S^* \]

**Thermal Conductivity**

\[ K \ (BTU/hr \ ft \ °F) \]

**Viscosity**

<table>
<thead>
<tr>
<th>°C</th>
<th>(Centipoises)</th>
<th>(Centistokes)</th>
<th>°F</th>
<th>(lb./ft-hr)</th>
<th>ft²/hr</th>
</tr>
</thead>
<tbody>
<tr>
<td>500</td>
<td>11.0</td>
<td>1100</td>
<td>1100</td>
<td>16.0</td>
<td>1100</td>
</tr>
<tr>
<td>600</td>
<td>6.4</td>
<td>1300</td>
<td>1300</td>
<td>10.3</td>
<td>1300</td>
</tr>
<tr>
<td>700</td>
<td>4.3</td>
<td>1500</td>
<td>1500</td>
<td>7.6</td>
<td>1500</td>
</tr>
<tr>
<td>800</td>
<td>3.25</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Denotes experimental values. Other values given are calculated or estimated.*
Mixture Component  Mol %  Wt. %  Avg. M.W.  Liquidus Temp.
20  NaF  5  2.01  104.2  425°C (797°F)
     KF  52  28.99
     ZrF₄  43  69.00

DENSITY

SOLID AT ROOM TEMPERATURE (gm/cc)  3.57
LIQUID (ρ = gm/cc, T = °C)  ρ = 3.38 - 0.00084T
LIQUID (ρ = lbs/ft³, T = °F)  ρ = 211.9 - 0.0291T
MEAN VOLUMETRIC COEFFICIENT OF LIQUID EXPANSION (1/°C x 10⁻⁴) 3.02

ENTHALPY, HEAT CAPACITY AND HEAT OF FUSION

SOLID
Enthalpy (cal/gm)  Hₜ-H₀°C =
Heat Capacity (cal/gm °C)  cₚ =
Heat Capacity at 300°C (572°F)  cₚ = 0.19

LIQUID
Enthalpy (cal/gm)  Hₜ-H₀°C =
Heat Capacity (cal/gm °C)  cₚ =
Heat Capacity at 700°C (1292°F)  cₚ = 0.26

HEAT OF FUSION (cal/gm)  Hₐ-Hₛ =

THERMAL CONDUCTIVITY

K (BTU/hr ft °F)

VISCOITY

<table>
<thead>
<tr>
<th>°C</th>
<th>(Centipoises)</th>
<th>(Centistokes)</th>
<th>°F</th>
<th>(lb./ft-hr)</th>
<th>ft²/hr</th>
</tr>
</thead>
<tbody>
<tr>
<td>500</td>
<td>10.5* (Ref. 19)</td>
<td>3.57</td>
<td>1100</td>
<td>15.2*</td>
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<td>1300</td>
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<td>0.0566</td>
</tr>
<tr>
<td>700</td>
<td>4.1*</td>
<td>1.47</td>
<td>1500</td>
<td>7.1*</td>
<td>0.0424</td>
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<tr>
<td>800</td>
<td>3.1*</td>
<td>1.15</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Exponential Form (centipoises)  μ = 0.161e³¹₇¹/T⁰K

*Denotes experimental values. Other values given are calculated or estimated.
<table>
<thead>
<tr>
<th>Mixture</th>
<th>Component</th>
<th>Mol %</th>
<th>Wt. %</th>
<th>Avg. M.W.</th>
<th>Liquidus Temp.</th>
</tr>
</thead>
<tbody>
<tr>
<td>21</td>
<td>NaF</td>
<td>4.8</td>
<td>1.80</td>
<td>112.1</td>
<td>540°C (1004°F)</td>
</tr>
<tr>
<td></td>
<td>KF</td>
<td>50.1</td>
<td>25.06</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>ZrF₄</td>
<td>41.3</td>
<td>61.59</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>UF₄</td>
<td>3.8</td>
<td>10.65</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Density**

SOLID AT ROOM TEMPERATURE (gm/cc) 3.76

LIQUID (ρ = gm/cc, T = °C) ρ* = 4.27 - 0.00163T (Ref. 18)

LIQUID (ρ = lbs/ft³, T = °F) ρ* = 268.3 - 0.0565T

MEAN VOLUMETRIC COEFFICIENT OF LIQUID EXPANSION (1/°C x 10⁴) 5.51 (800°C)

**Enthalpy, Heat Capacity and Heat of Fusion**

SOLID

Enthalpy (cal/gm) Hₜ-H₀°C*
Heat Capacity (cal/gm °C) c* =
Heat Capacity at 300°C (572°F) cₚ

LIQUID (510°C-890°C)**

Enthalpy (cal/gm) Hₜ-H₀°C* = -14.5 + 0.277T (Ref. 4)
Heat Capacity (cal/gm °C) c* = 0.28
Heat Capacity at 700°C (1292°F) cₚ = 0.28

HEAT OF FUSION (cal/gm) Hₜ-H₀°C*

**Thermal Conductivity**

K (BTU/hr ft °F)

**Viscosity**

<table>
<thead>
<tr>
<th>°C</th>
<th>(Centipoises)</th>
<th>(Centistokes)</th>
<th>°F</th>
<th>(lb./ft-hr)</th>
<th>ft²/hr</th>
</tr>
</thead>
<tbody>
<tr>
<td>600</td>
<td>6.7</td>
<td>1100</td>
<td>1100</td>
<td>16.9</td>
<td></td>
</tr>
<tr>
<td>700</td>
<td>4.5</td>
<td>1300</td>
<td>1300</td>
<td>10.8</td>
<td></td>
</tr>
<tr>
<td>800</td>
<td>3.4</td>
<td>1500</td>
<td>1500</td>
<td>8.0</td>
<td></td>
</tr>
</tbody>
</table>

Exponential Form (centipoises)

*Denotes experimental values. Other values given are calculated or estimated.

**No discontinuity was noted in the temperature-enthalpy relationship in this temperature range.
Mixture Component Mol % Wt. % Avg. M.W. Liquidus Temp.
22 KF 46 21.75 122.9 605°C (1121°F)
ZrF₄ 50 68.03
UF₄ 4 10.22

DENSITY

SOLID AT ROOM TEMPERATURE (gm/cc) 3.90
LIQUID (ρ = gm/cc, T = °C) ρ = 3.69 - 0.00089T
LIQUID (ρ = lbs/ft³, T = °F) ρ = 231.3 - 0.0309T
MEAN VOLUMETRIC COEFFICIENT OF LIQUID EXPANSION (1/°C x 10⁴) 2.91

ENTHALPY, HEAT CAPACITY AND HEAT OF FUSION

SOLID

Enthalpy (cal/gm) \( H_{T-H_0} °C^* \) =
Heat Capacity (cal/gm °C) \( c_p °C^* \) =
Heat Capacity at 300°C (572°F) \( c_p = 0.17 \)

LIQUID

Enthalpy (cal/gm) \( H_{T-H_0} °C^* \) =
Heat Capacity (cal/gm °C) \( c_p °C^* \) =
Heat Capacity at 700°C (1292°F) \( c_p = 0.24 \)

HEAT OF FUSION (cal/gm) \( H_{L-H_S} °C^* \)

THERMAL CONDUCTIVITY

K (BTU/hr ft °F)

Viscosity

°C (Centipoises) (Centistokes) °F (lb./ft-hr) ft²/hr

Exponential Form (centipoises)

*Denotes experimental values. Other values given are calculated or estimated.
### Mixture

<table>
<thead>
<tr>
<th>Component</th>
<th>Mol %</th>
<th>Wt. %</th>
<th>Avg. M.W.</th>
<th>Liquidus Temp.</th>
</tr>
</thead>
<tbody>
<tr>
<td>NaF</td>
<td>4.8</td>
<td>1.80</td>
<td>112.1</td>
<td>540°C (1004°F)</td>
</tr>
<tr>
<td>KF</td>
<td>50.1</td>
<td>25.96</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ZrF₄</td>
<td>41.3</td>
<td>61.59</td>
<td></td>
<td></td>
</tr>
<tr>
<td>UF₄</td>
<td>3.8</td>
<td>10.65</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### DENSITY

- **SOLID AT ROOM TEMPERATURE (gm/cc)**: 3.76
- **LIQUID (ρ = gm/cc, T = °C)**: ρ* = 4.27 - 0.00163T (Ref. 18)
- **LIQUID (ρ = lbs/ft³, T = °F)**: ρ* = 268.3 - 0.0565T

### MEAN VOLUMETRIC COEFFICIENT OF LIQUID EXPANSION (1/°C x 10⁴): 5.51 (800°C)

### ENTHALPY, HEAT CAPACITY AND HEAT OF FUSION

#### SOLID

- **Enthalpy (cal/gm)**
  \[ H_{T-H_{0°C}}^* = \]
- **Heat Capacity (cal/gm °C)**
  \[ c_p^* = \]
- **Heat Capacity at 300°C (572°F)**
  \[ c_p = \]

#### LIQUID (510°C-890°C)**

- **Enthalpy (cal/gm)**
  \[ H_{T-H_{0°C}}^* = -14.5 + 0.277T \] (Ref. 4)
- **Heat Capacity (cal/gm °C)**
  \[ c_p^* = 0.28 \]
- **Heat Capacity at 700°C (1292°F)**
  \[ c_p^* = 0.28 \]

### HEAT OF FUSION (cal/gm)

\[ H_{L-H_{S}}^* = \]

### THERMAL CONDUCTIVITY

\[ K (BTU/hr ft °F) \]

### VISCOSITY

<table>
<thead>
<tr>
<th>°C</th>
<th>(Centipoises)</th>
<th>(Centistokes)</th>
<th>°F</th>
<th>(lb./ft-hr)</th>
<th>ft²/hr</th>
</tr>
</thead>
<tbody>
<tr>
<td>600</td>
<td>6.7</td>
<td></td>
<td>1100</td>
<td>16.9</td>
<td></td>
</tr>
<tr>
<td>700</td>
<td>4.5</td>
<td></td>
<td>1300</td>
<td>10.8</td>
<td></td>
</tr>
<tr>
<td>800</td>
<td>3.4</td>
<td></td>
<td>1500</td>
<td>8.0</td>
<td></td>
</tr>
</tbody>
</table>

Exponential Form (centipoises)

*Denotes experimental values. Other values given are calculated or estimated.
**No discontinuity was noted in the temperature-enthalpy relationship in this temperature range.
<table>
<thead>
<tr>
<th>Mixture</th>
<th>Component</th>
<th>Mol %</th>
<th>Wt. %</th>
<th>Avg. M.W.</th>
<th>Liquidus Temp.</th>
</tr>
</thead>
<tbody>
<tr>
<td>22</td>
<td>KF</td>
<td>46</td>
<td>21.75</td>
<td>122.9</td>
<td>605°C (1121°F)</td>
</tr>
<tr>
<td></td>
<td>ZrF₄</td>
<td>50</td>
<td>66.03</td>
<td></td>
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<tr>
<td></td>
<td>UF₄</td>
<td>4</td>
<td>10.22</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Density**

SOLID AT ROOM TEMPERATURE (gm/cc) 3.90

LIQUID (ρ = gm/cc, T = °C) \( ρ = 3.69 - 0.00089T \)

LIQUID (ρ = lbs/ft³, T = °F) \( ρ = 231.3 - 0.0309T \)

MEAN VOLUMETRIC COEFFICIENT OF LIQUID EXPANSION \((1/°C \times 10^4)\) 2.91

**Enthalpy, Heat Capacity and Heat of Fusion**

**SOLID**

- Enthalpy (cal/gm) \( H_T - H_{0°C} * \)
- Heat Capacity (cal/gm °C) \( c_p * \)
- Heat Capacity at 300°C (572°F) \( c_p = 0.17 \)

**LIQUID**

- Enthalpy (cal/gm) \( H_T - H_{0°C} * \)
- Heat Capacity (cal/gm °C) \( c_p * \)
- Heat Capacity at 700°C (1292°F) \( c_p = 0.24 \)

**HEAT OF FUSION (cal/gm)** \( H_L - H_S * \)

**Thermal Conductivity**

\( K \) (BTU/hr ft °F)

**Viscosity**

<table>
<thead>
<tr>
<th>°C</th>
<th>(Centipoises)</th>
<th>(Centistokes)</th>
<th>°F</th>
<th>(lb./ft-hr)</th>
<th>ft²/hr</th>
</tr>
</thead>
</table>

Exponential Form (centipoises)

*Denotes experimental values. Other values given are calculated or estimated.*
## Mixture Component Mol % Wt. % Avg. M.W. Liquidus Temp.

<table>
<thead>
<tr>
<th>Mixture</th>
<th>Component</th>
<th>Mol %</th>
<th>Wt. %</th>
<th>Avg. M.W.</th>
<th>Liquidus Temp.</th>
</tr>
</thead>
<tbody>
<tr>
<td>23</td>
<td>KF</td>
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<td>56.61</td>
<td>42.9</td>
<td>450°C (842°F)</td>
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<tr>
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<td>NaF</td>
<td>11.4</td>
<td>11.16</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>LiF</td>
<td>46.2</td>
<td>27.92</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>ThF₄</td>
<td>0.6</td>
<td>4.31</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Density

- **Solid at Room Temperature (gm/cc)**: 2.53
- **Liquid** ($\rho = \text{gm/cc, } T = \circ\text{C}$): $\rho = 2.52 - 0.00070T$
- **Liquid** ($\rho = \text{lbs/ft}^3, T = \circ\text{F}$): $\rho = 158.1 - 0.0243T$
- **Mean Volumetric Coefficient of Liquid Expansion** ($1/\circ\text{C} \times 10^4$): 3.45

### Enthalpy, Heat Capacity and Heat of Fusion

**Solid**
- Enthalpy (cal/gm) $H_T - H_{0\circ\text{C}}^*$
- Heat Capacity (cal/gm °C) $c_p^*$
- Heat Capacity at 300°C (572°F) $c_p = 0.32$

**Liquid**
- Enthalpy (cal/gm) $H_T - H_{0\circ\text{C}}^*$
- Heat Capacity (cal/gm °C) $c_p^*$
- Heat Capacity at 700°C (1292°F) $c_p = 0.45$

### Heat of Fusion (cal/gm) $H_L - H_S^*$

### Thermal Conductivity

$K$ (BTU/hr ft °F)

### Viscosity

<table>
<thead>
<tr>
<th>°C</th>
<th>(Centipoises)</th>
<th>(Centistokes)</th>
<th>°F</th>
<th>(lb./ft-hr)</th>
<th>ft²/hr</th>
</tr>
</thead>
<tbody>
<tr>
<td>500</td>
<td>9.2</td>
<td></td>
<td>1100</td>
<td>12.1</td>
<td></td>
</tr>
<tr>
<td>600</td>
<td>4.75</td>
<td></td>
<td>1300</td>
<td>6.9</td>
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<tr>
<td>700</td>
<td>2.9</td>
<td></td>
<td>1500</td>
<td>4.4</td>
<td></td>
</tr>
<tr>
<td>800</td>
<td>1.95</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Exponential Form (centipoises)

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<table>
<thead>
<tr>
<th>Mixture</th>
<th>Component</th>
<th>Mol %</th>
<th>Wt. %</th>
<th>Avg. M.W.</th>
<th>Liquidus Temp.</th>
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</thead>
<tbody>
<tr>
<td>24</td>
<td>KF</td>
<td>18</td>
<td>10.20</td>
<td>102.5</td>
<td>450°C (842°F)</td>
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<tr>
<td></td>
<td>NaF</td>
<td>36</td>
<td>14.75</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>ZrF₄</td>
<td>46</td>
<td>75.04</td>
<td></td>
<td></td>
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</tbody>
</table>

**Density**

SOLID AT ROOM TEMPERATURE (gm/cc) 3.80
LIQUID (ρ = gm/cc, T = °C) ρ = 3.59 - 0.00087T
LIQUID (ρ = lbs/ft³, T = °F) ρ = 225.1 - 0.0302T
MEAN VOLUMETRIC COEFFICIENT OF LIQUID EXPANSION (1/°C x 10⁴) 2.92

**Enthalpy, Heat Capacity and Heat of Fusion**

**SOLID**

- Enthalpy (cal/gm) \( H_T - H_{0°C} \)
- Heat Capacity (cal/gm °C) \( c_p \)
- Heat Capacity at 300°C (572°F) \( c_p = 0.19 \)

**LIQUID**

- Enthalpy (cal/gm) \( H_T - H_{0°C} \)
- Heat Capacity (cal/gm °C) \( c_p \)
- Heat Capacity at 700°C (1292°F) \( c_p = 0.27 \)

**Heat of Fusion (cal/gm)** \( H_L - H_S \)

**Thermal Conductivity**

K (BTU/hr ft °F)

**Viscosity**

<table>
<thead>
<tr>
<th>°C</th>
<th>(Centipoises)</th>
<th>(Centistokes)</th>
<th>°F</th>
<th>(lb./ft-hr)</th>
<th>ft²/hr</th>
</tr>
</thead>
<tbody>
<tr>
<td>600</td>
<td>7.15</td>
<td></td>
<td>1100</td>
<td>17.9</td>
<td></td>
</tr>
<tr>
<td>700</td>
<td>4.4</td>
<td></td>
<td>1300</td>
<td>10.5</td>
<td></td>
</tr>
<tr>
<td>800</td>
<td>3.05</td>
<td></td>
<td>1500</td>
<td>6.9</td>
<td></td>
</tr>
</tbody>
</table>

Exponential Form (centipoises)

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<table>
<thead>
<tr>
<th>Mixture</th>
<th>Component</th>
<th>Mol %</th>
<th>Wt. %</th>
<th>Avg. M.W.</th>
<th>Liquidus Temp.</th>
</tr>
</thead>
<tbody>
<tr>
<td>25</td>
<td>KF</td>
<td>17.4</td>
<td>9.20</td>
<td>109.9</td>
<td>545°C (1013°F)</td>
</tr>
<tr>
<td></td>
<td>NaF</td>
<td>34.7</td>
<td>13.25</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>ZrF₄</td>
<td>44.4</td>
<td>67.55</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>UF₄</td>
<td>3.5</td>
<td>10.00</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**DENSITY**

SOLID AT ROOM TEMPERATURE (gm/cc) 3.97

LIQUID (ρ = gm/cc, T = °C) ρ* = 3.78 - 0.00091T (Ref. 18)

LIQUID (ρ = lbs/ft³, T = °F) ρ* = 237.0 - 0.0315T

MEAN VOLUMETRIC COEFFICIENT OF LIQUID EXPANSION (1/°C x 10⁴) 2.90

**ENTHALPY, HEAT CAPACITY AND HEAT OF FUSION**

SOLID

Enthalpy (cal/gm) \( H_T - H_{O C} = \)

Heat Capacity (cal/gm °C) \( c_p = \)

Heat Capacity at 300°C (572°F) \( c_p = 0.18 \)

LIQUID

Enthalpy (cal/gm) \( H_T - H_{O C} = \)

Heat Capacity (cal/gm °C) \( c_p = \)

Heat Capacity at 700°C (1292°F) \( c_p = 0.25 \)

**HEAT OF FUSION (cal/gm)** \( H_L - H_S = \)

**THERMAL CONDUCTIVITY**

K (BTU/hr ft °F)

**VISCOITY**

<table>
<thead>
<tr>
<th>°C</th>
<th>(Centipoises)</th>
<th>(Centistokes)</th>
<th>°F</th>
<th>(lb./ft-hr)</th>
<th>ft²/hr</th>
</tr>
</thead>
<tbody>
<tr>
<td>600</td>
<td>8.1</td>
<td></td>
<td>1100</td>
<td>20.3</td>
<td></td>
</tr>
<tr>
<td>700</td>
<td>5.2</td>
<td></td>
<td>1300</td>
<td>12.1</td>
<td></td>
</tr>
<tr>
<td>800</td>
<td>3.6</td>
<td></td>
<td>1500</td>
<td>8.0</td>
<td></td>
</tr>
</tbody>
</table>

Exponential Form (centipoises)

*Denotes experimental values. Other values given are calculated or estimated.*
<table>
<thead>
<tr>
<th>Mixture</th>
<th>Component</th>
<th>Mol %</th>
<th>Wt. %</th>
<th>Avg. M.W.</th>
<th>Liquidus Temp.</th>
</tr>
</thead>
<tbody>
<tr>
<td>25a</td>
<td>KF</td>
<td>17.6</td>
<td>13.65</td>
<td>107.7</td>
<td>545°C (1013°F)</td>
</tr>
<tr>
<td></td>
<td>NaF</td>
<td>35.1</td>
<td>9.47</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>ZrF₄</td>
<td>44.8</td>
<td>69.55</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>UF₄</td>
<td>2.5</td>
<td>7.34</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**DENSITY**

SOLID AT ROOM TEMPERATURE (gm/cc) 3.92

LIQUID (ρ = gm/cc, T = °C)

\[ \rho^* = 3.65 - 0.00080T \] (Ref. 18)

LIQUID (ρ = lbs/ft³, T = °F)

\[ \rho^* = 228.7 - 0.0277T \]

MEAN VOLUMETRIC COEFFICIENT OF LIQUID EXPANSION (1/°C x 10⁴) 2.59

**ENThalpy, HEAT CaPACITy AND HEAT OF FUSion**

**SOLID**

- Enthalpy (cal/gm)
- Heat Capacity (cal/gm °C)
- Heat Capacity at 300°C (572°F)

**LIQUID**

- Enthalpy (cal/gm)
- Heat Capacity (cal/gm °C)
- Heat Capacity at 700°C (1292°F)

**HEAT OF FUSION (cal/gm)**

**THERMAL CONDUCTIVITY**

K (BTU/hr ft °F)

**VISCOSITY**

<table>
<thead>
<tr>
<th>°C</th>
<th>(Centipoises)</th>
<th>(Centistokes)</th>
<th>°F</th>
<th>(lb./ft-hr)</th>
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<tbody>
<tr>
<td>600</td>
<td>8.1</td>
<td></td>
<td>1100</td>
<td>20.3</td>
<td></td>
</tr>
<tr>
<td>700</td>
<td>5.1</td>
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<td>1300</td>
<td>12.1</td>
<td></td>
</tr>
<tr>
<td>800</td>
<td>3.5</td>
<td></td>
<td>1500</td>
<td>8.0</td>
<td></td>
</tr>
</tbody>
</table>

Exponential Form (centipoises)

*Denotes experimental values. Other values given are calculated or estimated.
Mixture Component   Mol %   Wt. %   Avg. M.W.   Liquidus Temp.
26       KF 14.0  7.28  111.6  540°C (1004°F)
         NaF 36.6 13.76
         ZrF₄ 45.6 68.27
         UF₄ 3.8 10.69

DENSITY

SOLID AT ROOM TEMPERATURE (gm/cc)  4.02
LIQUID (ρ = gm/cc, T = °C)  ρ = 3.82 - 0.00091T
LIQUID (ρ = lbs/ft³, T = °F)  ρ = 239.5 - 0.0315T
MEAN VOLUMETRIC COEFFICIENT OF LIQUID EXPANSION (1/°C x 10⁴)  2.87

ENTHALPY, HEAT CAPACITY AND HEAT OF FUSION

SOLID

Enthalpy (cal/gm)  H_T-H₂O°C*
Heat Capacity (cal/gm °C)  c_p*
Heat Capacity at 300°C (572°F)  c_p = 0.18

LIQUID

Enthalpy (cal/gm)  H_T-H₂O°C*
Heat Capacity (cal/gm °C)  c_p*
Heat Capacity at 700°C (1292°F)  c_p = 0.25

HEAT OF FUSION (cal/gm)  H_L-H_S*

THERMAL CONDUCTIVITY

K (BTU/hr ft °F)

VISCOSITY

<table>
<thead>
<tr>
<th>°C</th>
<th>(Centipoises)</th>
<th>(Centistokes)</th>
<th>°F</th>
<th>(lb./ft-hr)</th>
<th>ft²/hr</th>
</tr>
</thead>
<tbody>
<tr>
<td>600</td>
<td>8.2</td>
<td></td>
<td>1100</td>
<td>20.6</td>
<td></td>
</tr>
<tr>
<td>700</td>
<td>5.3</td>
<td></td>
<td>1300</td>
<td>12.6</td>
<td></td>
</tr>
<tr>
<td>800</td>
<td>3.7</td>
<td></td>
<td>1500</td>
<td>8.5</td>
<td></td>
</tr>
</tbody>
</table>

Exponential Form (centipoises)

