SAND, SAND ADDITIVES, SAND PROPERTIES, and SAND RECLAMATION

Prof. Dr. Altan Turkeli
MSE-432
Foundry Technology
SAND ADDITIVES
Casting Sand

- SAND (SiO2......)
- CLAYS (Bentonite.....)
- WATER

- CELLULOSE (Wood flour, Cob flour.....)
- OIL-CHEMICALS (Soda ash, Polymers....)
- REFRACTORIES (Alumina, Silica flour...)
- SOLUBLES (Corn flour, Corn sugar...)

Flow Chart of a Metal Casting System

- **Ignots & Alloys**
  - Metal
  - Fuel
  - Flux
  - **Furnace**
  - **Scrap**
    - Off-Site Scrap

- **Pour**
  - **Cooling**
    - **Shakout**
      - **Cores**
      - **Mould**
      - **Sand Reclamation**
        - New Sand
          - Sand
          - Binder
          - Additives
          - Sand Mixer
            - Sand Reclamation
              - Heat Treatment
                - Inspection
                  - Cleaning
                    - Fettling
                      - Castings
                        - **Furnace**
                          - **Scrap**
                            - Off-Site Scrap

- **Finished Casting**
Fig. 1 Two sizes of rounded sand grains. 35×.
Fig. 2 Sizes of pores in faces of molds made from coarse sand and from fine sand. 35×.
Grain shape

Grain shape is defined in terms of angularity and sphericity. Sand grains vary from well rounded to rounded, sub-rounded, sub-angular, angular and very angular. Within each angularity band, grains may have high, medium or low sphericity. The angularity of sand is estimated by visual examination with a low power microscope and comparing with published charts, Fig. 12.1.

The best foundry sands have grains which are rounded with medium to high sphericity giving good flowability and permeability with high strength at low binder additions. More angular and lower sphericity sands require higher binder additions, have lower packing density and poorer flowability.
<table>
<thead>
<tr>
<th>Very Angular</th>
<th>Angular</th>
<th>Sub-Angular</th>
<th>Sub-Rounded</th>
<th>Rounded</th>
<th>Well Rounded</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Figure 12.1 *Classification of grain shapes.*
Casting Sands

- *Silica Sands*
- *Zircon*
- *Olivine*
- *Chromite*
- *Aluminum Silicates*
Silica Sands

• Most green sand molds consist of silica sands bonded with a bentonite-water mixture. (The term green means that the mold, which is tempered with water, is not dried or baked.) The composition, size, size distribution, purity, and shape of the sand are important to the success of the mold making operation.
• Sands are sometimes referred to as natural or synthetic.

• **Natural or Synthetic**
  
  • Natural sands contain enough naturally occurring clays that they can be mixed with water and used for sand molding.
  
  • Synthetic sands have been washed to remove clay and other impurities, carefully screened and classified to give a desired size distribution, and then reblended with clays and other materials to produce an optimized sand for the casting being produced.
  
  • Because of the demands of modern high-pressure molding machines and the necessity to exercise close control over every aspect of casting production, most foundries use only synthetic sands.
Composition

• Foundry sands are composed almost entirely of silica (SiO2) in the form of quartz. Some impurities may be present, such as ilmenite (FeO-TiO2), magnetite (Fe3O4), or olivine, which is composed of magnesium and ferrous orthosilicate [(Mg,Fe) SiO4]. Silica sand is used primarily because it is readily available and inexpensive.
• Quartz undergoes a series of crystallographic transitions as it is heated. The first, at 573 °C, is accompanied by expansion, which can cause mold spalling. Above 870 °C, quartz transforms to tridymite, and the sand may actually contract upon heating. At still higher temperatures (> 1470 °C), tridymite transforms to cristobalite.
Figure 11.4  The expansion/temperature relations for iron-based die materials, and silica and zircon sand moulding materials. (J. Campbell, Foundry International, March 1992)
Shape and Distribution of Sand Grains

• The size, size distribution, and shape of the sand grains are important in controlling the quality of the mold. Most mold aggregates are mixtures of new sand and reclaimed sand, which contain not only reclaimed molding sand but also core sands. In determining the size, shape, and distribution of the sand grains, it is important to realize that the grain shape contributes to the amount of sand surface area and that the grain size distribution controls the permeability of the mold.
• As the sand surface area increases, the amount of bonding material (normally clay and water) must increase if the sand is to be properly bonded. Thus, a change in surface area, perhaps due to a change in sand shape or the percentage of core sand being reclaimed, will result in a corresponding change in the amount of bond required.

• Rounded grains have a low surface-area-to-volume ratio and are therefore preferred for making cores because they require the least amount of binder. However, when they are recycled into the molding sand system, their shape can be a disadvantage if the molding system normally uses a high percentage of clay and water to facilitate rapid, automatic molding. This is because rounded grains require less binder than the rest of the system sand.
• Angular sands have the greatest surface area (except for sands that fracture easily and produce a large percentage of small grains and fines) and therefore require more mulling, bond, and moisture. The angularity of a sand increases with use because the sand is broken down by thermal and mechanical shock.

• The porosity of the mold controls its permeability, which is the ability of the mold to allow gases generated during pouring to escape through the mold. The highest porosity will result from grains that are all approximately the same size.

• As the size distribution broadens, there are more grains that are small enough to fill the spaces between large grains. As grains break down through repeated recycling, there are more and more of the smaller grains, and the porosity of the mold decreases.
• However, if the porosity of the mold is too great, metal may penetrate the sand grains and cause a burn-in defect.
• Therefore, it is necessary to balance the base sand distribution and continue to screen the sand and use dust collectors during recycling to remove fines and to determine the proper bond addition.
• Most foundries in the United States use the American Foundrymens' Society (AFS) grain fineness number as a general indication of sand fineness. The AFS grain fineness number of sand is approximately the number of openings per inch of a given sieve that would just pass the sample if its grains were of uniform size, that is, the weighted average of the sizes of grains in the sample. It is approximately proportional to the surface area per unit weight of sand exclusive of clay.
<table>
<thead>
<tr>
<th>USA series No.</th>
<th>Tyler screen scale sieves, openings per lineal inch</th>
<th>Sieve opening, mm</th>
<th>Sieve opening, μm</th>
<th>Permissible variation in average opening, ±mm</th>
<th>Wire diameter, mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>6</td>
<td>3.35</td>
<td>3350</td>
<td>0.11</td>
<td>1.23</td>
</tr>
<tr>
<td>8&lt;sup&gt;(a)&lt;/sup&gt;</td>
<td>8&lt;sup&gt;(a)&lt;/sup&gt;</td>
<td>2.36</td>
<td>2360</td>
<td>0.0937</td>
<td>0.08</td>
</tr>
<tr>
<td>12</td>
<td>10</td>
<td>1.70</td>
<td>1700</td>
<td>0.0661</td>
<td>0.06</td>
</tr>
<tr>
<td>16&lt;sup&gt;(a)&lt;/sup&gt;</td>
<td>14&lt;sup&gt;(a)&lt;/sup&gt;</td>
<td>1.18</td>
<td>1180</td>
<td>0.0469</td>
<td>0.045</td>
</tr>
<tr>
<td>20</td>
<td>20</td>
<td>0.850</td>
<td>850</td>
<td>0.0331</td>
<td>0.035</td>
</tr>
<tr>
<td>30</td>
<td>28</td>
<td>0.600</td>
<td>600</td>
<td>0.0234</td>
<td>0.025</td>
</tr>
<tr>
<td>40</td>
<td>35</td>
<td>0.425</td>
<td>425</td>
<td>0.0165</td>
<td>0.019</td>
</tr>
<tr>
<td>50</td>
<td>48</td>
<td>0.300</td>
<td>300</td>
<td>0.0117</td>
<td>0.014</td>
</tr>
<tr>
<td>70</td>
<td>65</td>
<td>0.212</td>
<td>212</td>
<td>0.0083</td>
<td>0.010</td>
</tr>
<tr>
<td>100</td>
<td>100</td>
<td>0.150</td>
<td>150</td>
<td>0.0059</td>
<td>0.008</td>
</tr>
<tr>
<td>140</td>
<td>150</td>
<td>0.106</td>
<td>106</td>
<td>0.0041</td>
<td>0.006</td>
</tr>
<tr>
<td>200</td>
<td>200</td>
<td>0.075</td>
<td>75</td>
<td>0.0029</td>
<td>0.005</td>
</tr>
<tr>
<td>270</td>
<td>270</td>
<td>0.053</td>
<td>53</td>
<td>0.0021</td>
<td>0.004</td>
</tr>
</tbody>
</table>
Size of sample: 50 g; AFS clay content: 5.9 g, or 11.8%; sand grains: 44.1 g, or 88.2%

<table>
<thead>
<tr>
<th>USA sieve series No.</th>
<th>Amount of 50 g sample retained on sieve</th>
<th>Multiplier</th>
<th>Product</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>none</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>12</td>
<td>none</td>
<td>5</td>
<td>0</td>
</tr>
<tr>
<td>20</td>
<td>none</td>
<td>10</td>
<td>0</td>
</tr>
<tr>
<td>30</td>
<td>none</td>
<td>20</td>
<td>0</td>
</tr>
<tr>
<td>40</td>
<td>0.20</td>
<td>30</td>
<td>12</td>
</tr>
<tr>
<td>50</td>
<td>0.65</td>
<td>40</td>
<td>52</td>
</tr>
<tr>
<td>70</td>
<td>1.20</td>
<td>50</td>
<td>120</td>
</tr>
<tr>
<td>100</td>
<td>2.25</td>
<td>70</td>
<td>315</td>
</tr>
<tr>
<td>140</td>
<td>8.55</td>
<td>100</td>
<td>1710</td>
</tr>
<tr>
<td>200</td>
<td>11.05</td>
<td>140</td>
<td>3094</td>
</tr>
<tr>
<td>270</td>
<td>10.90</td>
<td>200</td>
<td>4360</td>
</tr>
<tr>
<td>Pan</td>
<td>9.30</td>
<td>300</td>
<td>5580</td>
</tr>
<tr>
<td>Total</td>
<td>44.10</td>
<td></td>
<td>15,243</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Sand</th>
<th>Sand A</th>
<th>Sand B</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>12</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>20</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>30</td>
<td>1.0</td>
<td>0.0</td>
</tr>
<tr>
<td>40</td>
<td>24.0</td>
<td>1.0</td>
</tr>
<tr>
<td>50</td>
<td>22.0</td>
<td>24.0</td>
</tr>
<tr>
<td>70</td>
<td>16.0</td>
<td>41.0</td>
</tr>
<tr>
<td>100</td>
<td>17.0</td>
<td>24.0</td>
</tr>
<tr>
<td>140</td>
<td>14.0</td>
<td>7.0</td>
</tr>
<tr>
<td>200</td>
<td>4.0</td>
<td>2.0</td>
</tr>
<tr>
<td>270</td>
<td>1.7</td>
<td>0.0</td>
</tr>
<tr>
<td>Pan</td>
<td>0.3</td>
<td>1.0</td>
</tr>
<tr>
<td>Total</td>
<td>100.0</td>
<td>100.0</td>
</tr>
</tbody>
</table>

AFS grain fineness No: 60.0
Sieves used for sand grading are of 200 mm diameter and are now usually metric sizes, designated by their aperture size in micrometres (μm). The table lists sieve sizes in the British Standard Metric series (BS410:1976) together with other sieve types.

Sieve aperture, micrometres and sieve numbers

<table>
<thead>
<tr>
<th>ISO/R.565 series (BS410:1976) (μm)</th>
<th>BSS No.</th>
<th>BSS μm</th>
<th>BSS No.</th>
<th>BSS μm</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1000)</td>
<td>16</td>
<td>1003</td>
<td>18</td>
<td>1000</td>
</tr>
<tr>
<td>710</td>
<td>22</td>
<td>699</td>
<td>22</td>
<td>710</td>
</tr>
<tr>
<td>500</td>
<td>30</td>
<td>500</td>
<td>30</td>
<td>500</td>
</tr>
<tr>
<td>355</td>
<td>44</td>
<td>353</td>
<td>45</td>
<td>350</td>
</tr>
<tr>
<td>250</td>
<td>60</td>
<td>251</td>
<td>60</td>
<td>250</td>
</tr>
<tr>
<td>(212)</td>
<td>72</td>
<td>211</td>
<td>70</td>
<td>210</td>
</tr>
<tr>
<td>180</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(150)</td>
<td>100</td>
<td>152</td>
<td>100</td>
<td>149</td>
</tr>
<tr>
<td>125</td>
<td></td>
<td></td>
<td>120</td>
<td>125</td>
</tr>
<tr>
<td>90</td>
<td>150</td>
<td>104</td>
<td>150</td>
<td>105</td>
</tr>
<tr>
<td>63</td>
<td>200</td>
<td>76</td>
<td>200</td>
<td>74</td>
</tr>
<tr>
<td>(45)</td>
<td>300</td>
<td>53</td>
<td>325</td>
<td>44</td>
</tr>
</tbody>
</table>

Notes: The 1000 and 45 sieves are optional. The 212 and 150 sieves are also optional, but may be included to give better separation between the 250 and 125 sieves.
Calculation of average grain size

The adoption of the ISO metric sieves means that the old AFS grain fineness number can no longer be calculated. Instead, the average grain size, expressed as micrometres (µm) is now used. This is determined as follows:

1. Weigh a 100 g sample of dry sand.
2. Place the sample into the top sieve of a nest of ISO sieves on a vibrator. Vibrate for 15 minutes.
3. Remove the sieves and, beginning with the top sieve, weigh the quantity of sand remaining on each sieve.
4. Calculate the percentage of the sample weight retained on each sieve, and arrange in a column as shown in the example.
5. Multiply the percentage retained by the appropriate multiplier and add the products.
6. Divide by the total of the percentages retained to give the average grain size.
<table>
<thead>
<tr>
<th>ISO aperture (μm)</th>
<th>Percentage retained</th>
<th>Multiplier</th>
<th>Product</th>
</tr>
</thead>
<tbody>
<tr>
<td>≥710</td>
<td>trace</td>
<td>1180</td>
<td>0</td>
</tr>
<tr>
<td>500</td>
<td>0.3</td>
<td>600</td>
<td>180</td>
</tr>
<tr>
<td>355</td>
<td>1.9</td>
<td>425</td>
<td>808</td>
</tr>
<tr>
<td>250</td>
<td>17.2</td>
<td>300</td>
<td>5160</td>
</tr>
<tr>
<td>212</td>
<td>25.3</td>
<td>212</td>
<td>5364</td>
</tr>
<tr>
<td>180</td>
<td>16.7</td>
<td>212</td>
<td>3540</td>
</tr>
<tr>
<td>150</td>
<td>19.2</td>
<td>150</td>
<td>2880</td>
</tr>
<tr>
<td>125</td>
<td>10.6</td>
<td>150</td>
<td>1590</td>
</tr>
<tr>
<td>90</td>
<td>6.5</td>
<td>106</td>
<td>689</td>
</tr>
<tr>
<td>63</td>
<td>1.4</td>
<td>75</td>
<td>105</td>
</tr>
<tr>
<td>≤63</td>
<td>0.5</td>
<td>38</td>
<td>19</td>
</tr>
<tr>
<td>Total</td>
<td>99.6</td>
<td>–</td>
<td>20 335</td>
</tr>
</tbody>
</table>

Average grain size = \( \frac{20\,335}{99.6} \)  
= 204 μm
Calculation of AFS grain fineness number

Using either the old BS sieves or AFS sieves, follow, steps 1–4 above.
5 Arrange the results as shown in the example below.
6 Multiply each percentage weight by the preceding sieve mesh number.
7 Divide by the total of the percentages to give the AFS grain fineness number.
<table>
<thead>
<tr>
<th>BS sieve number</th>
<th>% sand retained on sieve</th>
<th>Multiplied by previous sieve no.</th>
<th>Product</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>nil</td>
<td></td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>nil</td>
<td></td>
<td></td>
</tr>
<tr>
<td>22</td>
<td>0.2</td>
<td>16</td>
<td>3.2</td>
</tr>
<tr>
<td>30</td>
<td>0.8</td>
<td>22</td>
<td>17.6</td>
</tr>
<tr>
<td>44</td>
<td>6.7</td>
<td>30</td>
<td>201.0</td>
</tr>
<tr>
<td>60</td>
<td>22.6</td>
<td>44</td>
<td>1104.4</td>
</tr>
<tr>
<td>100</td>
<td>48.3</td>
<td>60</td>
<td>2898.0</td>
</tr>
<tr>
<td>150</td>
<td>15.6</td>
<td>100</td>
<td>1560.0</td>
</tr>
<tr>
<td>200</td>
<td>1.8</td>
<td>150</td>
<td>270.0</td>
</tr>
<tr>
<td>pan</td>
<td>4.0</td>
<td>200</td>
<td>800.0</td>
</tr>
<tr>
<td>Total</td>
<td>100.0</td>
<td></td>
<td>6854.2</td>
</tr>
</tbody>
</table>

AFS grain fineness number = \( \frac{6854.2}{100} \) 
= 68.5 or 68 AFS
Foundry sands usually fall into the range 150–400 μm, with 220–250 μm being the most commonly used. Direct conversion between average grain size and AFS grain fineness number is not possible, but an approximate relation is shown below:

<table>
<thead>
<tr>
<th>AFS grain fineness no.</th>
<th>35</th>
<th>40</th>
<th>45</th>
<th>50</th>
<th>55</th>
<th>60</th>
<th>65</th>
<th>70</th>
<th>80</th>
<th>90</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average grain size (μm)</td>
<td>390</td>
<td>340</td>
<td>300</td>
<td>280</td>
<td>240</td>
<td>220</td>
<td>210</td>
<td>195</td>
<td>170</td>
<td>150</td>
</tr>
</tbody>
</table>

While average grain size and AFS grain fineness number are useful parameters, choice of sand should be based on particle size distribution.
Table 12.1 gives size gradings of typical foundry sands used in the UK and Germany.

