Kerphalite™ KF for Cores
Kersand™100-400 for Mould

SPECIAL SAND FOR FOUNDRY

Ankiros 2018
What is Kerphalite™ KF & Kersand™ 100-400?

- Kerphalite™ KF & Kersand™ 100-400 are both “andalusite” mineral.

- Kerphalite™ KF & Kersand™ 100-400 are an alternative to traditional natural sands such as silica sand and chromite or zircon for cores and molds production.

- Key properties are:
  - **High Refractoriness** (capability to withstand high temperature without melting or softening)
  - **Low Thermal Expansion**
  - **High Thermal Conductibility**
  - Suitable for all organic binders
  - Total compatibility with Silica Sand
Kerphalite™KF & Kersand™100-400 requires many processing stages to achieve the quality required by the foundry application.

- Mining and Processing plant is located in France.
- 18 years of extraction right.
Kerphalite™ KF & Kersand™ 100-400 – Chemistry

- Both are pure aluminosilicate: \( \text{Al}_2\text{O}_3 \cdot \text{SiO}_2 \)
- Typical Chemical composition:

<table>
<thead>
<tr>
<th></th>
<th>Kerphalite™ KF</th>
<th>Kersand™ 100-400</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \text{Al}_2\text{O}_3 )</td>
<td>61%</td>
<td>59%</td>
</tr>
<tr>
<td>( \text{SiO}_2 )</td>
<td>38%</td>
<td>39%</td>
</tr>
<tr>
<td>( \text{Fe}_2\text{O}_3 )</td>
<td>0,5%</td>
<td>0,75%</td>
</tr>
<tr>
<td>( \text{K}_2\text{O} + \text{Na}_2\text{O} + \text{MgO} + \text{CaO} )</td>
<td>&lt; 0,5%</td>
<td>&lt; 1%</td>
</tr>
</tbody>
</table>

- Typical Chemical comparison:

<table>
<thead>
<tr>
<th></th>
<th>%</th>
<th>Al2O3</th>
<th>SiO2</th>
<th>MgO</th>
<th>CaO</th>
<th>Fe2O3</th>
<th>K2O</th>
<th>TiO2</th>
<th>ZrO2</th>
<th>Na2O</th>
<th>Cr2O3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kerphalite™ KF</td>
<td>60,8</td>
<td>38,1</td>
<td>0</td>
<td>0</td>
<td>0,45</td>
<td>0,1</td>
<td>0,1</td>
<td>0,1</td>
<td>0</td>
<td>0,1</td>
<td>0</td>
</tr>
<tr>
<td>Kersand™ 100-400</td>
<td>59,1</td>
<td>38,5</td>
<td>0,15</td>
<td>0,1</td>
<td>0,75</td>
<td>0,3</td>
<td>0,25</td>
<td>0</td>
<td>0</td>
<td>0,15</td>
<td></td>
</tr>
<tr>
<td>Zircon Sand</td>
<td>0,8</td>
<td>32</td>
<td>0</td>
<td>0</td>
<td>0,1</td>
<td>0</td>
<td>0,2</td>
<td>63,5</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Chromite Sand</td>
<td>14,8</td>
<td>0,9</td>
<td>9</td>
<td>0</td>
<td>30,4</td>
<td>0</td>
<td>0,5</td>
<td>0</td>
<td>0</td>
<td>43,6</td>
<td></td>
</tr>
<tr>
<td>Ceramic Beads 60%</td>
<td>60,1</td>
<td>36,9</td>
<td>0</td>
<td>0,2</td>
<td>1,2</td>
<td>0,1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Due to the high alumina content (> 60%) and low alkalis level vs ceramic beads 60%

- Melting point of Kerphalite® KF exceeds 1800°C
- Fe$_2$O$_3$ content in chromite blended with silica sand can provide a tremendous drop of the melting point.
- Sintering phase occur at 1208°C
- These is fayalite
Chromite is mainly recommended when an effective magnetic separation system available.

If not, following sand penetration could occurred.
Thermal expansion is the key point to reduce veining defects.

Both shows a low thermal expansion rate, close to zircon and significantly lower than silica sand, olivine & chromite.
Kerphalite™ KF & Kersand™ 100-400 – Cooling Effect

- We have introduced relevant parameter in Software Magma5
- We have designed a simple but massive casting roller (40cm diam) with central core (4cm diam).
- The simulated curves have been taken from the center of core.

Results

- Cooling behavior of Kersand is performing as chromite
- Other sands like Treibacher Alodur ® WRG performe far better than chromite !!
Thermal resistance test allows to simulate thermal radiations & convections during pouring time.

- Thickness: 5mm
- Sand Sample: Furanic binder
- Moving support
- Final temperature is reached in about 2 minutes
Kerphalite™ KF & Kersand™ 100-400 doesn’t show any melted phases at 1500°C

- The blend with 50% of silica sand increases the melting phase but allows significant improvement vs pure silica.

![Graph showing Melted Phase after Thermal Shock 2 to 20 min at 1500°C - Furanic Resin](image)
Kerphalite™ KF & Kersand™ 100-400 – Heating Microscope

- Heating microscope chart below shown us, at 3 different % of shrinkage, the temperature of softening.