*Denotes experimental values. Other values given are calculated or estimated.
<table>
<thead>
<tr>
<th>Mixture</th>
<th>Component</th>
<th>Mol %</th>
<th>Wt. %</th>
<th>Avg. M.W.</th>
<th>Liquidus Temp.</th>
</tr>
</thead>
<tbody>
<tr>
<td>27</td>
<td>NaF</td>
<td>46</td>
<td>16.73</td>
<td>115.5</td>
<td>510°C (950°F)</td>
</tr>
<tr>
<td></td>
<td>ZrF₄</td>
<td>50</td>
<td>72.39</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>UF₄</td>
<td>4</td>
<td>10.88</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Density**

**Solid at Room Temperature (gm/cc)** 4.17

**Liquid**

- \( \rho = \text{gm/cc, } T = \circ^\circ \text{C} \):
  \[ \rho = 3.97 - 0.00093T \]

- \( \rho = \text{lbs/ft}^3, T = \circ^\circ \text{F} \):
  \[ \rho = 248.9 - 0.0322T \]

**Mean Volumetric Coefficient of Liquid Expansion \((1/\circ^\circ \text{C} \times 10^4)\)** 2.79

**Enthalpy, Heat Capacity and Heat of Fusion**

**Solid**

- Enthalpy (cal/gm)
- Heat Capacity (cal/gm \( \circ^\circ \text{C} \))
- Heat Capacity at 300°C (572°F)

**Liquid**

- Enthalpy (cal/gm)
- Heat Capacity (cal/gm \( \circ^\circ \text{C} \))
- Heat Capacity at 700°C (1292°F)

**Heat of Fusion (cal/gm)**

**Thermal Conductivity**

\( K \text{ (BTU/hr ft } \circ^\circ \text{F)} = 0.6 \text{ (solid sphere and slab)(Ref. 45)} \)

**Viscosity**

<table>
<thead>
<tr>
<th>°C</th>
<th>Centipoises</th>
<th>Centistokes</th>
<th>°F</th>
<th>(lb./ft-hr)</th>
<th>ft²/hr</th>
</tr>
</thead>
<tbody>
<tr>
<td>600</td>
<td>8.9</td>
<td></td>
<td>1100</td>
<td>22.3</td>
<td></td>
</tr>
<tr>
<td>700</td>
<td>5.7</td>
<td></td>
<td>1300</td>
<td>13.6</td>
<td></td>
</tr>
<tr>
<td>800</td>
<td>3.9</td>
<td></td>
<td>1500</td>
<td>9.0</td>
<td></td>
</tr>
</tbody>
</table>

**Exponential Form (centipoises)**

*Denotes experimental values. Other values given are calculated or estimated.
<table>
<thead>
<tr>
<th>Mixture</th>
<th>Component</th>
<th>Mol %</th>
<th>Wt. %</th>
<th>Avg. M.W.</th>
<th>Liquidus Temp.</th>
</tr>
</thead>
<tbody>
<tr>
<td>28</td>
<td>NaF</td>
<td>48</td>
<td>18.82</td>
<td>107.1</td>
<td>515°C (959°F)</td>
</tr>
<tr>
<td></td>
<td>ZrF₂₄</td>
<td>52</td>
<td>81.18</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**DENSITY**

SOLID AT ROOM TEMPERATURE (gm/cc) 3.99
LIQUID (ρ = gm/cc, T = °C) ρ = 3.79 - 0.00090T
LIQUID (ρ = lbs/ft³, T = °F) ρ = 237.6 - 0.0312T
MEAN VOLUMETRIC COEFFICIENT OF LIQUID EXPANSION (1/°C x 10⁴) 2.86

**ENTHALPY, HEAT CAPACITY AND HEAT OF FUSION**

SOLID

Enthalpy (cal/gm) \( H_{T-H_0C} \)
Heat Capacity (cal/gm °C) \( c_p^* \)
Heat Capacity at 300°C (572°F) \( c_p = 0.19 \)

LIQUID

Enthalpy (cal/gm) \( H_{T-H_0C} \)
Heat Capacity (cal/gm °C) \( c_p^* \)
Heat Capacity at 700°C (1292°F) \( c_p = 0.27 \)

HEAT OF FUSION (cal/gm) \( H_{L-H_S} \)

**THERMAL CONDUCTIVITY**

K (BTU/hr ft °F)

**VISCOITY**

<table>
<thead>
<tr>
<th>°C</th>
<th>(Centipoises)</th>
<th>(Centistokes)</th>
<th>°F</th>
<th>(lb./ft-hr)</th>
<th>ft²/hr</th>
</tr>
</thead>
<tbody>
<tr>
<td>600</td>
<td>8.5</td>
<td></td>
<td>1100</td>
<td>21.5</td>
<td></td>
</tr>
<tr>
<td>700</td>
<td>5.3</td>
<td>5.3</td>
<td>1300</td>
<td>12.5</td>
<td></td>
</tr>
<tr>
<td>800</td>
<td>3.5</td>
<td>3.5</td>
<td>1500</td>
<td>8.0</td>
<td></td>
</tr>
</tbody>
</table>

Exponential Form (centipoises)

*Denotes experimental values. Other values given are calculated or estimated.*
<table>
<thead>
<tr>
<th>Mixture</th>
<th>Component</th>
<th>Mol %</th>
<th>Wt. %</th>
<th>Avg. M.W.</th>
<th>Liquidus Temp.</th>
</tr>
</thead>
<tbody>
<tr>
<td>29</td>
<td>NaF</td>
<td>42.2</td>
<td>15.49</td>
<td>114.3</td>
<td>570°C (1058°F)</td>
</tr>
<tr>
<td></td>
<td>ZrF&lt;sub&gt;4&lt;/sub&gt;</td>
<td>57.8</td>
<td>84.51</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**DENSITY**

SOLID AT ROOM TEMPERATURE (gm/cc) 4.06

LIQUID (\(\rho = \text{gm/cc}, T = ^\circ\text{C}\)) \(\rho = 3.86 - 0.00092T\)

LIQUID (\(\rho = \text{lbs/ft}^3, T = ^\circ\text{F}\)) \(\rho = 242.0 - 0.0319T\)

MEAN VOLUMETRIC COEFFICIENT OF LIQUID EXPANSION (\(1/\text{°C} \times 10^4\)) 2.87

**ENTHALPY, HEAT CAPACITY AND HEAT OF FUSION**

**SOLID**

Enthalpy (cal/gm) \(H_T - H_0^\circ\text{C}\*)
Heat Capacity (cal/gm °C) \(c_p^*\)
Heat Capacity at 300°C (572°F) \(c_p = 0.19\)

**LIQUID**

Enthalpy (cal/gm) \(H_T - H_0^\circ\text{C}\*)
Heat Capacity (cal/gm °C) \(c_p^*\)
Heat Capacity at 700°C (1292°F) \(c_p = 0.26\)

**HEAT OF FUSION (cal/gm)** \(H_L - H_S^*\)

**THERMAL CONDUCTIVITY**

K (BTU/hr ft °F)

**VISCOITY**

<table>
<thead>
<tr>
<th>°C</th>
<th>(Centipoises)</th>
<th>(Centistokes)</th>
<th>°F</th>
<th>(lb./ft-hr)</th>
<th>ft&lt;sup&gt;2&lt;/sup&gt;/hr</th>
</tr>
</thead>
</table>

Exponential Form (centipoises)

*Denotes experimental values. Other values given are calculated or estimated.*
<table>
<thead>
<tr>
<th>Mixture</th>
<th>Component</th>
<th>Mol %</th>
<th>Wt. %</th>
<th>Avg. M.W.</th>
<th>Liquidus Temp.</th>
</tr>
</thead>
<tbody>
<tr>
<td>30 NaF</td>
<td>50</td>
<td>19.01</td>
<td>110.5</td>
<td>520°C (968°F)</td>
<td></td>
</tr>
<tr>
<td>ZrF₄</td>
<td>46</td>
<td>69.62</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>UF₄</td>
<td>4</td>
<td>11.37</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**DENSITY**

SOLID AT ROOM TEMPERATURE (gm/cc) 4.09* (Ref. 10)

LIQUID (ρ = gm/cc, T = °C) ρ = 3.93 - 0.00093T

LIQUID (ρ = lbs/ft³, T = °F) ρ = 246.4 - 0.0322T

MEAN VOLUMETRIC COEFFICIENT OF LIQUID EXPANSION (1/°C x 10⁴) 2.84

**ENTHALPY, HEAT CAPACITY AND HEAT OF FUSION**

SOLID (340°C-500°C)

- Enthalpy (cal/gm) \( H_T - H_{O,C}^* = -12.6 + 0.215T \) (Ref. 4)
- Heat Capacity (cal/gm °C) \( c_p^* = 0.22 \)
- Heat Capacity at 300°C (572°F) \( c_p^* = 0.22 \)

LIQUID (540°C-894°C)

- Enthalpy (cal/gm) \( H_T - H_{O,C}^* = 2.1 + 0.3178T - 4.28 \times 10^{-5}T^2 \)
- Heat Capacity (cal/gm °C) \( c_p^* = 0.3178 - 8.56 \times 10^{-5}T \)
- Heat Capacity at 700°C (1292°F) \( c_p^* = 0.258 \)

HEAT OF FUSION (cal/gm) \( H_L - H_S^* = 57 \)

**THERMAL CONDUCTIVITY**

\( K \) (BTU/hr ft °F) 0.5 (Solid slab) (Ref. 45)

1.3 (Liquid) (Ref. 14)

**VISCOSITY**

<table>
<thead>
<tr>
<th>°C</th>
<th>(Centipoises)</th>
<th>(Centistokes)</th>
<th>°F</th>
<th>(lb./ft-hr)</th>
<th>ft²/hr</th>
</tr>
</thead>
<tbody>
<tr>
<td>600</td>
<td>8.5* (Ref. 20)</td>
<td>2.52</td>
<td>1100</td>
<td>21.3*</td>
<td>0.1009</td>
</tr>
<tr>
<td>700</td>
<td>5.4*</td>
<td>1.65</td>
<td>1300</td>
<td>12.8*</td>
<td>0.0625</td>
</tr>
<tr>
<td>800</td>
<td>3.7*</td>
<td>1.16</td>
<td>1500</td>
<td>8.5*</td>
<td>0.0430</td>
</tr>
<tr>
<td>850</td>
<td>3.2*</td>
<td>1.02</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Exponential Form (centipoises) \( \mu = 0.0981e^{3959/TK} \)

PRANDTL NUMBER 4.4 at 1100°F, 2.5 at 1300°F, 1.6 at 1500°F

**ELECTRICAL CONDUCTIVITY** (ohm-cm)⁻¹ 0.87 at 1100°F, 1.16 at 1300°F, 1.45 at 1500°F

**SURFACE TENSION** (dynes/cm) 157 at 530°C, 132 at 650°C, 115 at 730°C (Ref. 21)

*Denotes experimental values. Other values given are calculated or estimated.
### Mixture Component Information

<table>
<thead>
<tr>
<th>Mixture</th>
<th>Component</th>
<th>Mol %</th>
<th>Wt. %</th>
<th>Avg. M.W.</th>
<th>Liquidus Temp.</th>
</tr>
</thead>
<tbody>
<tr>
<td>31</td>
<td>NaF</td>
<td>50</td>
<td>20.08</td>
<td>104.6</td>
<td>510°C (950°F)</td>
</tr>
<tr>
<td></td>
<td>ZrF₄</td>
<td>50</td>
<td>79.92</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Density

**Solid at Room Temperature** (gm/cc)  
4.11* (Ref. 22)

**Liquid**  \( \rho = \text{gm/cc}, \ T = \text{oC} \)  
\( \rho^* = 3.79 - 0.00093T \) (Ref. 23)

**Liquid**  \( \rho = \text{lbs/ft}^3, \ T = \text{°F} \)  
\( \rho^* = 237.6 - 0.0322T \)

**Mean Volumetric Coefficient of Liquid Expansion**  \( (1/\text{oC} \times 10^4) \)  
2.96

### Enthalpy, Heat Capacity and Heat of Fusion

**Solid**  \( (54°-488°\text{C}) \)

- **Enthalpy (cal/gm)**  
  \( H_T - H_{0°C}^* = 0.1 + 0.1798T + 2.69 \times 10^{-5}T^2 \) (Ref. 4)

- **Heat Capacity (cal/gm °C)**  
  \( c_p^* = 0.1798 + 5.38 \times 10^{-5}T \)

- **Heat Capacity at 300°C (572°F)**  
  \( c_p^* = 0.196 \)

**Liquid**  \( (546°-899°\text{C}) \)

- **Enthalpy (cal/gm)**  
  \( H_T - H_{0°C}^* = -5.3 + 0.3508T - 5.39 \times 10^{-5}T^2 \)

- **Heat Capacity (cal/gm °C)**  
  \( c_p^* = 0.3508 - 10.79 \times 10^{-5}T \)

- **Heat Capacity at 700°C (1292°F)**  
  \( c_p^* = 0.275 \)

**Heat of Fusion** (cal/gm)  
\( H_L - H_S^* = 61 \)

### Thermal Conductivity

K (BTU/hr ft °F)

### Viscosity

<table>
<thead>
<tr>
<th>°C</th>
<th>(Centipoises)</th>
<th>(Centistokes)</th>
<th>°F</th>
<th>(lb./ft-hr)</th>
<th>ft²/hr</th>
</tr>
</thead>
<tbody>
<tr>
<td>600</td>
<td>8.4* (Ref. 24)</td>
<td>2.60</td>
<td>1100</td>
<td>20.9*</td>
<td>0.1033</td>
</tr>
<tr>
<td>700</td>
<td>5.2*</td>
<td>1.66</td>
<td>1300</td>
<td>12.3*</td>
<td>0.0627</td>
</tr>
<tr>
<td>800</td>
<td>3.45*</td>
<td>1.13</td>
<td>1500</td>
<td>7.9*</td>
<td>0.0416</td>
</tr>
</tbody>
</table>

**Exponential Form (centipoises)**  
\( \mu = 0.0709e^{4168/°K} \)

**Electrical Conductivity** (ohm-cm)^{-1}  
0.64 at 1100°F, 1.05 at 1300°F, 1.47 at 1500°F  
(Ref. 13)

*Denotes experimental values. Other values given are calculated or estimated.*
<table>
<thead>
<tr>
<th>Mixture</th>
<th>Component</th>
<th>Mol %</th>
<th>Wt. %</th>
<th>Avg. M.W.</th>
<th>Liquidus Temp.</th>
</tr>
</thead>
<tbody>
<tr>
<td>32</td>
<td>NaF</td>
<td>52</td>
<td>21.39</td>
<td>102.1</td>
<td>515°C (959°F)</td>
</tr>
<tr>
<td></td>
<td>ZrF₄</td>
<td>48</td>
<td>78.61</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**DENSITY**

SOLID AT ROOM TEMPERATURE (gm/cc) 4.10* (Ref. 22)

LIQUID \( \rho = \text{gm/cc, } T = ^\circ \text{C} \) \( \rho = 3.72 - 0.00089T \)

LIQUID \( \rho = \text{lbs/ft}^3, T = ^\circ \text{F} \) \( \rho = 233.2 - 0.0309T \)

MEAN VOLUMETRIC COEFFICIENT OF LIQUID EXPANSION \( (1/\circ \text{C} \times 10^4) \) 2.87

**ENTHALPY, HEAT CAPACITY AND HEAT OF FUSION**

SOLID

- Enthalpy (cal/gm) \( H_T - H_{0 \circ C} * = \)
- Heat Capacity (cal/gm \( ^\circ \text{C} \)) \( c^* = \)
- Heat Capacity at 300°C (572°F) \( c_p = 0.20 \)

LIQUID

- Enthalpy (cal/gm) \( H_T - H_{0 \circ C} * = \)
- Heat Capacity (cal/gm \( ^\circ \text{C} \)) \( c^* = \)
- Heat Capacity at 700°C (1292°F) \( c_p = 0.27 \)

HEAT OF FUSION (cal/gm) \( H_L - H_S^* = \)

**THERMAL CONDUCTIVITY**

\( K \) (BTU/hr ft \( ^\circ \text{F} \))

**VISCOSITY**

<table>
<thead>
<tr>
<th>°C</th>
<th>(Centipoises)</th>
<th>(Centistokes)</th>
<th>°F</th>
<th>(lb./ft-hr)</th>
<th>ft²/hr</th>
</tr>
</thead>
<tbody>
<tr>
<td>600</td>
<td>7.9</td>
<td></td>
<td>1100</td>
<td>20.1</td>
<td></td>
</tr>
<tr>
<td>700</td>
<td>4.8</td>
<td></td>
<td>1300</td>
<td>11.4</td>
<td></td>
</tr>
<tr>
<td>800</td>
<td>3.35</td>
<td></td>
<td>1500</td>
<td>7.7</td>
<td></td>
</tr>
</tbody>
</table>

Exponential Form (centipoises)

*Denotes experimental values. Other values given are calculated or estimated.*
Mixture  Component  Mol %  Wt. %  Avg. M.W.  Liquidus Temp.
-  33  NaF  50  14.86  141.4  610°C (1130°F)
   ZrF₄  25  29.58  
   UF₄  25  55.56  

DENSITY

SOLID AT ROOM TEMPERATURE (gm/cc)  4.93
LIQUID (ρ = gm/cc, T = °C)  ρ* = 5.09 - 0.00159T (Ref. 23)
LIQUID (ρ = lbs/ft³, T = °F)  ρ* = 319.5 - 0.0551T
MEAN VOLUMETRIC COEFFICIENT OF LIQUID EXPANSION (1/°C x 10⁶) 3.99

ENTHALPY, HEAT CAPACITY AND HEAT OF FUSION

SOLID (280°C-610°C)

<table>
<thead>
<tr>
<th>Enthalpy (cal/gm)</th>
<th>Hₜ-H₀°C * = -17.7 + 0.166T (Ref. 4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heat Capacity (cal/gm °C)</td>
<td>cₚ* = 0.17</td>
</tr>
<tr>
<td>Heat Capacity at 300°C (572°F)</td>
<td>cₚ = 0.17</td>
</tr>
</tbody>
</table>

LIQUID (610°C-930°C)

<table>
<thead>
<tr>
<th>Enthalpy (cal/gm)</th>
<th>Hₜ-H₀°C * = -39.0 + 0.270T</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heat Capacity (cal/gm °C)</td>
<td>cₚ* = 0.27</td>
</tr>
<tr>
<td>Heat Capacity at 700°C (1292°F)</td>
<td>cₚ = 0.27</td>
</tr>
</tbody>
</table>

HEAT OF FUSION (cal/gm)  Hₗ-Hₛ* = 42

THERMAL CONDUCTIVITY

K (BTU/hr ft °F)

VISCOSITY

<table>
<thead>
<tr>
<th>°C</th>
<th>(Centipoises)</th>
<th>(Centistokes)</th>
<th>°F</th>
<th>(lb./ft-hr)</th>
<th>ft²/hr</th>
</tr>
</thead>
<tbody>
<tr>
<td>700</td>
<td>8.5* (Ref. 25)</td>
<td>2.05</td>
<td>1300</td>
<td>20.1*</td>
<td>0.0781</td>
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<tr>
<td>800</td>
<td>5.0*</td>
<td>1.24</td>
<td>1500</td>
<td>11.3*</td>
<td>0.0451</td>
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<tr>
<td>900</td>
<td>3.5*</td>
<td>0.89</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Exponential Form (centipoises)

*Denotes experimental values. Other values given are calculated or estimated.
Mixture Component Mol % Wt. % Avg. M.W. Liquidus Temp.
34 NaF 57 24.98 95.8 500°C (932°F)
ZrF₄ 43 75.02

DENSITY

SOLID AT ROOM TEMPERATURE (gm/cc) 3.86
LIQUID (ρ = gm/cc, T = °C) ρ = 3.65 - 0.00088T
LIQUID (ρ = lbs/ft³, T = °F) ρ = 228.8 - 0.0305T
MEAN VOLUMETRIC COEFFICIENT OF LIQUID EXPANSION (1/°C x 10⁴) 2.90

ENTHALPY, HEAT CAPACITY AND HEAT OF FUSION

SOLID
Enthalpy (cal/gm) Hₜ-H₀°C *=
Heat Capacity (cal/gm °C) cₚ *=
Heat Capacity at 300°C (572°F) cₚ = 0.20
LIQUID
Enthalpy (cal/gm) Hₜ-H₀°C *=
Heat Capacity (cal/gm °C) cₚ *=
Heat Capacity at 700°C (1292°F) cₚ = 0.28
HEAT OF FUSION (cal/gm) Hₗ-Hₛ *=

THERMAL CONDUCTIVITY

K (BTU/hr ft °F)

VISCOITY

°C (Centipoises) (Centistokes) °F (lb./ft-hr) ft²/hr
600 7.5 1100 18.9
700 4.6 1300 10.9
800 3.2 1500 7.4

Exponential Form (centipoises)

ELECTRICAL CONDUCTIVITY (ohm-cm)^-¹ 0.95 at 1100°F, 1.41 at 1300°F, 1.85 at 1500°F (Ref. 13)

*Denotes experimental values. Other values given are calculated or estimated.
Mixture Component Mol % Wt. % Avg. M.W. Liquidus Temp.
35
NaF 57 54.22 44.1 360°C (680°F)
BeF₂ 43 45.78

DENSITY
SOLID AT ROOM TEMPERATURE (gm/cc) 2.35
LIQUID (ρ = gm/cc, T = °C) ρ = 2.27 - 0.00037T
LIQUID (ρ = lbs/ft³, T = °F) ρ = 142.1 - 0.0128T
MEAN VOLUMETRIC COEFFICIENT OF LIQUID EXPANSION (1/°C x 10⁴) 1.84

ENTHALPY, HEAT CAPACITY AND HEAT OF FUSION

SOLID
- Enthalpy (cal/gm)
- Heat Capacity (cal/gm °C)
- Heat Capacity at 300°C (572°F)

LIQUID
- Enthalpy (cal/gm)
- Heat Capacity (cal/gm °C)
- Heat Capacity at 700°C (1292°F)

HEAT OF FUSION (cal/gm)

THERMAL CONDUCTIVITY
K (BTU/hr ft °F) 2.4 (Liquid) (Ref. 26)

VISCOITY

<table>
<thead>
<tr>
<th>°C</th>
<th>(Centipoises)</th>
<th>(Centistokes)</th>
<th>°F</th>
<th>(lb./ft-hr)</th>
<th>ft²/hr</th>
</tr>
</thead>
<tbody>
<tr>
<td>550</td>
<td>18.0 (Ref. 27)</td>
<td>8.70</td>
<td>1100</td>
<td>32.7*</td>
<td>0.2555</td>
</tr>
<tr>
<td>600</td>
<td>12.8*</td>
<td>6.27</td>
<td>1300</td>
<td>16.5*</td>
<td>0.1315</td>
</tr>
<tr>
<td>700</td>
<td>7.0*</td>
<td>3.43</td>
<td>1500</td>
<td>9.6*</td>
<td>0.0783</td>
</tr>
<tr>
<td>800</td>
<td>4.25*</td>
<td>2.16</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Exponential Form (centipoises) 𝜇 = 0.0346e^5164/T^0K

PRANDTL NUMBER 7.1 at 1100°F, 3.6 at 1300°F, 2.1 at 1500°F

*Denotes experimental values. Other values given are calculated or estimated.
### Mixture Component Mol % Wt. % Avg. M.W. Liquidus Temp.