<table>
<thead>
<tr>
<th>Sieve size</th>
<th>UK sands</th>
<th>German sands</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Chelford 50</td>
<td>Chelford 60</td>
</tr>
<tr>
<td>microns</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1000</td>
<td>16</td>
<td>trace</td>
</tr>
<tr>
<td>700</td>
<td>22</td>
<td>0.7</td>
</tr>
<tr>
<td>500</td>
<td>30</td>
<td>4.5</td>
</tr>
<tr>
<td>355</td>
<td>44</td>
<td>19.8</td>
</tr>
<tr>
<td>250</td>
<td>60</td>
<td>44.6</td>
</tr>
<tr>
<td>210</td>
<td>72</td>
<td>21.6</td>
</tr>
<tr>
<td>150</td>
<td>100</td>
<td>8.2</td>
</tr>
<tr>
<td>100</td>
<td>150</td>
<td>2.6</td>
</tr>
<tr>
<td>75</td>
<td>200</td>
<td>nil</td>
</tr>
<tr>
<td>75</td>
<td>-200</td>
<td>nil</td>
</tr>
</tbody>
</table>

AFS grain fineness no.
Average grain size mm

0.275  0.23  0.27  0.23  0.23

Note: Haltern 32, 33 and Frechen 32 are commonly used, high quality German sands. German sieve gradings are based on ISO sieves. The German sands have rounder grains and are distributed on fewer sieves than UK sands, they require significantly less binder to achieve the required core strength.
Sieve grading of Chelford 60 sand:

<table>
<thead>
<tr>
<th>Aperture size (μm)</th>
<th>BSS mesh no.</th>
<th>% wt. retained</th>
</tr>
</thead>
<tbody>
<tr>
<td>1000</td>
<td>16</td>
<td>nil</td>
</tr>
<tr>
<td>700</td>
<td>22</td>
<td>0.4</td>
</tr>
<tr>
<td>500</td>
<td>30</td>
<td>2.3</td>
</tr>
<tr>
<td>355</td>
<td>44</td>
<td>10.0</td>
</tr>
<tr>
<td>250</td>
<td>60</td>
<td>25.7</td>
</tr>
<tr>
<td>210</td>
<td>72</td>
<td>23.8</td>
</tr>
<tr>
<td>150</td>
<td>100</td>
<td>28.7</td>
</tr>
<tr>
<td>105</td>
<td>150</td>
<td>7.6</td>
</tr>
<tr>
<td>75</td>
<td>200</td>
<td>1.3</td>
</tr>
<tr>
<td>−75</td>
<td>−200</td>
<td>0.2</td>
</tr>
</tbody>
</table>

AFS grain fineness no. 59
Base permeability: 106
Size distribution

The size distribution of the sand affects the quality of the castings. Coarse-grained sands allow metal penetration into moulds and cores giving poor surface finish to the castings. Fine-grained sands yield better surface finish but need higher binder content and the low permeability may cause gas defects in castings. Most foundry sands fall within the following size range:

<table>
<thead>
<tr>
<th>Property</th>
<th>Range</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grain fineness number</td>
<td>50–60 AFS</td>
<td>Yields good surface finish at low binder levels</td>
</tr>
<tr>
<td>Average grain size</td>
<td>220–250 microns</td>
<td></td>
</tr>
<tr>
<td>Fines content, below 200 mesh</td>
<td>2% max</td>
<td>Allows low binder level to be used</td>
</tr>
<tr>
<td>Clay content, below 20 microns</td>
<td>0.5% max</td>
<td>Allows low binder levels</td>
</tr>
<tr>
<td>Size spread</td>
<td>95% on 4 or 5 screens</td>
<td>Gives good packing and resistance to expansion defects</td>
</tr>
<tr>
<td>Specific surface area</td>
<td>120–140 cm²/g</td>
<td>Allows low binder levels</td>
</tr>
<tr>
<td>Dry permeability</td>
<td>100–150</td>
<td>Reduces gas defects</td>
</tr>
</tbody>
</table>
Safe handling of silica sand

Fine silica sand (below 5 microns) can give rise to respiratory troubles. Modern foundry sands are washed to remove the dangerous size fractions and do not present a hazard as delivered. It must be recognised, however, that certain foundry operations such as shot blasting, grinding of sand covered castings or sand reclamation can degrade the sand grains, producing a fine quartz dust having particle size in the harmful range below 5 microns. Operators must be protected by the use of adequate ventilation and the wearing of suitable face masks.
Zircon is zirconium silicate (ZrSiO4). It is highly refractory and possesses excellent foundry characteristics. Its primary advantages are a very low thermal expansion, high thermal conductivity and bulk density (which gives it a chilling rate about four times that of quartz), and very low reactivity with molten metal. Zircon requires less binder than other sands because its grains are rounded. The very high dimensional and thermal stabilities exhibited by zircon are the reasons it is widely used in steel foundries and investment foundries making high-temperature alloy components.
Olivine

• Olivine minerals (so called because of their characteristic green color) are a solid solution of forsterite (Mg2SiO4) and fayalite (Fe2SiO4). Their physical properties vary with their chemical compositions; therefore, the composition of the olivine used must be specified to control the reproducibility of the sand mixture. Care must be taken to calcine the olivine sand before use to decompose the serpentine content, which contains water.

• The specific heat of olivine is similar to that of silica, but its thermal expansion is far less. Therefore, olivine is used for steel casting to control mold dimensions. Olivine is somewhat less durable than silica, and it is an angular sand.
Chromite

- Chromite (FeCr2O4), a black, angular sand, is highly refractory and chemically unreactive, and it has good thermal stability and excellent chilling properties. However, it has twice the thermal expansion of zircon sand, and it often contains hydrous impurities that cause pinholing and gas defects in castings. It is necessary to specify the calcium oxide (CaO) and silicon dioxide (SiO2) limits in chromite sand to avoid sintering reactions and reactions with molten metal that cause burn-in.
Aluminum Silicates

Aluminum silicate (Al2SiO5) occurs in three common forms: kyanite, sillimanite, and andalusite. All break down at high temperatures to form mullite and silica. Therefore, aluminum silicates for foundry use are produced by calcining these minerals. Depending on the sintering cycle, the silica may be present as cristobalite or as amorphous silica. The grains are highly angular. These materials have high refractoriness, low thermal expansion, and high resistance to thermal shock. They are widely used in precision investment foundries, often in combination with zircon.
**Bulk density** = The mass of powdered or granulated solid material per unit of volume

<table>
<thead>
<tr>
<th>Property</th>
<th>Silica</th>
<th>Zircon</th>
<th>Chromite</th>
<th>Olivine</th>
</tr>
</thead>
<tbody>
<tr>
<td>AFS grain size no.</td>
<td>60</td>
<td>102</td>
<td>74</td>
<td>65</td>
</tr>
<tr>
<td>Grain shape</td>
<td>rounded</td>
<td>rounded</td>
<td>angular</td>
<td>angular</td>
</tr>
<tr>
<td>Specific gravity</td>
<td>2.65</td>
<td>4.66</td>
<td>4.52</td>
<td>3.3</td>
</tr>
<tr>
<td>Bulk density (kg/m³)</td>
<td>1490</td>
<td>2770</td>
<td>2670</td>
<td>1700</td>
</tr>
<tr>
<td></td>
<td>(lb/ft³)</td>
<td>93</td>
<td>167</td>
<td>106</td>
</tr>
<tr>
<td>Thermal expansion</td>
<td>1.9%</td>
<td>0.45%</td>
<td>0.6%</td>
<td>1.1%</td>
</tr>
<tr>
<td>20–1200°C</td>
<td>non linear</td>
<td>refractoriness</td>
<td>resistance to penetration</td>
<td>Mn steel</td>
</tr>
<tr>
<td>Application</td>
<td>general</td>
<td>chill</td>
<td>chill</td>
<td></td>
</tr>
</tbody>
</table>
Figure 12.2 Thermal expansion characteristics of zircon, chromite and olivine sands compared with silica sand.
SAND ADDITIVES

Water

- Water
- $\text{H}_2\text{O}$
SAND ADDITIVES
Clays

- Clays
- Bentonite, Southern (Ca-Bentonite)
- Bentonite, Western (Na-Bentonite)
- Fireclay
- Kaolin Clay
The most common clays used in bonding green sand molds are bentonites, which are forms of montmorillonite or hydrated aluminum silicate. Montmorillonite is built up of alternating tetrahedra of silicon atoms surrounded by oxygen atoms, and aluminum atoms surrounded by oxygen atoms, as shown in Fig. 1. This is a layered structure, and it produces clay particles that are flat plates. Water is adsorbed on the surfaces of these plates, and this causes bentonite to expand in the presence of water and to contract when dried.
**Fig. 1** Structure of montmorillonite. Large closed circles are aluminum, magnesium, sodium, or calcium. Small closed circles are silicon. Large open circles are hydroxyls. Small open circles are oxygen.
ŞEKİL 2: Na ve Ca bentonitlerine ait şişmiş montmorolit kristalleri
<table>
<thead>
<tr>
<th>BİLEŞİM</th>
<th>TSE</th>
<th></th>
<th>REŞADIYE</th>
<th></th>
<th>ÜNYE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>EN FAZLA</td>
<td>EN AZ</td>
<td>EN FAZLA</td>
<td>EN AZ</td>
<td>EN FAZLA</td>
</tr>
<tr>
<td>SiO₂</td>
<td>68</td>
<td>58</td>
<td>65</td>
<td>54</td>
<td>70</td>
</tr>
<tr>
<td>Al₂O₃</td>
<td>25</td>
<td>18</td>
<td>23</td>
<td>17</td>
<td>18</td>
</tr>
<tr>
<td>Fe₂O₃</td>
<td>5.5</td>
<td></td>
<td>5</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>FeO</td>
<td>0.5</td>
<td></td>
<td>3</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>MgO</td>
<td>4.5</td>
<td></td>
<td>4</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>CaO</td>
<td>0.5</td>
<td>0.5</td>
<td>3</td>
<td>0.3</td>
<td>20</td>
</tr>
<tr>
<td>Na₂O+K₂O</td>
<td>0.5</td>
<td></td>
<td>3</td>
<td>0.3</td>
<td>1</td>
</tr>
</tbody>
</table>

**TABLO 2:** Türkiye'nin farklı yörerlerinden hazırlanan bentonitlerin kimyasal analizi ve TSE tarafından taslak olarak önerilen kimyasal bileşim aralığı.
ŞEKİL 1: BENTONİTLERİN KULLANILDIĞI YERLER

- Çöküm: 5.66%
- Ziraat: 8.82%
- Defterjan: 10.66%
- Motosyon: 5.15%
- İnşaat Sanayi: 4.78%
- Yem ve incontris: 5.25%
- Yakın söndürülen: 3.66%
- İlaç: 1.94%
- Boya: 5.88%
- Lastik Sanayi: 5.51%
D) Bentonitin Şişmesi
(Hacim Büyümesi):
Bentonitin en önemli özelliklerinden bir tanesi de su içinde kabarıp şişmesi ve jelimi bir kitle meydana getirmesidir. Bir kilin gerçekleştir ve kelimenin ticari anlam ile bentonit olabilmesi için en azından kendi hacminin beş katlı şişmesi gerek- mektedir. Normal olarak iyi vasıflı bentonitler 10 - 20, çok ender bentonitlerde 25 hatta 30 kat şişebilmektedirler.
BENTONITE, SOUTHERN
(INORGANIC)

Description ............(Ca\textsuperscript{++} calcium bentonite)
also known as nonswellng bentonite.

Typical Color ............ cream, tan, bluish gray

Purpose .... basic bond in green sand system. To promote good green strength, moderate dry and hot compression strengths. Gives higher green, lower dry and hot strengths and promotes better flowability than western bentonite.

Bulk Density .................. 52 lb/ft\textsuperscript{3}

Typical Sizing ...... 60-90\% thru USA Sieve 200

pH .................................. 4.0-8.5

Fusion Point ............ 1900-2440\degree F (1038-1338\degree C)

\% Volatile @ 900\degree F (482\degree C) .............. 0\%*

\% Volatile @ 1800\degree F (982\degree C) .............. 0.5

\% Total Combustibles .............. 0.5\%*

Effective Temperature of Destruction .................. 1292\degree F (700\degree C)

Effect on:

Green Compression Strength ........... increases

Dry Compression Strength .............. increases

Hot Compression Strength .............. increases

Miscellaneous Data or Observations

Typical base exchange (in me/100 g) .... Na(<5),
K(2.8), Ca(74.7), Mg(1.0)

*Does not include chemically or mechanically held water.

Typical Chemical Analysis (Percent)

\begin{tabular}{llll}
SiO\textsubscript{2} & 56-59 & CaO & 1.2-35 \\
Al\textsubscript{2}O\textsubscript{3} & 18-21 & Na\textsubscript{2}O & 0.34-46 \\
Fe\textsubscript{2}O\textsubscript{3} & 5.4-9.1 & H\textsubscript{2}O, as shipped & 5.0-8.0 \\
MgO & 3.0-3.3 & & \\
\end{tabular}
BENTONITE, WESTERN
(INORGANIC)

Description .................. powdered (Na⁺ sodium bentonite). Also known as Wyoming bentonite, high-swelling bentonite.

Typical Color ........ bluish, cream, gray, light yellow

Purpose ................. basic bond in a green sand system.
To promote green, dry and hot compression strengths. To prevent erosion, cuts, washes, and allow for silica sand expansion.

Bulk Density ............... 54 lb/ft³

Typical Sizing .......... 60-92% thru USA Sieve 200

pH ................................ 9.0-10.0

Fusion Point ............. 1900-2440°F (1038-1383°C)

% Volatile @ 900°F (482°C) ....... 0*
% Volatile @ 1800°F (982°C) ....... 5
(H₂O of hydration driven off @ 1292°F (700°C). Lattice destroyed @ 1832°F (1000°C).

