Ceramic filters for glass furnace off-gas treatment

Filtration using low density ceramic filter elements is now a well-established technique for air pollution control and product recovery. Dr. Purv J. Purohit*, Dr. Ian Chisem** and Prof. Richard Lydon*** discuss a technology in use in the glass industry that reduces high levels of pollution while operating at elevated temperature.

The global glass industry is extremely diverse in its products made and the manufacturing techniques employed. Products range from intricate handmade lead crystal goblets to huge volumes of float glass produced for the construction and automotive industries. Manufacturing techniques vary from small electrically-heated furnaces in the high temperature insulation wools (HTIW) sector to the cross-fired regenerative furnaces in the flat glass sector, producing up to 1000 tonnes per day. The wider glass industry also includes many smaller installations that fall below the 20 tonnes per day threshold.

The production of glass involves high temperatures and high energy input processing, which results in the emission of combustion products and oxidation of atmospheric nitrogen. The main pollutants in the glass furnace off-gas are particulate matter (PM), oxides of sulphur (SOX) and nitrogen (NOX).

To reduce the risk to the environment, a Directive was annexed in the Directive 2010/75/EU of the European Parliament and the Council on industrial emissions (integrated pollution prevention and control). The purpose of the Directive is to achieve integrated prevention and control of pollution arising from the activities in the industry leading to a high level of protection of the environment as a whole.

The legal basis of the Directive relates to environmental protection. The term ‘best available techniques’ (BAT) is defined in Article 2(11) of the Directive as: “The most effective and advanced stage in the development of activities and their methods of operation which indicate the practical suitability of particular techniques for providing in principle the basis for emission limit values designed to prevent and, where that is not practicable, generally to reduce emissions and the impact on the environment as a whole.”

The United States Environmental Protection Agency (EPA) is currently introducing stricter legislation to control these mixed pollutants across industries including glass, carbon black manufacture, cement kilns and coal production.

**Background**

There are other techniques available to treat the glass furnace off-gas to meet emission requirements. These solutions are always installed downstream of the...
furnace and can be operated while it is running. For de-dusting, techniques such as electrostatic precipitator (ESP) or bag filters are used. ESP’s can attain dust levels of less than 20 mg/Nm³ while bag filters may achieve less than 10 mg/Nm³. In terms of costing, bag filters are comparable to ESPs, however the durability of bag filters is always an issue. In general, bag filters need to be replaced every two to three years depending on the operating conditions, thus increasing the OPEX of the abatement system. ESP’s are not very efficient in de-dusting as the OPEX of the abatement system is running. For de-dusting, techniques such as lime or sodium bicarbonate is used before the de-dusting and SCR as a reaction chamber upstream of the filter or ESP is usually required for high SOx removal.

Some of the features of Cerafil technology in critical applications.

<table>
<thead>
<tr>
<th>Year</th>
<th>Dust</th>
<th>NOx (mg/m³)</th>
<th>SOx (mg/m³)</th>
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<tr>
<td>2012</td>
<td>&lt; 5</td>
<td>&lt; 600 mg/m</td>
<td>&lt; 400 mg/m</td>
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<tr>
<td>2013</td>
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<tr>
<td>2014</td>
<td>&lt; 5</td>
<td>&lt; 600 mg/m</td>
<td>&lt; 400 mg/m</td>
</tr>
</tbody>
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*Permitted limits: NOx: 800 mg/m³ and SOx: 800 mg/m³

Table 3. NOx, SOx and Dust emissions noted over a three-year period.

Cerafil, from Clear Edge, is a range of low-density ceramic filters used in filter plants in much the same way as filter bags, albeit at higher temperatures. Cerafil is typically used in the 200 to 800°C (ca. 400 to 1500°F) range, thereby avoiding acid and water dew points and allowing for application at the temperature that best suits the duty. In addition, Cerafil elements are extremely efficient, corrosion resistant and can be used in the most challenging conditions (Table 1).

Cerafil is a monolithic ceramic filter candle comprising alumino-silicate fibres developed over several years and formed by a proprietary process. The resulting filter element is effective at handling sub-micron particles in industrial gas processes.

The applications of this Best Available Technology include air pollution control (APC), product collection and product recovery. The one-piece element is self-supporting and robust, can be utilised in a variety of conditions and exhibits long service life. The highly porous candle, which is capable of filtering gas to limits of <2 mg/m³, provides a future proof solution for forthcoming tighter environmental legislation.

Some of the features of Cerafil technology are in Table 1.

### Catalystic ceramic filters

Clear Edge has recently advanced the technology to develop Cerafil TopKat, a technology that combines the advantages of Cerafil with an incorporated active catalyst for the removal of NOx, dioxin, SOx and VOCs. This patented technology protects the catalyst from poisoning and deactivation, a common problem with selective catalytic reduction (SCR) technology, by incorporating it in the wall of the filter element (Table 2).

Clear Edge has researched and developed the Cerafil TopKat technology platform for more than 10 years and has built up experience applying this technology in critical applications.
Thousands of TopKat filter elements are in circulation in applications worldwide covering a variety of industrial uses.

**Case Study: Glass furnace exhaust**
There are 22 installations housing Cerafil TopKat filters in the glass furnace exhaust. With all these sites taken together there are more than 24,500 filter elements in operation.

Cerafil TopKat installations have shown remarkable levels of operational stability over a period of time. In many cases, filter installations remain operational with high levels of filtration and catalytic performance even after five to six years of use (*Table 3*). Control of emissions from glass furnaces has become a key market for Cerafil TopKat. For example, one installation (*Fig. 2*), dating from 2009, which uses 1700 TopKat 3000mm elements, is still performing with efficiency in excess of 95% of initial performance. To date, no elements have been replaced.

**Application: Glass furnace**
Cerafil TopKat (3 m): 1700 elements
Commissioned: September 2009
Volumetric flow: 85,000 Nm³/h
Operating temperature: 325°C-350°C

**References**

*Development Engineer, Geldern-Walbeck, Germany.*
**IP Manager & Senior Engineer, Stoke-On-Trent, UK.***
***VP Technology & Business Development, Stoke on Trent, UK.***
www.clear-edge.com