<table>
<thead>
<tr>
<th>Mixture</th>
<th>Component</th>
<th>Mol %</th>
<th>Wt. %</th>
<th>Avg. M.W.</th>
<th>Liquidus Temp.</th>
</tr>
</thead>
<tbody>
<tr>
<td>36</td>
<td>NaF</td>
<td>55</td>
<td>40.10</td>
<td>57.6</td>
<td>450°C (842°F)</td>
</tr>
<tr>
<td></td>
<td>BeF₂</td>
<td>40</td>
<td>32.64</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>UF₄</td>
<td>5</td>
<td>27.26</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Density

**Solid at Room Temperature** (gm/cc) 2.86

**Liquid** (ρ = gm/cc, T = °C)

\[ \rho = 2.76 - 0.00050T \]

**Liquid** (ρ = lbs/ft³, T = °F)

\[ \rho = 172.8 - 0.0173T \]

**Mean Volumetric Coefficient of Liquid Expansion** (1/°C x 10⁴) 2.08

### Enthalpy, Heat Capacity and Heat of Fusion

**Solid**

- Enthalpy (cal/gm) \( H_{T-H_0} \cdot C^* \)
- Heat Capacity (cal/gm °C) \( c^*_p \)
- Heat Capacity at 300°C (572°F) \( c_p = 0.30 \)

**Liquid**

- Enthalpy (cal/gm) \( H_{T-H_0} \cdot C^* \)
- Heat Capacity (cal/gm °C) \( c^*_p \)
- Heat Capacity at 700°C (1292°F) \( c_p = 0.42 \)

**Heat of Fusion (cal/gm)** \( H_L-H_S^* \)

### Thermal Conductivity

\[ K (BTU/hr ft °F) \]

### Viscosity

<table>
<thead>
<tr>
<th>°C</th>
<th>(Centipoises)</th>
<th>(Centistokes)</th>
<th>°F</th>
<th>(lb./ft-hr)</th>
<th>ft²/hr</th>
</tr>
</thead>
<tbody>
<tr>
<td>600</td>
<td>11.2</td>
<td></td>
<td>1100</td>
<td>28.3</td>
<td></td>
</tr>
<tr>
<td>700</td>
<td>5.6</td>
<td></td>
<td>1300</td>
<td>13.1</td>
<td></td>
</tr>
<tr>
<td>800</td>
<td>3.2</td>
<td></td>
<td>1500</td>
<td>7.1</td>
<td></td>
</tr>
</tbody>
</table>

**Exponential Form (centipoises)**

*Denotes experimental values. Other values given are calculated or estimated."
Mixture Component Mol % Wt. % Avg. M.W. Liquidus Temp.
37 NaF 50 11.80 178.05 715°C (1319°F)
UF₄ 50 88.20

DENSITY
SOLID AT ROOM TEMPERATURE (gm/cc) 5.75
LIQUID (ρ = gm/cc, T = °C) ρ = 6.16 - 0.00123T
LIQUID (ρ = lbs/ft³, T = °F) ρ = 385.9 - 0.0426T
MEAN VOLUMETRIC COEFFICIENT OF LIQUID EXPANSION (1/°C x 10⁴) 2.32

ENTHALPY, HEAT CAPACITY AND HEAT OF FUSION
SOLID
Enthalpy (cal/gm) Hₜ-H₂O°C* =
Heat Capacity (cal/gm °C) cₚ* =
Heat Capacity at 300°C (572°F) cₚ = 0.13

LIQUID
Enthalpy (cal/gm) Hₜ-H₂O°C* =
Heat Capacity (cal/gm °C) cₚ* =
Heat Capacity at 700°C (1292°F) cₚ =

HEAT OF FUSION (cal/gm) H_L-H_S*

THERMAL CONDUCTIVITY
K (BTU/hr ft °F)

VISCOITY
°C (Centipoises) (Centistokes) °F (lb./ft-hr) ft²/hr

Exponential Form (centipoises)

*Denotes experimental values. Other values given are calculated or estimated.
Mixture Component  Mol %  Wt. %  Avg. M.W.  Liquidus Temp.
38  NaF  50  19.53  107.5  510°C (950°F)
     ZrF₄  48  74.63
     UF₄  2  5.84

DENSITY

SOLID AT ROOM TEMPERATURE (gm/cc)  4.04
LIQUID (ρ = gm/cc, T = °C)  ρ = 3.83 - 0.00091T
LIQUID (ρ = lbs/ft³, T = °F)  ρ = 240.1 - 0.0315T
MEAN VOLUMETRIC COEFFICIENT OF LIQUID EXPANSION (1/°C x 10⁴)  2.84

ENTHALPY, HEAT CAPACITY AND HEAT OF FUSION

SOLID
Enthalpy (cal/gm)  Hₜ-H₀°C * =
Heat Capacity (cal/gm °C)  c_p * =
Heat Capacity at 300°C (572°F)  c_p = 0.19

 LIQUID
Enthalpy (cal/gm)  Hₜ-H₀°C * =
Heat Capacity (cal/gm °C)  c_p * =
Heat Capacity at 700°C (1292°F)  c_p = 0.26

HEAT OF FUSION (cal/gm)  Hₜ-Hₛ * =

THERMAL CONDUCTIVITY

K (BTU/hr ft °F)

VISCOITY

<table>
<thead>
<tr>
<th>°C</th>
<th>(Centipoises)</th>
<th>(Centistokes)</th>
<th>°F</th>
<th>(lb./ft-hr)</th>
<th>ft²/hr</th>
</tr>
</thead>
<tbody>
<tr>
<td>600</td>
<td>8.5</td>
<td></td>
<td>1100</td>
<td>21.3</td>
<td></td>
</tr>
<tr>
<td>700</td>
<td>5.4</td>
<td></td>
<td>1300</td>
<td>12.8</td>
<td></td>
</tr>
<tr>
<td>800</td>
<td>3.7</td>
<td></td>
<td>1500</td>
<td>8.5</td>
<td></td>
</tr>
</tbody>
</table>

Exponential Form (centipoises)

*Denotes experimental values. Other values given are calculated or estimated.
<table>
<thead>
<tr>
<th>Mixture</th>
<th>Component</th>
<th>Mol %</th>
<th>Wt. %</th>
<th>Avg. M.W.</th>
<th>Liquidus Temp.</th>
</tr>
</thead>
<tbody>
<tr>
<td>39</td>
<td>NaF</td>
<td>65</td>
<td>23.69</td>
<td>115.2</td>
<td>610°C (1130°F)</td>
</tr>
<tr>
<td></td>
<td>ZrF$_4$</td>
<td>15</td>
<td>21.80</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>UF$_4$</td>
<td>20</td>
<td>54.51</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Density**

Solid at room temperature (gm/cc) 4.64

Liquid ($\rho = \text{gm/cc, } T = ^\circ\text{C}$) $\rho = 4.55 - 0.00102T$

Liquid ($\rho = \text{lbs/ft}^3, T = ^\circ\text{F}$) $\rho = 285.2 - 0.0354T$

Mean volumetric coefficient of liquid expansion ($1/\circ\text{C} \times 10^4$) 2.66

**Enthalpy, Heat Capacity and Heat of Fusion**

**Solid** (90° - 610°C)

- Enthalpy (cal/gm) $H_T - H_{0 \circ C}^*$ = -2.9 + 0.172T (Ref. 4)
- Heat Capacity (cal/gm°C) $c_p^* = 0.17$
- Heat Capacity at 300°C (572°F) $c_p = 0.17$

**Liquid** (653° - 924°C)

- Enthalpy (cal/gm) $H_T - H_{0 \circ C}^*$ = 22.3 + 0.199T
- Heat Capacity (cal/gm°C) $c_p^* = 0.20$
- Heat Capacity at 700°C (1292°F) $c_p = 0.20$

Heat of Fusion (cal/gm) $H_L - H_S^* = 42$

**Thermal Conductivity**

$K$ (BTU/hr ft °F)

**Viscosity**

<table>
<thead>
<tr>
<th>°C</th>
<th>(Centipoises)</th>
<th>(Centistokes)</th>
<th>°F</th>
<th>(lb./ft-hr)</th>
<th>ft$^2$/hr</th>
</tr>
</thead>
</table>

Exponential Form (centipoises)

*Denotes experimental values. Other values given are calculated or estimated.*
<table>
<thead>
<tr>
<th>Mixture</th>
<th>Component</th>
<th>Mol %</th>
<th>Wt. %</th>
<th>Avg. M.W.</th>
<th>Liquidus Temp.</th>
</tr>
</thead>
<tbody>
<tr>
<td>40</td>
<td>NaF</td>
<td>53</td>
<td>20.83</td>
<td>106.8</td>
<td>520°C (968°F)</td>
</tr>
<tr>
<td></td>
<td>ZrF₄</td>
<td>43</td>
<td>67.42</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>UF₄</td>
<td>4</td>
<td>11.75</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Density**

SOLID AT ROOM TEMPERATURE (gm/cc) 4.09
LIQUID (ρ = gm/cc, T = °C) ρ = 3.90 - 0.00092T
LIQUID (ρ = lbs/ft³, T = °F) ρ = 244.5 - 0.0319T
MEAN VOLUMETRIC COEFFICIENT OF LIQUID EXPANSION (1/°C x 10⁴) 2.83

**Enthalpy, Heat Capacity and Heat of Fusion**

SOLID (70° - 520°C)
- Enthalpy (cal/gm) $H_T - H_0°C = 0.0 + 0.182T$ (Ref. 4)
- Heat Capacity (cal/gm °C) $c_p^* = 0.18$
- Heat Capacity at 300°C (572°F) $c_p^* = 0.18$

LIQUID (571° - 884°C)
- Enthalpy (cal/gm) $H_T - H_0°C = 19.4 + 0.2656T$
- Heat Capacity (cal/gm °C) $c_p^* = 0.266$
- Heat Capacity at 700°C (1292°F) $c_p^* = 0.266$

HEAT OF FUSION (cal/gm) $H_L - H_S^* = 63$

**Thermal Conductivity**

K (BTU/hr ft °F)

**Viscosity**

<table>
<thead>
<tr>
<th>°C</th>
<th>(Centipoises)</th>
<th>(Centistokes)</th>
<th>°F</th>
<th>(lb./ft-hr)</th>
<th>ft²/hr</th>
</tr>
</thead>
<tbody>
<tr>
<td>600</td>
<td>8.3</td>
<td></td>
<td>1100</td>
<td>20.8</td>
<td></td>
</tr>
<tr>
<td>700</td>
<td>5.3</td>
<td></td>
<td>1300</td>
<td>12.6</td>
<td></td>
</tr>
<tr>
<td>800</td>
<td>3.65</td>
<td></td>
<td>1500</td>
<td>8.4</td>
<td></td>
</tr>
</tbody>
</table>

Exponential Form (centipoises)

*Denotes experimental values. Other values given are calculated or estimated.*
<table>
<thead>
<tr>
<th>Mixture</th>
<th>Component</th>
<th>Mol %</th>
<th>Wt. %</th>
<th>Avg. M.W.</th>
<th>Liquidus Temp.</th>
</tr>
</thead>
<tbody>
<tr>
<td>41</td>
<td>NaF</td>
<td>63</td>
<td>24.97</td>
<td>106.0</td>
<td>595°C (1103°F)</td>
</tr>
<tr>
<td></td>
<td>ZrF₄</td>
<td>25</td>
<td>39.45</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>UF₄</td>
<td>12</td>
<td>35.57</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Density

- **Solid at room temperature (g/m³)**: 4.32
- **Liquid (ρ = g/m³, T = °C)**: ρ = 4.15 - 0.00096T
- **Liquid (ρ = lbs/ft³, T = °F)**: ρ = 260.1 - 0.0333T
- **Mean volumetric coefficient of liquid expansion (1/°C x 10⁴)**: 2.77

### Enthalpy, Heat Capacity and Heat of Fusion

#### Solid

- **Enthalpy (cal/gm)**: \( H_{T-HO_C} \)
- **Heat Capacity (cal/gm °C)**: \( c_p^* \)
- **Heat Capacity at 300°C (572°F)**: \( c_p = 0.17 \)

#### Liquid

- **Enthalpy (cal/gm)**: \( H_{T-HO_C} \)
- **Heat Capacity (cal/gm °C)**: \( c_p^* \)
- **Heat Capacity at 700°C (1292°F)**: \( c_p = 0.24 \)

#### Heat of Fusion (cal/gm)

- **Hₜ-Hₛ**

### Thermal Conductivity

- **K (BTU/hr ft °F)**

### Viscosity

<table>
<thead>
<tr>
<th>°C</th>
<th>(Centipoises)</th>
<th>(Centistokes)</th>
<th>°F</th>
<th>(lb./ft-hr)</th>
<th>ft²/hr</th>
</tr>
</thead>
</table>

Exponential Form (centipoises)

*Denotes experimental values. Other values given are calculated or estimated.*
Mixture | Component | Mol % | Wt. % | Avg. M.W. | Liquidus Temp.  
--- | --- | --- | --- | --- | ---  
42 | NaF | 64.5 | 20.87 | 129.8 | 650°C (1202°F)  
| ZrF₄ | 6.0 | 7.73 | | |  
| UF₄ | 29.5 | 71.40 | | |  

**DENSITY**

**SOLID AT ROOM TEMPERATURE (gm/cc)**  
5.03

**LIQUID (ρ = gm/cc, T = °C)**  
ρ = 5.05 - 0.00107T

**LIQUID (ρ = lbs/ft³, T = °F)**  
ρ = 316.4 - 0.0371T

**MEAN VOLUMETRIC COEFFICIENT OF LIQUID EXPANSION (1/°C x 10⁴)**  
2.49

**ENTHALPY, HEAT CAPACITY AND HEAT OF FUSION**

**SOLID**

Enthalpy (cal/gm)  
Hₜ-H₀°C * =

Heat Capacity (cal/gm °C)  
cₚ * =

Heat Capacity at 300°C (572°F)  
cₚ = 0.14

**LIQUID**

Enthalpy (cal/gm)  
Hₜ-H₀°C * =

Heat Capacity (cal/gm °C)  
cₚ * =

Heat Capacity at 700°C (1292°F)  
cₚ = 0.19

**HEAT OF FUSION (cal/gm)**  
Hₜ-Hₛ * =

**THERMAL CONDUCTIVITY**

K (BTU/hr ft °F)

**VISCOSITY**

<table>
<thead>
<tr>
<th>°C</th>
<th>(Centipoises)</th>
<th>(Centistokes)</th>
<th>°F</th>
<th>(lb./ft-hr)</th>
<th>ft²/hr</th>
</tr>
</thead>
<tbody>
<tr>
<td>700</td>
<td>10.25</td>
<td></td>
<td>1300</td>
<td>24.2</td>
<td></td>
</tr>
<tr>
<td>800</td>
<td>7.0</td>
<td></td>
<td>1500</td>
<td>16.1</td>
<td></td>
</tr>
<tr>
<td>900</td>
<td>5.15</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Exponential Form (centipoises)

*Denotes experimental values. Other values given are calculated or estimated.*
<table>
<thead>
<tr>
<th>Mixture</th>
<th>Component</th>
<th>Mol %</th>
<th>Wt. %</th>
<th>Avg. M.W.</th>
<th>Liquidus Temp.</th>
</tr>
</thead>
<tbody>
<tr>
<td>43</td>
<td>NaF</td>
<td>66.7</td>
<td>21.12</td>
<td>132.6</td>
<td>665°C (1229°F)</td>
</tr>
<tr>
<td></td>
<td>UF₄</td>
<td>33.3</td>
<td>78.88</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Density**

SOLID AT ROOM TEMPERATURE (gm/cc) 5.17

LIQUID ($\rho = gm/cc, T = °C$) $\rho^* = 5.51 - 0.0013T$ (Ref. 16)

LIQUID ($\rho = lbs/ft^3, T = °F$) $\rho^* = 345.4 - 0.0451T$

MEAN VOLUMETRIC COEFFICIENT OF LIQUID EXPANSION ($1/°C \times 10^4$) 2.83

**Enthalpy, Heat Capacity and Heat of Fusion**

**SOLID**

Enthalpy (cal/gm) $H_T - H_{0°C}^*$ =

Heat Capacity (cal/gm °C) $C_p^* =$

Heat Capacity at 300°C (572°F) $C_p = 0.15$

**LIQUID**

Enthalpy (cal/gm) $H_T - H_{0°C}^*$ =

Heat Capacity (cal/gm °C) $C_p^* =$

Heat Capacity at 700°C (1292°F) $C_p = 0.21$

**Heat of Fusion (cal/gm)** $H_L - H_S^*$ =

**Thermal Conductivity**

$K$ (BTU/hr ft °F)

**Viscosity**

<table>
<thead>
<tr>
<th>°C</th>
<th>(Centipoises)</th>
<th>(Centistokes)</th>
<th>°F</th>
<th>(lb./ft-hr)</th>
<th>ft²/hr</th>
</tr>
</thead>
<tbody>
<tr>
<td>700</td>
<td>10.25* (Ref. 28)</td>
<td>2.23</td>
<td>1300</td>
<td>24.2*</td>
<td>0.0043</td>
</tr>
<tr>
<td>800</td>
<td>7.0*</td>
<td>1.57</td>
<td>1500</td>
<td>16.1*</td>
<td>0.0580</td>
</tr>
<tr>
<td>900</td>
<td>5.15*</td>
<td>1.19</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Exponential Form (centipoises) $\mu = 0.18e^{3927/T°K}$

*Denotes experimental values. Other values given are calculated or estimated.*
Mixture | Component | Mol % | Wt. % | Avg. M.W. | Liquidus Temp.  
--- | --- | --- | --- | --- | ---  
44 | NaF | 53.5 | 20.47 | 109.8 | 540°C (1004°F)  
 | ZrF₄ | 40.0 | 607.93 |  |  
 | UF₄ | 6.5 | 18.60 |  |  

**DENSITY**

SOLID AT ROOM TEMPERATURE (gm/cc)  
4.19  
LIQUID (ρ = gm/cc, T = °C)  
\[ \rho^* = 4.04 - 0.0011T \] (Ref. 16)  
LIQUID (ρ = lbs/ft³, T = °F)  
\[ \rho^* = 253.4 - 0.0381T \]  
MEAN VOLUMETRIC COEFFICIENT OF LIQUID EXPANSION (\(1/°C \times 10^4\))  
3.36

**ENTHALPY, HEAT CAPACITY AND HEAT OF FUSION**

SOLID (260° - 490°C)  
Enthalpy (cal/gm)  
\[ H_T - H_{0°C}^* = -4.1 + 0.189T \] (Ref. 4)  
Heat Capacity (cal/gm °C)  
\[ c_p^* = 0.19 \]  
Heat Capacity at 300°C (572°F)  
\[ c_p^* = 0.19 \]  
LIQUID (590°C - 920°C)  
Enthalpy (cal/gm)  
\[ H_T - H_{0°C}^* = 34.5 + 0.235T \]  
Heat Capacity (cal/gm °C)  
\[ c_p^* = 0.24 \]  
Heat Capacity at 700°C (1292°F)  
\[ c_p^* = 0.24 \]  
HEAT OF FUSION (cal/gm)  
\[ H_L - H_S^* = 63 \]

**THERMAL CONDUCTIVITY**

\[ K (BTU/hr ft °F) = 1.2 \text{ (Liquid)} \] (Ref. 29)

**VISCOITY**

<table>
<thead>
<tr>
<th>°C</th>
<th>(Centipoises)</th>
<th>(Centistokes)</th>
<th>°F</th>
<th>(lb./ft-hr)</th>
<th>ft²/hr</th>
</tr>
</thead>
<tbody>
<tr>
<td>600</td>
<td>8.5* (Ref.22)</td>
<td>2.51</td>
<td>1100</td>
<td>21.1*</td>
<td>0.0968</td>
</tr>
<tr>
<td>700</td>
<td>5.7*</td>
<td>1.74</td>
<td>1300</td>
<td>13.7*</td>
<td>0.0648</td>
</tr>
<tr>
<td>800</td>
<td>4.2*</td>
<td>1.33</td>
<td>1500</td>
<td>9.7*</td>
<td>0.0474</td>
</tr>
<tr>
<td>850</td>
<td>3.7*</td>
<td>1.14</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Exponential Form (centipoises)  
\[ \mu = 0.194 e^{3302/T°K} \]

PRANDTL NUMBER  
4.2 at 1100°F, 2.7 at 1300°F, 1.9 at 1500°F

ELECTRICAL CONDUCTIVITY (ohm-cm)-¹  
0.66 at 1100°F, 0.97 at 1300°F, 1.27 at 1500°F (Ref. 13)

*Denotes experimental values. Other values given are calculated or estimated.
Mixture Component Mol % Wt. % Avg. M.W. Liquidus Temp.
45 NaF 53 22.07 100.9 520°C (968°F)
ZrF₄ 47 77.93

**DENSITY**

SOLID AT ROOM TEMPERATURE (gm/cc) 4.11* (Ref. 22)
LIQUID (ρ = gm/cc, T = °C) ρ = 3.71 - 0.00089T
LIQUID (ρ = lbs/ft³, T = °F) ρ = 232.6 - 0.0309T
MEAN VOLUMETRIC COEFFICIENT OF LIQUID EXPANSION (1/°C x 10⁴) 2.89

**ENTHALPY, HEAT CAPACITY AND HEAT OF FUSION**

**SOLID**

Enthalpy (cal/gm) H_T-H₀°C*
Heat Capacity (cal/gm °C) c_p*
Heat Capacity at 300°C (572°F) c_p = 0.20

**LIQUID**

Enthalpy (cal/gm) H_T-H₀°C*
Heat Capacity (cal/gm °C) c_p*
Heat Capacity at 700°C (1292°F) c_p = 0.27

**HEAT OF FUSION (cal/gm)** H_L-H_S*

**THERMAL CONDUCTIVITY**

K (BTU/hr ft °F)

**VISCOITY**

<table>
<thead>
<tr>
<th>°C</th>
<th>(Centipoises)</th>
<th>(Centistokes)</th>
<th>°F</th>
<th>(lb./ft-hr)</th>
<th>ft²/hr</th>
</tr>
</thead>
<tbody>
<tr>
<td>600</td>
<td>7.5* (Ref. 22)</td>
<td>2.36</td>
<td>1100</td>
<td>18.9*</td>
<td>0.0952</td>
</tr>
<tr>
<td>700</td>
<td>4.6*</td>
<td>1.49</td>
<td>1300</td>
<td>10.9*</td>
<td>0.0567</td>
</tr>
<tr>
<td>800</td>
<td>3.2*</td>
<td>1.07</td>
<td>1500</td>
<td>7.4*</td>
<td>0.0398</td>
</tr>
</tbody>
</table>

Exponential Form (centipoises)

*Denotes experimental values. Other values given are calculated or estimated.
<table>
<thead>
<tr>
<th>Mixture</th>
<th>Component</th>
<th>Mol %</th>
<th>Wt. %</th>
<th>Avg. M.W.</th>
<th>Liquidus Temp.</th>
</tr>
</thead>
<tbody>
<tr>
<td>C TEST</td>
<td>NaF</td>
<td>66.7</td>
<td>33.47</td>
<td>83.7</td>
<td>680°C (1256°F)</td>
</tr>
<tr>
<td></td>
<td>ZrF₄</td>
<td>33.3</td>
<td>66.53</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**DENSITY**

SOLID AT ROOM TEMPERATURE (gm/cc) 3.70
LIQUID (\(\rho = \text{gm/cc, T} = 0^\circ\text{C}\)) \(\rho = 3.49 - 0.00086T\)
LIQUID (\(\rho = \text{lbs/ft}^3, \text{T} = 0^\circ\text{F}\)) \(\rho = 218.8 - 0.0298T\)

MEAN VOLUMETRIC COEFFICIENT OF LIQUID EXPANSION (1/°C x 10\(^4\)) 2.53

**ENTHALPY, HEAT CAPACITY AND HEAT OF FUSION**

SOLID

Enthalpy (cal/gm) \(H_T - H_{0^\circ\text{C}}\) = 
Heat Capacity (cal/gm °C) \(c_p^*\) = 
Heat Capacity at 300°C (572°F) \(c_p = 0.21\)

LIQUID

Enthalpy (cal/gm) \(H_T - H_{0^\circ\text{C}}\) = 
Heat Capacity (cal/gm °C) \(c_p^*\) = 
Heat Capacity at 700°C (1292°F) \(c_p = 0.29\)

HEAT OF FUSION (cal/gm) \(H_L - H_S\) =

**THERMAL CONDUCTIVITY**

\(K (\text{BTU/hr ft °F})\)

**VISCOSITY**

\(\nu^\circ\text{C} (\text{Centipoises}) (\text{Centistokes}) \quad \nu^\circ\text{F} (\text{lb./ft-hr}) \quad ft^2/\text{hr}\)

Exponential Form (centipoises)

*Denotes experimental values. Other values given are calculated or estimated.*
Mixture Component Mol % Wt. % Avg. M.W. Liquidus Temp.
46 NaF 62.5 20.90 125.7 635°C (1175°F)
ZrF₄ 12.5 16.61
UF₄ 25.0 62.49

**DENSITY**

SOLID AT ROOM TEMPERATURE (gm/cc) 4.86
LIQUID (ρ = gm/cc, T = °C) ρ* = 4.75 - 0.0012T (Ref. 16)
LIQUID (ρ = lbs/ft³, T = °F) ρ* = 266.6 - 0.0416T

MEAN VOLUMETRIC COEFFICIENT OF LIQUID EXPANSION (1/°C x 10⁴) 3.07

**ENTHALPY, HEAT CAPACITY AND HEAT OF FUSION**

**SOLID**

Enthalpy (cal/gm) Hₜ-H₀°C*
Heat Capacity (cal/gm °C) cₚ*
Heat Capacity at 300°C (572°F) cₚ = 0.15