% Total Combustibles .......... 0.5*

Effective Temperature of Destruction ........ 1832°F (1000°C)

Effect on:
Green Compression Strength ........ increases
Dry Compression Strength .......... increases
Hot Compression Strength .......... increases

Miscellaneous Data or Observations

1) Base exchange (in me./100 g)
Total Na, K, Ca & Mg ............... 85-100
Combined Na & K ions ............ 60.0% min.
Combined Ca & Mg ions .......... 40.0% max.

2) Consists primarily of the mineral montmorillonite.

3) Various other grinds available.

*Does not include chemically or mechanically held water.

Typical Chemical Analysis (Percent)

<table>
<thead>
<tr>
<th>Element</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>SiO₂</td>
<td>60-62</td>
</tr>
<tr>
<td>Al₂O₃</td>
<td>21-23</td>
</tr>
<tr>
<td>Fe₂O₃</td>
<td>3.4</td>
</tr>
<tr>
<td>Na₂O</td>
<td>2.5-2.7</td>
</tr>
<tr>
<td>MgO</td>
<td>0.2-3</td>
</tr>
<tr>
<td>CaO</td>
<td>0.5-1.5</td>
</tr>
<tr>
<td>K₂O</td>
<td>0.4-0.45</td>
</tr>
<tr>
<td>H₂O₅</td>
<td>5.0-9.0</td>
</tr>
</tbody>
</table>
Fireclay

• Fireclay consists essentially of kaolinite, a hydrous aluminum silicate that is usually combined with bentonites in molding sand. It is highly refractory, but has low plasticity. It improves the hot strength of the mold and allows the water content to be varied over greater ranges. Because of its high hot strength potential, it is used for large castings. It is also used to improve sieve analysis by creating fines whenever the system does not have an optimum wide sieve distribution of the base sand. However, because of its low durability, its use is generally limited. In addition, the need for fireclay can usually be eliminated through close control of sand mixes and materials.
FIRECLAY
(INORGANIC)

Description ................................................. 50 mesh
Typical Color .................................................. gray
Purpose ........................................ basic bond in a green sand system.
   Increases green, dry and hot strengths. Used particularly to increase dry and hot properties.
Bulk Density .................................................. 60 lb/ft³
pH ................................................................. 4-5
Fusion Point ................................................... 3000F (1649C)
% Volatile @ 900F (482C) .......................... varies
% Volatile @ 1800F (982C)................................. 9.0
% Total Combustibles ................................. 9.39*
Effective Temperature of Destruction .................. 3055F (1679C)
Effect on:
Green Compression Strength ..................... increases
Dry Compression Strength ...................... increases
Hot Compression Strength ..................... increases

Miscellaneous Data or Observations
PCE Cone 31 ................................................. 3055F (1679C)
AFS GFN ....................................................... 180
Finer and coarser grinds also available.

*Includes approximately 4-5% H₂O as shipped.

<table>
<thead>
<tr>
<th>Typical U.S.A. Sieve Analysis (Percent Retained)</th>
<th>Typical Chemical Analysis (Percent)</th>
</tr>
</thead>
<tbody>
<tr>
<td>30 .................................................. 0.3</td>
<td>SiO₂ ........................................ 57.32</td>
</tr>
<tr>
<td>40 .................................................. 1.7</td>
<td>Al₂O₃ ....................................... 28.50</td>
</tr>
<tr>
<td>50 .................................................. 5.3</td>
<td>Fe₂O₃ ....................................... 1.23</td>
</tr>
<tr>
<td>70 .................................................. 9.5</td>
<td>TiO₂ .......................................... 1.98</td>
</tr>
<tr>
<td>100 .................................................. 13.5</td>
<td>CaCO₃ ....................................... 0.08</td>
</tr>
<tr>
<td>.................................................. 140 ......... 11.4</td>
<td>MgO .......................................... 0.22</td>
</tr>
</tbody>
</table>
KAOLIN CLAY
(INORGANIC)

Description ........................................ also called “China Clay”
although China Clay is primarily used in the ceramic industry, and is slightly different.

Typical Color ........................................ gray

Purpose ............................................. primarily increases dry and hot compression strengths

Bulk Density ........................................ 30 lb/ft^3

pH ....................................................... 4.5

Fusion Point ........................................ 2921°F (1605°C)

% Volatile @ 1800°F (982°C) .................... 14.2

% Total Combustibles .............................. 14.2

Effective Temperature of Destruction .......... 3000°F (1649°C)

Effect on:
Green Compression Strength ..................... increases
Dry Compression Strength ........................ increases
Hot Compression Strength ........................ increases

Miscellaneous Data or Observations
Modulus of rupture .................................. 75 psi
H₂O of plasticity .................................... 32.7%

*Includes H₂O as shipped.

<table>
<thead>
<tr>
<th>Typical Chemical Analysis (Percent)</th>
<th>Typical Particle Size Analysis</th>
<th>Typical Particle Size Analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>SiO₂ ........................................ 44.90</td>
<td>% Finer 98 ........................ 26.6</td>
<td>Microns Below 10 ................ 90</td>
</tr>
<tr>
<td>Al₂O₃ ........................................ 38.90</td>
<td>95.7 .................. 8.5</td>
<td>Below 5 .......................... 80</td>
</tr>
<tr>
<td>Fe₂O₃ ........................................ 0.40</td>
<td>90.5 .................. 6.9</td>
<td>Below 2 .......................... 60</td>
</tr>
<tr>
<td>TiO₂ ........................................ 0.06</td>
<td>81.5 .................. 3.9</td>
<td>Below 1 .......................... 44</td>
</tr>
<tr>
<td>CaO .......................................... 0.06</td>
<td>69.7 .................. 2.3</td>
<td>Below 0.5 ........................ 24</td>
</tr>
<tr>
<td>MgO .......................................... 0.10</td>
<td>55.4 .................. 1.8</td>
<td>Below 0.25 ........................ 10</td>
</tr>
<tr>
<td>Na₂O ........................................ 0.22</td>
<td>39.7 .................. 0.44</td>
<td>Below 0.10 ........................ 2</td>
</tr>
<tr>
<td>K₂O .......................................... 0.20</td>
<td>20 ........................ 0.32</td>
<td>Microns Percent</td>
</tr>
</tbody>
</table>
Sand Properties

- Green Compression Strength
- Dry Compression Strength
- Hot Compression Strength
- Moisture (water)
- Permeability
- Flowability
- Refractoriness
- Thermal Stability
- Collapsibility
- Produces good casting finish
- Mold Hardness
- Deformation
- Is reusable
- Remove heat from the cooling casting
GENERAL PROPERTIES OF MOLDING Sands

• From a general viewpoint, the molding sand must be readily moldable and produce defect-free castings if it is to qualify as a good one. Certain specific properties have been identified, and testing procedures adapted for their quantitative description.

• The AFS "Foundry Sand Hand-book"\(^1\) sets forth the standard conditions of testing the sand properties. Those properties of most obvious importance include:
GENERAL PROPERTIES OF MOLDING SANDS

1. **Green strength.** The green sand, after water has been mixed into it, must have adequate strength and plasticity for making and handling of the mold.

2. **Dry strength.** As a casting is poured, sand adjacent to the hot metal quickly loses its water as steam. The dry sand must have strength to resist erosion, and also the metallostatic pressure of the molten metal, or else the mold may enlarge.
GENERAL PROPERTIES OF MOLDING SANDS

3. Hot strength. After the moisture has evaporated, the sand may be required to possess strength at some elevated temperature, above 100 °C. Metallostatic pressure of the liquid-metal bearing against the mold walls may cause mold enlargement, or if the metal is still flowing, erosion, cracks, or breakage may occur unless the sand possesses adequate hot strength.

4. Permeability. Heat from the casting causes a green-sand mold to evolve a great deal of steam and other gases. The mold must be permeable, i.e. porous, to permit the gases to pass off, or the casting will contain gas holes.
5. Thermal stability. Heat from the casting causes rapid expansion of the sand surface at the mold-metal interface. The mold surface may then crack, buckle, or flake off (scab) unless the molding sand is relatively stable dimensionally under rapid heating.

6. Refractoriness. Higher pouring temperatures, such as those for ferrous alloys at 2400 to 3200 F, require greater refractoriness of the sand. Low-pouring-temperature metals, for example, aluminum, poured at 1300 F, do not require a high degree of refractoriness from the sand.
GENERAL PROPERTIES OF MOLDING SANDS

7. Flowability. The sand should respond to molding processes.
8. Produces good casting finish.
9. Collapsibility. Heated sand which becomes hard and rocklike is difficult to remove from the casting and may cause the contracting metal to tear or crack.
10. Is reusable.
11. Offers ease of sand preparation and control.
12. Removes heat from the cooling casting.

This list by no means includes all the properties which might be desirable. Obviously, the most important characteristic of a molding sand is that it facilitate the economic production of good castings.
(a) Southern bentonite.
(b) Western bentonite.

![Graph showing green compression strength vs. tempering water percentage.](image)

- Green compression strength, kPa
- Green compression strength, psi
- Tempering water, %

10% clay
0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5 5.0 5.5
Kaolinite.
Şekil 3.1 Tane incelğinin yağ mukavemete etkisi.

Şekil 3.2 Değişik tane inceliğine göre yağ mukavemetteki değişim.
Şekil 3.3 Kum tane şeklini göre yaş mukavemetekə değişim.
Şekil 3.4 Değişik bentonit yüzdeleri için nem miktarına göre yağ mukavemeteki değişim.

Şekil 3.5 Bentonit ve ateş klinin yağ mukavemetete etkisi.
Şekil 3.6  Kum tane boyutuna göre gaz geçirgenliği değişimi.
**Sand Properties**

**Şekil 3.7** Kum tane inceliği ve nem mixtarına göre gaz geçirgenliği değişim.

**Şekil 3.8** Kum tane şekli ve nem mixtarına göre gaz geçirgenliğine etkisi.
Sand Properties

Şekil 3.9 Bentonitin ve nem oranının gaz geçirgenliği üzerine etkisi.

Şekil 3.10 Bentonit ve ateş kılıının gaz geçirgenliği üzerine etkisi.
### Tablo 3.1 — Gri Dökümler için Kum Karışmaları

<table>
<thead>
<tr>
<th>Tip</th>
<th>Tane Sınıfı</th>
<th>İncelik No.</th>
<th>Kum</th>
<th>Bentonit</th>
<th>Hububat</th>
<th>Diğer</th>
<th>Su</th>
<th>Mukavemet kg/cm²</th>
<th>Geçirgenlik</th>
<th>Döküm Ağırlığı kg</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yaş</td>
<td>4</td>
<td>70-100</td>
<td>89.4</td>
<td>5.3</td>
<td></td>
<td>5.3</td>
<td>2.8</td>
<td>0.58</td>
<td>110</td>
<td>1-14</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>70-100</td>
<td>94.0</td>
<td>4.1</td>
<td>0.2</td>
<td>1.7</td>
<td>4.4-5.5</td>
<td>0.70</td>
<td>76</td>
<td>68-362</td>
</tr>
<tr>
<td>Kurutulmuş kabuk</td>
<td>4</td>
<td>70-100</td>
<td>45.5</td>
<td>3.9</td>
<td>0.6</td>
<td>4.5</td>
<td>3.5-4.0</td>
<td>0.56</td>
<td>70-80</td>
<td>27 ve üstü</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>100-140</td>
<td>45.5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Tablo 3.2 — Çelik Dökümleri için Kum Karışmaları

<table>
<thead>
<tr>
<th>Tip</th>
<th>Tane Sınıfı</th>
<th>İncelik No.</th>
<th>Kum</th>
<th>Bentonit</th>
<th>Hububat</th>
<th>Diğer</th>
<th>Su</th>
<th>Mukavemet kg/cm²</th>
<th>Geçirgenlik</th>
<th>Döküm Ağırlığı kg</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yaş yüzey kumu</td>
<td>5</td>
<td>50-70</td>
<td>94.0</td>
<td>5.0</td>
<td>1.0</td>
<td></td>
<td>3.0-4.0</td>
<td>0.53-0.60</td>
<td>120</td>
<td>225</td>
</tr>
<tr>
<td>Yaş dolgu kumu</td>
<td>Kullanılmış kum</td>
<td>97.5</td>
<td>1.8</td>
<td>0.7</td>
<td></td>
<td></td>
<td>2.5-3.5</td>
<td>0.35-0.50</td>
<td>120</td>
<td>225</td>
</tr>
<tr>
<td>Kurutulmuş kabuk</td>
<td>5</td>
<td>50-70</td>
<td>95.5</td>
<td>3.0</td>
<td>1.5</td>
<td></td>
<td>4.0-4.5</td>
<td>0.39-0.46</td>
<td>90-120</td>
<td>45 ve üstü</td>
</tr>
</tbody>
</table>
### Tablo 3.3 — Alüminyum Dökümler İçin Kum Karışmaları

<table>
<thead>
<tr>
<th>Tip</th>
<th>Tane Sınıfı</th>
<th>İncelik</th>
<th>Kuma, % Ağırlık</th>
<th>Malzeme, % Ağırlık</th>
<th>Özellikler</th>
<th>Döküm Ağırlığı kg</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yağ</td>
<td>4</td>
<td>95.0</td>
<td>5.0</td>
<td>50</td>
<td>5.0-5.5</td>
<td>0.35-0.70</td>
</tr>
</tbody>
</table>

### Tablo 3.4 — Bakır Esash Alasımalar İçin Kum Karışmaları

<table>
<thead>
<tr>
<th>Tip</th>
<th>Tane Sınıfı</th>
<th>İncelik</th>
<th>Kuma, % Ağırlık</th>
<th>Malzeme, % Ağırlık</th>
<th>(Properties)</th>
<th>Döküm Ağırlığı kg</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yağ</td>
<td>4</td>
<td>70-100</td>
<td>95.0</td>
<td>4.0</td>
<td>4.0</td>
<td>0.42-0.50</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>100-140</td>
<td>20.0</td>
<td>2.0</td>
<td>4.0</td>
<td>0.50-0.84</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>75.0</td>
<td>5.0</td>
<td>7.0</td>
<td>4.0</td>
<td>0.50-0.84</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>70-100</td>
<td>80.0</td>
<td>4.0</td>
<td>5.5</td>
<td>0.50-0.84</td>
</tr>
</tbody>
</table>

Kuma: % Ağırlık
Malzeme: % Ağırlık
Su: Mukavemet kg/cm²
Geçirgenlik: kg/cm²

Yağ: % Ağırlık
Geçirgenlik: kg/cm²
Döküm: Ağırlığı kg
Şekil 3.18 Nem miktarı, bentonit miktarı, yaş basma mukavemeti ve gaz geçitronluğu arasındaki ilişki.
(63 AFS tane inceliğindeki kum için).
Şekil 3.19 Nem miktarı, bentonit miktarı, yaş basma mukavemeti ve kuru basma mukavemeti arasındaki ilişki. (63 AFS tane inceliğindeki kum için).
**SAND ADDITIVES**

- Clays
- Water
- Carbons
- Cellulose
- Oil-Chemicals
- Refrakteries
- Starches-Solubles (Nişasta)
SAND ADDITIVES

Clays

- Clays
- Bentonite, Southern (Ca-Bentonite)
- Bentonite, Western (Na-Bentonite)
- Fireclay
- Kaolin Clay
BENTONITE, SOUTHERN
(INORGANIC)

Description ................. (Ca\(^{++}\) calcium bentonite)
also known as nonswelling bentonite.

Typical Color ............... cream, tan, bluish gray

Purpose ................. basic bond in green sand system. To
promote good green strength, moderate dry and
hot compression strengths. Gives higher green,
lower dry and hot strengths and promotes
better flowability than western bentonite.

