Tests have been carried out in order to compare the conventional preparation of a synthetic bentonite bonded unit sand in the intensive mixer (Figure 1) with a vacuum preparation of the same moulding sand in the plant shown in Figure 2. The best facilities for the tests were to be found in the Technical Centre of the plant manufacturer because of the availability of mixers with the same capacity (75 l), the same equipment and the same mixer speed. The analyses of the circulating and finished sand were carried out in the Technical Centre of the plant manufacturer by the project partner (IKO-Erbshöh) in accordance with VDG Data Sheets.

The aim of the tests was to establish the effects of the vacuum preparation on the quality of preparation as well as on the bentonite and the additives respectively.

The unit sand was obtained from the original circulating sand in a large German automobile foundry working with cast iron materials. The initial material (a synthetic unit sand) had the following composition and physical properties:

- average grain size: 0.218 mm
- AFS No. 66
- moisture: 2.9%
- fines content: 13.7%
- bulk density: 1.370 g/l
- active clay content: 9.5%
- loss on ignition 6.9%

Figure 1. Intensive mixer for the conventional preparation (Eirich Type R 08 W)
When comparing the two types of preparation it was
strictly observed that almost the same test conditions were
maintained in both cases. Preparation was as follows:

In the intensive mixer (Table 1):
- introduction of 60 kg of used sand (45 °C) into the mixer
- addition of QuickBond-D, Antrapur and G 634 quartz
  sand
- 10 s dry mixing
- addition of water
- 80 s wet mixing
- emptying of mixer
- packing of the sand in plastic bags.

With the vacuum preparation (Table 1):
- introduction of 60 kg of hot used sand into the mixer
- addition of QuickBond-D, Antrapur and G 634 quartz
  sand
- 10 s dry mixing
- determination of moisture and sand temperature
- calculation of amount of water for vacuum cooling and
  moistening
- addition of calculated amount of water
- 80 s vacuum cooling and preparation
- 10 s vacuum breaking
- emptying of mixer
- packing of sand in plastic bags.

Compaction of the sand was adjusted to 38% via the
addition of water.

The sand was firstly tested directly after preparation and
then after 60 min. A 5 kg sample was additionally prepared
for 5 min in the 5 l laboratory mixer (R 02) in order to be
able to completely assess the degree of preparation.

Test results

Sample weight (Figure 3a). The sample prepared with the
vacuum process is approx. 2 g lighter than that of the con-
ventionally prepared sample.

Green compressive strength (Figure 3b). With a specific
density of 0.9 kg/dm³ the sand prepared by the new process
has a 1.2 N/cm² greater green compressive strength. A
60 min maturing time does not result in any increase in the
compressive strength.

Wet tensile strength (Figure 3c). The vacuum preparation
results in higher wet tensile strengths.

Green splitting strength (Figure 3d). This is considerably
greater with the vacuum sand preparation. A maturing
time of 60 min results in an increase with conventional
preparation but with the vacuum preparation it remains
constant.

<table>
<thead>
<tr>
<th>Test</th>
<th>Preparation in intensive mixer</th>
<th>Vacuum preparation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Circulating sand into the mixer</td>
<td>45 °C QuickBond-D, Antrapur, G 634 quartz sand</td>
<td>115 °C</td>
</tr>
<tr>
<td>Introduction of additives</td>
<td></td>
<td>10 s Moistening</td>
</tr>
<tr>
<td>Dry mixing</td>
<td></td>
<td>Wet mixing with simultaneous vacuum cooling</td>
</tr>
<tr>
<td>Water addition</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Preparation (80 s)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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Figure 3. Test results from the two types of preparation in relationship to the bulk density (K = conventional, V = vacuum): 

a) sample weight; b) green compressive strength; c) wet tensile strength; d) splitting strength; e) gas permeability; f) compaction.
**Table 2.** Comparison of test results with the two types of preparation (compatibility 38%; bulk density 0.9 kg/dm³)

<table>
<thead>
<tr>
<th>Property</th>
<th>Conventional</th>
<th>EVACTHERM</th>
<th>Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Green compressive strength (Figure 4a)</td>
<td>18.7 N/cm²</td>
<td>19.9 N/cm²</td>
<td>+ 6%</td>
</tr>
<tr>
<td>Wet tensile strength (Figure 4b)</td>
<td>0.185 N/cm²</td>
<td>0.205 N/cm²</td>
<td>+10%</td>
</tr>
<tr>
<td>Splitting strength (Figure 4c)</td>
<td>4.9 N/cm²</td>
<td>4.6 N/cm²</td>
<td>+15%</td>
</tr>
<tr>
<td>Gas permeability (Figure 4d)</td>
<td>72</td>
<td>92</td>
<td>+27%</td>
</tr>
</tbody>
</table>

Gas permeability (Figure 3e). With the vacuum preparation this is around 20 units higher than with the conventional and still remains at the same level after 60 min.

In addition to these results there are also positive tendencies in the flowability according to Orlov, water content, compaction, bulk density.

The results of the tests with both types of preparation are summarized in Table 2 and Figure 4.

**Conclusion**

Under the given production conditions, the vacuum preparation leads to better preparation results than the conventional preparation.

It is to be noted that the QUICKBOND bentonite (prepared with process carbon) used in the tests resulted in a higher compaction per percentage of water, so that the water content could therefore be minimized.

It is also to be noted:

1. In the tests it was not possible to investigate the cumulative changes of the sand parameters with preparation under production conditions, i.e. in a circulating sand system. Improvements in the moulding sand only normally develop after several circulations.

2. With the vacuum preparation the cooling water is fed back in the form of condensate. Salination of the sand is thus lower, through which the deactivation of the bentonite in the circulating sand is reduced.

According to the moulding sand system, i.e. according to the sand/iron ratio, water addition and water quality, new sand addition etc., it is to be expected that more favourable results would be achieved in practice than those carried out in the tests in the Technical Centre.

**Figure 4.** Test results from the two types of preparation with a compatibility of 38% and a bulk density of 0.9 kg/dm³: a) green compressive strength; b) wet tensile strength; c) splitting strength; d) gas permeability