**LIQUID**

Enthalpy (cal/gm) Hₜ-H₀°C*
Heat Capacity (cal/gm °C) cₚ*
Heat Capacity at 700°C (1292°F) cₚ = 0.20

**HEAT OF FUSION (cal/gm) Hₐ-Hₜ**

**THERMAL CONDUCTIVITY**

K (BTU/hr ft °F)

**VISCOITY**

<table>
<thead>
<tr>
<th>°C</th>
<th>(Centipoises)</th>
<th>(Centistokes)</th>
<th>°F</th>
<th>(lb./ft-hr)</th>
<th>ft²/hr</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Exponential Form (centipoises)

*Denotes experimental values. Other values given are calculated or estimated.*
<table>
<thead>
<tr>
<th>Mixture</th>
<th>Component</th>
<th>Mol %</th>
<th>Wt. %</th>
<th>Avg. M.W.</th>
<th>Liquidus Temp.</th>
</tr>
</thead>
<tbody>
<tr>
<td>47</td>
<td>NaF</td>
<td>35</td>
<td>16.75</td>
<td>41.1</td>
<td>335°C (635°F)</td>
</tr>
<tr>
<td></td>
<td>LiF</td>
<td>20</td>
<td>59.13</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>BeF₂</td>
<td>45</td>
<td>24.12</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**DENSITY**

SOLID AT ROOM TEMPERATURE (gm/cc) 2.26

LIQUID ($\rho = \text{gm/cc, } T = 0°C$) $\rho = 2.19 - 0.00035T$

LIQUID ($\rho = \text{lbs/ft}^3, T = 0°F$) $\rho = 137.1 - 0.0121T$

MEAN VOLUMETRIC COEFFICIENT OF LIQUID EXPANSION ($1°C \times 10^4$) 1.79

**ENTHALPY, HEAT CAPACITY AND HEAT OF FUSION**

**SOLID**

Enthalpy (cal/gm) $H_T - H_{0°C}$

Heat Capacity (cal/gm °C) $c_p^*$

Heat Capacity at 300°C (572°F) $c_p = 0.40$

**LIQUID**

Enthalpy (cal/gm) $H_T - H_{0°C}$

Heat Capacity (cal/gm °C) $c_p^*$

Heat Capacity at 700°C (1292°F) $c_p = 0.56$

**HEAT OF FUSION (cal/gm)** $H_L - H_S^*$

**THERMAL CONDUCTIVITY**

$K$ (BTU/hr ft °F)

**VISCOITY**

°C (Centipoises) (Centistokes) °F (lb./ft-hr) ft²/hr

Exponential Form (centipoises)

*Denotes experimental values. Other values given are calculated or estimated.*
<table>
<thead>
<tr>
<th>Mixture</th>
<th>Component</th>
<th>Mol %</th>
<th>Wt. %</th>
<th>Avg. M.W.</th>
<th>Liquidus Temp.</th>
</tr>
</thead>
<tbody>
<tr>
<td>48</td>
<td>NaF</td>
<td>50</td>
<td>12.00</td>
<td>175.1</td>
<td>733°C (1351°F)</td>
</tr>
<tr>
<td></td>
<td>ThF₄</td>
<td>50</td>
<td>88.00</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**DENSITY**

SOLID AT ROOM TEMPERATURE (gm/cc) 5.73
LIQUID ($\rho = \text{gm/cc, } T = \text{oC}$) $\rho = 6.13 - 0.00123T$
LIQUID ($\rho = \text{lbs/ft}^3, T = \text{°F}$) $\rho = 384.0 - 0.0426T$

MEAN VOLUMETRIC COEFFICIENT OF LIQUID EXPANSION ($1/\text{oC} \times 10^4$) 2.32

**ENTHALPY, HEAT CAPACITY AND HEAT OF FUSION**

**SOLID**

Enthalpy (cal/gm) $H_T - H_{0°C}^*$
Heat Capacity (cal/gm °C) $c_p^*$
Heat Capacity at 300°C (572°F) $c_p = 0.14$

**LIQUID**

Enthalpy (cal/gm) $H_T - H_{0°C}^*$
Heat Capacity (cal/gm °C) $c_p^*$
Heat Capacity at 700°C (1292°F) $c_p$

HEAT OF FUSION (cal/gm) $H_L - H_S^*$

**THERMAL CONDUCTIVITY**

$K (\text{BTU/hr ft °F})$

**VISCOITY**

$^°C$ (Centipoises) (Centistokes) $^°F$ (lb./ft-hr) ft²/hr

Exponential Form (centipoises)

*Denotes experimental values. Other values given are calculated or estimated.*
## Mixture Component Mol % Wt. % Avg. M.W. Liquidus Temp.

<table>
<thead>
<tr>
<th>Mixture</th>
<th>Component</th>
<th>Mol %</th>
<th>Wt. %</th>
<th>Avg. M.W.</th>
<th>Liquidus Temp.</th>
</tr>
</thead>
<tbody>
<tr>
<td>49</td>
<td>NaF</td>
<td>40</td>
<td>13.85</td>
<td>121.0</td>
<td>510°C (950°F)</td>
</tr>
<tr>
<td></td>
<td>ZrF₄</td>
<td>57</td>
<td>78.85</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>UF₃</td>
<td>3</td>
<td>7.30</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### DENSITY

- **Solid at room temperature** (gm/cc) 4.24
- **Liquid** (ρ = gm/cc, T = °C) ρ = 4.06 - 0.00094T
- **Liquid** (ρ = lbs/ft³, T = °F) ρ = 254.5 - 0.0326T

### MEAN VOLUMETRIC COEFFICIENT OF LIQUID EXPANSION (1/°C x 10⁴)

2.76

### ENTHALPY, HEAT CAPACITY AND HEAT OF FUSION

**Solid**

- Enthalpy (cal/gm) \( H_{T-H_0°C}^* \)
- Heat Capacity (cal/gm °C) \( c_p^* \)
- Heat Capacity at 300°C (572°F) \( c_p \) = 0.18

**Liquid**

- Enthalpy (cal/gm) \( H_{T-H_0°C}^* \)
- Heat Capacity (cal/gm °C) \( c_p^* \)
- Heat Capacity at 700°C (1292°F) \( c_p \) = 0.25

**Heat of fusion (cal/gm)** \( H_{L-H_S}^* \)

### THERMAL CONDUCTIVITY

K (BTU/hr ft °F)

### VISCOSITY

<table>
<thead>
<tr>
<th>°C</th>
<th>(Centipoises)</th>
<th>(Centistokes)</th>
<th>°F</th>
<th>(lb./ft-hr)</th>
<th>ft²/hr</th>
</tr>
</thead>
</table>

Exponential Form (centipoises)

*Denotes experimental values. Other values given are calculated or estimated.*
### Mixture Component Mol % Wt. % Avg. M.W. Liquidus Temp.

<table>
<thead>
<tr>
<th>Mixture</th>
<th>Component</th>
<th>Mol %</th>
<th>Wt. %</th>
<th>Avg. M.W.</th>
<th>Liquidus Temp.</th>
</tr>
</thead>
<tbody>
<tr>
<td>70</td>
<td>NaF</td>
<td>56</td>
<td>22.52</td>
<td>104.4</td>
<td>530°C (986°F)</td>
</tr>
<tr>
<td></td>
<td>ZrF$_4$</td>
<td>39</td>
<td>62.45</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>U$_3$F$_4$</td>
<td>5</td>
<td>15.03</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Density

- **Solid at room temperature (gm/cc)**: 4.10
- **Liquid (ρ = gm/cc, T = °C)**: $\rho = 3.90 - 0.00092T$
- **Liquid (ρ = lbs/ft$^3$, T = °F)**: $\rho = 244.5 - 0.0319T$

### Mean Volumetric Coefficient of Liquid Expansion (1/°C x 10$^{-4}$)

- 2.83

### Enthalpy, Heat Capacity and Heat of Fusion

#### Solid (137° - 503°C)
- **Enthalpy (cal/gm)**
  
  \[ H_{t-H_0}^* = 1.3 + 0.1596T + 5.15 \times 10^{-5}T^2 \]
- **Heat Capacity (cal/gm °C)**
  \[ c_p^* = 0.1596 + 10.29 \times 10^{-5}T \text{ (Ref. 4)} \]
- **Heat Capacity at 300°C (572°F)**
  \[ c_p = 0.190 \]

#### Liquid (567° - 892°C)
- **Enthalpy (cal/gm)**
  \[ H_{t-H_0}^* = 6.2 + 0.3033T - 3.24 \times 10^{-5}T^2 \]
- **Heat Capacity (cal/gm °C)**
  \[ c_p^* = 0.3033 - 6.47 \times 10^{-5}T \]
- **Heat Capacity at 700°C (1292°F)**
  \[ c_p = 0.258 \]

#### Heat of Fusion (cal/gm)

- **H$_L$ - H$_S$** = 57

### Thermal Conductivity

### Viscosity

<table>
<thead>
<tr>
<th>°C</th>
<th>(Centipoises)</th>
<th>(Centistokes)</th>
<th>°F</th>
<th>(lb./ft-hr)</th>
<th>ft$^2$/hr</th>
</tr>
</thead>
<tbody>
<tr>
<td>600</td>
<td>8.1* (Ref. 30)</td>
<td>2.42</td>
<td>1100</td>
<td>20.3*</td>
<td>0.0969</td>
</tr>
<tr>
<td>700</td>
<td>5.2*</td>
<td>1.60</td>
<td>1300</td>
<td>12.3*</td>
<td>0.0606</td>
</tr>
<tr>
<td>800</td>
<td>3.6*</td>
<td>1.14</td>
<td>1500</td>
<td>8.2*</td>
<td>0.0418</td>
</tr>
</tbody>
</table>

Exponential Form (centipoises) \[ \mu = 0.104e^{3.798/T^0K} \]

*Denotes experimental values. Other values given are calculated or estimated.*
Mixture | Component | Mol % | Wt. % | Avg. M.W. | Liquidus Temp.
--- | --- | --- | --- | --- | ---
71 | NaF | 54.1 | 22.84 | 99.5 | 520°C (968°F)
 | ZrF$_4$ | 45.9 | 77.16 | |

**DENSITY**

SOLID AT ROOM TEMPERATURE (gm/cc) 3.91
LIQUID ($\rho = \text{gm/cc, } T = ^\circ \text{C}$) $\rho = 3.70 - 0.00089T$
LIQUID ($\rho = \text{lbs/ft}^3, T = ^\circ \text{F}$) $\rho = 232.0 - 0.0309T$

MEAN VOLUMETRIC COEFFICIENT OF LIQUID EXPANSION ($1/\text{°C} \times 10^4$) 2.87

**ENTHALPY, HEAT CAPACITY AND HEAT OF FUSION**

SOLID

Enthalpy (cal/gm) $H_T - H_0^\circ C^\ast =$
Heat Capacity (cal/gm °C) $c_p^\ast =$
Heat Capacity at 300°C (572°F) $c_p = 0.20$

LIQUID

Enthalpy (cal/gm) $H_T - H_0^\circ C^\ast =$
Heat Capacity (cal/gm °C) $c_p^\ast =$
Heat Capacity at 700°C (1292°F) $c_p = 0.28$

HEAT OF FUSION (cal/gm) $H_L - H_S^\ast =$

**THERMAL CONDUCTIVITY**

$K (\text{BTU/hr ft } ^\circ \text{F})$

**VISCOSITY**

<table>
<thead>
<tr>
<th>°C</th>
<th>(Centipoises)</th>
<th>(Centistokes)</th>
<th>°F</th>
<th>(lb./ft-hr)</th>
<th>ft$^2$/hr</th>
</tr>
</thead>
<tbody>
<tr>
<td>600</td>
<td>7.5</td>
<td></td>
<td>1100</td>
<td>18.9</td>
<td></td>
</tr>
<tr>
<td>700</td>
<td>4.6</td>
<td></td>
<td>1300</td>
<td>16.9</td>
<td></td>
</tr>
<tr>
<td>800</td>
<td>3.2</td>
<td></td>
<td>1500</td>
<td>7.4</td>
<td></td>
</tr>
</tbody>
</table>

Exponential Form (centipoises)

*Denotes experimental values. Other values given are calculated or estimated.
Mixture Component  Mole %  Weight %  Avg. M.W.  Liquidus Temp.

72  NaF  20.9  9.33  94.1  490°C (914°F)
    LiF  38.4  10.58
    ZrF₄  35.7  63.41
    UF₄  5.0  16.68

DENSITY

SOLID AT ROOM TEMPERATURE (gm/cc)  4.04
LIQUID (ρ = gm/cc, T = °C)  ρ = 3.83 - 0.00091T
LIQUID (ρ = lbs/ft³, T = °F)  ρ = 240.1 - 0.0315T

MEAN VOLUMETRIC COEFFICIENT OF LIQUID EXPANSION (1/°C x 10⁴)  2.84

ENTHALPY, HEAT CAPACITY AND HEAT OF FUSION

SOLID

Enthalpy (cal/gm)  Hₜ-H₀°C*
Heat Capacity (cal/gm °C)  cₚ
Heat Capacity at 300°C (572°F)  cₚ = 0.20

LIQUID

Enthalpy (cal/gm)  Hₜ-H₀°C*
Heat Capacity (cal/gm °C)  cₚ
Heat Capacity at 700°C (1292°F)  cₚ = 0.28

HEAT OF FUSION (cal/gm)  Hₐ-Hₛ*

THERMAL CONDUCTIVITY

K (BTU/hr ft °F)

<table>
<thead>
<tr>
<th>°C</th>
<th>(Centipoises)</th>
<th>(Centistokes)</th>
<th>°F</th>
<th>(lb./ft·hr)</th>
<th>ft²/hr</th>
</tr>
</thead>
<tbody>
<tr>
<td>500</td>
<td>20.0* (Ref.31)</td>
<td>5.88</td>
<td>1100</td>
<td>24.8*</td>
<td>0.1198</td>
</tr>
<tr>
<td>600</td>
<td>9.9*</td>
<td>3.0</td>
<td>1300</td>
<td>14.3*</td>
<td>0.0714</td>
</tr>
<tr>
<td>700</td>
<td>6.0*</td>
<td>1.88</td>
<td>1500</td>
<td>9.8*</td>
<td>0.0505</td>
</tr>
<tr>
<td>800</td>
<td>4.25*</td>
<td>1.36</td>
<td>-----</td>
<td>-------------</td>
<td>--------</td>
</tr>
</tbody>
</table>

Exponential Form (centipoises)

*Denotes experimental values. Other values given are calculated or estimated.
<table>
<thead>
<tr>
<th>Mixture</th>
<th>Component</th>
<th>Mol %</th>
<th>Wt. %</th>
<th>Avg. M.W.</th>
<th>Liquidus Temp.</th>
</tr>
</thead>
<tbody>
<tr>
<td>73</td>
<td>NaF</td>
<td>22.0</td>
<td>11.21</td>
<td>82.4</td>
<td>510°C (950°F)</td>
</tr>
<tr>
<td></td>
<td>LiF</td>
<td>40.5</td>
<td>12.75</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>ZrF₄</td>
<td>37.5</td>
<td>76.04</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**DENSITY**

- **SOLID AT ROOM TEMPERATURE (gm/cc)**: 3.74
- **LIQUID** (\(\rho = \text{gm/cc}, T = {^\circ}\text{C}\)): \(\rho = 3.52 - 0.00086T\)
- **LIQUID** (\(\rho = \text{lbs/ft}^3, T = {^\circ}\text{F}\)): \(\rho = 220.7 - 0.0298T\)
- **MEAN VOLUMETRIC COEFFICIENT OF LIQUID Expansion** (\(1/{^\circ}\text{C} \times 10^4\)): 2.95

**ENTHALPY, HEAT CAPACITY AND HEAT OF FUSION**

**SOLID**
- Enthalpy (cal/gm) = \(H_T - H_{0^\circ\text{C}}\)
- Heat Capacity (cal/gm °C) = \(c_p\)
- Heat Capacity at 300°C (572°F) = \(c_p = 0.22\)

**LIQUID**
- Enthalpy (cal/gm) = \(H_T - H_{0^\circ\text{C}}\)
- Heat Capacity (cal/gm °C) = \(c_p\)
- Heat Capacity at 700°C (1292°F) = \(c_p = 0.31\)

**HEAT OF FUSION (cal/gm)** = \(H_L - H_S\)

**THERMAL CONDUCTIVITY**

\(K (\text{BTU/hr ft °F})\)

**VISCOITY**

<table>
<thead>
<tr>
<th>°C</th>
<th>(Centipoises)</th>
<th>(Centistokes)</th>
<th>°F</th>
<th>(lb./ft-hr)</th>
<th>ft²/hr</th>
</tr>
</thead>
<tbody>
<tr>
<td>500</td>
<td>19.0</td>
<td></td>
<td>1100</td>
<td>23.7</td>
<td></td>
</tr>
<tr>
<td>600</td>
<td>9.4</td>
<td></td>
<td>1300</td>
<td>13.7</td>
<td></td>
</tr>
<tr>
<td>700</td>
<td>5.7</td>
<td></td>
<td>1500</td>
<td>9.3</td>
<td></td>
</tr>
<tr>
<td>800</td>
<td>4.05</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Exponential Form (centipoises)

*Denotes experimental values. Other values given are calculated or estimated.
**Table:**

<table>
<thead>
<tr>
<th>Mixture</th>
<th>Component</th>
<th>Mol %</th>
<th>Wt. %</th>
<th>Avg. M.W.</th>
<th>Liquidus Temp.</th>
</tr>
</thead>
<tbody>
<tr>
<td>74</td>
<td>LiF</td>
<td>69</td>
<td>55.13</td>
<td>32.4</td>
<td>505°C (941°F)</td>
</tr>
<tr>
<td></td>
<td>BeF₂</td>
<td>31</td>
<td>44.87</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Density**

- Solid at room temperature (gm/cc): 2.14
- Liquid (ρ = gm/cc, T = °C): \[\rho^* = 2.16 - 0.00040T\] (Ref. 3)
- Liquid (ρ = lbs/ft³, T = °F): \[\rho^* = 135.3 - 0.0139T\]

**Mean Volumetric Coefficient of Liquid Expansion** (1/°C x 10⁻⁴): 2.13

**Enthalpy, Heat Capacity and Heat of Fusion**

**Solid**
- Enthalpy (cal/gm): \[H_{T-H_0°C}^*\]
- Heat Capacity (cal/gm °C): \[c_p^*\]
- Heat Capacity at 300°C (572°F): \[c_p = 0.48\]

**Liquid**
- Enthalpy (cal/gm): \[H_{T-H_0°C}^*\]
- Heat Capacity (cal/gm °C): \[c_p^*\]
- Heat Capacity at 700°C (1292°F): \[c_p = 0.67\]

**Heat of Fusion (cal/gm)**: \[H_L-H_S^*\]

**Thermal Conductivity**

**Viscosity**

<table>
<thead>
<tr>
<th>°C</th>
<th>(Centipoises)</th>
<th>(Centistokes)</th>
<th>°F</th>
<th>(lb./ft-hr)</th>
<th>ft²/hr</th>
</tr>
</thead>
<tbody>
<tr>
<td>600</td>
<td>7.5**</td>
<td>3.90</td>
<td>1100</td>
<td>18.9**</td>
<td>0.1577</td>
</tr>
<tr>
<td>700</td>
<td>4.9**</td>
<td>2.60</td>
<td>1300</td>
<td>11.6**</td>
<td>0.0994</td>
</tr>
<tr>
<td>800</td>
<td>3.45**</td>
<td>1.89</td>
<td>1500</td>
<td>8.0**</td>
<td>0.0700</td>
</tr>
</tbody>
</table>

Exponential Form (centipoises): \[\mu = 0.118e^{3624/T^°K}\]

*Denotes experimental values. Other values given are calculated or estimated.

**Average values, Refs. 3 and 27.**
<table>
<thead>
<tr>
<th>Mixture</th>
<th>Component</th>
<th>Mol %</th>
<th>Wt. %</th>
<th>Avg. M.W.</th>
<th>Liquidus Temp.</th>
</tr>
</thead>
<tbody>
<tr>
<td>75</td>
<td>LiF</td>
<td>67.0</td>
<td>43.92</td>
<td>39.5</td>
<td>464°C (867°F)</td>
</tr>
<tr>
<td></td>
<td>BeF₂</td>
<td>30.5</td>
<td>36.24</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>UF₄</td>
<td>2.5</td>
<td>19.84</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Density**

SOLID AT ROOM TEMPERATURE (gm/cc)  2.48

LIQUID (\(\rho = \text{gm/cc}, T = °C\))  \(\rho = 2.38 - 0.00040T\)

LIQUID (\(\rho = \text{lbs/ft}^3, T = °F\))  \(\rho = 149.0 - 0.0139T\)

MEAN VOLUMETRIC COEFFICIENT OF LIQUID EXPANSION (1/°C \(x 10^4\))  1.90

**Enthalpy, Heat Capacity and Heat of Fusion**

**SOLID**

Enthalpy (cal/gm)  \(H_T - H_{0°C}\) \(*=\)

Heat Capacity (cal/gm °C)  \(c_p * = \)

Heat Capacity at 300°C (572°F)  \(c_p = 0.41\)

**LIQUID**

Enthalpy (cal/gm)  \(H_T - H_{0°C}\) \(*=\)

Heat Capacity (cal/gm °C)  \(c_p * = \)

Heat Capacity at 700°C (1292°F)  \(c_p = 0.57\)

**HEAT OF FUSION (cal/gm)**  \(H_L - H_S * = \)

**Thermal Conductivity**

\(K (\text{BTU/hr ft °F})\)

**Viscosity**

<table>
<thead>
<tr>
<th>°C</th>
<th>(Centipoises)</th>
<th>(Centistokes)</th>
<th>°F</th>
<th>(lb./ft-hr)</th>
<th>ft²/hr</th>
</tr>
</thead>
<tbody>
<tr>
<td>600</td>
<td>8.4</td>
<td></td>
<td>1100</td>
<td>21.1</td>
<td></td>
</tr>
<tr>
<td>700</td>
<td>5.5</td>
<td></td>
<td>1300</td>
<td>13.1</td>
<td></td>
</tr>
<tr>
<td>800</td>
<td>3.85</td>
<td></td>
<td>1500</td>
<td>9.0</td>
<td></td>
</tr>
</tbody>
</table>

Exponential Form (centipoises)

*Denotes experimental values. Other values given are calculated or estimated.*
### Mixture Component Table

<table>
<thead>
<tr>
<th>Mixture</th>
<th>Component</th>
<th>Mol %</th>
<th>Wt. %</th>
<th>Avg. M.W.</th>
<th>Liquidus Temp.</th>
</tr>
</thead>
<tbody>
<tr>
<td>76</td>
<td>NaF</td>
<td>55.5</td>
<td>45.80</td>
<td>50.9</td>
<td>400°C (752°F)</td>
</tr>
<tr>
<td></td>
<td>BeF₂</td>
<td>42.0</td>
<td>38.78</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>UF₄</td>
<td>2.5</td>
<td>15.42</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Density

**Solid at Room Temperature (gm/cc)** 2.61

**Liquid (ρ = gm/cc, T = °C)**

\[ ρ = 2.50 - 0.00043T \]

**Liquid (ρ = lbs/ft³, T = °F)**

\[ ρ = 156.5 - 0.0149T \]

**Mean Volumetric Coefficient of Liquid Expansion (1/°C x 10⁴)** 1.95

### Enthalpy, Heat Capacity and Heat of Fusion

**Solid**

- **Enthalpy (cal/gm)**
  \[ H_{T-H_0}°C * = \]

- **Heat Capacity (cal/gm °C)**
  \[ c_p * = \]

- **Heat Capacity at 300°C (572°F)**
  \[ c_p = 0.33 \]

**Liquid**

- **Enthalpy (cal/gm)**
  \[ H_{T-H_0}°C * = \]

- **Heat Capacity (cal/gm °C)**
  \[ c_p * = \]

- **Heat Capacity at 700°C (1292°F)**
  \[ c_p = 0.46 \]

**Heat of Fusion (cal/gm)**

\[ H_{L-H_s}°C * = \]

### Thermal Conductivity

\[ K (BTU/hr ft °F) \]