Bulk Density .......................... 52 lb/ft\(^3\)

Typical Sizing .............. 60-90% thru USA Sieve 200

pH ........................................ 4.0-8.5

Fusion Point ................. 1900-2440F (1038-1338C)

% Volatile @ 900F (482C) .................. 0*%
% Volatile @ 1800F (982C) .................. 0.5%
% Total Combustibles ...................... 0.5*

Effective Temperature of
Destruction .......................... 1292F (700C)

Effect on:
Green Compression Strength ........ increases
Dry Compression Strength ........ increases
Hot Compression Strength .......... increases

Miscellaneous Data or Observations
Typical base exchange (in me/100 g) ........ Na\((<5)\),
K(2.8), Ca(74.7), Mg(1.0)

*Does not include chemically or mechanically held
water.

Typical Chemical Analysis (Percent)

<table>
<thead>
<tr>
<th>SiO(_2)</th>
<th>Al(_2)O(_3)</th>
<th>Fe(_2)O(_3)</th>
<th>MgO</th>
<th>CaO</th>
<th>Na(_2)O</th>
<th>H(_2)O, as shipped</th>
</tr>
</thead>
<tbody>
<tr>
<td>56-59</td>
<td>18-21</td>
<td>5.4-9.1</td>
<td>3.0-3.3</td>
<td>1.2-35</td>
<td>0.34-46</td>
<td>5.0-8.0</td>
</tr>
</tbody>
</table>
BENTONITE, WESTERN  
(INORGANIC)

Description .......... powdered (Na⁺ sodium bentonite). Also known as Wyoming bentonite, high-swelling bentonite.

Typical Color .... bluish, cream, gray, light yellow

Purpose .......... basic bond in a green sand system.  
To promote green, dry and hot compression strengths. To prevent erosion, cuts, washes, 
and allow for silica sand expansion.

Bulk Density .................. 54 lb/ft³

Typical Sizing ........ 60-92% thru USA Sieve 200

pH ......................... 9.0-10.0

Fusion Point .......... 1900-2440°F (1038-1338°C)
% Volatile @ 900°F (842°C) ............... 0*
% Volatile @ 1800°F (982°C) ............... 5 
(H₂O of hydration driven off @ 1292°F (700°C). 
Lattice destroyed @ 1832°F (1000°C).
% Total Combustibles ........ 0.5 *

Effective Temperature of Destruction ........ 1832°F (1000°C)

Effect on:  
Green Compression Strength .......... increases  
Dry Compression Strength .......... increases  
Hot Compression Strength .......... increases

Miscellaneous Data or Observations

1) Base exchange (in me/100 g)  
   Total Na, K, Ca & Mg ................. 85-100  
   Combined Na & K ions .............. 60.0% min.  
   Combined Ca & Mg ions ............. 40.0% max.

2) Consists primarily of the mineral montmorillonite.

3) Various other grinds available.

*Does not include chemically or mechanically held water.

<table>
<thead>
<tr>
<th>Typical Chemical Analysis (Percent)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SiO₂ .......................... 60-62</td>
</tr>
<tr>
<td>Al₂O₃ ................................ 21-23</td>
</tr>
<tr>
<td>Fe₂O₃ .................................. 3.4</td>
</tr>
<tr>
<td>Na₂O .................................. 2.5-2.7</td>
</tr>
<tr>
<td>MgO ................................... 0.2-3</td>
</tr>
<tr>
<td>CaO ................................... 0.5-1.5</td>
</tr>
<tr>
<td>K₂O .................................. 0.4-0.45</td>
</tr>
<tr>
<td>H₂O, as shipped ...................... 5.0-9.0</td>
</tr>
</tbody>
</table>
FIRECLAY  
(INORGANIC)

Description ........................................ 50 mesh  
Typical Color ..................................... gray  
Purpose ............................................. basic bond in a green sand system.  
Increases green, dry and hot strengths. Used particularly to increase dry and hot properties.  
Bulk Density ....................................... 60 lb/ft³  
pH ..................................................... 4-5  
Fusion Point ....................................... 3000°F (1649°C)  
% Volatile @ 900°F (482°C) ...................... varies  
% Volatile @ 1800°F (982°C) ...................... 9.0  
% Total Combustibles ............................... 9.39*  
Effective Temperature of Destruction .......... 3055°F (1679°C)  
Effect on:  
Green Compression Strength .................... increases  
Dry Compression Strength ....................... increases  
Hot Compression Strength ........................ increases  

Miscellaneous Data or Observations  
PCE Cone 31 ......................................... 3055°F (1679°C)  
AFS GFN ............................................ 180  
Finer and coarser grinds also available.  

*Includes approximately 4-5% H₂O as shipped.

<table>
<thead>
<tr>
<th>Typical U.S.A. Sieve Analysis (Percent Retained)</th>
<th>Typical Chemical Analysis (Percent)</th>
</tr>
</thead>
<tbody>
<tr>
<td>30 ...... 0.3</td>
<td>SiO₂ ..................................... 57.32</td>
</tr>
<tr>
<td>40 ...... 1.7</td>
<td>Al₂O₃ ..................................... 28.50</td>
</tr>
<tr>
<td>50 ...... 5.3</td>
<td>Fe₂O₃ ..................................... 1.23</td>
</tr>
<tr>
<td>70 ...... 9.5</td>
<td>TiO₂ ..................................... 1.98</td>
</tr>
<tr>
<td>100 ...... 13.5</td>
<td>CaCO₃ ..................................... 0.08</td>
</tr>
<tr>
<td></td>
<td>MgO ..................................... 0.22</td>
</tr>
</tbody>
</table>
KAOLIN CLAY
(INORGANIC)

Description .................................. also called "China Clay"
although China Clay is primarily used in the ceramic industry, and is slightly different.

Typical Color .................................... gray
Purpose ..................................... primarily increases dry and hot compression strengths
Bulk Density ................................... 30 lb/ft³
pH ............................................. 4.5
Fusion Point ................................... 2921°F (1605°C)
% Volatile @ 1800°F (982°C) ............. 14.2
% Total Combustibles .................. 14.2
Effective Temperature of Destruction ...... 3000°F (1649°C)

Effect on:
Green Compression Strength .......... increases
Dry Compression Strength .......... increases
Hot Compression Strength .......... increases

Miscellaneous Data or Observations
Modulus of rupture ......................... 75 psi
H₂O of plasticity ..................... 32.7%

*Includes H₂O as shipped.

<table>
<thead>
<tr>
<th>Typical Chemical Analysis (Percent)</th>
<th>Typical Particle Size Analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>SiO₂ ..................................</td>
<td>% Finer</td>
</tr>
<tr>
<td>Al₂O₃ ..................................</td>
<td>98</td>
</tr>
<tr>
<td>Fe₂O₃ ..................................</td>
<td>90.5</td>
</tr>
<tr>
<td>TiO₂ ..................................</td>
<td>81.5</td>
</tr>
<tr>
<td>CaO ..................................</td>
<td>69.7</td>
</tr>
<tr>
<td>MgO ..................................</td>
<td>55.4</td>
</tr>
<tr>
<td>Na₂O ..................................</td>
<td>39.7</td>
</tr>
<tr>
<td>K₂O ..................................</td>
<td>29.7</td>
</tr>
</tbody>
</table>

<p>| Typical Particle Size Analysis |</p>
<table>
<thead>
<tr>
<th>Microns</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Below 10</td>
<td>90</td>
</tr>
<tr>
<td>Below 5</td>
<td>80</td>
</tr>
<tr>
<td>Below 2</td>
<td>60</td>
</tr>
<tr>
<td>Below 1</td>
<td>44</td>
</tr>
<tr>
<td>Below 0.5</td>
<td>24</td>
</tr>
<tr>
<td>Below 0.25</td>
<td>10</td>
</tr>
<tr>
<td>Below 0.10</td>
<td>2</td>
</tr>
</tbody>
</table>
SAND ADDITIVES

Water

• Water

• H₂O
SAND ADDITIVES

Carbons

- Carbons
- Asphalt
- Gilsonite (a kind of asphalt)
- Graphite
- Lamp Black (lamba isi)
- Lignite (brown coal)
- Pitch, Coal Tar (zift, kömür katranı)
- Seacoal (pulverized coal)
• Carbon is added to the mold to provide a reducing atmosphere and a gas film during pouring that protects against oxidation of the metal and reduces burn-in.

• Carbon can be added in the form of seacoal (finely ground bituminous coal), asphalt, gilsonite (a naturally occurring asphaltite), or proprietary petroleum products.

• Seacoal changes to coke at high temperatures expanding three times as it does so; this action fills voids at the mold/metal interface. Too much carbon in the mold gives smoke, fumes, and gas defects, and the use of asphalt products must be controlled closely because their overuse waterproofs the sand.

• The addition of carbonaceous materials will give improved surface finish to castings. Best results are achieved with such materials as seacoal and pitch, which volatilize and deposit a pyrolytic (lustrous) carbon layer on sand at the casting surface.
ASPHALT
(ORGANIC)

Description ............................................ ground*
Typical Color ........................................... brown to black
Purpose ........................................... improves casting finish and
controls mold atmosphere. Replacement
or supplement for seacoal or pitch.

% Volatile @ 900F (482C) ...................... 75-80
% Volatile @ 1800F (982C) ...................... 83-92
% Total Combustibles .............................. 99+

Effect on:
Green Compression Strength ................. little or none
Dry Compression Strength ..................... increases
Hot Compression Strength ...................... decreases
Sulphur Range ......................................... trace to 2% max

Miscellaneous Data or Observations
1) Product source is usually from refining process
   of oil. It is the still residue. Type depends on
   cracking process.
2) Softening point of solid type can be obtained
   from 140-380F (60-193C). Softening point of
   foundry powder types is 300-340F (148-171C).
3) Volatile will vary according to specific cracking
   process used by the individual refinery in
   manufacturing asphalt from crude petroleum.
4) Liquid types are available. See chapter 4 on oils
   and chemicals — asphaltic oils and asphalt
   emulsions.
GILSONITE
(ORGANIC)

Description: naturally occurring hydrocarbon similar to asphalt
Typical Color: brownish-black
Individual Characteristics: powder
Purpose: improves casting finish and controls mold atmosphere. Replacement for pitch in smaller dry sand work.

Bulk Density: 38.5 lb/ft³
% Volatile @ 1800F (982C): 75-85
% Total Combustibles: .99

Effect on:
Green Compression Strength: little or none
Dry Compression Strength: increases
Hot Compression Strength: decreases

Miscellaneous Data or Observations:
Gilsonite is heat softening. Softening point is 300-380F (150-190C) (ball and ring ASTM #28-51T).
Specific gravity: 1.04 to 1.06

Typical Chemical Analysis (Percent)

<table>
<thead>
<tr>
<th>Element</th>
<th>Content</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>85.0</td>
</tr>
<tr>
<td>H</td>
<td>10.5</td>
</tr>
<tr>
<td>N</td>
<td>2.5</td>
</tr>
<tr>
<td>O</td>
<td>1.5</td>
</tr>
<tr>
<td>S</td>
<td>0.3</td>
</tr>
<tr>
<td>Si-Ni</td>
<td>0.2</td>
</tr>
<tr>
<td>Trace elements</td>
<td>balance</td>
</tr>
<tr>
<td>Ash content</td>
<td>0.2</td>
</tr>
</tbody>
</table>
GRAPHITE
(ORGANIC)

Description ............... pure carbon distinguished by its hexagonal crystallinity

Typical Color ....................... gray to black
Purpose .................. improves casting peel and finish
Bulk Density ...................... 28-50 lb/ft³
% Total Combustibles .............. 75-80

Effect on:
Green Compression Strength ........ increases
Dry Compression Strength ........ increases
Hot Compression Strength .......... increases

Miscellaneous Data or Observations
Specific gravity .................. 2.1 to 2.25
Mohs hardness .................. 1/2 to 1-1/2
Sublimation point ........ greater than 6000°F (3315°C)

Above data and analysis based on Mexican graphite. Many other types from throughout the world are available, all of which have different properties. Mexican graphite is the most widely used in the United States.

<table>
<thead>
<tr>
<th>Typical Chemical Analysis (Percent)</th>
<th>Typical Ash Analysis (Percent)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moisture</td>
<td>0.75</td>
</tr>
<tr>
<td>Volatile</td>
<td>4.00</td>
</tr>
<tr>
<td>Carbon</td>
<td>83.25</td>
</tr>
<tr>
<td>Ash</td>
<td>12.00</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>
LAMP BLACK
(ORGANIC)

Description ................ extremely fine, pure carbon
Typical Color .................. black
Individual Characteristics .......... powder
Purpose ........ improves casting peel and finish
% Volatile @ 1800F (982C) .......... 2-15

Effect on:
Green Compression Strength ........ decreases
Dry Compression Strength .......... decreases
Hot Compression Strength .......... decreases

Miscellaneous Data or Observations
Produced by burning gas or oil with a very smoky, reducing flame. Lamp black (soot) collects in special housing and then is packaged for sale.
LIGNITE
(ORGANIC)

Description.................. causticized
Typical Color.................. brown to black
Purpose.................. improves casting peel and finish
pH........................................ 8.0+
% Volatile @ 900F (482C) ........... 22-25
% Volatile @ 1800F (982C) ........... 40-60
% Total Combustibles............. 60-85

Effect on:
Green Compression Strength ......... increases
Dry Compression Strength .............. decreases
Hot Compression Strength .............. decreases

Miscellaneous Data or Observations
Varies widely according to mining source. Can be used to reduce the viscosity of a slurry system. Will increase temper water requirements.
PITCH, COAL TAR

(ORGANIC)

Description ....................... byproduct of coke manufacturing
Color ........................................ black
Purpose .................................. primary use is as a binder for dry sand work. Heat hardening forms a coke bond between sand grains which also provides peel.
Bulk Density .............................. 37-42 lb/ft³
% Volatile @ 1800F (982C) .............. 48
% Total Combustibles ..................... 98-99
Effect on:
Green Compression Strength ............. little or none
Dry Compression Strength ............... increases
Hot Compression Strength ............... decreases

Miscellaneous Data or Observations
A petroleum derived pitch. Used for the same purpose, having similar characteristics.

<table>
<thead>
<tr>
<th>Typical Screen Analysis</th>
<th>Typical Chemical Analysis (Percent)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mesh</td>
<td>%</td>
</tr>
<tr>
<td>6</td>
<td>0.0</td>
</tr>
<tr>
<td>12</td>
<td>0.0</td>
</tr>
<tr>
<td>20</td>
<td>0.02</td>
</tr>
<tr>
<td>30</td>
<td>0.02</td>
</tr>
<tr>
<td>40</td>
<td>0.04</td>
</tr>
<tr>
<td>50</td>
<td>0.06</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>C</td>
<td>....</td>
</tr>
<tr>
<td>H₂</td>
<td>....</td>
</tr>
<tr>
<td>N₂</td>
<td>....</td>
</tr>
<tr>
<td>O₂</td>
<td>....</td>
</tr>
<tr>
<td>S</td>
<td>....</td>
</tr>
<tr>
<td>Ash</td>
<td>....</td>
</tr>
</tbody>
</table>
SEACOAL
(ORGANIC)

Description .......... ground, bituminous coal
Typical Color .......... brown to black
Purpose .......... improves casting peel or finish
Bulk Density ............. 44-53 lb/ft³
pH ................. 7.0
% Volatile @ 900F (482C) .......... 20.00
% Volatile @ 1800F (982C) .......... 38.00
% Total Combustibles .......... 93 min

Effect on:
Green Compression Strength .......... increases
Dry Compression Strength .......... increases
Hot Compression Strength .......... decreases

Miscellaneous Data or Observations
Properties and analysis will vary according to mining source. Different grinds are available. Treated coals are also available. Treatments can be simple oils, oleic acid or paraffin to make coals dustless.

