NEW LINING CONSTRUCTIONS BASED ON FIBROUS REFRACTORY MATERIALS

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Recently, in the construction of thermal plants increasing use has been made of linings made of fibrous refractory materials [1]. These materials (felts, slabs, mats, etc.) have apparent densities of 200–400 kg/m³ and service temperatures of up to 1200°C, and can be used either as insulation or as working layers of linings of thermal plants. The use of fibrous materials for the working layer is most advantageous in periodic (batch) furnaces, ensuring a reduction in heat loss in heating up the lining.

The absence of industrial experience in the use of linings made of fibrous materials means that before they are adopted industrially there must be thorough research on the thermotechnical indices and stability of materials and lining designs at high varying temperatures. The determination of these indices on small specimens cannot elucidate the behavior of the material in service, because no account is taken of the influence of multilayer structure, attachments, and other factors.

At VNIPftepluproekt we have investigated fibrous materials and linings made of them in conditions reproducing real service. For this purpose we made heating rigs for testing lining parts.

The heating rig for testing lining parts (Fig. 1) permits us to make simultaneous tests on two specimens measuring 1.0 × 3.5 m in conditions of one-sided heating to the maximum temperature. One-sided heating of the specimens at 200–250 deg C/h, prolonged retention at the given temperature, and cooling at any rate permit us to determine the thermotechnical indices of the linings and their stability under variable temperatures.

Fig. 1. Rig for testing wall parts. 1) Dismountable crown; 2) side walls; 3) service areas; 4) furnace chamber; 5) heater; 6) test panels; T, point of temperature measurement in panels; Tₓ, point of measurement of temperatures in rig; q, point of measurement of heat fluxes.

The rig is made up of three elements — two side walls and a crown (Fig. 2). The lining of the walls and crown is made of slabs based on high-alumina fiber. The rig is wider than the panels, so that they can be heated uniformly across their width. Vertically uniform heating is attained by leading the flue gases out downward (the vertical drop did not exceed 25–30°C at 1100–1200°C).

The heating rig for testing crown parts (Fig. 3) permits tests on specimens measuring 1.6 × 3.5 m. The arrangement of the burners and the site of removal of the flue gases permit uniform heating of the crown to 1200°C at 150–200 deg C/h.

In both rigs heating is by combustion of solar oil in burners of the Stal'proekt design. The rigs are fitted with a system of automatic temperature recording in the heated space and through the thickness of the test pieces.

We tested various designs of walls and crowns in which the following materials were used as the working layer: i) thermal insulation slabs (MKRV–350–1) with an apparent density of 250 kg/m³ based on high-alumina fiber and a combustible binder (TU 14–8–159–75) made at the Pervouralskii Dinas Factory; ii) roasted slabs

TABLE 1. Main Results of Thermo-technical Tests on Linings

<table>
<thead>
<tr>
<th>Design of lining (sec)</th>
<th>Temp. at measurement points °C</th>
<th>Heat flux, kcal/m²-h-deg C</th>
<th>Thermal conductivity of working layer, * kcal/m²-h-deg C</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>800 70</td>
<td>540</td>
<td>0.141 (578)</td>
</tr>
<tr>
<td></td>
<td>900 80</td>
<td>590</td>
<td>0.147 (653)</td>
</tr>
<tr>
<td></td>
<td>950 90</td>
<td>640</td>
<td>0.149 (695)</td>
</tr>
<tr>
<td>II</td>
<td>900 70</td>
<td>560</td>
<td>0.152 (745)</td>
</tr>
<tr>
<td></td>
<td>1000 85</td>
<td>670</td>
<td>0.161 (833)</td>
</tr>
<tr>
<td>III</td>
<td>750 50</td>
<td>320</td>
<td>0.145 (650)</td>
</tr>
<tr>
<td></td>
<td>850 55</td>
<td>435</td>
<td>0.153 (750)</td>
</tr>
<tr>
<td></td>
<td>950 60</td>
<td>530</td>
<td>0.160 (838)</td>
</tr>
<tr>
<td></td>
<td>1050 70</td>
<td>630</td>
<td>0.165 (890)</td>
</tr>
<tr>
<td></td>
<td>1150 80</td>
<td>750</td>
<td>0.190 (1000)</td>
</tr>
</tbody>
</table>

*Figures in parentheses are mean temperatures in thermal conductivity determinations, in °C.

293