### Viscosity

<table>
<thead>
<tr>
<th>°C</th>
<th>(Centipoises)</th>
<th>(Centistokes)</th>
<th>°F</th>
<th>(lb./ft-hr)</th>
<th>ft²/hr</th>
</tr>
</thead>
<tbody>
<tr>
<td>600</td>
<td>10.5</td>
<td></td>
<td>1100</td>
<td>26.6</td>
<td></td>
</tr>
<tr>
<td>700</td>
<td>6.0</td>
<td></td>
<td>1300</td>
<td>14.2</td>
<td></td>
</tr>
<tr>
<td>800</td>
<td>3.75</td>
<td></td>
<td>1500</td>
<td>8.6</td>
<td></td>
</tr>
</tbody>
</table>

**Exponential Form (centipoises)**

*Denotes experimental values. Other values given are calculated or estimated.*
<table>
<thead>
<tr>
<th>Mixture</th>
<th>Component</th>
<th>Mol %</th>
<th>Wt. %</th>
<th>Avg. M.W.</th>
<th>Liquidus Temp.</th>
</tr>
</thead>
<tbody>
<tr>
<td>77</td>
<td>NaF</td>
<td>70</td>
<td>67.59</td>
<td>43.5</td>
<td>590°C (1094°F)</td>
</tr>
<tr>
<td></td>
<td>BeF₂</td>
<td>30</td>
<td>32.41</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**DENSITY**

SOLID AT ROOM TEMPERATURE (gm/cc) 2.46

LIQUID (ρ = gm/cc, T = °C) ρ* = 2.41 - 0.00050T (Ref. 3)

LIQUID (ρ = lbs/ft³, T = °F) ρ* = 151.0 - 0.0173T

MEAN VOLUMETRIC COEFFICIENT OF LIQUID EXPANSION (1/°C x 10⁴) 2.43

**ENTHALPY, HEAT CAPACITY AND HEAT OF FUSION**

**SOLID**

<table>
<thead>
<tr>
<th>Enthalpy (cal/gm)</th>
<th>Hₜ-H₀°C* =</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heat Capacity (cal/gm °C)</td>
<td>cₚ* =</td>
</tr>
<tr>
<td>Heat Capacity at 300°C (572°F)</td>
<td>cₚ = 0.36</td>
</tr>
</tbody>
</table>

**LIQUID**

<table>
<thead>
<tr>
<th>Enthalpy (cal/gm)</th>
<th>Hₜ-H₀°C* =</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heat Capacity (cal/gm °C)</td>
<td>cₚ* =</td>
</tr>
<tr>
<td>Heat Capacity at 700°C (1292°F)</td>
<td>cₚ = 0.50</td>
</tr>
</tbody>
</table>

**HEAT OF FUSION (cal/gm) Hₜ-Hₛ* =**

**THERMAL CONDUCTIVITY**

K (BTU/hr ft °F)

**VISCOSITY**

<table>
<thead>
<tr>
<th>°C</th>
<th>(Centipoises)</th>
<th>(Centistokes)</th>
<th>°F</th>
<th>(lb./ft-hr)</th>
<th>ft²/hr</th>
</tr>
</thead>
<tbody>
<tr>
<td>600</td>
<td>5.0* (Ref. 3)</td>
<td>2.37</td>
<td>1100</td>
<td>12.5*</td>
<td>0.0944</td>
</tr>
<tr>
<td>700</td>
<td>3.9*</td>
<td>1.77</td>
<td>1300</td>
<td>8.6*</td>
<td>0.0669</td>
</tr>
<tr>
<td>800</td>
<td>2.8*</td>
<td>1.39</td>
<td>1500</td>
<td>6.5*</td>
<td>0.0519</td>
</tr>
</tbody>
</table>

Exponential Form (centipoises) µ = 0.223e²⁷¹⁶/T°K

*Denotes experimental values. Other values given are calculated or estimated.*
Mixture Component Mol % Wt. % Avg. M.W. Liquidus Temp.
78 NaF 56 57.60 40.8 478°C (892°F)
   LiF 16 10.17
   BeF₂ 28 32.23

**Density**

SOLID AT ROOM TEMPERATURE (gm/cc) 2.42

LIQUID (ρ = gm/cc, T = °C) ρ* = 2.22 - 0.00041T (Ref. 3)

LIQUID (ρ = lbs/ft³, T = °F) ρ* = 139.0 - 0.0142T

MEAN VOLUMETRIC COEFFICIENT OF LIQUID EXPANSION (1/°C x 10⁻⁴) 2.11

**Enthalpy, Heat Capacity and Heat of Fusion**

SOLID

Enthalpy (cal/gm) Hₜ-H₀°C* =
Heat Capacity (cal/gm °C) cₚ*
Heat Capacity at 300°C (572°F) cₚ = 0.38

LIQUID

Enthalpy (cal/gm) Hₜ-H₀°C* =
Heat Capacity (cal/gm °C) cₚ*
Heat Capacity at 700°C (1292°F) cₚ = 0.53

HEAT OF FUSION (cal/gm) H_L-H_S* =

**Thermal Conductivity**

K (BTU/hr ft °F)

**Viscosity**

<table>
<thead>
<tr>
<th>°C</th>
<th>(Centipoises)</th>
<th>(Centistokes)</th>
<th>°F</th>
<th>(lb./ft-hr)</th>
<th>ft²/hr</th>
</tr>
</thead>
<tbody>
<tr>
<td>600</td>
<td>6.0**</td>
<td>3.03</td>
<td>1100</td>
<td>15.0**</td>
<td>0.1213</td>
</tr>
<tr>
<td>700</td>
<td>4.0**</td>
<td>2.07</td>
<td>1300</td>
<td>9.5**</td>
<td>0.0788</td>
</tr>
<tr>
<td>800</td>
<td>2.85**</td>
<td>1.50</td>
<td>1500</td>
<td>6.6**</td>
<td>0.0559</td>
</tr>
</tbody>
</table>

Exponential Form (centipoises) μ = 0.11le⁻³⁴⁸⁶/T⁰K

*Denotes experimental values. Other values given are calculated or estimated.

**Average values, Refs. 3 and 32.
<table>
<thead>
<tr>
<th>Mixture</th>
<th>Component</th>
<th>Mol %</th>
<th>Wt. %</th>
<th>Avg. M.W.</th>
<th>Liquidus Temp.</th>
</tr>
</thead>
<tbody>
<tr>
<td>79</td>
<td>NaF</td>
<td>55.0</td>
<td>48.36</td>
<td>47.8</td>
<td>470°C (878°F)</td>
</tr>
<tr>
<td></td>
<td>LiF</td>
<td>15.0</td>
<td>8.14</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>BeF₂</td>
<td>27.5</td>
<td>27.07</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>UF₄</td>
<td>2.5</td>
<td>16.43</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### DENSITY

**SOLID AT ROOM TEMPERATURE (gm/cc)**

ρ = 2.70

**LIQUID** (ρ = gm/cc, T = °C)

ρ = 2.60 - 0.00045T

**LIQUID** (ρ = lbs/ft³, T = °F)

ρ = 162.8 - 0.0156T

**MEAN VOLUMETRIC COEFFICIENT OF LIQUID EXPANSION (1/°C x 10⁴)**

1.98

### ENTHALPY, HEAT CAPACITY AND HEAT OF FUSION

**SOLID**

- Enthalpy (cal/gm)
- Heat Capacity (cal/gm °C)
- Heat Capacity at 300°C (572°F)

**LIQUID**

- Enthalpy (cal/gm)
- Heat Capacity (cal/gm °C)
- Heat Capacity at 700°C (1292°F)

**HEAT OF FUSION (cal/gm)**

### THERMAL CONDUCTIVITY

*Denotes experimental values. Other values given are calculated or estimated.*

<table>
<thead>
<tr>
<th>°C</th>
<th>(Centipoises)</th>
<th>(Centistokes)</th>
<th>°F</th>
<th>(lb./ft-hr)</th>
<th>ft²/hr</th>
</tr>
</thead>
<tbody>
<tr>
<td>600</td>
<td>6.6</td>
<td></td>
<td>1100</td>
<td>16.7</td>
<td></td>
</tr>
<tr>
<td>700</td>
<td>4.4</td>
<td></td>
<td>1300</td>
<td>10.5</td>
<td></td>
</tr>
<tr>
<td>800</td>
<td>3.15</td>
<td></td>
<td>1500</td>
<td>7.3</td>
<td></td>
</tr>
</tbody>
</table>

Exponential Form (centipoises)
<table>
<thead>
<tr>
<th>Mixture</th>
<th>Component</th>
<th>Mol %</th>
<th>Wt. %</th>
<th>Avg. M.W.</th>
<th>Liquidus Temp.</th>
</tr>
</thead>
<tbody>
<tr>
<td>80</td>
<td>NaF</td>
<td>51</td>
<td>43.12</td>
<td>49.7</td>
<td>605°C (1121°F)</td>
</tr>
<tr>
<td></td>
<td>LiF</td>
<td>38</td>
<td>19.85</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>ZrF₄</td>
<td>11</td>
<td>37.02</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Density**

Solid at room temperature (gm/cc) 3.08

Liquid (p = gm/cc, T = °C) \( \rho = 2.95 - 0.00077T \)

Liquid (\( \rho = \text{lbs/ft}^3, T = °F \)) \( \rho = 185.0 - 0.0267T \)

Mean volumetric coefficient of liquid expansion \( (1/°C \times 10^4) \) 3.21

**Enthalpy, Heat Capacity and Heat of Fusion**

**Solid**

Enthalpy (cal/gm) \( H_{T-H_0} °C^* = \)

Heat Capacity (cal/gm °C) \( c_p^* = \)

Heat Capacity at 300°C (572°F) \( c_p = 0.27 \)

**Liquid**

Enthalpy (cal/gm) \( H_{T-H_0} °C^* = \)

Heat Capacity (cal/gm °C) \( c_p^* = \)

Heat Capacity at 700°C (1292°F) \( c_p = 0.38 \)

**Heat of Fusion (cal/gm)** \( H_{L-H_S}^* = \)

**Thermal Conductivity**

K (BTU/hr ft °F)

**Viscosity**

\( °C \) (Centipoises) (Centistokes) \( °F \) (lb./ft-hr) \( ft^2/hr \)

Exponential Form (centipoises)

*Denotes experimental values. Other values given are calculated or estimated.*
### Mixture Component Data

<table>
<thead>
<tr>
<th>Mixture</th>
<th>Component</th>
<th>Mol %</th>
<th>Wt. %</th>
<th>Avg. M.W.</th>
<th>Liquidus Temp.</th>
</tr>
</thead>
<tbody>
<tr>
<td>81</td>
<td>NaF</td>
<td>22</td>
<td>14.91</td>
<td>62.0</td>
<td>570°C (1058°F)</td>
</tr>
<tr>
<td></td>
<td>LiF</td>
<td>55</td>
<td>23.03</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>ZrF₄</td>
<td>23</td>
<td>62.06</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Density

**Solid at Room Temperature (gm/cc)**

\[ \rho = 3.41 \]

**Liquid (\( \rho = \text{gm/cc}, T = °C \))**

\[ \rho = 3.22 - 0.00081T \]

**Liquid (\( \rho = \text{lbs/ft}^3, T = °F \))**

\[ \rho = 201.9 - 0.0281T \]

**Mean Volumetric Coefficient of Liquid Expansion (1/°C x 10⁴)**

\[ 3.06 \]

### Enthalpy, Heat Capacity and Heat of Fusion

**Solid (1060°-360°C)**

\[ H_{T} - H_{0} C^* = -1.5 + 0.2392T + 7.20 \times 10^{-5}T^2 \]

\[ c_{p}^* = 0.2392 + 14.39 \times 10^{-5}T \] (Ref. 33)

\[ c_{P}^* = 0.282 \]

**Liquid (603°-897°C)**

\[ H_{T} - H_{0} C^* = -13.0 + 0.4526T - 5.95 \times 10^{-5}T^2 \]

\[ c_{p}^* = 0.4526 - 11.89 \times 10^{-5}T \]

\[ c_{P}^* = 0.369 \]

**Heat of Fusion (cal/gm)**

\[ H_{L} - H_{S} = \]

### Thermal Conductivity

\[ K (\text{BTU/hr ft °F}) \]

<table>
<thead>
<tr>
<th>°C</th>
<th>(Centipoises)</th>
<th>(Centistokes)</th>
<th>°F</th>
<th>(lb./ft-hr)</th>
<th>ft²/hr</th>
</tr>
</thead>
<tbody>
<tr>
<td>600</td>
<td>12.0* (Ref. 34)</td>
<td>4.4</td>
<td>1100</td>
<td>30.3*</td>
<td>0.1771</td>
</tr>
<tr>
<td>700</td>
<td>7.0*</td>
<td>2.64</td>
<td>1300</td>
<td>16.5*</td>
<td>0.0997</td>
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<tr>
<td>800</td>
<td>4.45*</td>
<td>1.73</td>
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<td>0.0638</td>
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<tr>
<td>900</td>
<td>3.05*</td>
<td>1.22</td>
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<td></td>
</tr>
</tbody>
</table>

Exponential Form (centipoises)

\[ \mu = 0.0585e^{4647/T^0K} \]

*Denotes experimental values. Other values given are calculated or estimated.*
<table>
<thead>
<tr>
<th>Mixture</th>
<th>Component</th>
<th>Mol %</th>
<th>Wt. %</th>
<th>Avg. M.W.</th>
<th>Liquidus Temp.</th>
</tr>
</thead>
<tbody>
<tr>
<td>82</td>
<td>NaF</td>
<td>20</td>
<td>11.93</td>
<td>70.3</td>
<td>545°C (1013°F)</td>
</tr>
<tr>
<td></td>
<td>LiF</td>
<td>55</td>
<td>20.30</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>ZrF₄</td>
<td>21</td>
<td>49.92</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>UF₄</td>
<td>4</td>
<td>17.85</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

DENSITY

SOLID AT ROOM TEMPERATURE (gm/cc) 3.70
LIQUID (ρ = gm/cc, T = °C) ρ = 3.49 - 0.00085T
LIQUID (ρ = lbs/ft³, T = °F) ρ = 218.8 - 0.0295T
MEAN VOLUMETRIC COEFFICIENT OF LIQUID EXPANSION (°C x 10⁴) 2.93

ENTHALPY, HEAT CAPACITY AND HEAT OF FUSION

SOLID (98°C - 363°C)

Enthalpy (cal/gm) \( H_{T-H_0}^{\circ}C^* = -3.7 + 0.230T + 4.07 \times 10^{-5}T^2 \)
Heat Capacity (cal/gm °C) \( c_p^* = 0.2304 + 8.14 \times 10^{-5}T \) (Ref. 4)
Heat Capacity at 300°C (572°F) \( c_p^* = 0.255 \)

LIQUID (582°C - 900°C)

Enthalpy (cal/gm) \( H_{T-H_0}^{\circ}C^* = -20.1 + 0.4314T - 7.42 \times 10^{-5}T^2 \)
Heat Capacity (cal/gm °C) \( c_p^* = 0.4314 - 14.85 \times 10^{-5}T \)
Heat Capacity at 700°C (1292°F) \( c_p^* = 0.327 \)

HEAT OF FUSION (cal/gm) \( H_{L-H_s}^{\circ}C^* = \)

THERMAL CONDUCTIVITY

K (BTU/hr ft °F)

<table>
<thead>
<tr>
<th>°C</th>
<th>(Centipoises)</th>
<th>(Centistokes)</th>
<th>°F</th>
<th>(lb./ft-hr)</th>
<th>ft²/hr</th>
</tr>
</thead>
<tbody>
<tr>
<td>600</td>
<td>12.0* (Ref. 34)</td>
<td>4.03</td>
<td>1100</td>
<td>30.3*</td>
<td>0.1626</td>
</tr>
<tr>
<td>700</td>
<td>7.0*</td>
<td>2.42</td>
<td>1300</td>
<td>16.5*</td>
<td>0.0915</td>
</tr>
<tr>
<td>800</td>
<td>4.45*</td>
<td>1.61</td>
<td>1500</td>
<td>10.2*</td>
<td>0.0586</td>
</tr>
</tbody>
</table>

Exponential Form (centipoises) \( \mu = 0.0585e^{4.647/T°K} \)

*Denotes experimental values. Other values given are calculated or estimated.
<table>
<thead>
<tr>
<th>Mixture</th>
<th>Component</th>
<th>Mol %</th>
<th>Wt. %</th>
<th>Avg. M.W.</th>
<th>Liquidus Temp.</th>
</tr>
</thead>
<tbody>
<tr>
<td>83</td>
<td>NaF</td>
<td>81</td>
<td>51.71</td>
<td>65.8</td>
<td>750°C (1382°F)</td>
</tr>
<tr>
<td></td>
<td>ZrF₄</td>
<td>19</td>
<td>48.29</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Density**

- **Solid at Room Temperature (gm/cc)**
  - 3.40

- **Liquid (ρ = gm/cc, T = °C)**
  - \( \rho = 3.22 - 0.00081T \)

- **Liquid (ρ = lbs/ft³, T = °F)**
  - \( \rho = 201.9 - 0.0281T \)

**Mean Volumetric Coefficient of Liquid Expansion (1/°C x 10⁴)**
- 3.06

**Enthalpy, Heat Capacity and Heat of Fusion**

**Solid**

- Enthalpy (cal/gm)
- Heat Capacity (cal/gm °C)
- Heat Capacity at 300°C (572°F)

**Liquid**

- Enthalpy (cal/gm)
- Heat Capacity (cal/gm °C)
- Heat Capacity at 700°C (1292°F)

**Heat of Fusion (cal/gm)**
- \( H_L - H_S \)

**Thermal Conductivity**

- \( K \) (BTU/hr ft °F)

**Viscosity**

<table>
<thead>
<tr>
<th>°C</th>
<th>(Centipoises)</th>
<th>(Centistokes)</th>
<th>°F</th>
<th>(lb./ft-hr)</th>
<th>ft²/hr</th>
</tr>
</thead>
</table>

**Exponential Form (centipoises)**

*Denotes experimental values. Other values given are calculated or estimated.*
### Mixture Component

<table>
<thead>
<tr>
<th>Mixture</th>
<th>Component</th>
<th>Mol %</th>
<th>Wt. %</th>
<th>Avg. M.W.</th>
<th>Liquidus Temp.</th>
</tr>
</thead>
<tbody>
<tr>
<td>84 NaF</td>
<td>27</td>
<td>29.62</td>
<td></td>
<td>38.3</td>
<td>338°C (640°F)</td>
</tr>
<tr>
<td>LiF</td>
<td>35</td>
<td>23.72</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BeF₂</td>
<td>38</td>
<td>46.66</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Density

**Solid at Room Temperature (gm/cc)**

2.25

**Liquid**

(\(\rho = \text{gm/cc, } T = ^\circ\text{C}\))

\(\rho^* = 2.22 - 0.00041T\) (Ref. 35)

LIQUID (\(\rho = \text{lbs/ft}^3, T = ^\circ\text{F}\))

\(\rho^* = 139.0 - 0.0142T\)

### Mean Volumetric Coefficient of Liquid Expansion

\(\left(1/\text{°C} \times 10^4\right) 2.09\)

### Enthalpy, Heat Capacity and Heat of Fusion

#### Solid

**Enthalpy (cal/gm)**

\(H_T - H_{0\text{°C}} *\)

**Heat Capacity (cal/gm °C)**

\(c_p *\)

**Heat Capacity at 300°C (572°F)**

\(c_p = 0.42\)

#### Liquid

**Enthalpy (cal/gm)**

\(H_T - H_{0\text{°C}} *\)

**Heat Capacity (cal/gm °C)**

\(c_p *\)

**Heat Capacity at 700°C (1292°F)**

\(c_p = 0.59\)

### Heat of Fusion (cal/gm)

\(H_L - H_S *\)

#### Thermal Conductivity

\(K (\text{BTU/hr ft °F})\)

### Viscosity

<table>
<thead>
<tr>
<th>°C</th>
<th>(Centipoises)</th>
<th>(Centistokes)</th>
<th>°F</th>
<th>(lb./ft-hr)</th>
<th>ft²/hr</th>
</tr>
</thead>
<tbody>
<tr>
<td>600</td>
<td>7.8* (Ref. 35)</td>
<td>3.91</td>
<td>1100</td>
<td>19.8*</td>
<td>0.1586</td>
</tr>
<tr>
<td>700</td>
<td>4.45*</td>
<td>2.27</td>
<td>1300</td>
<td>10.5*</td>
<td>0.0858</td>
</tr>
<tr>
<td>800</td>
<td>2.8*</td>
<td>1.48</td>
<td>1500</td>
<td>6.3*</td>
<td>0.0530</td>
</tr>
</tbody>
</table>

Exponential Form (centipoises) \(\mu = 0.0338e^{4738/TK}\)

*Denotes experimental values. Other values given are calculated or estimated.*
Mixture Component   Mol %  Wt. %  Avg. M.W.  Liquidus Temp.
85   NaF     26.5   24.62    45.2    360°C (680°F)
     LiF     34.0   19.52
     BeF₂    37.0   38.50
     UF₄      2.5   17.36

DENSITY

SOLID AT ROOM TEMPERATURE (gm/cc)       2.54
LIQUID (ρ = gm/cc, T = °C)       ρ* = 2.33 - 0.00018T (Ref. 35)
LIQUID (ρ = lbs/ft³, T = °F)       ρ* = 145.7 - 0.00624T
MEAN VOLUMETRIC COEFFICIENT OF LIQUID EXPANSION (1/°C x 10⁴)

ENTHALPY, HEAT CAPACITY AND HEAT OF FUSION

SOLID

Enthalpy (cal/gm)   Hₜ-Hₜ₀°C * =
Heat Capacity (cal/gm °C)   cₚ * =
Heat Capacity at 300°C (572°F)   cₚ = 0.37

LIQUID

Enthalpy (cal/gm)   Hₜ-Hₜ₀°C * =
Heat Capacity (cal/gm °C)   cₚ * =
Heat Capacity at 700°C (1292°F)   cₚ = 0.51

HEAT OF FUSION (cal/gm)   Hₗ-Hₗ₀*=

THERMAL CONDUCTIVITY

K (BTU/hr ft °F)

<table>
<thead>
<tr>
<th>°C</th>
<th>(Centipoises)</th>
<th>(Centistokes)</th>
<th>°F</th>
<th>(lb./ft-hr)</th>
<th>ft²/hr</th>
</tr>
</thead>
<tbody>
<tr>
<td>600</td>
<td>9.0* (Ref. 35)</td>
<td>4.04</td>
<td>1100</td>
<td>22.7*</td>
<td>0.1631</td>
</tr>
<tr>
<td>700</td>
<td>4.95*</td>
<td>2.24</td>
<td>1300</td>
<td>11.7*</td>
<td>0.0848</td>
</tr>
<tr>
<td>800</td>
<td>3.05*</td>
<td>1.41</td>
<td>1500</td>
<td>6.9*</td>
<td>0.0506</td>
</tr>
</tbody>
</table>

Exponential Form (centipoises)   μ = 0.0261e⁰.⁵⁰⁹⁴/T°K

*Denotes experimental values. Other values given are calculated or estimated.
Mixture | Component | Mol % | Wt. % | Avg. M.W. | Liquidus Temp.
--- | --- | --- | --- | --- | ---
86 | LiF | 35 | 10.87 | 83.6 | 445°C (833°F)
 | NaF | 32 | 16.08 | | |
 | ZrF₄ | 29 | 58.02 | | |
 | UF₄ | 4 | 15.03 | | |

**DENSITY**

**SOLID AT ROOM TEMPERATURE (gm/cc)**
3.87

**LIQUID (ρ = gm/cc, T = °C)**
\[ \rho = 3.66 - 0.00088T \]

**LIQUID (ρ = lbs/ft³, T = °F)**
\[ \rho = 229.4 - 0.0305T \]

**MEAN VOLUMETRIC COEFFICIENT OF LIQUID EXPANSION (1/°C x 10⁴)**
2.89

**ENTHALPY, HEAT CAPACITY AND HEAT OF FUSION**

**SOLID**

Enthalpy (cal/gm)
\[ H_T-H_{0°C} \]

Heat Capacity (cal/gm °C)
\[ c_p \]

Heat Capacity at 300°C (572°F)
\[ c_p = 0.21 \]

**LIQUID**

Enthalpy (cal/gm)
\[ H_T-H_{0°C} \]

Heat Capacity (cal/gm °C)
\[ c_p \]

Heat Capacity at 700°C (1292°F)
\[ c_p = 0.29 \]

**HEAT OF FUSION (cal/gm)**
\[ H_L-H_S \]

**THERMAL CONDUCTIVITY**

\[ K \text{(BTU/hr ft °F)} \]