<table>
<thead>
<tr>
<th>Typical Gas Analysis (Percent)</th>
<th>Typical Chemical Analysis (Percent)</th>
<th>Analysis of Ash (Percent)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Volatile Portion</td>
<td>C.......... 82</td>
<td>SiO₂.......... 49.22</td>
</tr>
<tr>
<td>tar fraction</td>
<td>H₂.......... 5.4</td>
<td>Al₂O₃.......... 25.32</td>
</tr>
<tr>
<td>bed water</td>
<td>N₂.......... 1.6</td>
<td>Fe₂O₃.......... 17.64</td>
</tr>
<tr>
<td>light oils</td>
<td>O₂.......... 6.6</td>
<td>CaO.......... 2.96</td>
</tr>
<tr>
<td>uncondensable gases</td>
<td>S.......... 0.7</td>
<td>MgO.......... 1.28</td>
</tr>
<tr>
<td></td>
<td>Ash .......... 3.7</td>
<td>Misc. .......... 3.58</td>
</tr>
</tbody>
</table>
SAND ADDITIVES

Cellulose

• Cellulose
• Cob Flour (mısır unu)
• Furfural Residue (liquid aldehyde)
• Oat Hulls (yulaf kabuğu)
• Walnut Shell Flour (çeviz kabuğu unu)
• Wood Flour
• **Cellulose** is added to control sand expansion and to broaden the allowable water content range. It is usually added in the form of wood flour, or nut shells.

• Cellulose reduces hot compressive strength and provides good collapsibility, thus improving shakeout.

• At high temperatures, it forms soot (an amorphous form of carbon), which deposits at the mold/metal interface and resists wetting by metal or slags.

• It also improves the flowability of the sand during molding. Excessive amounts generate smoke and fumes and can cause gas defects. In addition, if present when the clay content drops too low, defects such as cuts, washes, and mold inclusions will occur in the castings.
COB FLOUR
(ORGANIC)

Description: ground corn cobs
Typical Color: yellow to reddish brown
Purpose: reduces sand expansion defects and improves shakeout. Acts as a cushioning material and improves sand flowability.

Bulk Density: 16-21 lb/ft³
pH: 6.0-7.5
% Volatile @ 900F (482C): 96*
% Volatile @ 1800F (982C): 98-99*
% Total Combustibles: 98-99

Approximate Temperature of Destruction: 700F (371C)

Effect on:
Green Compression Strength: little or none
Dry Compression Strength: decreases
Hot Compression Strength: decreases

Typical Chemical Analysis: a complete hydrocarbon

Miscellaneous Data or Observations
Increases temper water requirements.

*Volatiles are of an oxidizing nature.
FURFURAL RESIDUE
(ORGANIC)

Typical Color .................... dark brown
Purpose ......................... reduces sand expansion
defects and improves shakeout.
Act as a cushioning material.

pH ........................................ 4-5
% Volatile @ 900F (482C) ................. 90
% Volatile @ 1800F (982C) .................. 90
% Total Combustibles ................. 95

Effect on:
Green Compression Strength ........ decreases
Dry Compression Strength ........ decreases
Hot Compression Strength ........ decreases

Miscellaneous Data or Observations
Material partially charred.
OAT HULLS
(ORGANIC)

Description: ground
Typical Color: yellow-brown
Purpose: reduces sand expansion defects and improves shakeout. Acts as a cushioning material and improves sand flowability.

Bulk Density: 18-22 lb/ft³
pH: 6.0-8.0
% Volatile @ 900F (482C): 96
% Volatile @ 1800F (982C): 98-99
% Total Combustibles: 98-99

Approximate Temperature of Destruction: 700F (370C)

Effect on:
Green Compression Strength: increases
Dry Compression Strength: decreases
Hot Compression Strength: decreases

Typical Chemical Analysis: a complete hydrocarbon

Miscellaneous Data or Observations:
Increases temper water requirements.

*Volatiles are of an oxidizing nature.
WALNUT SHELL FLOUR
(ORGANIC)

Typical Color ............................................. tan
Purpose .............................................. reduces sand expansion defects
                                                and improves shakeout.
                                                Acts as a cushioning material.
Bulk Density ............................................. 33 lb/ft³
pH ......................................................... 4-6
% Volatile @ 900F (482C) ............................ 21.7*
% Volatile @ 1800F (982C) ....................... 25
% Total Combustibles ................................. 99

Effect on:
Green Compression Strength ............... little or none
Dry Compression Strength ................... decreases
Hot Compression Strength ................... decreases

Miscellaneous Data or Observations
Increases temper water requirements.

*Volatiles are of an oxidizing nature.

<table>
<thead>
<tr>
<th>Typical Chemical Analysis (Percent)</th>
<th>Typical Particle Size</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Sieve</td>
<td></td>
</tr>
<tr>
<td>Nitrogen (N)</td>
<td>0.10</td>
<td>0</td>
</tr>
<tr>
<td>Furfural (Calculated as Pentosan)</td>
<td>10.00</td>
<td>40</td>
</tr>
<tr>
<td>Sugar (Calculated as Glucose)</td>
<td>0.30</td>
<td>50</td>
</tr>
<tr>
<td>Cellulose</td>
<td>60.00</td>
<td>70</td>
</tr>
<tr>
<td>Lignin</td>
<td>24.00</td>
<td>100</td>
</tr>
<tr>
<td>Cutin</td>
<td>5.00</td>
<td>140</td>
</tr>
<tr>
<td>Methoxyl</td>
<td>6.50</td>
<td>200</td>
</tr>
<tr>
<td>Chlorine (Cl)</td>
<td>0.10</td>
<td>270</td>
</tr>
<tr>
<td>Ash</td>
<td>0.50</td>
<td>Pan</td>
</tr>
</tbody>
</table>
WOOD FLOUR
(ORGANIC)

Purpose ...... reduces sand expansion defects and improves shakeout. Acts as a cushioning material and improves sand flowability.

Bulk Density .................. soft wood, 17-20 lb/ft³
                   hard wood, 25-30 lb/ft³

pH ........................................... 4.0-7.0*

% Volatile @ 900F (482C) .............. 96**
% Volatile @ 1800F (982C) .............. 98-99**
% Total Combustibles .................... .99

Approximate Temperature of Destruction .................. 700F (371C)

Effect on:
Green Compression Strength .......... little or none
Dry Compression Strength .......... decreases
Hot Compression Strength .......... decreases

Typical Chemical Analysis ................... a complete hydrocarbon

Miscellaneous Data or Observations
Increases temper water requirements.

*Varies with source.

**Volatile are of an oxidizing nature.
SAND ADDITIVES

Oils-Chemicals

• Oils-Chemicals
• Asphalt Emulsion
• Asphaltic Oils
• Kerosene (gaz yağı)
• Soda Ash
• Wetting Agent
ASPHALT EMULSION
(INORGANIC)

Description ............... asphalt bitumen, water and a suitable emulsifying agent
Purpose ........... improves casting peel and finish.
A replacement or supplement for seacoal.

Bulk Density ........................................ 8.4 lb/gal
pH .......................................................... 9.0
% Volatile @ 900F (482C) ....................... 92.0
% Volatile @ 1800F (982C) ....................... 99.3
Other ...................................................... 0.7
% Total Combustibles ................................. 99.8

Effect on:
Green Compression Strength ........ increases
Dry Compression Strength .......... increases
Hot Compression Strength ...... decreases

Miscellaneous Data or Observations
Asphalt emulsions are sometimes preferred due to ease of application and reduced fire hazard.

<table>
<thead>
<tr>
<th>Typical Cationic Emulsion (parts)</th>
<th>Typical Anionic Emulsion (parts)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asphalt .................................. 65</td>
<td>Asphalt bitumen .................. 55</td>
</tr>
<tr>
<td>Water .................................... 35</td>
<td>Water .................................. 44</td>
</tr>
<tr>
<td>Tallow diamine ....................... 0.30</td>
<td>Sodium linoleate .................. 0.10</td>
</tr>
<tr>
<td>Calcium chloride .................... 0.10</td>
<td>Alkali ................................ 0.01</td>
</tr>
<tr>
<td>Glacial acetic acid ............... 0.12</td>
<td></td>
</tr>
</tbody>
</table>
ASPHALTIC OILS
(ORGANIC)

Description: composed principally of hydrocarbons

Purpose: improves casting peel and finish

% Volatile @ 900°F (482°C) ......................... 95
% Volatile @ 1800°F (982°C) ...................... 98
% Total Combustibles ................................. 99

Effect on:
Green Compression Strength ............ increases
Dry Compression Strength .............. little or none
Hot Compression Strength .............. decreases

Miscellaneous Data or Observations
Liquid polymers of natural origin, thermoplastic.

Typical Chemical Analysis (Percent)

<table>
<thead>
<tr>
<th>Element</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>84.42</td>
</tr>
<tr>
<td>H</td>
<td>8.53</td>
</tr>
<tr>
<td>O</td>
<td>1.86</td>
</tr>
<tr>
<td>N</td>
<td>1.12</td>
</tr>
<tr>
<td>S</td>
<td>2.0</td>
</tr>
</tbody>
</table>
KEROSENE
(ORGANIC)

Description..........................hydrocarbon oil
byproduct of petroleum distillation
Purpose....... increases amount of volatiles, adds
lubricity, keeps sand moist longer
% Volatile @ 900F (482C) ...................... 99.95
Distillation End Point ................. 550F (288C)
% Total Combustibles ....................... 99.95
Effective Temperature of

   Destruction ............................ 500F (260C)

Effect on:
Green Compression Strength ............... decreases
Dry Compression Strength .................... decreases
Hot Compression Strength .................... decreases
Typical Chemical
Analysis.............................. a complex hydrocarbon

Miscellaneous Data or Observations
Specific gravity @ 68F (20C) ............... 0.785
Flammable boiling point between 302-572F (150-
300C).
POLYMERS
(ORGANIC)

Description.................. giant molecule formed when thousands of the original molecules have been linked together end-to-end

Typical Color.................. various

Purpose...................... supplement for cereal and to prevent expansion defects

Effect on:
Green Compression Strength .............. increases
Dry Compression Strength .............. increases
Hot Compression Strength .............. increases

Miscellaneous Data or Observations
These are generally organic. Used in conjunction with soda ash or tetrasodium pyrophosphate.
SODA ASH
(INORGANIC)

Description: sodium carbonate
Typical Color: white
Individual Characteristics: powder, hygroscopic
Purpose: pH control
pH (in aqueous solution): 11.6
Melting point: 1563 F (851 C)

Effect on:
Green Compression Strength: increases
Dry Compression Strength: increases
Hot Compression Strength: increases
Typical Chemical Analysis: Na₂CO₃

Miscellaneous Data or Observations
Specific gravity: 2.533
Molecular weight: 106
Soluble in water. Slightly soluble in absolute alcohol.
WETTING AGENT
(INORGANIC)

Description ...................... promotes spreading of a liquid over a solid. It must therefore have the property of reducing the contact angle to a value of zero.

Typical Color or Characteristics ....... may vary depending on type and source of supply

Purpose ...................... reduces the surface tension of water to such a point that temper water will spread and penetrate the material to be wetted to a far greater extent and in a faster time than is possible with regular water.

Effect on:
Green Compression Strength ........... increases
Dry Compression Strength ............ increases
Hot Compression Strength .......... no significant change

Miscellaneous Data or Observations
Wetting agents and emulsifiers are much the same kind of materials but seen from rather different viewpoints. Material may be organic or inorganic.

Typical Chemical Analysis (Percent)

<table>
<thead>
<tr>
<th>Component</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moisture</td>
<td>7.9</td>
</tr>
<tr>
<td>Polyoxyethylene Alkphenol surfactant</td>
<td>92.1</td>
</tr>
</tbody>
</table>
SAND ADDITIVES
Refractories (other than clays)

- Refractories (other than clays)
- Alumina
- Chromite Flour
- Fly Ash
- Iron Oxide
- Olivine Flour
- Silica Flour
- Staurolite Flour
- Zircon Flour
ALUMINA
(INORGANIC)

Description ........................................... $\text{Al}_2\text{O}_3$
Typical Color ........................................... white
Individual Characteristics ............... calcined alumina
Purpose ............. increases sand mixture refractoriness
Bulk Density ............. 47 lb/ft$^3$, loose
........................................... 60 lb/ft$^3$, packed
pH .................................................. 9.0-10.50
Fusion Point ................................. 3670°F (2021°C)
% Volatile @ 900°F (482°C) ............... 10
% Volatile @ 1800°F (982°C) ............... 10
% Total Combustibles ......................... 20
Effect on:
Green Compression Strength .............. increases
Dry Compression Strength ............... increases
Hot Compression Strength .............. increases

Miscellaneous Data or Observations
Produced by fusing bauxite in a special controlled atmosphere electric furnace.

Typical Chemical Analysis (Percent)

<table>
<thead>
<tr>
<th>Component</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\text{SiO}_2$</td>
<td>0.024</td>
</tr>
<tr>
<td>$\text{Al}_2\text{O}_3$</td>
<td>99.100</td>
</tr>
<tr>
<td>$\text{Fe}_{2}\text{O}_3$</td>
<td>0.015</td>
</tr>
<tr>
<td>$\text{H}_2\text{O}$ (combined)</td>
<td>0.100</td>
</tr>
<tr>
<td>$\text{H}_2\text{O}$ (absorbed)</td>
<td>0.100</td>
</tr>
</tbody>
</table>
CHROMITE FLOUR
(INORGANIC)

Typical Color ................. dark brown to black
Purpose ....................... reduces metal penetration
and improves surface finish

Bulk Density ................... 105 lb/ft³
Typical Sizing .................. 300 mesh
pH ............................... 7.0-9.5 (20% in H₂O)
Fusion Point ................... 3800F (2090C)
% Volatile @ 1800F (982C) .............. 0.12
Loss on Ignition ............... 0.02%
% Total Combustibles ............. 14
Effective Temperature of
  Destruction ................... 4500F (2482C)

Effect on:
Green Compression Strength ...... increases
Dry Compression Strength ........ increases
Hot Compression Strength .......... increases

Miscellaneous Data or Observations
Specific gravity .................. 4.45
Thermal exp (in./in.) .............. 0.005
Hardness (Moh scale) ............. 5.5
Classification — acid-base .......... basic
Percent lineal change after 2730F
  (1500C) firing ..................... 0 to -3
Sintering point (Dietert) ........ 2552F (1400C)
Wettability to molten metal .......... resistant
Apparent heat transfer
  compared to silica .............. very high

Typical Chemical Analysis (Percent)

<table>
<thead>
<tr>
<th>Element</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>SiO₂</td>
<td>45.80</td>
</tr>
<tr>
<td>MgO</td>
<td>8.75</td>
</tr>
<tr>
<td>Al₂O₃</td>
<td>21.34</td>
</tr>
<tr>
<td>CaO</td>
<td>0.94</td>
</tr>
<tr>
<td>Fe₂O₃</td>
<td>19.50</td>
</tr>
<tr>
<td>TiO₂</td>
<td>0.03</td>
</tr>
</tbody>
</table>

SAND ADDITIVES  Refractories (other than clays)
FLY ASH
(INORGANIC)

Typical Color .................................. gray
Purpose .................................. increases flowability
Typical Sizing ................................ Fineness:
    mean particle diameter, 6.3 microns
pH ............................................. 9.0
% Volatile @ 1800F (982C) .................. 2.73
Carbon ..................................... 1.83
% Total Combustibles ...................... 4.56
Effect on:
Green Compression Strength ............... increases
Dry Compression Strength ..................... increases
Hot Compression Strength ..................... increases

Miscellaneous Data or Observations
Permits castings to peel easier from sand cores. Fly ash is used more widely in aluminum core sand mixtures than for casting ferrous alloys.