- Kersand™ 100-400 as Kerphalite™ KF perform well and much better than mullite beads e.g.
Kerphalite™ KF & Kersand™ 100-400 – Reclaimed level & LOI

- Courtesy of Omega
- Yield recovery ➔ between 77% and 82% of Kerphalite KF recovered.

### Tab.1: Camsizer analyses of the samples

<table>
<thead>
<tr>
<th></th>
<th>AFS</th>
<th>d10 (µm)</th>
<th>d50 (µm)</th>
<th>d90 (µm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>KF 100-400 as received</td>
<td>56,73</td>
<td>163,0</td>
<td>239,4</td>
<td>354,0</td>
</tr>
<tr>
<td>KF 100-400 after USR</td>
<td>56,24</td>
<td>163,2</td>
<td>245,3</td>
<td>369,8</td>
</tr>
</tbody>
</table>

#### LOI graph
- LOI values for different stages of processing:
  - KF 100-400 As received
  - KF 100-400 Before USR
  - KF 100-400 After 1st Pass USR
  - 1st Pass USR re-check
Kerphalite™ KF & Kersand™ 100-400 – Reclaimed PSD and Sphericity

- Courtesy of Omega

- Kerphalite KF 100-400 as received - AFS 64
- Kerphalite KF 100-400 after 1 pass USR - AFS 71
**Kerphalite™ KF & Kersand™ 100-400 – Bending Strength**

- Bending Strength in Mpa on various materials.
- In the same lab conditions.

<table>
<thead>
<tr>
<th>Material*</th>
<th>furane 24 hours</th>
<th>Sodium Silicate 24 hours</th>
<th>Phenolic Alkalin 24 hours</th>
<th>Phenolic Urethane Self Set 24 hours</th>
<th>Phenolic Urethane Cold Box</th>
<th>Pre Coated Sand in Mpa</th>
</tr>
</thead>
<tbody>
<tr>
<td>European Silica Sand</td>
<td>4,5</td>
<td>2,2</td>
<td>1,9</td>
<td>3,6</td>
<td>4,3</td>
<td>5,2</td>
</tr>
<tr>
<td>Kerphalite KF 100-400</td>
<td>3,8</td>
<td>2</td>
<td>1,8</td>
<td>3,2</td>
<td>3,3</td>
<td>3,8</td>
</tr>
<tr>
<td>Kersand 100-400</td>
<td>3,5</td>
<td>2</td>
<td>1,7</td>
<td>3</td>
<td>3,2</td>
<td>4,1</td>
</tr>
<tr>
<td>ImerBeads 45AFS</td>
<td>4,6</td>
<td>2,3</td>
<td>2</td>
<td>3,5</td>
<td>4,9</td>
<td>6,2</td>
</tr>
<tr>
<td>Clayrac F45 100-400</td>
<td>3</td>
<td>1,9</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Blended with 50% silica sand
Kerphalite™ KF & Kersand™ 100-400 – Differents Grades

- All usual AFS grades are available and possibly designed for special needs.
Both have the same bulk density close to silica sand.

You can produce **40% more cores**, using Kerphalite or Kersand vs chromite or zircon

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20 tons

Kerphalite KF
12.5 m3

Kersand™
7.4 m3

Zircon
Based on previous slide, we take an example of foundry which is buying 300tons/year of chromite.

The Volume of chromite bought is 111m³.

For same volume, that’s means, same quantity of core & mold, you ONLY need to purchase 178 tons per year instead of 300Tons of chromite.

Resin consumption is also a sensitive topic.

As all resin setting are based on sand, we weight resin/catalyst & sand at the screw of mixer.

So, we should calculate on weight = Tons/year.

Even using 40% more resin with KERPHALITE !!

- Foundry Manager introduce less resin in his sand reclamation => Less gas to remove during pouring
- Purchasing manager will save 17% on total binder cost.

<table>
<thead>
<tr>
<th>Type of Sands</th>
<th>Density</th>
<th>Quantity of Sand needed in Tons per year</th>
<th>Equivalent in Volume in m³</th>
<th>Savings in tons</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHROMITE</td>
<td>2,7</td>
<td>300</td>
<td>111,1</td>
<td>0</td>
</tr>
<tr>
<td>KERPHALITE KF</td>
<td>1,6</td>
<td>177,8</td>
<td>111,1</td>
<td>122</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Sands</th>
<th>% of resin</th>
<th>Resin needed per Year (en Kg)</th>
<th>Savings</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHROMITE</td>
<td>1,00%</td>
<td>3000</td>
<td>0</td>
</tr>
<tr>
<td>KERPHALITE KF</td>
<td>1,40%</td>
<td>2489</td>
<td>-17%</td>
</tr>
</tbody>
</table>
Kerphalite™ KF & Kersand™ 100-400 – Summaries

Kerphalite™ KF & Kersand™ 100-400 will respond to special core shop as molding requirements:

- Low Thermal Expansion ➔ High anti veining properties
- Good Thermal diffusivity and Conductivity ➔ Relative good Chilling effect.
- Very low level of Fe₂O ➔ No risk of fayalite Defect, no sand penetration
- High refractoriness - 58 - 60% alumina
- PSD properly design for all type of core application
- Acceptable sand reclamation level.
- Low density ➔ 40% more cores produced
- Aluminosilicate mining and processing in Europe.
Thanks for your attention