**VISCOSITY**

<table>
<thead>
<tr>
<th>°C</th>
<th>(Centipoises)</th>
<th>(Centistokes)</th>
<th>°F</th>
<th>(lb./ft-hr)</th>
<th>ft²/hr</th>
</tr>
</thead>
<tbody>
<tr>
<td>500</td>
<td>20.5* (Ref. 36)</td>
<td>6.37</td>
<td>1100</td>
<td>26.6*</td>
<td>0.1357</td>
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<tr>
<td>600</td>
<td>10.5*</td>
<td>3.35</td>
<td>1300</td>
<td>15.4*</td>
<td>0.0811</td>
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<tr>
<td>700</td>
<td>6.45*</td>
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<td>1500</td>
<td>10.5*</td>
<td>0.0572</td>
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<tr>
<td>800</td>
<td>4.55*</td>
<td>1.54</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Exponential Form (centipoises)*

*Denotes experimental values. Other values given are calculated or estimated.*
<table>
<thead>
<tr>
<th>Mixture</th>
<th>Component</th>
<th>Mol %</th>
<th>Wt. %</th>
<th>Avg. M.W.</th>
<th>Liquidus Temp.</th>
</tr>
</thead>
<tbody>
<tr>
<td>87</td>
<td>RbF</td>
<td>48</td>
<td>35.08</td>
<td>143.0</td>
<td>425°C (797°F)</td>
</tr>
<tr>
<td></td>
<td>ZrF₄</td>
<td>48</td>
<td>56.13</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>UF₄</td>
<td>4</td>
<td>8.79</td>
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</tr>
</tbody>
</table>

**DENSITY**

SOLID AT ROOM TEMPERATURE (gm/cc) 4.19

LIQUID (ρ = gm/cc, T = °C) ρ = 4.00 - 0.00093T

LIQUID (ρ = lbs/ft³, T = °F) ρ = 250.7 - 0.0322T

MEAN VOLUMETRIC COEFFICIENT OF LIQUID EXPANSION (1/°C x 10⁴) 2.78

**ENTHALPY, HEAT CAPACITY AND HEAT OF FUSION**

SOLID (142°-398°C)

- Enthalpy (cal/gm) $H_T - H_{O{C}°} = -3.2 + 0.1490T + 3.2 \times 10^{-5}T^2$
- Heat Capacity (cal/gm °C) $c_p° = 0.1490 + 6.5 \times 10^{-5}T$ (Ref. 37)
- Heat Capacity at 300°C (572°F) $c_p° = 0.169$

LIQUID (458°-880°C)

- Enthalpy (cal/gm) $H_T - H_{O{C}°} = -9.8 + 0.2844T - 5.4 \times 10^{-5}T^2$
- Heat Capacity (cal/gm °C) $c_p° = 0.2844 - 10.8 \times 10^{-5}T$
- Heat Capacity at 700°C (1292°F) $c_p° = 0.209$

HEAT OF FUSION (cal/gm) $H_L - H_S° = 35$

**THERMAL CONDUCTIVITY**

$K$ (BTU/hr ft °F) 1.0 (Liquid, constant gap) (Ref. 45)

**VISCOSITY**

<table>
<thead>
<tr>
<th>°C</th>
<th>Centipoises</th>
<th>(Centistokes)</th>
<th>°F</th>
<th>(lb./ft-hr)</th>
<th>ft²/hr</th>
</tr>
</thead>
<tbody>
<tr>
<td>600</td>
<td>7.1* (Ref. 38)</td>
<td>2.11</td>
<td>1100</td>
<td>17.8*</td>
<td>0.0844</td>
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<tr>
<td>700</td>
<td>4.65*</td>
<td>1.41</td>
<td>1300</td>
<td>11.0*</td>
<td>0.0537</td>
</tr>
<tr>
<td>800</td>
<td>3.3*</td>
<td>1.03</td>
<td>1500</td>
<td>7.6*</td>
<td>0.0382</td>
</tr>
</tbody>
</table>

- Exponential Form (centipoises) $μ = 0.116 e^{3590/T°K}$

PRANDTL NUMBER 3.9 at 1100°F, 2.3 at 1300°F, 1.5 at 1500°F

*Denotes experimental values. Other values given are calculated or estimated.
Mixture  Component  Mol %  Wt. %  Avg. M.W.  Liquidus Temp.
88  NaF  64  62.88  42.8  555°C (1031°F)
    LiF  5  3.04
    BeF₂  31  34.08

**DENSITY**

SOLID AT ROOM TEMPERATURE (gm/cc)  2.44
LIQUID (ρ = gm/cc, T = °C)  ρ* = 2.39 - 0.0005T (Ref. 3)
LIQUID (ρ = lbs/ft³, T = °F)  ρ* = 149.7 - 0.0173T
MEAN VOLUMETRIC COEFFICIENT OF LIQUID EXPANSION (1/°C x 10⁴)  2.45

**ENTHALPY, HEAT CAPACITY AND HEAT OF FUSION**

**SOLID**
- Enthalpy (cal/gm)  \( H_T-H_{O\degree C} \star \)
- Heat Capacity (cal/gm °C)  \( c_p \star \)
- Heat Capacity at 300°C (572°F)  \( c_p = 0.37 \)

**LIQUID**
- Enthalpy (cal/gm)  \( H_T-H_{O\degree C} \star \)
- Heat Capacity (cal/gm °C)  \( c_p \star \)
- Heat Capacity at 700°C (1292°F)  \( c_p = 0.51 \)

**HEAT OF FUSION (cal/gm)**  \( H_L-H_S \star \)

**THERMAL CONDUCTIVITY**

K (BTU/hr ft °F)

**VISCOFIGITY**

<table>
<thead>
<tr>
<th>T (°C)</th>
<th>(Centipoises)</th>
<th>(Centistokes)</th>
<th>T (°F)</th>
<th>(lb./ft·hr)</th>
<th>ft²/hr</th>
</tr>
</thead>
<tbody>
<tr>
<td>600</td>
<td>7.1**</td>
<td>3.39</td>
<td>1100</td>
<td>17.8**</td>
<td>0.1364</td>
</tr>
<tr>
<td>700</td>
<td>4.75**</td>
<td>2.32</td>
<td>1300</td>
<td>11.3**</td>
<td>0.0887</td>
</tr>
<tr>
<td>800</td>
<td>3.4*</td>
<td>1.71</td>
<td>1500</td>
<td>7.9**</td>
<td>0.0636</td>
</tr>
</tbody>
</table>

Exponential Form (centipoises)  \( \mu = 0.138e^{34.35/T^\circ K} \)

*Denotes experimental values. Other values given are calculated or estimated. **Average values, Refs. 3 and 39.
### Mixture Component Mol % Wt. % Avg. M.W. Liquidus Temp.

<table>
<thead>
<tr>
<th>Mixture</th>
<th>Component</th>
<th>Mol %</th>
<th>Wt. %</th>
<th>Avg. M.W.</th>
<th>Liquidus Temp.</th>
</tr>
</thead>
<tbody>
<tr>
<td>89</td>
<td>NaF</td>
<td>63.5</td>
<td>63.12</td>
<td>42.2</td>
<td>535°C (995°F)</td>
</tr>
<tr>
<td></td>
<td>LiF</td>
<td>7.5</td>
<td>4.62</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>BeF₂</td>
<td>29.0</td>
<td>32.26</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### DENSITY

- **SOLID AT ROOM TEMPERATURE (gm/cc)**: 2.44
- **LIQUID (ρ = gm/cc, T = °C)**: $\rho^* = 2.38 - 0.00051T$ (Ref. 3)
- **LIQUID (ρ = lbs/ft³, T = °F)**: $\rho^* = 149.1 - 0.0177T$

### MEAN VOLUMETRIC COEFFICIENT OF LIQUID EXPANSION ($1/°C \times 10^4$): 2.52

### ENTHALPY, HEAT CAPACITY AND HEAT OF FUSION

#### SOLID

- **Enthalpy (cal/gm)**: $H_T - H_0°C^*$
- **Heat Capacity (cal/gm °C)**: $c_p^*$
- **Heat Capacity at 300°C (572°F)**: $c_p = 0.37$

#### LIQUID

- **Enthalpy (cal/gm)**: $H_L - H_0°C^*$
- **Heat Capacity (cal/gm °C)**: $c_p^*$
- **Heat Capacity at 700°C (1292°F)**: $c_p = 0.51$

### HEAT OF FUSION (cal/gm)

- **$H_L - H_S^*$**

### THERMAL CONDUCTIVITY

- **K (BTU/hr ft °F)**

### VISCOSITY

<table>
<thead>
<tr>
<th>°C</th>
<th>(Centipoises)</th>
<th>(Centistokes)</th>
<th>°F</th>
<th>(lb./ft-hr)</th>
<th>ft²/hr</th>
</tr>
</thead>
<tbody>
<tr>
<td>600</td>
<td>7.0* (Ref. 5)</td>
<td>3.37</td>
<td>1100</td>
<td>17.4*</td>
<td>0.1340</td>
</tr>
<tr>
<td>700</td>
<td>4.6*</td>
<td>2.28</td>
<td>1300</td>
<td>10.9*</td>
<td>0.0864</td>
</tr>
<tr>
<td>800</td>
<td>3.5*</td>
<td>1.67</td>
<td>1500</td>
<td>7.6*</td>
<td>0.0620</td>
</tr>
</tbody>
</table>

Exponential Form (centipoises) $\mu = 0.124e^{3543/T^0K}$

*Denotes experimental values. Other values given are calculated or estimated.*
<table>
<thead>
<tr>
<th>Mixture</th>
<th>Component</th>
<th>Mol %</th>
<th>Wt. %</th>
<th>Avg. M.W.</th>
<th>Liquidus Temp.</th>
</tr>
</thead>
<tbody>
<tr>
<td>90</td>
<td>NaF</td>
<td>49</td>
<td>45.00</td>
<td>46.2</td>
<td>555°C (1031°F)</td>
</tr>
<tr>
<td></td>
<td>KF</td>
<td>15</td>
<td>17.95</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>BeF₂</td>
<td>36</td>
<td>37.05</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**DENSITY**

SOLID AT ROOM TEMPERATURE (gm/cc) 2.38

LIQUID (ρ = gm/cc, T = °C) ρ = 2.30 - 0.00038T

LIQUID (ρ = lbs/ft³, T = °F) ρ = 144.0 - 0.0132T

MEAN VOLUMETRIC COEFFICIENT OF LIQUID EXPANSION (1/°C x 10⁴) 1.86

**ENTHALPY, HEAT CAPACITY AND HEAT OF FUSION**

**SOLID**

- Enthalpy (cal/gm) $H_T-H_{0°C}$
- Heat Capacity (cal/gm °C) $c_p^*$
- Heat Capacity at 300°C (572°F) $c_p = 0.35$

**LIQUID**

- Enthalpy (cal/gm) $H_T-H_{0°C}$
- Heat Capacity (cal/gm °C) $c_p^*$
- Heat Capacity at 700°C (1292°F) $c_p = 0.48$

**HEAT OF FUSION (cal/gm) $H_L-H_S^*$**

**THERMAL CONDUCTIVITY**

$K$ (BTU/hr ft °F)

**VISCOSITY**

<table>
<thead>
<tr>
<th>°C</th>
<th>(Centipoises)</th>
<th>(Centistokes)</th>
<th>°F</th>
<th>(lb./ft-hr)</th>
<th>ft²/hr</th>
</tr>
</thead>
<tbody>
<tr>
<td>600</td>
<td>8.0* (Ref. 40)</td>
<td>3.86</td>
<td>1100</td>
<td>20.1*</td>
<td>0.1555</td>
</tr>
<tr>
<td>700</td>
<td>5.0*</td>
<td>2.46</td>
<td>1300</td>
<td>11.9*</td>
<td>0.0937</td>
</tr>
<tr>
<td>800</td>
<td>3.4*</td>
<td>1.70</td>
<td>1500</td>
<td>7.9*</td>
<td>0.0634</td>
</tr>
</tbody>
</table>

Exponential Form (centipoises) $\mu = 0.0811e^{4008/T^K}$

*Denotes experimental values. Other values given are calculated or estimated.*
<table>
<thead>
<tr>
<th>Mixture</th>
<th>Component</th>
<th>Mol %</th>
<th>Wt. %</th>
<th>Avg. M.W.</th>
<th>Liquidus Temp.</th>
</tr>
</thead>
<tbody>
<tr>
<td>91</td>
<td>NaF</td>
<td>53</td>
<td>38.86</td>
<td>57.3</td>
<td>590°C (1094°F)</td>
</tr>
<tr>
<td></td>
<td>LiF</td>
<td>35</td>
<td>15.85</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>ZrF$_4$</td>
<td>8</td>
<td>25.36</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>UF$_4$</td>
<td>4</td>
<td>21.93</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**DENSITY**

- **SOLID AT ROOM TEMPERATURE (gm/cc)**: 3.40
- **LIQUID** ($\rho = \text{gm/cc, } T = ^\circ\text{C}$): $\rho = 3.22 - 0.00081T$
- **LIQUID** ($\rho = \text{lbs/ft}^3, T = ^\circ\text{F}$): $\rho = 201.9 - 0.0281T$

**MEAN VOLUMETRIC COEFFICIENT OF LIQUID EXPANSION** $(1/\circ\text{C} \times 10^4)$: 3.06

**ENTHALPY, HEAT CAPACITY AND HEAT OF FUSION**

**SOLID**

- Enthalpy (cal/gm): $H_T - H_0^{} * = ~$
- Heat Capacity (cal/gm °C): $c_p^{} * = ~$
- Heat Capacity at 300°C (572°F): $c_p^{} = 0.24$

**LIQUID**

- Enthalpy (cal/gm): $H_T - H_0^{} * = ~$
- Heat Capacity (cal/gm °C): $c_p^{} * = ~$
- Heat Capacity at 700°C (1292°F): $c_p^{} = 0.33$

**HEAT OF FUSION (cal/gm)**: $H_L - H_S^{} * = ~$

**THERMAL CONDUCTIVITY**

$K$ (BTU/hr ft °F)

**VISCOSITY**

<table>
<thead>
<tr>
<th>°C</th>
<th>(Centipoises)</th>
<th>(Centistokes)</th>
<th>°F</th>
<th>(lb./ft-hr)</th>
<th>ft$^2$/hr</th>
</tr>
</thead>
<tbody>
<tr>
<td>600</td>
<td>10.5</td>
<td></td>
<td>1100</td>
<td>26.6</td>
<td></td>
</tr>
<tr>
<td>700</td>
<td>6.45</td>
<td></td>
<td>1300</td>
<td>15.4</td>
<td></td>
</tr>
<tr>
<td>800</td>
<td>4.55</td>
<td></td>
<td>1500</td>
<td>10.5</td>
<td></td>
</tr>
</tbody>
</table>

Exponential Form (centipoises)

*Denotes experimental values. Other values given are calculated or estimated.
Mixture Component Mol % Wt. % Avg. M.W. Liquidus Temp.
92 NaF 49.5 40.61 51.2 415°C (779°F)
BeF₂ 48.0 44.06
UF₄ 2.5 15.33

DENSITY
SOLID AT ROOM TEMPERATURE (gm/cc) 2.56
LIQUID (ρ = gm/cc, T = °C) ρ = 2.46 - 0.00042T
LIQUID (ρ = lbs/ft³, T = °F) ρ = 154.0 - 0.0146T
MEAN VOLUMETRIC COEFFICIENT OF LIQUID EXPANSION (1/°C x 10⁴) 1.94

ENTHALPY, HEAT CAPACITY AND HEAT OF FUSION

SOLID
Enthalpy (cal/gm) \( H_T - H_{0°C} \star \)
Heat Capacity (cal/gm ºC) \( c_p \star \)
Heat Capacity at 300°C (572°F) \( c_p = 0.34 \)

LIQUID
Enthalpy (cal/gm) \( H_T - H_{0°C} \star \)
Heat Capacity (cal/gm ºC) \( c_p \star \)
Heat Capacity at 700°C (1292°F) \( c_p = 0.47 \)

HEAT OF FUSION (cal/gm) \( H_L - H_S \star \)

THERMAL CONDUCTIVITY

K (BTU/hr ft °F)

VISCOSITY

<table>
<thead>
<tr>
<th>°C</th>
<th>(Centipoises)</th>
<th>(Centistokes)</th>
<th>°F</th>
<th>(lb./ft-hr)</th>
<th>ft²/hr</th>
</tr>
</thead>
<tbody>
<tr>
<td>600</td>
<td>13.7</td>
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<td>1100</td>
<td>34.6</td>
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</tr>
<tr>
<td>700</td>
<td>7.3</td>
<td></td>
<td>1300</td>
<td>17.3</td>
<td></td>
</tr>
<tr>
<td>800</td>
<td>4.4</td>
<td></td>
<td>1500</td>
<td>9.9</td>
<td></td>
</tr>
</tbody>
</table>

Exponential Form (centipoises)

*Denotes experimental values. Other values given are calculated or estimated.
Mixture | Component | Mol % | Wt. % | Avg. M.W. | Liquidus Temp.
--- | --- | --- | --- | --- | ---
93 | LiF | 50 | 12.66 | 102.4 | 550°C (1022°F)
| ZrF₄ | 46 | 75.08 | |
| UF₄ | 4 | 12.26 | |

**Density**

**Solid at Room Temperature (gm/cc)**
4.12

**Liquid (ρ = gm/cc, T = °C)**
ρ = 3.92 - 0.00092T

**Liquid (ρ = lbs/ft³, T = °F)**
ρ = 245.7 - 0.0319T

**Mean Volumetric Coefficient of Liquid Expansion (1/°C x 10⁴)**
2.81

**Enthalpy, Heat Capacity and Heat of Fusion**

**Solid**

- Enthalpy (cal/gm) = Hₜ₋₀°C
- Heat Capacity (cal/gm °C) = cᵥ
- Heat Capacity at 300°C (572°F) = cᵥ = 0.20

**Liquid**

- Enthalpy (cal/gm) = Hₜ₋₀°C
- Heat Capacity (cal/gm °C) = cᵥ
- Heat Capacity at 700°C (1292°F) = cᵥ = 0.28

**Heat of Fusion (cal/gm)** = Hₐ₋₀

**Thermal Conductivity**

K (BTU/hr ft °F)

**Viscosity**

°C | (Centipoises) | (Centistokes) | °F | (lb./ft-hr) | ft²/hr
--- | --- | --- | --- | --- | ---

Exponential Form (centipoises)

*Denotes experimental values. Other values given are calculated or estimated.*
Mixture  Component  Mol %  Wt. %  Avg. M.W.  Liquidus Temp.
94  KF  50  24.51  118.5
ZrF₄  46  64.89
UF₄  4  10.60

DENSITY
SOLID AT ROOM TEMPERATURE (gm/cc)  3.83
LIQUID (ρ = gm/cc, T = °C)  ρ = 3.61 - 0.00087T
LIQUID (ρ = lbs/ft³, T = °F)  ρ = 226.3 - 0.0302T

MEAN VOLUMETRIC COEFFICIENT OF LIQUID EXPANSION (1/°C x 10⁴)  2.90

ENTHALPY, HEAT CAPACITY AND HEAT OF FUSION

SOLID
Enthalpy (cal/gm)  Hₜ-H₀°C *=
Heat Capacity (cal/gm °C)  cₚ *=
Heat Capacity at 300°C (572°F)  cₚ = 0.17

LIQUID
Enthalpy (cal/gm)  Hₜ-H₀°C *
Heat Capacity (cal/gm °C)  cₚ *
Heat Capacity at 700°C (1292°F)  cₚ = 0.24

HEAT OF FUSION (cal/gm)  Hₜ-H₀°C *

THERMAL CONDUCTIVITY
K (BTU/hr ft °F)

VISCOOSITY

°C  (Centipoises)  (Centistokes)  °F  (lb./ft-hr)  ft²/hr

Exponential Form (centipoises)

*Denotes experimental values. Other values given are calculated or estimated.
Mixture Component Mol % Wt. % Avg. M.W. Liquidus Temp.
95 RbF 50 36.87 141.7 500°C (932°F)
ZrF₄ 46 54.27
UF₄ 4 8.86

**Density**

SOLID AT ROOM TEMPERATURE (gm/cc) 4.18
LIQUID (ρ = gm/cc, T = °C) ρ = 4.00 - 0.00093T
LIQUID (ρ = lbs/ft³, T = °F) ρ = 250.7 - 0.0322T
MEAN VOLUMETRIC COEFFICIENT OF LIQUID EXPANSION (1/°C x 10⁴) 2.78

**Enthalpy, Heat Capacity and Heat of Fusion**

SOLID

Enthalpy (cal/gm) Hₜ-H₀°C *
Heat Capacity (cal/gm °C) cₚ *
Heat Capacity at 300°C (572°F) cₚ = 0.14

LIQUID

Enthalpy (cal/gm) Hₜ-H₀°C *
Heat Capacity (cal/gm °C) cₚ *
Heat Capacity at 700°C (1292°F) cₚ = 0.20

HEAT OF FUSION (cal/gm) Hₗ-Hₛ *

**Thermal Conductivity**

K (BTU/hr ft °F)

**Viscosity**

<table>
<thead>
<tr>
<th>°C</th>
<th>(Centipoises)</th>
<th>(Centistokes)</th>
<th>°F</th>
<th>(lb./ft-hr)</th>
<th>ft²/hr</th>
</tr>
</thead>
<tbody>
<tr>
<td>600</td>
<td>7.05* (Ref. 38)</td>
<td>2.06</td>
<td>1100</td>
<td>17.9*</td>
<td>0.0837</td>
</tr>
<tr>
<td>700</td>
<td>4.35*</td>
<td>1.31</td>
<td>1300</td>
<td>10.4*</td>
<td>0.0501</td>
</tr>
<tr>
<td>800</td>
<td>2.95*</td>
<td>0.91</td>
<td>1500</td>
<td>6.8*</td>
<td>0.0338</td>
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</tbody>
</table>

Exponential Form (centipoises) \( \mu = 0.0657e^{4081/T°K} \)

*Denotes experimental values. Other values given are calculated or estimated.
<table>
<thead>
<tr>
<th>Mixture</th>
<th>Component</th>
<th>Mol %</th>
<th>Wt. %</th>
<th>Avg. M.W.</th>
<th>Liquidus Temp.</th>
</tr>
</thead>
<tbody>
<tr>
<td>96</td>
<td>NaF</td>
<td>53</td>
<td>56.66</td>
<td>39.3</td>
<td>535°C (995°F)</td>
</tr>
<tr>
<td></td>
<td>LiF</td>
<td>24</td>
<td>15.83</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>BeF₂</td>
<td>23</td>
<td>27.51</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**DENSITY**

SOLID AT ROOM TEMPERATURE (gm/cc) 2.43

LIQUID ($\rho = \text{gm/cc, } T = ^\circ\text{C}$)

$\rho = 2.34 - 0.00039T$

LIQUID ($\rho = \text{lbs/ft}^3, T = ^\circ\text{F}$)

$\rho = 146.5 - 0.0135T$

MEAN VOLUMETRIC COEFFICIENT OF LIQUID EXPANSION ($1/\text{°C} \times 10^4$) 1.88

**ENTHALPY, HEAT CAPACITY AND HEAT OF FUSION**

SOLID

Enthalpy (cal/gm) $H_{T-H_0°C}$

Heat Capacity (cal/gm °C) $c_p^*$

Heat Capacity at 300°C (572°F) $c_p = 0.38$

LIQUID

Enthalpy (cal/gm) $H_{T-H_0°C}$

Heat Capacity (cal/gm °C) $c_p^*$

Heat Capacity at 700°C (1292°F) $c_p = 0.54$

HEAT OF FUSION (cal/gm) $H_{L-H_S}$

**THERMAL CONDUCTIVITY**

$K$ (BTU/hr ft °F)

**VISCOITY**

<table>
<thead>
<tr>
<th>°C</th>
<th>(Centipoises)</th>
<th>(Centistokes)</th>
<th>°F</th>
<th>(lb./ft-hr)</th>
<th>ft²/hr</th>
</tr>
</thead>
<tbody>
<tr>
<td>600</td>
<td>5.9* (Ref. 40)</td>
<td>2.80</td>
<td>1100</td>
<td>14.8*</td>
<td>0.1121</td>
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<tr>
<td>700</td>
<td>4.1*</td>
<td>1.98</td>
<td>1300</td>
<td>9.7*</td>
<td>0.0749</td>
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<td>800</td>
<td>3.0*</td>
<td>1.47</td>
<td>1500</td>
<td>6.9*</td>
<td>0.0543</td>
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Exponential Form (centipoises) $\mu = 0.157e^{3168/T^{°K}}$