<table>
<thead>
<tr>
<th>Typical Chemical Analysis</th>
<th>(Percent)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SiO₂</td>
<td>43.9</td>
</tr>
<tr>
<td>R₂O</td>
<td>34.8</td>
</tr>
<tr>
<td>MgO</td>
<td>2.3</td>
</tr>
<tr>
<td>SO₄</td>
<td>1.6</td>
</tr>
</tbody>
</table>
IRON OXIDE
(INORGANIC)

Description .................................. hematite ore
Color ....................................... red brown
Purpose ...................................... increases hot plasticity
and reduces or eliminates veining, metal
penetration, burn on, or pinhole porosity.
Also used as a coloring agent.

Bulk Density ................................. flour, 73.6 lb/ft\(^3\)
granular, 90.0 lb/ft\(^3\)

Typical Sizing .............................. 200 mesh
pH ............................................. 8.2 (20% \(H_2O\) solution)
Fusion Point ................................. 2850F (1565C)
% Volatile @ 1800F (982C) .............. 2.25 as loss on ignition
% Total Combustibles ..................... 2.25

Effect on:
Green Compression Strength .............. increases
Dry Compression Strength ................. increases
Hot Compression Strength ................. increases

Miscellaneous Data or Observations
Specific gravity ............................. 5.24
Bulk density ............................... 73.6 lb/ft\(^3\) 2.4 lb/qt; 37 lb/solid gal
Hardness (Moh scale) ........................ 6
Classification — acid-base ............... acid or basic
Wettability to metal ....................... not easily
Apparent heat transfer
 compared to silica ......................... average

Typical Chemical Analysis (Percent)

<table>
<thead>
<tr>
<th></th>
<th>(Fe_2O_3)</th>
<th>(CaO)</th>
<th>(Mn)</th>
<th>(MgO)</th>
<th>(SiO_2)</th>
<th>(Al_2O_3)</th>
<th>(P)</th>
<th>(H_2O)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>60.0-86.6</td>
<td>0.10-11.0</td>
<td>0.24-0.41</td>
<td>0.18-2.56</td>
<td>0.99-6.4</td>
<td>2.1-9.5</td>
<td>0.09-0.3</td>
<td>nil</td>
</tr>
</tbody>
</table>
OLIVINE FLOUR
(INORGANIC)

Typical Color ................................................. green
Purpose ..................................................... reduces or eliminates metal penetration and improves casting finish
Bulk Density .............................................. 91 lb/ft³
Typical Sizing ............................................. 200 mesh
pH .......................................................... 9.2-9.5 (20% in H₂O)
Fusion Point ............................................... 3400°F (1870°C)
% Volatile @ 900°F (482°C) ......................... 1
% Volatile @ 1800°F (982°C) ....................... 1.35 as loss on ignition
% Total Combustibles ................... increases

Effect on:
Green Compression Strength ........... increases
Dry Compression Strength ................. increases
Hot Compression Strength ................. increases

Miscellaneous Data or Observations
Specific gravity ........................................... 3.3
Hardness (Moh scale) ......................... 6.5-7.0
Thermal exp (in./in.) ......................... 0.0083
Classification — acid-base .............. basic
Sintering point ................................... 2507°F (1375°C)
% Lineal change after 2732°F
(1500°C) firing ........................................... -2.0
Wettability to molten metal ............. not easily
Apparent heat transfer
   compared to silica ......................... low

Typical Chemical Analysis (Percent)

<table>
<thead>
<tr>
<th>Chemical</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>MgO</td>
<td>49.4</td>
</tr>
<tr>
<td>SiO₂</td>
<td>41.2</td>
</tr>
<tr>
<td>Fe₂O₃</td>
<td>7.1</td>
</tr>
<tr>
<td>Al₂O₃ + MnO + CaO</td>
<td>1.8</td>
</tr>
<tr>
<td>CaO</td>
<td>0.2</td>
</tr>
<tr>
<td>H₂O</td>
<td>0.5</td>
</tr>
</tbody>
</table>
SILICA FLOUR
(INORGANIC)

Typical Color: white to light yellow

Purpose: increases hot and dry strengths and reduces or eliminates metal penetration

Bulk Density: 63.2 lb/ft³

Typical Sizing: 200* mesh

pH: 6.8-7.8 (10% in H₂O)

Fusion Point: 3110°F (1710°C)

% Volatile @ 1800°F (982°C): 0.070 as loss on ignition

Effect on:

Green Compression Strength: increases

Dry Compression Strength: increases

Hot Compression Strength: increases

Miscellaneous Data or Observations

Specific gravity: 1.59-2.66

Hardness (Moh scale): 6.00-6.50

Thermal exp (in./in.): 0.018

Classification — acid-base: acid

Sintering point: 2510°F (1375°C)

% Lineal change after 2732°F (1500°C) firing: +0.5

Wettability to molten metal: easily

Apparent heat transfer:

compared to silica: average

*140 mesh to 400 mesh available.

Typical Chemical Analysis (Percent)

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>SiO₂</td>
<td>99.820</td>
<td>Fe₂O₃</td>
</tr>
<tr>
<td>MgO</td>
<td>0.031</td>
<td>CaO</td>
</tr>
<tr>
<td>Al₂O₃</td>
<td>0.049</td>
<td>TiO₂</td>
</tr>
</tbody>
</table>
STAUROLITE FLOUR
(INORGANIC)

Typical Color ......................... reddish brown
Purpose .............................. increases hot plasticity
and reduces or eliminates veining
Bulk Density .......................... 100 lb/ft^3
Typical Sizing ....................... 95% through USA Sieve 200
Fusion Point ......................... 2800F (1538C)
% Total Combustibles ............... 0
Effective Temperature of
  Destruction ......................... 2800F (1538C)
Effect on:
  Green Compression Strength ...... increases
  Dry Compression Strength ........ increases
  Hot Compression Strength ........ increases

Miscellaneous Data or Observations
  Specific ............................ 3.6
  Hardness (Moh scale) ............... 7
  Different grinds available

<table>
<thead>
<tr>
<th>Typical Mineral Composition (Percent)</th>
<th>Typical Chemical Analysis (Percent)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Staurolite .......................... 77</td>
<td>Al₂O₃ .................................. 45 (min.)</td>
</tr>
<tr>
<td>Tourmaline ................................ 10</td>
<td>Fe₂O₃ ................................ 18 (max.)</td>
</tr>
<tr>
<td>Titanium minerals .................... 4</td>
<td>ZrO₂ .................................. 3 (max.)</td>
</tr>
<tr>
<td>Kyanite .................................. 2</td>
<td>TiO₂ ................................... 5 (max.)</td>
</tr>
<tr>
<td>Zircon .................................. 3</td>
<td>Free silica ............................. 5 (max.)</td>
</tr>
<tr>
<td>Quartz .................................. 4</td>
<td>Combined silicates .................. balance</td>
</tr>
</tbody>
</table>
ZIRCON FLOUR
(INORGANIC)

Typical Color ......................... white, tan
Individual Characteristics .......... calcined
Purpose ..................... increases sand mix refractoriness,
                          reduces or eliminates metal penetration
                          and improves casting surface finish
Bulk Density ....................... 114 lb/ft³
Typical Sizing ..................... 200-325 mesh
pH ................................ 5.7-6.4 (10% in H₂O)
Fusion Point ....................... 3800 F (2100 C)
% Volatile @ 900 F (482 C) ............ 0.10
% Volatile @ 1800 F (982 C) 0.10 as loss on ignition
% Total Combustibles ............... 10
Effective Temperature of
  Destruction ....................... 4100 F (2260 C)
Effect on:
  Green Compression Strength .......... increases
  Dry Compression Strength .......... increases
  Hot Compression Strength .......... increases

Miscellaneous Data or Observations
  Specific gravity ................... 4.4-4.7
  Hardness (Moh scale) ............... 7.0-7.5
  Thermal exp (in./in.) .............. 0.003
  Classification — acid-base ........ acid
  Sintering point ................... 2552 F (1400 C)
  % Lineal change after 2732 F
  (1500 C) firing .................. -2.0
  Wettability to molten metal .......... resistant
  Apparent heat transfer
    compared to silica ................ high

Typical Chemical Analysis (Percent)

<p>| | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>SiO₂</td>
<td>33.50</td>
<td>Fe₂O₃</td>
<td>0.02</td>
</tr>
<tr>
<td>ZrO₂</td>
<td>66.50</td>
<td>TiO₂</td>
<td>0.14</td>
</tr>
</tbody>
</table>
SAND ADDITIVES
Starches-Solubles (Cereals)

- Solubles
  - Bran Flour (kepek unu)
  - British Gum
  - Corn Flour
  - Dextrin
  - Lignin Sulfate
  - Molasses (pekmez – melas)
  - Sodium Silicate
  - Wheat Flour
• They include corn flour, dextrine, and other starches, are adhesive when wetted and therefore act as a binder.

• They stiffen the sand and improve its ability to draw deep pockets. However, use of cereals makes shakeout more difficult, and excessive quantities make the sand tough and can cause the sand to form balls in the muller. Because cereals are volatile, they can cause gas defects in castings if used improperly.
BRAN FLOUR
(ORGANIC)

Description ......................... cereal binder
Purpose ......................... green strength additive
Effect on:
Green Compression Strength .......... increases
Dry Compression Strength .......... decreases
Hot Compression Strength .......... decreases

Miscellaneous Data or Observations
Similar to corn, wheat and rye flours.
BRITISH GUM
(ORGANIC)

Description ................ form of dextrin that has high tack characteristics
Typical Color ................. light to dark brown
Purpose ..................... bonding agent in green sand molding with a wide range of properties

Effect on:
Green Compression Strength ..... slight increase
Dry Compression Strength ......... increases
Hot Compression Strength ........ increases
Chemical Formula .............. $C_6H_{10}O_5$

Miscellaneous Data or Observations
Little or no acid is used in preparation. Longer baking time used in preparation; otherwise similar to dextrin. Highly soluble. Very gummy when mixed with water. British gum solutions are quite stable and have good film-forming properties.
CORN FLOUR
(ORGANIC)

Description ........... highly gelatinized cereal binder produced from a corn dry milling process

Typical Color .......... light to dark yellow

Purpose ............... additive for green sand mold facing mixes, decreases buckles, rat tails, scabs, erosion; increases green deformation

Bulk Density ........... heavy weight 37 lb/ft³, 5.00 lb/gal
                      light weight 19 lb/ft³, 2.6 lb/gal

pH ........................ 4.4-6.5

% Volatile @ 1800F (982C) ................. .99

% Total Combustibles ................. 99.5

Effective Temperature of Destruction ........... 600-700F (316-371C)

Effect on:
Green Compression Strength ............... increases
Dry Compression Strength ................ increases
Hot Compression Strength ............... increases up to 500F (260C)

Miscellaneous Data or Observations
Increases green deformation 0-2% with or without change in green strength. Decreases spalling, scabbing. Increases gas. Decreases permeability. Used 0.4-1.3% by weight in facing sands. Increases toughness and plasticity. Quick drying in oven. High moisture absorption. Increases sag and overhead properties in core mixes. Increases collapsibility. Reduces rate of drying out of fireclay and bentonite bonded sands.

Typical Analysis (Percent)

<table>
<thead>
<tr>
<th>Property</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moisture</td>
<td>4-9</td>
</tr>
<tr>
<td>Ash</td>
<td>0.3-0.5</td>
</tr>
<tr>
<td>Water Soluble</td>
<td>10-27.5</td>
</tr>
<tr>
<td>Dextrin</td>
<td>18-24</td>
</tr>
</tbody>
</table>
DEXTRIN
(ORGANIC)

Description...................... a soluble gummy carbohydrate formed by the decomposition of starch by heat, acid or enzymes

Typical Color or Characteristics........... from white to canary, dependent on amount of acid and degree of heat used in its preparation

Purpose.................... dry binder in foundry binder compounds and foundry core washes. Reduces brittleness and friability in molding sand mixes. Increases dry compression strength. Improves surface hardness.

Bulk Density....................... 31.5-41.5 lb/ft³ dependent on degree of packing

pH.................................. 3.5-5.0

% Total Combustibles............... 99.2

Effective Temperature of Destruction
start decomposing at 350-430°F (176-221°C)
completely decomposed at 650-750°F (343-399°C)

Effect on:
Dry Compression Strength.............. increases
Dry Shear Strength..................... increases
Hot Compression Strength.............. no change or increased slightly
Green Strength...................... no change

Miscellaneous Data or Observations
Decreases flowability if used in excess. Decreases scabbing. Increases smoothness. Causes sand to be more tacky. Used 1/8 to 1-1/2% by weight. Reduces drying out in the mold. Tends to soften in humid atmosphere. Variable amount of gas produced. Soluble dextrin material migrates toward outer edges producing a high dry sand hardness on the surfaces. Hardens in bag in humid storage.

Typical Analysis (Percent)

Moisture.............. 3-6
Water soluble........ 98
Reducing sugar as dextrose ....... (of soluble) 4
LIGNIN SULFATE
(ORGANIC)

Description ....................... a sulfite pulp byproduct binder (sulfite lye) (lignin liquor)
Typical Color ........... if dried — light brown powder
Individual Characteristics .......... dark liquid 60-70% solids.
Purpose ...................... binder for clay materials.
                      Surface hardener for oil sand cores.
Bulk Density ....................... 54 lb/ft$^3$ dry.
Fusion Point ............... 1900-2700°F (1037-1482°C)
Melting Point ............... 482-527°F (250-275°C)
% Volatile @ 275°F (135°C) .......... 50
Effective Temperature of Destruction .............. 212-400°F (100-205°C)
Effect on Dry Compression Strength .......... increases
Typical Chemical Analysis .......... a form of C$_{47}$H$_{32}$O$_{6}$

Miscellaneous Data or Observations
Binding power for open sands is poor. The higher the moisture, the harder the core. High moisture promotes concentration at the surface and gives a slight shell structure to the core. Avidity for moisture makes dry storage advisable. Causes sand to fuse. Forms hard mold edges or forms a surface shell. Usually contains lime; fairly collapsible. Bad odor, low in gas. Used in the range of 0.2-1.0% by weight. Grade is partly dependent on the process procedure used to manufacture. Completely soluble in water. Non-fermentable (stable in storage). As a mold spray dilute 1:1 with water or 1:20. Has high binding power for clay materials.
MOLASSES
(ORGANIC)

Description ........... product of refining cane and beet sugar (cane or blackstrap molasses)

Typical Color ..................... black

Individual Characteristics ........ syrup usually diluted with water

Purpose ..................... increases dry strength, usually torch dried or can be air dried

Effective Temperature of Destruction ................... 212-750°F (100-399°C)

Effect on Dry Compression Strength .... increases

Miscellaneous Data or Observations
60-70% solids. Used diluted with water 1:15 by volume. Holds the last traces of moisture tenaciously. Molasses spray provides a superficial crust. Never used alone.
RYE FLOUR
(ORGANIC)

Description.......................... cereal binder
Purpose ................................ green strength additive
Bulk Density ................................ 45 lb/(ft³)
Effect on:
Green Compression Strength .......... increases
Dry Compression Strength ............. increases
Hot Compression Strength ............ decreases

Miscellaneous Data or Observations
Reduces expansion without increasing deformation as much as corn cereal. Increases permeability. Increases gas.
**SODIUM SILICATE**  
**INORGANIC**

**Description** (water glass) a viscous liquid which when mixed with powdered fireclay forms a refractory cement. Compositions of sodium oxide and silica in varying proportions.