*Denotes experimental values. Other values given are calculated or estimated.
<table>
<thead>
<tr>
<th>Mixture</th>
<th>Component</th>
<th>Mol %</th>
<th>Wt. %</th>
<th>Avg. M.W.</th>
<th>Liquidus Temp.</th>
</tr>
</thead>
<tbody>
<tr>
<td>97</td>
<td>NaF</td>
<td>49</td>
<td>55.70</td>
<td>37.0</td>
<td>597°C (1107°F)</td>
</tr>
<tr>
<td></td>
<td>LiF</td>
<td>36</td>
<td>25.22</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>BeF₂</td>
<td>15</td>
<td>19.08</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**DENSITY**

SOLID AT ROOM TEMPERATURE (gm/cc) 2.47

LIQUID (\( p = \text{gm/cc}, T = 0°C \)) \( p = 2.37 - 0.00039T \)

LIQUID (\( p = \text{lbs/ft}^3, T = 0°F \)) \( p = 148.4 - 0.0135T \)

MEAN VOLUMETRIC COEFFICIENT OF LIQUID EXPANSION (\(1/°C \times 10^4\)) 1.87

**ENTHALPY, HEAT CAPACITY AND HEAT OF FUSION**

**SOLID**

Enthalpy (cal/gm) \( \Delta H_{T-H_0}^o \)

Heat Capacity (cal/gm °C) \( c_p^* = \)

Heat Capacity at 300°C (572°F) \( c_p = 0.39 \)

**LIQUID**

Enthalpy (cal/gm) \( \Delta H_{T-H_0}^o \)

Heat Capacity (cal/gm °C) \( c_p^* = \)

Heat Capacity at 700°C (1292°F) \( c_p = 0.55 \)

**HEAT OF FUSION (cal/gm)** \( \Delta H_{L-H_S}^o \)

**THERMAL CONDUCTIVITY**

K (BTU/hr ft °F)

**VISCOSETY**

<table>
<thead>
<tr>
<th>°C</th>
<th>(Centipoises)</th>
<th>(Centistokes)</th>
<th>°F</th>
<th>(lb./ft-hr)</th>
<th>ft²/hr</th>
</tr>
</thead>
<tbody>
<tr>
<td>600</td>
<td>5.65* (Ref. 41)</td>
<td>2.65</td>
<td>1100</td>
<td>14.0*</td>
<td>0.1053</td>
</tr>
<tr>
<td>700</td>
<td>3.95*</td>
<td>1.89</td>
<td>1300</td>
<td>9.4*</td>
<td>0.0720</td>
</tr>
<tr>
<td>800</td>
<td>2.95*</td>
<td>1.44</td>
<td>1500</td>
<td>6.9*</td>
<td>0.0540</td>
</tr>
</tbody>
</table>

Exponential Form (centipoises) \( \mu = 0.173e^{3043/T^0K} \)

*Denotes experimental values. Other values given are calculated or estimated.
Mixture Component Mol % Wt. % Avg. M.W. Liquidus Temp.
98 NaF 56 49.23 47.8 505°C (941°F)
LiF 21 11.39
BeF₂ 20 19.67
UF₄ 3 19.72

DENSITY

SOLID AT ROOM TEMPERATURE (gm/cc) 2.82
LIQUID (ρ = gm/cc, T = °C) ρ = 2.72 - 0.00048T
LIQUID (ρ = lbs/ft³, T = °F) ρ = 170.3 - 0.0166T
MEAN VOLUMETRIC COEFFICIENT OF LIQUID EXPANSION (1/°C x 10⁴) 2.03

ENTHALPY, HEAT CAPACITY AND HEAT OF FUSION

SOLID
Enthalpy (cal/gm) Hₜ-H₀°C* =
Heat Capacity (cal/gm °C) cₚ* =
Heat Capacity at 300°C (572°F) cₚ = 0.32

LIQUID
Enthalpy (cal/gm) Hₜ-H₀°C* =
Heat Capacity (cal/gm °C) cₚ* =
Heat Capacity at 700°C (1292°F) cₚ = 0.45

HEAT OF FUSION (cal/gm) Hₐ-H₇* =

THERMAL CONDUCTIVITY

K (BTU/hr ft °F)

VISCOSITY

°C (Centipoises) (Centistokes) °F (lb./ft-hr) ft²/hr
600 7.3* (Ref. 41) 3.0 1100 18.4* 0.1215
700 4.6* 1.94 1300 10.9* 0.0737
800 3.1* 1.34 1500 7.1* 0.0492

Exponential Form (centipoises) µ = 0.0737e⁴012/TOK

*Denotes experimental values. Other values given are calculated or estimated.
### Mixture Component Table

<table>
<thead>
<tr>
<th>Mixture</th>
<th>Component</th>
<th>Mol %</th>
<th>Wt. %</th>
<th>Avg. M.W.</th>
<th>Liquidus Temp.</th>
</tr>
</thead>
<tbody>
<tr>
<td>99</td>
<td>NaNF</td>
<td>63.5</td>
<td>23.22</td>
<td>114.9</td>
<td>607°C (1125°F)</td>
</tr>
<tr>
<td></td>
<td>ZrF₄</td>
<td>18.0</td>
<td>26.20</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>UF₄</td>
<td>18.5</td>
<td>50.58</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### DENSITY

- **SOLID AT ROOM TEMPERATURE (gm/cc)**
  - 4.59
- **LIQUID (\( \rho = \text{gm/cc}, T = ^\circ \text{C} \))**
  - \( \rho = 4.46 - 0.0010T \)
- **LIQUID (\( \rho = \text{lvs/ft}^3, T = ^\circ \text{F} \))**
  - \( \rho = 279.5 - 0.0347T \)
- **MEAN VOLUMETRIC COEFFICIENT OF LIQUID EXPANSION (1/°C x 10⁴)**
  - 2.66

### ENTHALPY, HEAT CAPACITY AND HEAT OF FUSION

#### SOLID
- **Enthalpy (cal/gm)**
  - \( H_{T} - H_{0} \)
- **Heat Capacity (cal/gm °C)**
  - \( c_p \)
- **Heat Capacity at 300°C (572°F)**
  - \( c_p = 0.16 \)

#### LIQUID
- **Enthalpy (cal/gm)**
  - \( H_{T} - H_{0} \)
- **Heat Capacity (cal/gm °C)**
  - \( c_p \)
- **Heat Capacity at 700°C (1292°F)**
  - \( c_p = 0.22 \)

#### HEAT OF FUSION (cal/gm)
- **\( H_{L} - H_{S} \)**

### THERMAL CONDUCTIVITY
- **K (BTU/hr ft °F)**

### VISCOITY

<table>
<thead>
<tr>
<th>°C</th>
<th>(Centipoises)</th>
<th>(Centistokes)</th>
<th>°F</th>
<th>(lb./ft-hr)</th>
<th>ft²/hr</th>
</tr>
</thead>
</table>

**Exponential Form (centipoises)**

*Denotes experimental values. Other values given are calculated or estimated.*
<table>
<thead>
<tr>
<th>Mixture</th>
<th>Component</th>
<th>Mol %</th>
<th>Wt. %</th>
<th>Avg. M.W.</th>
<th>Liquidus Temp.</th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
<td>LiF</td>
<td>60</td>
<td>48.08</td>
<td>32.3</td>
<td>652°C (1206°F)</td>
</tr>
<tr>
<td></td>
<td>NaF</td>
<td>40</td>
<td>51.92</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Density**

**SOLID AT ROOM TEMPERATURE (gm/cc)**

ρ = 2.53

**LIQUID (ρ = gm/cc, T = °C)**

ρ* = 2.42 - 0.00055T (Ref. 16)

**LIQUID (ρ = lbs/ft³, T = °F)**

ρ* = 151.7 - 0.0191T

**MEAN VOLUMETRIC COEFFICIENT OF LIQUID EXPANSION (1/°C x 10⁴)** 2.71

**Enthalpy, Heat Capacity and Heat of Fusion**

**SOLID (112°C-572°C)**

- **Enthalpy (cal/gm)**
  \[ H_{T-H_0} = -0.1 + 0.3191T + 9.94 \times 10^{-5}T^2 \]

- **Heat Capacity (cal/gm °C)**
  \[ c_p^* = 0.3191 + 19.87 \times 10^{-5}T \] (Ref. 42)

- **Heat Capacity at 300°C (572°F)**
  \[ c_p^* = 0.379 \]

**LIQUID (688°C-898°C)**

- **Enthalpy (cal/gm)**
  \[ H_{T-H_0} = -78.5 + 0.9249T - 24.62 \times 10^{-5}T^2 \]

- **Heat Capacity (cal/gm °C)**
  \[ c_p^* = 0.9249 - 49.23 \times 10^{-5}T \]

- **Heat Capacity at 700°C (1292°F)**
  \[ c_p^* = 0.580 \]

**Heat of Fusion (cal/gm)**

\[ H_{L-H_S} = 170 \]

**Thermal Conductivity**

**Viscosity**

<table>
<thead>
<tr>
<th>°C</th>
<th>(Centipoises)</th>
<th>(Centistokes)</th>
<th>°F</th>
<th>(lb./ft-hr)</th>
<th>ft²/hr</th>
</tr>
</thead>
<tbody>
<tr>
<td>700</td>
<td>3.2* (Ref. 25)</td>
<td>1.58</td>
<td>1300</td>
<td>7.6*</td>
<td>0.0597</td>
</tr>
<tr>
<td>800</td>
<td>2.35*</td>
<td>1.19</td>
<td>1500</td>
<td>5.4*</td>
<td>0.0439</td>
</tr>
</tbody>
</table>

Exponential Form (centipoises)

\[ \mu = 0.116e^{3225/TK} \]

*Denotes experimental values. Other values given are calculated or estimated.*
Mixture | Component | Mol % | Wt. % | Avg. M.W. | Liquidus Temp.
--- | --- | --- | --- | --- | ---
101 | LiF | 57.6 | 34.24 | 43.6 | 645°C (1193°F)
   | NaF | 38.4 | 36.97 |   |   
   | UF₄ | 4.0 | 28.79 |   |   

**DENSITY**

SOLID AT ROOM TEMPERATURE (gm/cc) 3.08

LIQUID (\(\rho = \text{gm/cc}, T = ^\circ\text{C}\)) \(\rho = 2.95 - 0.00077T\)

LIQUID (\(\rho = \text{lbs/ft}^3, T = ^\circ\text{F}\)) \(\rho = 185.0 - 0.0267T\)

MEAN VOLUMETRIC COEFFICIENT OF LIQUID EXPANSION (1/°C \times 10^4) 3.21

**ENTHALPY, HEAT CAPACITY AND HEAT OF FUSION**

SOLID (97°-594°C)

Enthalpy (cal/gm) \[ H_{T-H_2O}^{c} = 0 + 0.227T + 17 \times 10^{-5}T^2 \]

Heat Capacity (cal/gm °C) \[ c_p^* = 0.227 + 33 \times 10^{-5}T \] (Ref. 4)

Heat Capacity at 300°C (572°F) \[ c_p^* = 0.326 \]

LIQUID (655°-916°C)

Enthalpy (cal/gm) \[ H_{T-H_2O}^{c} = -68.9 + 0.531T \]

Heat Capacity (cal/gm °C) \[ c_p^* = 0.53 \]

Heat Capacity at 700°C (1292°F) \[ c_p^* = 0.53 \]

HEAT OF FUSION (cal/gm) \[ H_{L-H_S}^* = 56 \]

**THERMAL CONDUCTIVITY**

\(K \text{ (BTU/hr ft °F)}\)

**VISCOSITY**

\(\text{°C} \quad \text{(Centipoises)} \quad \text{(Centistokes)} \quad \text{°F} \quad \text{(lb./ft-hr)} \quad \text{ft}^2/\text{hr}\)

| 700 | 3.5 | 1300 | 8.4 |
| 800 | 2.6 | 1500 | 6.0 |

Exponential Form (centipoises)

*Denotes experimental values. Other values given are calculated or estimated.*
<table>
<thead>
<tr>
<th>Mixture</th>
<th>Component</th>
<th>Mol %</th>
<th>Wt. %</th>
<th>Avg. M.W.</th>
<th>Liquidus Temp.</th>
</tr>
</thead>
<tbody>
<tr>
<td>102</td>
<td>LiF</td>
<td>50</td>
<td>30.85</td>
<td>42.1</td>
<td>492°C (918°F)</td>
</tr>
<tr>
<td></td>
<td>KF</td>
<td>50</td>
<td>69.15</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### DENSITY

**SOLID AT ROOM TEMPERATURE (gm/cc)**

$2.43$

**LIQUID ($\rho = \text{gm/cc}, T = ^\circ\text{C}$)**

$\rho = 2.46 - 0.00068T$

**LIQUID ($\rho = \text{lbs/ft}^3, T = ^\circ\text{F}$)**

$\rho = 154.3 - 0.0236T$

**MEAN VOLUMETRIC COEFFICIENT OF LIQUID EXPANSION ($1/\text{°C} \times 10^4$)**

$3.40$

### ENTHALPY, HEAT CAPACITY AND HEAT OF FUSION

**SOLID (107°C - 466°C)**

- **Enthalpy (cal/gm)**
  \[ H_{T \to 0}^C = -2.3 + 0.2817T + 3.82 \times 10^{-5}T^2 \]

- **Heat Capacity (cal/gm °C)**
  \[ c_p^* = 0.2817 + 7.64 \times 10^{-5}T \text{ (Ref. 4)} \]

- **Heat Capacity at 300°C (572°F)**
  \[ c_p^* = 0.305 \]

**LIQUID (532°C - 893°C)**

- **Enthalpy (cal/gm)**
  \[ H_{T \to 0}^C = -23.8 + 0.5839T - 10.28 \times 10^{-5}T^2 \]

- **Heat Capacity (cal/gm °C)**
  \[ c_p^* = 0.5839 - 20.56 \times 10^{-5}T \]

- **Heat Capacity at 700°C (1292°F)**
  \[ c_p^* = 0.440 \]

**HEAT OF FUSION (cal/gm)**

\[ H_{L \to S}^* = 93 \]

### THERMAL CONDUCTIVITY

**K (BTU/hr ft °F)**

VISCOSITY

<table>
<thead>
<tr>
<th>°C</th>
<th>(Centipoises)</th>
<th>(Centistokes)</th>
<th>°F</th>
<th>(lb./ft-hr)</th>
<th>ft²/hr</th>
</tr>
</thead>
<tbody>
<tr>
<td>600</td>
<td>4.75</td>
<td></td>
<td>1100</td>
<td>12.1</td>
<td></td>
</tr>
<tr>
<td>700</td>
<td>2.9</td>
<td></td>
<td>1300</td>
<td>6.9</td>
<td></td>
</tr>
<tr>
<td>800</td>
<td>1.95</td>
<td></td>
<td>1500</td>
<td>4.4</td>
<td></td>
</tr>
</tbody>
</table>

- Exponential Form (centipoises)

\[ \text{Exponential Form (centipoises)} \]

*Denotes experimental values. Other values given are calculated or estimated.*
<table>
<thead>
<tr>
<th>Mixture</th>
<th>Component</th>
<th>Mol %</th>
<th>Wt. %</th>
<th>Avg. M.W.</th>
<th>Liquidus Temp.</th>
</tr>
</thead>
<tbody>
<tr>
<td>103</td>
<td>LiF</td>
<td>48</td>
<td>23.55</td>
<td>52.9</td>
<td>560°C (1040°F)</td>
</tr>
<tr>
<td></td>
<td>KF</td>
<td>48</td>
<td>52.70</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>UF₄</td>
<td>4</td>
<td>23.75</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Density**

SOLID AT ROOM TEMPERATURE (gm/cc) 2.85
LIQUID ($\rho = \text{gm/cc}, T = ^\circ\text{C}$) $\rho = 2.75 - 0.00073T$
LIQUID ($\rho = \text{lbs/ft}^3, T = ^\circ\text{F}$) $\rho = 172.5 - 0.0253T$
MEAN VOLUMETRIC COEFFICIENT OF LIQUID EXPANSION ($1/^\circ\text{C} \times 10^4$) 3.24

**Enthalpy, Heat Capacity and Heat of Fusion**

SOLID ($127^\circ\text{C} - 465^\circ\text{C}$)

- Enthalpy (cal/gm) $H_T - H_{0^\circ\text{C}} = 0.1 + 0.234T + 4.9 \times 10^{-5}T^2$
- Heat Capacity (cal/gm °C) $c_p^* = 0.234 + 9.7 \times 10^{-5}T$ (Ref. 4)
- Heat Capacity at 300°C (572°F) $c_p^* = 0.263$

LIQUID ($563^\circ\text{C} - 882^\circ\text{C}$)

- Enthalpy (cal/gm) $H_L - H_{0^\circ\text{C}} = -82.4 + 0.657T - 19.7 \times 10^{-5}T^2$
- Heat Capacity (cal/gm °C) $c_p^* = 0.657 - 39.3 \times 10^{-5}T$
- Heat Capacity at 700°C (1292°F) $c_p^* = 0.382$

HEAT OF FUSION (cal/gm) $H_L - H_S^* = 68$ at 500°C**

**Thermal Conductivity**

$K$ (BTU/hr ft °F) 1.4 (solid sphere and slab)(Ref. 45)

**Viscosity**

<table>
<thead>
<tr>
<th>°C</th>
<th>(Centipoises)</th>
<th>(Centistokes)</th>
<th>°F</th>
<th>(lb./ft-hr)</th>
<th>ft²/hr</th>
</tr>
</thead>
<tbody>
<tr>
<td>600</td>
<td>5.25</td>
<td></td>
<td></td>
<td>1100</td>
<td>13.2</td>
</tr>
<tr>
<td>700</td>
<td>3.2</td>
<td></td>
<td></td>
<td>1300</td>
<td>7.6</td>
</tr>
<tr>
<td>800</td>
<td>2.15</td>
<td></td>
<td></td>
<td>1500</td>
<td>5.0</td>
</tr>
</tbody>
</table>

Exponential Form (centipoises)

*Denotes experimental values. Other values given are calculated or estimated.
**The major break in the enthalpy-temperature curve was at 500°C.
<table>
<thead>
<tr>
<th>Mixture</th>
<th>Component</th>
<th>Mol %</th>
<th>Wt. %</th>
<th>Avg. M.W.</th>
<th>Liquidus Temp.</th>
</tr>
</thead>
<tbody>
<tr>
<td>104</td>
<td>LiF</td>
<td>43</td>
<td>15.77</td>
<td>70.7</td>
<td>475°C (887°F)</td>
</tr>
<tr>
<td></td>
<td>RbF</td>
<td>57</td>
<td>84.23</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Density**

**Solid at Room Temperature (gm/cc):** 3.27

**Liquid (ρ = gm/cc, T = °C):**

- \( \rho^* = 3.30 - 0.00096T \) (Ref. 22)

**Liquid (ρ = lbs/ft³, T = °F):**

- \( \rho^* = 207.1 - 0.0333T \)

**Mean Volumetric Coefficient of Liquid Expansion (1/°C x 10⁴):** 3.65

**Enthalpy, Heat Capacity and Heat of Fusion**

**Solid (134°C - 420°C):**

- **Enthalpy (cal/gm):** \( H_T - H_0°C^* = -1.1 + 0.1849T + 2.45 \times 10^{-5}T^2 \)
- **Heat Capacity (cal/gm °C):** \( c_p^* = 0.1849 + 4.9 \times 10^{-5}T \) (Ref. 37)
- **Heat Capacity at 300°C (572°F):** \( c_p^* = 0.200 \)

**Liquid (497°C - 878°C):**

- **Enthalpy (cal/gm):** \( H_T - H_0°C^* = -22.9 + 0.3969T - 8.1 \times 10^{-5}T^2 \)
- **Heat Capacity (cal/gm °C):** \( c_p^* = 0.3969 - 16.1 \times 10^{-5}T \)
- **Heat Capacity at 700°C (1292°F):** \( c_p^* = 0.284 \)

**Heat of Fusion (cal/gm):** \( H_L - H_S^* = 55 \)

**Thermal Conductivity:**

- K (BTU/hr ft °F) 1.2 (Liquid) (Ref. 43)

**Viscosity**

<table>
<thead>
<tr>
<th>°C</th>
<th>(Centipoises)</th>
<th>(Centistokes)</th>
<th>°F</th>
<th>(lb./ft-hr)</th>
<th>ft²/hr</th>
</tr>
</thead>
<tbody>
<tr>
<td>500</td>
<td>9.0* (Ref. 38)</td>
<td>3.19</td>
<td>1100</td>
<td>11.4*</td>
<td>0.0491</td>
</tr>
<tr>
<td>550</td>
<td>6.2*</td>
<td>2.24</td>
<td>1200</td>
<td>8.2*</td>
<td></td>
</tr>
<tr>
<td>600</td>
<td>4.5*</td>
<td>1.65</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>650</td>
<td>3.4*</td>
<td>1.27</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Exponential Form (centipoises): \( \mu = 0.0212e^{4678/T^0K} \)

**Prandtl Number:** 2.9 at 1100°F

*Denotes experimental values. Other values given are calculated or estimated.*
### Mixture Component

<table>
<thead>
<tr>
<th>Mixture</th>
<th>Component</th>
<th>Mol %</th>
<th>Wt. %</th>
<th>Avg. M.W.</th>
<th>Liquidus Temp.</th>
</tr>
</thead>
<tbody>
<tr>
<td>105</td>
<td>LiF</td>
<td>41.3</td>
<td>13.32</td>
<td>80.5</td>
<td>660°C (1220°F)</td>
</tr>
<tr>
<td></td>
<td>RbF</td>
<td>54.7</td>
<td>71.06</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>UF₄</td>
<td>4.0</td>
<td>15.62</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Density

- **Solid at Room Temperature** (gm/cc) 3.56
- **Liquid** ($\rho = gm/cc, T = ^\circ C$) $\rho = 3.36 - 0.00084T$
- **Liquid** ($\rho = lbs/ft^3, T = ^\circ F$) $\rho = 210.7 - 0.0291T$

Mean Volumetric Coefficient of Liquid Expansion ($1/\circ C \times 10^4$) 2.57

### Enthalpy, Heat Capacity and Heat of Fusion

#### Solid

- Enthalpy (cal/gm) $H_T - H_{T \cdot 0_C}^*$
- Heat Capacity (cal/gm °C) $c_p^*$
- Heat Capacity at 300°C (572°F) $c_p = 0.18$

#### Liquid

- Enthalpy (cal/gm) $H_T - H_{T \cdot 0_C}^*$
- Heat Capacity (cal/gm °C) $c_p^*$
- Heat Capacity at 700°C (1292°F) $c_p = 0.25$

### Heat of Fusion (cal/gm)

$H_L - H_S^*$

### Thermal Conductivity

$K$ (BTU/hr ft °F)

### Viscosity

<table>
<thead>
<tr>
<th>°C</th>
<th>(Centipoises)</th>
<th>(Centistokes)</th>
<th>°F</th>
<th>(lb./ft-hr)</th>
<th>ft²/hr</th>
</tr>
</thead>
</table>

Exponential Form (centipoises)

*Denotes experimental values. Other values given are calculated or estimated.*

<table>
<thead>
<tr>
<th></th>
<th>Component</th>
<th>Mol %</th>
<th>Wt. %</th>
<th>Avg. M.W.</th>
<th>Liquidus Temp.</th>
</tr>
</thead>
<tbody>
<tr>
<td>106</td>
<td>LiF</td>
<td>44.7</td>
<td>22.23</td>
<td>52.2</td>
<td>560°C (1040°F)</td>
</tr>
<tr>
<td></td>
<td>KF</td>
<td>40.3</td>
<td>8.85</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>NaF</td>
<td>11.0</td>
<td>44.86</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>UF₄</td>
<td>4.0</td>
<td>24.06</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Density**

SOLID AT ROOM TEMPERATURE (gm/cc) 2.90

LIQUID ($\rho = $ gm/cc, T = °C) $\rho = 2.80 - 0.00074T$

LIQUID ($\rho =$ lbs/ft³, T = °F) $\rho = 175.6 - 0.0257T$

MEAN VOLUMETRIC COEFFICIENT OF LIQUID EXPANSION ($1/°C \times 10^4$) 3.26

**Enthalpy, Heat Capacity and Heat of Fusion**

**SOLID**

Enthalpy (cal/gm) $H_T-H_{0°C}$

Heat Capacity (cal/gm °C) $c_p$

Heat Capacity at 300°C (572°F) $c_p = 0.27$

**LIQUID**

Enthalpy (cal/gm) $H_T-H_{0°C}$

Heat Capacity (cal/gm °C) $c_p$

Heat Capacity at 700°C (1292°F) $c_p = 0.38$

**Heat of Fusion (cal/gm)** $H_L-H_S$

**Thermal Conductivity**

**Viscosity**

<table>
<thead>
<tr>
<th>°C</th>
<th>(Centipoises)</th>
<th>(Centistokes)</th>
<th>°F</th>
<th>(lb./ft-hr)</th>
<th>ft²/hr</th>
</tr>
</thead>
<tbody>
<tr>
<td>600</td>
<td>5.35</td>
<td></td>
<td>1100</td>
<td>13.6</td>
<td></td>
</tr>
<tr>
<td>700</td>
<td>3.2</td>
<td></td>
<td>1300</td>
<td>7.6</td>
<td></td>
</tr>
<tr>
<td>800</td>
<td>2.15</td>
<td></td>
<td>1500</td>
<td>4.8</td>
<td></td>
</tr>
</tbody>
</table>

**Exponential Form (centipoises)**

*Denotes experimental values. Other values given are calculated or estimated.*
### Mixture Component Mol % Wt. % Avg. M.W. Liquidus Temp.