**Individual Characteristics**  
Clear liquid; powder form can contain 0-17% H₂O.

**Purpose**  
Secondary binder in clay-bonded sand. Reduces brittleness and friability in molding sand mixtures.

**Bulk Density**  
11.6-13.0 lb/gal @ 60°F (16°C)

**pH**  
10.8-12.8

**Effect on:**

**Green Compression Strength**  
Increases

**Dry Compression Strength**  
Increases

**Typical Chemical Analysis**

\[
xNa_2O\cdot ySiO_2 \cdot H_2O
\]

<table>
<thead>
<tr>
<th>Ratio</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>SiO₂:Na₂O</td>
<td>1.6 to 3.3</td>
</tr>
<tr>
<td>SiO₂:H₂O</td>
<td>0.46 to 0.63</td>
</tr>
</tbody>
</table>

**Miscellaneous Data or Observations**

Can be hardened with CO₂ or by air setting. Tends to allow fusion of the sand. Sugar acts as hygroscopic agent in sodium silicate systems. Solid hydrates of low ratio sodium silicates dissolve quite readily. Has a tendency to spall. Has poor shakeout characteristics. Most common method of manufacture is to heat mixtures of sodium carbonate and silica sand in open hearth type furnaces. Viscosities comparable to light-to-heavy syrups are produced with SiO₂:Na₂O ratios from 1.6 to 3.75. Sand mixtures are quite sticky. Over milling of sand mix causes progressive stickiness and compacted molds tend to become friable after gassing. Silicate bonded sand has high chilling power. Propensity to hot tears not any greater with CO₂ process compared to conventional materials. If SiO₂:Na₂O ratio is above 3, then the bond is weak and friable. The lower the SiO₂:Na₂O ratio, the longer the gassing time required.
WHEAT FLOUR
(ORGANIC)

Description.......................... cereal binder
Purpose............................... green strength additive, reduces expansion
Bulk Density.......................... 28 lb/ft³ loose, 47 lb/ft³ compacted

Effect on:
Green Compression Strength......... increases

Miscellaneous Data or Observations
Reduces expansion without increases in deformation as much as corn cereal. Increases permeability. Increases gas.
Sand Reclamation

- The economics of a foundry operation require sand reclamation to reduce the costs associated with new sand and the costs of landfill use, and to reduce the problems associated with the control of environmentally undesirable contaminants in the discarded sand.
• In addition, tangible operational advantages result from sand reclamation. These begin with the ability to select the best sand for the casting process, knowing that most of it will be reclaimed during operation. In addition, the use of reclaimed sand reduces the number of variables that must be controlled, and provides operational consistency over a period of time.

• Sand grain shape and distribution and binder system bonding are more uniform, thus reducing sand defects. A properly designed sand reclamation system begins with green sand and converts it to a product very similar to new sand. Figure 5 shows the appearance of sand before casting, after molding, and after reclamation.
Fig. 5 Influence of sand reclamation on the appearance of green sand. (a) After molding (no reclamation). (b) After thermal reclamation. (c) New sand.
• Sand reclamation begins with the removal of tramp and foreign materials, such as core rods, metal spills, slag, and paper, and the disintegration of lumps of sand. Then organic and inorganic binders are removed by attrition (scrubbing) and/or thermal methods. Dead clay is removed as fines. The sand is then brought up to specification by the addition of new sand, clay, and other sand additives.

• Sand reclamation systems must be selected with regard to their cost, the specifications for the system sand, system capacity, compatibility with the sand system, metal being poured, and core mixes being used. It is important for the foundry to have a clear understanding of its needs in sand reclamation before calling in vendors. A variety of reclamation systems are described below.
Wet Washing/Scrubbing

• The cores of large castings can be removed by high-velocity jets of water. In the process, the cores are broken down into grains, and some binder is removed. Excess molding sand can be added and washed simultaneously. If the shakeout system is dry, the sand is charged into an agitator system where the solid content is held between 25 and 35%. Excess molding sand may be blended with the core knockout material. A similar system uses intensive scrubbing with a solids content of 75 to 80% and units in series.
• This latter method is superior because of closer and more frequent grain-to-grain contact. After washing, the sand is classified and may be used either wet (naturally drained to 4 to 5% moisture) and added to a system sand, dried for cores, or used for facing sand.

• Facing sand mixes derive their name from the fact that they are used in limited quantities against the face of the pattern or core box. They have properties usually different from those of the backup or system sand and contain additives not otherwise present. Facing sands are designed to perform special functions, such as providing higher green strength for lifting deep pockets, higher deformation for limited draft patterns, and special carbons that enhance skin drying.

• The wet system has limitations in that only a portion of the binder, clay, and carbon is removed. The product, however, is excellent for use as a makeup sand in systems.
Dry Scrubbing/Attrition

• This method is widely used, and there is a large variety of equipment available in price ranges and capacities adaptable to most binder systems and foundry capacities. Dry scrubbing may be divided into pneumatic, mechanical, and combined thermal-calcining/thermal-dry scrubbing systems.
In pneumatic scrubbing

• In pneumatic scrubbing, grains of sand are agitated in streams of air normally confined in vertical steel tubes called cells. The grains of sand are propelled upward and rub and impact each other, thus removing the binder. In some systems, grains are impacted against a steel target. Banks of tubes may be used depending on capacity and degree of cleanliness desired. Retention time can be regulated, and fines are removed through dust collectors.
In mechanical scrubbing

- **In mechanical scrubbing**, the equipment available offers foundrymen a number of techniques for consideration. An impeller may be used to accelerate the sand grains at a controlled velocity in a horizontal or vertical plane against a metal plate. The sand grains impact each other and metal targets, thereby removing the binder. The speed of rotation has some control on impact energy. The binder and fines are removed by exhaust systems, and screen analysis is controlled by air gates and/or air wash separators.
Thermal-Calcining/Thermal-Dry Scrubbing Combinations

• These systems offer the best reclamation for the organic and clay-bonded systems. Grain surfaces are not smooth; they have numerous crevices and indentations. The application of heat with sufficient oxygen oxidizes the binders or burns them off. In attrition, only because there is no contact in the crevices, the binder remains. Heat offers the simplest method of reducing the encrusted grains of molding sand to pure grains. Both horizontal and vertical rotary kiln and fluidized bed systems are available.
In the horizontal rotary kiln, material is fed into one end (usually the cold one) and moved progressively through the heat zone by rotation assisted by baffles, flights, or other mechanical means. Some mechanical scrubbing also occurs. Some systems incorporate heat exchanger technology to considerably reduce the energy required. The latest technology also includes provision for recovery of metal entrained in the sand and collection and detoxification of the process wastes for suitable nonhazardous waste disposal.
• Several fluidized bed system designs are available. Some use preheating chambers and hot air recuperation. A drying compartment may also be added. Sand is introduced into the top (preheating) chamber of the reactor and is lifted by the hot air stream from below until it assumes some of the characteristics of a fluid. The hot air coming in contact with the sand grains burns the organics and calcines the clay. At the same time, some attrition takes place. A correct pressure differential must be maintained between the compartments if more than one is used in order to ensure downward flow of sand; otherwise gravity flow must be provided. Fluidizing is a very good method for cooling sand when using cool air.
Multiple-Hearth Furnace/Vertical Shaft Furnace

- The multiple-hearth furnace consists of circular refractory hearths placed one above the other and enclosed in a refractory-lined steel shell. A vertical rotating shaft through the center of the furnace is equipped with air-cooled alloy arms containing rabble blades (plows) that stir the sand and move it in a spiral path across each hearth. Alternate hearths are "in" or "out." That is, sand is repeatedly moved outward from the center of a given hearth to the periphery, where it drops through holes to the next hearth. This action gives excellent contact between sand grains and the heated gases.
• Material is fed into the top of the furnace. It makes its way to the bottom in a zigzag fashion, while the hot gases rise counter currently, burning the organic material and calcining clay, if one or both are present. Discharge can be directly from the bottom hearth into a tube cooler, or other cooling methods may be used. The units are best suited to large tonnages, that is, five tons or more. They are extremely rugged and relatively maintenance free.
Combinations of systems

- **Combinations of systems** may also be used, for example, thermal methods followed by dry attrition scrub to remove calcined clay from molding sand or undesirable chemicals and oxides from core processes. Also, commercial centers for sand reclamation are in operation and may be used by smaller foundries.
Şekil 3.15 Kuru kum yenileme sistemi.
Şekil 3.16  Yağ kum yenileme sistemi.
Şekil 3.17 Yaş-Isısal kum yenileme sistemi.
Sand testing

Regular testing of the properties of the sand is essential. One or two sand tests do not truly indicate the condition of the whole sand system, since a sand sample weighs only about 1 kg and cannot represent the whole 200 tonnes or so of the system. At least 5 samples should be taken per shift and measured for moisture, green strength, compactability and permeability. LOI and volatiles should be measured once per day. Active clay, twice per week.

Records of additions should also be kept:

Weight of clay, coal dust and new sand added each day
Number of moulds made
Weight of metal poured
Weight of used sand removed from the system each day
Control graphs

Individual figures mean rather little, but daily average sand properties should be plotted together with weekly figures of active clay and average additions of clay, coal dust and new sand. After a few weeks of plotting the data, it will be possible to draw control lines. Variation within the lines is permissible but if results appear outside the control lines, then action must be taken such as increasing or reducing clay or coal or new sand. If action is
Figure 12.3  Flow diagram for a typical green sand plant. (From Foundryman, March 1998, p. 102. Courtesy Foundry and Technical Liaison Ltd.)
Figure 12.3  Flow diagram for a typical green sand plant. (From Foundryman, March 1996, p. 102. Courtesy Foundry and Technical Liaison Ltd.)

Figure 12.4  Vertical wheel batch muller. (Sixth Report of Institute Working Group 730, Mould and Core Production. Foundryman, Feb. 1986.)
Kuvars Kumu

ATİLLA UÇAR
KUMSAN A.Ş. ŞUBAT 2008
Kullanıdıkları sanayı dah ve tabiatta bulunan kalitesine göre değişiklik gösteren Kuvars kumları, genel olarak Cam ve Döküm sanayinde kullanılmakla beraber inşaat, boya ve plastik sanayinde ayrıca yapı kimyasalları ve aşındıricıların üretiminde de kullanılmaktadır.

Kuvars kumları kuvarsça zengin magmatik, metamorfik kayaçların ayrışması sonucu oluşan, 2 mm’den küçük kuvars (SiO₂) tanecikleridir. Kuvars kumları beyaz renklidir, demir oksit içermeye durumlarına göre renkleri pembeden kahverengi kadar değişebilir. Silisten oluşan (SiO₂) kuvars kumu, az miktarda kil, feldspat, demir oksitler, karbonatlar ihtiva edebilir.

Doğada saf olarak bulundukları gibi istenmeyen safsızlıklar ile karışmış olarak ta bulunabilirler. Döküm sanayinde kullanılan Kuvars kumları maden sahalarının içerisinde % 95’in üzerinde (SiO₂), % 7-15 kil. ihtiva eden ve sinterleşme sıcaklığı 1500 °C’nin üzerinde bulunan kumdur.
Döküm sektöründe kullanılan Kuvars Kumlari, doğada daha serbest taneler halinde bulunup, daha gevşek karakterli yapıya sahiptirler.

Dünya Kuvars kumu üretim kapasitelerinin 150 Milyon ton seviyelerinde olduğu bilinmektedir. Dünya Kuvars kumu rezervlerinin ise sağlıklı bir şekilde hesaplanamamasına rağmen, rezervlerin, rezerv sırasına göre; **Avrupa:** Belçika, Almanya, Hollanda, Fransa, İngiltere, İspanya, İtalya, Avusturya, Rusya

<table>
<thead>
<tr>
<th>ÜLKЕ</th>
<th>TÜCKETİM (Bin ton)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rusya</td>
<td>10.800</td>
</tr>
<tr>
<td>A.B.D</td>
<td>5.470</td>
</tr>
<tr>
<td>Almanya</td>
<td>2.745</td>
</tr>
<tr>
<td>Fransa</td>
<td>1.428</td>
</tr>
<tr>
<td>İtalya</td>
<td>1.245</td>
</tr>
<tr>
<td>Brezilya</td>
<td>871</td>
</tr>
<tr>
<td>Çekoslovakya</td>
<td>860</td>
</tr>
<tr>
<td>İngiltere</td>
<td>853</td>
</tr>
<tr>
<td>Kore</td>
<td>837</td>
</tr>
<tr>
<td>Polonya</td>
<td>755</td>
</tr>
<tr>
<td>Romanya</td>
<td>609</td>
</tr>
<tr>
<td>Tayvan</td>
<td>561</td>
</tr>
<tr>
<td>Meksika</td>
<td>508</td>
</tr>
<tr>
<td>İspanya</td>
<td>501</td>
</tr>
<tr>
<td>Kanada</td>
<td>450</td>
</tr>
<tr>
<td>Türkiye</td>
<td>450</td>
</tr>
<tr>
<td>Avusturya</td>
<td>151</td>
</tr>
<tr>
<td>Belçika</td>
<td>146</td>
</tr>
</tbody>
</table>

Kuvars kumu üretimi içinde yer alan Dünya Genelinde Döküm kumu tüketimleri ilk sıralara göre yandaki tabloda gösterilmiştir.
Sektörde üretim yapan önemli kuruluşlar:
Avrupa’da SCR Sibelco SA (Belçika) firması dört kitada 120 Tesisi ile Dünyada kuvars kumu üretiminde lider konurdu.

Dünyada Kuvars kumu üretimini ve pazarını aşağıdaki firmalar kontrol altında tutmaktadır.

Avrupa Birliği Firmaları: SCR-Sibelco (Belçika), Quarzwerke GmbH (Almanya), Hepworth Minerals ve Chemicals Ltd. (Inglite), Saint – Gobain (Fransa), Samin (Fransa), Sifraco (Fransa)
Türkiye’de Durum:
Türkiye’de çökel kayaların ayrışmasıyla serbest hale gelen kuvars taneleri, akarsularla taşınma sırasında, bir miktar kil ile beraber karasal havzalarda çökelmişlerdir.

Şile ve Zonguldak Yöreleri kuvars kumu yataklanmaları açısından çok zengin olup, Türkiye’nin en önemli maden havzalarındandır.

Elemanları orta ve ince taneli kuvars yada kuvars-sitten ibaret olan sılış kumları, yörede üst kotalarda geniş bir yayılma sahip olduklarını için aranıp bulunması kolay olduğu gibi işletmecilik ve çevre açısından sorunları en az olan hammadedir.

Özellikle Şile Bölgesinde büyük bir yataklanma gösteren kuvars kumları gerek jeolojik yapıları gerekse işletme tesislerinde uygulanan ileri teknoloji nedeni ile Döküm Sanayi Kuruluşlarının taleplerine uygun ürün niteliğindedir ve Türkiye döküm kumu tüketiminin tamamını karşılamaktadır.
Rezervler: İstanbul Şile yörəsində;
- Görünür rezerv 55 Milyon Ton
- Muhtemel rezerv 23 Milyon Ton
- Toplam 78 milyon tondur.

ÜRETİM


Üretimde Dozer, Loder ekskavatör, Kamyon ve Konveyörler kullanılır. Ekonomik olarak kum üretilebilmesi için, kumun üzerindeki kaldırılacak olan örtü tabakasının kalınlığının, örtü/kum 1/4 seviyesinde olması öngörülür.

Üretim yapılacak alanda 20-30 m eninde ve 50-100 m boyunda, panolar seçilmekte olup, önce paletli kepçeler vasıtası ile 2-4 m kalınlığında örtü tabakası alınmakta, daha sonra aynı makine techizatı ile döküm kumu üretimi yapılarak...
damperli kamyonlara yüklenmiş ve bu kamyonlar vasıtası ile Entegre Döküm Kumu Hazırlama Tesislerine taşınmaktadır.

Ocaktan üretilerek Tesislere getirilen ham kum lastik tekerlekli kepçeler ile silolara beslenmekte, eleklerden su ile karışım sağlanmıştır sonra pompalar vasıtası ile, sıklonlardan geçirilerek yıkama, karıştırıcı, tasnif ünitelerine taşınmaktadır daha sonra dinlendirilerek rutubeti % 7 seviyelerine getirilip mamul silolarına aktarılmaktadır.
Fiyatlar:
Kuvars kumu fiyatları sınıflandırma, kullanımyerii, kalite açılarından büyük farklılıklar içermektedir. Buna rağmen standartlar ve kullanım alanlarına bağlı olarak oluşan fiyat seviyeleri aşağıda verilmiştir.

<table>
<thead>
<tr>
<th></th>
<th>Türkiye, Avrupa</th>
<th>ABD</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Fob $/ton</td>
<td>Fob$/ton</td>
</tr>
<tr>
<td>Cam Sanayi</td>
<td>10-15</td>
<td>17</td>
</tr>
<tr>
<td>Döküm Sanayi</td>
<td>18-22</td>
<td>14</td>
</tr>
<tr>
<td>Seramik Sanayi</td>
<td>20-100</td>
<td>53</td>
</tr>
<tr>
<td>Yapı Kimyasal</td>
<td>18-25</td>
<td>19</td>
</tr>
<tr>
<td>İnşaat ve Diğer</td>
<td>---</td>
<td>---</td>
</tr>
</tbody>
</table>

Kum fiyatlarının en önemli noktası navlun fiyatlarının kum fiyatlarından yüksek olabildir. Avrupa'da Döküm Kumların önemli miktarı kurutulmuş pazarlandığından yukarıdaki fiyatlar yaş fiyatlar olup yaklaşıktır.
İHRACAT
İhracat açısından navlun fiyatlarının kuvars kumu maliyetlerinin üstünde seyretmesi, ayrıca rezerv sıkıntları ve kalite gibi nedenler dolayısı ile kuvars kum ihracatında iddialı olduğuuzun söylenememek.

Sınıflandırma:
Enterge Döküm Kumu Hazırlama Tesislerinden elde edilen döküm kumlarının fiziksel, kimyasal ve teknolojik özellikleri şöyledir;

Sinterleşme Sıcaklığı: 1500 °C üzerinde
Yanma Kaybı (%): 0,011 - 0,30
Kil Oranı (%): 0,16 - 1,27
<table>
<thead>
<tr>
<th>A.B.D STANDART ELEK NO</th>
<th>mm</th>
<th>Mikrun</th>
<th>Ø</th>
<th>KIRINTI</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>4</td>
<td>-2</td>
<td>İNCE ÇAKIL</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>3.86</td>
<td>-1.0</td>
<td>ÇAKIL</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>2.83</td>
<td>-0.75</td>
<td>ÇOK İRİ KUM</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>2.38</td>
<td>-0.50</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>2.00</td>
<td>-0.25</td>
<td>İRİ KUM</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>1.68</td>
<td>-0.25</td>
<td>İRİ KUM</td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>1.41</td>
<td>0.25</td>
<td></td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>1.19</td>
<td>0.50</td>
<td></td>
<td></td>
</tr>
<tr>
<td>18</td>
<td>1.00</td>
<td>0.75</td>
<td></td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>0.84</td>
<td>0.25</td>
<td></td>
<td></td>
</tr>
<tr>
<td>25</td>
<td>0.71</td>
<td>0.50</td>
<td></td>
<td></td>
</tr>
<tr>
<td>30</td>
<td>0.59</td>
<td>0.75</td>
<td></td>
<td></td>
</tr>
<tr>
<td>35</td>
<td>0.50</td>
<td>1.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>40</td>
<td>0.42</td>
<td>1.25</td>
<td>ORTA BOY KUM</td>
<td></td>
</tr>
<tr>
<td>45</td>
<td>0.35</td>
<td>1.50</td>
<td>KUM</td>
<td></td>
</tr>
<tr>
<td>50</td>
<td>0.30</td>
<td>1.75</td>
<td></td>
<td></td>
</tr>
<tr>
<td>60</td>
<td>0.25</td>
<td>2.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>70</td>
<td>0.210</td>
<td>2.25</td>
<td>İNCE KUM</td>
<td></td>
</tr>
<tr>
<td>80</td>
<td>0.177</td>
<td>2.50</td>
<td></td>
<td></td>
</tr>
<tr>
<td>100</td>
<td>0.149</td>
<td>2.75</td>
<td></td>
<td></td>
</tr>
<tr>
<td>120</td>
<td>0.125</td>
<td>3.00</td>
<td>ÇOK İNCE KUM</td>
<td></td>
</tr>
<tr>
<td>140</td>
<td>0.105</td>
<td>3.25</td>
<td></td>
<td></td>
</tr>
<tr>
<td>170</td>
<td>0.088</td>
<td>3.50</td>
<td></td>
<td></td>
</tr>
<tr>
<td>200</td>
<td>0.074</td>
<td>3.75</td>
<td></td>
<td></td>
</tr>
<tr>
<td>230</td>
<td>0.0625</td>
<td>4.00</td>
<td>İRİ MIL</td>
<td></td>
</tr>
<tr>
<td>325</td>
<td>0.044</td>
<td>4.50</td>
<td>ÇAMUR</td>
<td></td>
</tr>
</tbody>
</table>
Kum Köşeliği: 1,25 - 1,27
Öğülme (%): 40,8
H₃PO₄ te yanma kaybı (%): 0,1
Kızdırma Kaybı (%): 0,36
SiO₂: % 97 - 99
Al₂O₃: % 0,5 - 1,2
Fe₂O₃: % 0,015 - 0,30
MgO: % 0,015 - 0,030
K₂O: % 0,03 - 0,08
Na₂O: % 0,02 - 0,09
TiO₂: % 0,01 - 0,04
<table>
<thead>
<tr>
<th>Kuruluşun Adı</th>
<th>Yeri</th>
<th>Üretim Konusu</th>
<th>Kapasitesi (Binton/yıl)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cam iş Madencilik A.Ş.</td>
<td>Yahkoly</td>
<td>Cam Kumu</td>
<td>1000</td>
</tr>
<tr>
<td>Cam iş Madencilik A.Ş.</td>
<td>Kırklareli</td>
<td>Cam Kumu</td>
<td>1000</td>
</tr>
<tr>
<td>Sıltas A.Ş.</td>
<td>İstanbul</td>
<td>Döküm Kumu</td>
<td>300</td>
</tr>
<tr>
<td>Kumsan A.Ş.</td>
<td>İstanbul</td>
<td>Döküm Kumu</td>
<td>250</td>
</tr>
<tr>
<td>Çeliktaş A.Ş.</td>
<td>İstanbul</td>
<td>Döküm Kumu</td>
<td>150</td>
</tr>
<tr>
<td>Erbatu A.Ş.</td>
<td>İstanbul</td>
<td>Döküm Kumu</td>
<td>80</td>
</tr>
<tr>
<td>Trakya Silis A.Ş.</td>
<td>İstanbul</td>
<td>İnşaat,Dolgu</td>
<td>200</td>
</tr>
<tr>
<td>Marmara Silis A.Ş.</td>
<td>İstanbul</td>
<td>İnşaat,Dolgu</td>
<td>110</td>
</tr>
<tr>
<td>Matel A.Ş.</td>
<td>Bilecik</td>
<td>Seramik Kumu</td>
<td>40</td>
</tr>
<tr>
<td>Esan A.Ş.</td>
<td>Bilecik</td>
<td>Seramik Kumu</td>
<td>20</td>
</tr>
<tr>
<td>Kale Maden</td>
<td>Ş ile</td>
<td>Seramik Kumu</td>
<td>100</td>
</tr>
<tr>
<td>Dış α</td>
<td>-</td>
<td>Seramik Kumu</td>
<td>90</td>
</tr>
</tbody>
</table>

Döküm, Cam, Seramik, Boya sanayilerinin kuvars kumu ihtiyaçlarını karşılayan kuruluşların Listesi aşağıdadır. Türkiye Kuvars Kumu üretiminin büyük bir kısmını yukarıda belirtilen bu firmalar karşılamaktadır. Bu firmalardan Siltaş A.Ş. 'nin Şilede 2, Kumsan'ın Şile ve İstanbul Tuzla'da birer tesisleri, Çeliktaş firmasının ise Şile'de bir tesisı mevcuttur.
KUVARS KUMU YURTİÇİ TALEP PROJEKSİ-YONU ( Bin Ton )

Döküm sektöründeki artan talep, buna bağlı fabrikaların döküm üretimi kapasiteleri artmasına rağmen, kum üreticileri mevcut kapasiteleri ile bu talepleri karşılayabilecek düzeydedirler.

Döküm fabrikalarının önemli bir atığı olan proses sonrası oluşan atık kum, son yıllarda bilindiği gibi bu fabrikalar çevreSEL baskıların odağlı haline getirmiştir. Bir çok önemli döküm üreticisinin kuman geri kazanımını sağlayan rejenerasyon yatırımlarına yönelmesi, artan
Son yıllarda önemli bir gelişmesi de inşaat kolundadır. Özellikle Yapı Kimyasalları, Seramik Fayans Yapılaştırıcıları yüksek oranlarda döküm sektörü ile aynı sınıflandırma kategorilerine sahip kuru kum talebinde bulunmaktadırlar. Bu talep çok önemli bir şekilde büyümeekte olup, Döküm üreticileri talebinin çok üzerinde seyretmektedir.

Bu çerçevede kum üreticileri, kapasitelerinin önemli bir kısmını Yapı Kimyasalları ve inşaat sektörüne ayır-
makta ve katma değeri yüksek kuru kum vermektedirler. Yapı Kimyasallar ve İnşaat sektöründe artarak devam eden bu talep, Döküm sektöründe üretim yapan firmaları döküm kumu tedariki ve maliyet açısından ciddi sıkıntılaraya sokabilir.
Šile Bölgesi özellikle Döküm ve İnşaat sektörü üreticilerinin talebine uygun tane aralığına sahip rezervlere sahiptir.
Döküm Kumunun kullanıldığı Döküm yolu ile üretilen manüllerin sınıflandırılması:

<table>
<thead>
<tr>
<th>KULLANICI SEKTÖR</th>
<th>MAL TANIMLARI</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Otomotiv Sanayi</td>
<td>Otomobil, Traktör, Kamyon, Otobüs, Çekici Minibüs, Treyler üretiminde kullanılan döküm parçalar.</td>
</tr>
<tr>
<td>2 İnşaat Sanayi</td>
<td>Fittings, Radyatör, kazan, Küvet, Soba, Kanalizasyon izgara v.s.</td>
</tr>
<tr>
<td>3 Makine İmalat Sanayi</td>
<td>İş Makinaları, Takım Tezgahları, Tarma aletleri ve makinaları, Çimento, Tuğla ve Refraktör İmalat Sanayi, Kaldırma Makinaları, Pompa, Vana Kimya Sanayi Parçaları, Dişli ve Makaralar, Kompresör v.s.</td>
</tr>
<tr>
<td>4 Çelik Sanayi</td>
<td>İngot Kalibi, Mardane Taban Plakaları v.s.</td>
</tr>
<tr>
<td>5 Basınçlı Döküm Boru</td>
<td>Pik ve Sfero Döküm Boruları</td>
</tr>
<tr>
<td>6 Diğer</td>
<td>Enerji Nakil Sanayi, dayanıklı Tüketim Malları Sanayi, El Aletleri, Elektrik Motorları, Cam Kalıpları v.s.</td>
</tr>
</tbody>
</table>

Döküm sektörünün ihtiyaç duyduğu 50-55 AFS dağılımı kum Şile Bölgesinin özellikle sahle yakın bölgelerde rezervlerin önemli bir kısmını teşkil etmektedir.
ÜRETİM

Sorunlar:
Döküm kumunun da dahil olduğu Kuvars kumu üreticilerinin sorunlarını 3 ana başlıkta toplamak gerekir.
• Artan talebe ve ürette me bağlı olarak İstanbul-Şile Bölgesi kuvars kumu sahalarının rezervlerini azaltma
• Özellikle kil üretimine paralel Maden
<table>
<thead>
<tr>
<th>KULLANICI SEKTÖR</th>
<th>MAL TANIMLARI</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Otomotiv Sanayi</td>
<td>Otomobil, Traktör, Kamyon, Otobüs, Çekici Minibüs, Treyler üretiminde kullanılan döküm parçalar.</td>
</tr>
<tr>
<td>2 İnşaat Sanayi</td>
<td>Fittings, Radyatör, kazan, Küvet, Soba, Kanalizasyon işgaraat v.s.</td>
</tr>
<tr>
<td>3 Makine İmalat Sanayi</td>
<td>İş Makinaları, Takım Tezgahları, Tarım aletleri ve makinaları, Çimento, Tuğla ve Refraktör İmalat Sanayi, Kaldırma Makinaları, Pompa, Vana Kimya Sanayi Parçaları, Dişli ve Makaralar, Kompresör v.s.</td>
</tr>
<tr>
<td>4 Çelik Sanayi</td>
<td>İngot Kabı, Merdane Taban Plakaları v.s.</td>
</tr>
<tr>
<td>5 Basıncılı Döküm Boru</td>
<td>Pik ve Sfero Döküm Boruları</td>
</tr>
<tr>
<td>6 Diğer</td>
<td>Enerji Nakil Sanayi, dayanıklı Tüketim Malları Sanayi, El Aletleri, Elektrik Motorları, Cam Kalıpları v.s.</td>
</tr>
</tbody>
</table>
sahalarında yaratılan tahribat ve bu sahaların rehabilitasyonu

- Çevresel baskılar ve bunun neticesiyle ilgili Bakanlıklarda bekleyen ve verilmeyen izinler Atğın (çamur + su) bertarafı veya yeniden kazanımı bunun için ortaya çıkan çevresel ve mali sıkıntılar.

Bilindiği gibi madenler yenilenemeyen hammadde kaynaklarıdır ve yeryüzünde eşit dağılmamıştır ve madenlerin bulundukları yerde işletme zorunlulukları vardır. Sanayileşmenin ve üretiminin
baş dönürtücü bir şekilde artış maden rezervlerinin çok hızla bir şekilde tüketilmesini de beraberinde getirmektedir.

Kuvars kumu sanayinin Cam, Döküm, İnşaat ve bir çok sanayi kolunda hammadde olarak kullanılması ve çok büyük oranlarda talebin olması kum rezervlerini önemli bir şekilde azaltmak-
ta, yeni rezerv ve sahaların bulunmasını zorunlu hale getirmektedir.

Madenciliğin doğada milyonlarca yıl süren bir zaman dilimi içerisinde doğal olarak ve sınırlı miktarda Jeolojik şartların uygun olduğu ortamlarda oluşabildiği ve bulunabildiği yerde çevre, ekonomi dengesini gözeterek çikarılmasını gerektir.

Madencilikte kullanılan alanların rehabilitle edilerek ekosisteme kazandırılması ve sektörde bertaraf, arıtma yeniden kazanım teknolojilerinin
gelişmiş olması, madenciliğin sürdürülebilir kalkınma prensiplerine uygun bir faaliyet dahı olmasını sağlar.

İstanbul Şile Bölgesi kuvars kumu rezervleri, uzun yıllardır sanayinin ihtiyaçı olan kum talebini karşılamış ve karşılamaya devam etmektedir. Bu bölgede özellikle kuvars kumu üretimi dışında yapılan kömür, taş ve kil gibi çeşitli maddelerin üretimi için çevrede yaratılan tahribat, Enerji ve Orman Bakanlığı tarafından verilen izin ve ruhsatlardaki sıkıntıyı da beraberinde getirmiş bulunmaktadır.
Şile Bölgesinde kum üreticilerinin en büyük sorunu ruhsatlı sahalar da Çevre ve Orman Bakanlığı tarafından bekletilen izinlerdir. Bekleyen bu izinler çerçevesinde bölgede faaliyette bulunan kum üreticilerinin mevcut sahalarının kum stokları hızla erimekte ve üretim yapılamaz duruma gelmektedirler.

Türk Otomotiv yan sanayi, cam ve diğer sektörlerin en önemli girdisi olan kuvars kumu maden sahalarında yaşanan bu sıkıntıların kısa vadede mutlaka aşılması gerekmektedir.