- **107**
  - NaF 11.2 9.77 48.1 490°C (914°F)
  - KF 41.0 49.52
  - LiF 45.3 24.39
  - UF₄ 2.5 16.32

### DENSITY

**SOLID AT ROOM TEMPERATURE (gm/cc)**

- 2.74

**LIQUID (\(\rho = \text{gm/cc}, T = ^\circ\text{C}\))**

- \(\rho = 2.67 - 0.00072T\)

**LIQUID (\(\rho = \text{lbs/ft}^3, T = ^\circ\text{F}\))**

- \(\rho = 167.5 - 0.0250T\)

**MEAN VOLUMETRIC COEFFICIENT OF LIQUID EXPANSION (1/°C x 10⁴)**

- 3.32

### ENTHALPY, HEAT CAPACITY AND HEAT OF FUSION

**SOLID**

- Enthalpy (cal/gm): \(H_{T-H_0}°C\)
- Heat Capacity (cal/gm °C): \(c_p°C\)
- Heat Capacity at 300°C (572°F): \(c_{p}°C\)

**LIQUID**

- Enthalpy (cal/gm): \(H_{T-H_0}°C\)
- Heat Capacity (cal/gm °C): \(c_p°C\)
- Heat Capacity at 700°C (1292°F): \(c_{p}°C\)

**HEAT OF FUSION (cal/gm)**

### THERMAL CONDUCTIVITY

**K (BTU/hr ft °F)**

### VISCOSITY

<table>
<thead>
<tr>
<th>°C</th>
<th>(Centipoises)</th>
<th>(Centistokes)</th>
<th>°F</th>
<th>(lb./ft-hr)</th>
<th>ft²/hr</th>
</tr>
</thead>
<tbody>
<tr>
<td>600</td>
<td>5.1* (Ref.12)</td>
<td>2.27</td>
<td>1100</td>
<td>12.8*</td>
<td>0.0909</td>
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<td>3.0*</td>
<td>1.38</td>
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<td>0.0523</td>
</tr>
</tbody>
</table>

Exponential Form (centipoises) \(\mu = 0.0292e^{4507/TOK}\)

*Denotes experimental values. Other values given are calculated or estimated.*
### Mixture Component Table

<table>
<thead>
<tr>
<th>Mixture</th>
<th>Component</th>
<th>Mol %</th>
<th>Wt. %</th>
<th>Avg. M.W.</th>
<th>Liquidus Temp.</th>
</tr>
</thead>
<tbody>
<tr>
<td>108</td>
<td>NaF</td>
<td>56.0</td>
<td>22.06</td>
<td>106.6</td>
<td>550°C (1022°F)</td>
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<tr>
<td></td>
<td>ZrF₄</td>
<td>37.5</td>
<td>58.80</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>UF₄</td>
<td>6.5</td>
<td>19.15</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Density

- **Solid at Room Temperature (gm/cc)**: 4.16
- **Liquid (ρ = gm/cc, T = °C)**: \( ρ = 3.97 - 0.00093T \)
- **Liquid (ρ = lbs/ft³, T = °F)**: \( ρ = 248.9 - 0.0322T \)
- **Mean Volumetric Coefficient of Liquid Expansion (1/°C x 10⁴)**: 2.80

### Enthalpy, Heat Capacity and Heat of Fusion

#### Solid

- **Enthalpy (cal/gm)**: \( H_{T-H_{0°C}} \)
- **Heat Capacity (cal/gm °C)**: \( c_p \)
- **Heat Capacity at 300°C (572°F)**: \( c_p = 0.18 \)

#### Liquid

- **Enthalpy (cal/gm)**: \( H_{T-H_{0°C}} \)
- **Heat Capacity (cal/gm °C)**: \( c_p \)
- **Heat Capacity at 700°C (1292°F)**: \( c_p = 0.25 \)

#### Heat of Fusion (cal/gm)

- **Heat of Fusion (cal/gm)**: \( H_{L-H_S} \)

### Thermal Conductivity

- **K (BTU/hr ft °F)**

### Viscosity

<table>
<thead>
<tr>
<th>°C</th>
<th>(Centipoises)</th>
<th>(Centistokes)</th>
<th>°F</th>
<th>(lb./ft-hr)</th>
<th>ft²/hr</th>
</tr>
</thead>
<tbody>
<tr>
<td>600</td>
<td>8.5</td>
<td>5.4</td>
<td>1100</td>
<td>21.3</td>
<td></td>
</tr>
<tr>
<td>700</td>
<td>5.4</td>
<td>3.7</td>
<td>1300</td>
<td>12.8</td>
<td></td>
</tr>
<tr>
<td>800</td>
<td>3.7</td>
<td></td>
<td>1500</td>
<td>8.5</td>
<td></td>
</tr>
</tbody>
</table>

**Exponential Form (centipoises)**

- Denotes experimental values. Other values given are calculated or estimated.
<table>
<thead>
<tr>
<th>Mixture</th>
<th>Component</th>
<th>Mol %</th>
<th>Wt. %</th>
<th>Avg. M.W.</th>
<th>Liquidus Temp.</th>
</tr>
</thead>
<tbody>
<tr>
<td>109</td>
<td>NaF</td>
<td>32</td>
<td>16.96</td>
<td>79.3</td>
<td>535°C (995°F)</td>
</tr>
<tr>
<td></td>
<td>RbF</td>
<td>31</td>
<td>40.88</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>BeF₂</td>
<td>31</td>
<td>18.38</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>UF₄</td>
<td>6</td>
<td>23.78</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Density**

- **Solid at Room Temperature** (gm/cc): 3.29
- **Liquid** \((\rho = \text{gm/cc}, T = °C)\):
  \[ \rho = 3.20 - 0.00064T \]
- **Liquid** \((\rho = \text{lbs/ft}^3, T = °F)\):
  \[ \rho = 200.5 - 0.0222T \]

**Mean Volumetric Coefficient of Liquid Expansion** \((1/°C \times 10^4)\): 2.33

**Enthalpy, Heat Capacity and Heat of Fusion**

**Solid**
- Enthalpy (cal/gm)
- Heat Capacity (cal/gm °C)
- Heat Capacity at 300°C (572°F)

**Liquid**
- Enthalpy (cal/gm)
- Heat Capacity (cal/gm °C)
- Heat Capacity at 700°C (1292°F)

**Heat of Fusion** (cal/gm)

**Thermal Conductivity**

**Viscosity**

<table>
<thead>
<tr>
<th>°C</th>
<th>(Centipoises)</th>
<th>(Centistokes)</th>
<th>°F</th>
<th>(lb./ft-hr)</th>
<th>ft²/hr</th>
</tr>
</thead>
</table>

Exponential Form (centipoises)

*Denotes experimental values. Other values given are calculated or estimated.*
<table>
<thead>
<tr>
<th>Mixture</th>
<th>Component</th>
<th>Mol %</th>
<th>Wt. %</th>
<th>Avg. M.W.</th>
<th>Liquidus Temp.</th>
</tr>
</thead>
<tbody>
<tr>
<td>110</td>
<td>NaF</td>
<td>61.7</td>
<td>37.2</td>
<td>69.6</td>
<td>775°C (1427°F)</td>
</tr>
<tr>
<td></td>
<td>KF</td>
<td>20.5</td>
<td>17.1</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>ZrF₄</td>
<td>16.4</td>
<td>39.4</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>UF₄</td>
<td>1.4</td>
<td>6.3</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Density**

Solid at room temperature (gm/cc) 3.27* (Ref. 22)

Liquid (ρ = gm/cc, T = °C) ρ = 3.15 - 0.00080T

Liquid (ρ = lbs/ft³, T = °F) ρ = 197.5 - 0.0277T

Mean volumetric coefficient of liquid expansion (1/°C x 10⁴) 3.19

**Enthalpy, Heat Capacity and Heat of Fusion**

**Solid**

Enthalpy (cal/gm) Hₜ-H₀°C* =

Heat Capacity (cal/gm °C) cₚ* =

Heat Capacity at 300°C (572°F) cₚ = 0.21

**Liquid**

Enthalpy (cal/gm) Hₜ-H₀°C* =

Heat Capacity (cal/gm °C) cₚ* =

Heat Capacity at 700°C (1292°F) cₚ =

**Heat of Fusion (cal/gm)** Hₐ-Hₜ* =

**Thermal Conductivity**

K (BTU/hr ft °F)

**Viscosity**

°C (Centipoises) (Centistokes) °F (lb./ft-hr) ft²/hr

Exponential Form (centipoises)

*Denotes experimental values. Other values given are calculated or estimated.
Mixture Component Mol % Wt. % Avg. M.W. Liquidus Temp.
111  LiF  71  27.86  66.02
     BeF₂  16  11.39
     ThF₄  12  56.00
     UF₄  1   4.76

DENSITY

SOLID AT ROOM TEMPERATURE (gm/cc)  3.71
LIQUID (ρ = gm/cc, T = °C)  ρ = 3.82 - 0.00062T
LIQUID (ρ = lbs/ft³, T = °F)  ρ = 239.4 - 0.0284T
MEAN VOLUMETRIC COEFFICIENT OF LIQUID EXPANSION (1/°C x 10⁴)  2.52

ENTHALPY, HEAT CAPACITY AND HEAT OF FUSION

SOLID
Enthalpy (cal/gm)  Hₜ-H₀°C* =
Heat Capacity (cal/gm °C)  cₚ* =
Heat Capacity at 300°C (572°F)  cₚ = 0.26

LIQUID
Enthalpy (cal/gm)  Hₜ-H₀°C* =
Heat Capacity (cal/gm °C)  cₚ* =
Heat Capacity at 700°C (1292°F)  cₚ = 0.37

HEAT OF FUSION (cal/gm)  Hₙ-Hₜ* =

THERMAL CONDUCTIVITY

K (BTU/hr ft °F)

VISCOITY

<table>
<thead>
<tr>
<th>°C</th>
<th>(Centipoises)</th>
<th>(Centistokes)</th>
<th>°F</th>
<th>(lb./ft-hr)</th>
<th>ft²/hr</th>
</tr>
</thead>
<tbody>
<tr>
<td>600</td>
<td>13.0* (Ref.22)</td>
<td>3.90</td>
<td>1100</td>
<td>33.9*</td>
<td>0.1628</td>
</tr>
<tr>
<td>700</td>
<td>7.1*</td>
<td>2.18</td>
<td>1300</td>
<td>16.9*</td>
<td>0.0835</td>
</tr>
<tr>
<td>800</td>
<td>4.8*</td>
<td>1.51</td>
<td>1500</td>
<td>11.0*</td>
<td>0.0559</td>
</tr>
</tbody>
</table>

Exponential Form (centipoises)  μ = 0.0620e

*Denotes experimental values. Other values given are calculated or estimated.
### Mixture Component Mol % Wt. % Avg. M.W. Liquidus Temp.

<table>
<thead>
<tr>
<th>Mixture</th>
<th>Component</th>
<th>Mol %</th>
<th>Wt. %</th>
<th>Avg. M.W.</th>
<th>Liquidus Temp.</th>
</tr>
</thead>
<tbody>
<tr>
<td>112</td>
<td>LiF</td>
<td>50</td>
<td>35.53</td>
<td>36.5</td>
<td>350°C (662°F)</td>
</tr>
<tr>
<td></td>
<td>BeF₂</td>
<td>50</td>
<td>64.47</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Density

- **Solid at room temperature (gm/cc)**: 2.08
- **Liquid (ρ = gm/cc, T = °C)**: \( \rho^* = 2.22 - 0.00040T \) (Ref. 3)
- **Liquid (ρ = lbs/ft³, T = °F)**: \( \rho^* = 139.0 - 0.0139T \)

**Mean volumetric coefficient of liquid expansion \((1/°C \times 10^4)\)**: 2.06

### Enthalpy, Heat Capacity and Heat of Fusion

#### Solid
- **Enthalpy (cal/gm)**
- **Heat capacity (cal/gm °C)**
- **Heat capacity at 300°C (572°F)**: \( c_p = 0.46 \)

#### Liquid
- **Enthalpy (cal/gm)**
- **Heat capacity (cal/gm °C)**
- **Heat capacity at 700°C (1292°F)**: \( c_p = 0.65 \)

#### Heat of Fusion (cal/gm)

**Thermal Conductivity**

### Viscosity

<table>
<thead>
<tr>
<th>°C</th>
<th>Centipoises</th>
<th>Centistokes</th>
<th>°F</th>
<th>(lb./ft-hr)</th>
<th>ft²/hr</th>
</tr>
</thead>
<tbody>
<tr>
<td>600</td>
<td>22.2* (Ref. 3)</td>
<td>11.2</td>
<td>1100</td>
<td>56.9*</td>
<td>0.4874</td>
</tr>
<tr>
<td>700</td>
<td>10.7*</td>
<td>5.52</td>
<td>1300</td>
<td>25.2*</td>
<td>0.2200</td>
</tr>
<tr>
<td>800</td>
<td>5.95*</td>
<td>3.12</td>
<td>1500</td>
<td>13.3*</td>
<td>0.1184</td>
</tr>
</tbody>
</table>

Exponential form (centipoises): \( \mu = 0.0189e^{6174/T^°K} \)

*Denotes experimental values. Other values given are calculated or estimated.*
Mixture Component Mol % Wt. % Avg. M.W. Liquid Temp.
113 NaF 50 47.19 44.5 380°C (716°F)
BeF₂ 50 52.81

DENSITY
SOLID AT ROOM TEMPERATURE (gm/cc) 2.45* (Ref. 10)
LIQUID (ρ = gm/cc, T = °C) ρ = 2.25 - 0.00040T
LIQUID (ρ = lbs/ft³, T = °F) ρ = 140.9 - 0.0139T
MEAN VOLUMETRIC COEFFICIENT OF LIQUID EXPANSION (1/°C x 10⁴) 2.02

ENTHALPY, HEAT CAPACITY AND HEAT OF FUSION

SOLID
Enthalpy (cal/gm) \( H_{T-H₀°C} = \)
Heat Capacity (cal/gm °C) \( c_p = \)
Heat Capacity at 300°C (572°F) \( c_p = 0.38 \)

LIQUID
Enthalpy (cal/gm) \( H_{L-H₀°C} = \)
Heat Capacity (cal/gm °C) \( c_p = \)
Heat Capacity at 700°C (1292°F) \( c_p = 0.53 \)

HEAT OF FUSION (cal/gm) \( H_{L-H_S} = \)

THERMAL CONDUCTIVITY
K (BTU/hr ft °F)

VISCOSITY

<table>
<thead>
<tr>
<th>°C</th>
<th>(Centipoises)</th>
<th>(Centistokes)</th>
<th>°F</th>
<th>(lb./ft·hr)</th>
<th>ft²/hr</th>
</tr>
</thead>
<tbody>
<tr>
<td>600</td>
<td>15.3* (Ref. 44)</td>
<td>7.61</td>
<td>1100</td>
<td>38.7*</td>
<td>0.3084</td>
</tr>
<tr>
<td>700</td>
<td>8.4*</td>
<td>4.26</td>
<td>1300</td>
<td>20.1*</td>
<td>0.1634</td>
</tr>
<tr>
<td>800</td>
<td>5.25*</td>
<td>2.72</td>
<td>1500</td>
<td>11.9*</td>
<td>0.0988</td>
</tr>
</tbody>
</table>

Exponential Form (centipoises) \( \mu = 0.0493e^{5009/T_K} \)

*Denotes experimental values. Other values given are calculated or estimated.
Mixture Component Mol % Wt. % Avg. M.W. Liquidus Temp.
114 KF 50 55.28 52.6 445°C (833°F)
BeF₂ 50 44.72

DENSITY
SOLID AT ROOM TEMPERATURE (gm/cc) 2.23
LIQUID (\( \rho = \text{gm/cc}, T = ^0\text{C} \)) \( \rho = 2.18 - 0.00035T \)
LIQUID (\( \rho = \text{lbs/ft}^3, T = ^0\text{F} \)) \( \rho = 136.5 - 0.0121T \)
MEAN VOLUMETRIC COEFFICIENT OF LIQUID EXPANSION \( (1/^	ext{°C} \times 10^4) \) 1.81

ENTHALPY, HEAT CAPACITY AND HEAT OF FUSION

SOLID
- Enthalpy (cal/gm) \( H_T - H_0°C^* \)
- Heat Capacity (cal/gm °C) \( c_p^* \)
- Heat Capacity at 300°C (572°F) \( c_p = 0.32 \)

LIQUID
- Enthalpy (cal/gm) \( H_T - H_0°C^* \)
- Heat Capacity (cal/gm °C) \( c_p^* \)
- Heat Capacity at 700°C (1292°F) \( c_p = 0.45 \)

HEAT OF FUSION (cal/gm) \( H_L - H_S^* \)

THERMAL CONDUCTIVITY

K (BTU/hr ft °F)

Viscosity

\( ^0\text{C} \) (Centipoises) (Centistokes) \( ^0\text{F} \) (lb./ft-hr) ft²/hr
600 15.3* (Ref.44) 7.77 1100 39.2* 0.3187
700 6.7* 3.45 1300 15.7* 0.1300
800 3.45 1.82 1500 7.6* 0.0641

Exponential Form (centipoises) \( \mu = 0.00517e^{6976/T^0K} \)

*Denotes experimental values. Other values given are calculated or estimated.
<table>
<thead>
<tr>
<th>Mixture</th>
<th>Component</th>
<th>Mol %</th>
<th>Wt. %</th>
<th>Avg. M.W.</th>
<th>Liquidus Temp.</th>
</tr>
</thead>
<tbody>
<tr>
<td>115</td>
<td>RbF</td>
<td>50</td>
<td>68.98</td>
<td>75.8</td>
<td>400°C(752°F)</td>
</tr>
<tr>
<td></td>
<td>BeF₂</td>
<td>50</td>
<td>31.02</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**DENSITY**

- **SOLID AT ROOM TEMPERATURE (gm/cc)**: 2.85
- **LIQUID** ($\rho = \text{gm/cc, } T = \text{oC}$): $\rho = 2.75 - 0.00050T$
- **LIQUID** ($\rho = \text{lbs/ft}^3, T = \text{oF}$): $\rho = 172.2 - 0.0173T$

**MEAN VOLUMETRIC COEFFICIENT OF LIQUID EXPANSION ($1/\text{oC} \times 10^4$)**: 2.08

**ENTHALPY, HEAT CAPACITY AND HEAT OF FUSION**

**SOLID**

- Enthalpy (cal/gm)
- Heat Capacity (cal/gm °C)
  - $c_p^* = \ldots$
- Heat Capacity at 300°C (572°F)
  - $c_p = 0.22$

**LIQUID**

- Enthalpy (cal/gm)
- Heat Capacity (cal/gm °C)
  - $c_p^* = \ldots$
- Heat Capacity at 700°C (1292°F)
  - $c_p = 0.31$

**HEAT OF FUSION (cal/gm)**

$H_L - H_S^* = \ldots$

**THERMAL CONDUCTIVITY**

$K (\text{BTU/hr ft °F})$

<table>
<thead>
<tr>
<th>°F</th>
<th>(Centipoises)</th>
<th>(Centistokes)</th>
<th>°F</th>
<th>(lb./ft·hr)</th>
<th>ft²/hr</th>
</tr>
</thead>
<tbody>
<tr>
<td>1100</td>
<td>30.3*</td>
<td>0.1977</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1300</td>
<td>12.3</td>
<td>0.0821</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1500</td>
<td>6.1*</td>
<td>0.0417</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Exponential Form (centipoises)**

$\mu = 0.00534e^{\frac{6701}{TOK}}$

*Denotes experimental values. Other values given are calculated or estimated.
**Table: Mixture Component**

<table>
<thead>
<tr>
<th>Mixture</th>
<th>Component</th>
<th>Mol %</th>
<th>Wt. %</th>
<th>Avg. M.W.</th>
<th>Liquidus Temp.</th>
</tr>
</thead>
<tbody>
<tr>
<td>116</td>
<td>KF</td>
<td>79</td>
<td>82.30</td>
<td>55.8</td>
<td>730°C (1346°F)</td>
</tr>
<tr>
<td></td>
<td>BeF₂</td>
<td>21</td>
<td>17.70</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Density**

- **Solid at Room Temperature (gm/cc)**: 2.38
- **Liquid (ρ = gm/cc, T = °C)**: \( ρ = 2.32 - 0.00040T \)
- **Liquid (ρ = lbs/ft³, T = °F)**: \( ρ = 145.3 - 0.0139T \)
- **Mean Volumetric Coefficient of Liquid Expansion (1/°C x 10⁴)**: 1.97

**Enthalpy, Heat Capacity and Heat of Fusion**

**Solid**

- **Enthalpy (cal/gm)**: \( H_{T-H_0}^* \)
- **Heat Capacity (cal/gm °C)**: \( c_p^* \)
- **Heat Capacity at 300°C (572°F)**: \( c_p = 0.27 \)

**Liquid**

- **Enthalpy (cal/gm)**: \( H_{T-H_0}^* \)
- **Heat Capacity (cal/gm °C)**: \( c_p^* \)
- **Heat Capacity at 700°C (1292°F)**: \( c_p \)

**Heat of Fusion (cal/gm)**: \( H_{L-H_S}^* \)

**Thermal Conductivity**

**Viscosity**

<table>
<thead>
<tr>
<th>°C</th>
<th>(Centipoises)</th>
<th>(Centistokes)</th>
<th>°F</th>
<th>(lb./ft-hr)</th>
<th>ft²/hr</th>
</tr>
</thead>
<tbody>
<tr>
<td>800</td>
<td>2.2* (Ref. 40)</td>
<td>1.10</td>
<td>1500</td>
<td>5.0*</td>
<td>0.0401</td>
</tr>
</tbody>
</table>

**Exponential Form (centipoises)**: \( μ = 0.0770e^{3600/T°K} \)

*Denotes experimental values. Other values given are calculated or estimated.*
Figure I. Viscosity Worksheet (This sheet of specially prepared graph paper has been included to facilitate interpolation and extrapolation of viscosity data).
CONCLUDING REMARKS

The summary of physical properties presented in this report has been compiled for the various technical groups within the AMP Project who need it. Properties have been measured or predicted for a large portion of the fluoride systems that have been of interest to the Project thus far. It is anticipated that more measurements will be made for new fluoride systems as they become attractive.

In the meantime, however, in most cases the thermal properties of such new fluoride systems can be estimated satisfactorily for preliminary design purposes with the aid of the correlation relations that have been developed. For example, molten densities have been related uniquely to room temperature densities or molecular weight which can be calculated (see topical report, ORNL 1702). The heat capacities were found to be inversely proportional to the average molecular weight and directly proportional to the average number of atoms in the mixture (see topical report, ORNL 1956).

Topical reports on the viscosity and thermal conductivity research on fluorides are being prepared. Viscosities have been found to vary with molecular weight and also with molar volume along the lines indicated by the Batchinski relation. The thermal conductivities have been found to vary inversely with average molecular weight. In addition, liquid thermal conductivities have been proportioned into atomic and ionic contributions each of which has been separately correlated.
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11. L. Cooper, S. J. Claiborne, ORNL CF 52-8-163.
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