High Productivity, Reduced Pentane Flame Retardant Expandable Polystyrene (RF) Grades

Environmentally Friendly
1 Introduction

Expanded polystyrene (EPS) foam is widely used in the construction industry, particularly as a thermal insulation material. EPS board can be used for insulation of walls, floors and roofs in Building and Construction application.

The production of EPS foam starting from the raw beads which contain some 6-7%wt pentane as a blowing agent comprises three main stages: pre-expansion, maturing and moulding. The moulded blocks are subsequently cut to the required dimensions to EPS boards destined for end-use applications.

Given the growing environmental concern of today and the associated green-house effect due to the release of pentane during the conversion of EPS beads leading up to a foam article, INEOS Styrenics have developed reduced-pentane flame retardant EPS grades (RF) in response to these challenges. The RF grades are speciality materials consisting of spherical EPS beads containing typically less than 5%wt pentane and produced according to high quality standards at our facility in Marl, Germany. They are available in three different grades and can be used in wide range of applications:

<table>
<thead>
<tr>
<th>Grade</th>
<th>Bead size class, mm</th>
<th>Pre-foam Density*, kg/m³</th>
<th>Typical moulded density, kg/m³</th>
<th>Typical applications</th>
</tr>
</thead>
<tbody>
<tr>
<td>RF23W</td>
<td>1.0-1.6</td>
<td>14</td>
<td>14-30</td>
<td>Medium to high density block moulding for external insulation, also for floor elements, cut perimeter boards, flat roof, etc</td>
</tr>
<tr>
<td>RF33W</td>
<td>0.7-1.0</td>
<td>17</td>
<td>17-30</td>
<td>Medium and high density block and moulded boards with low water absorption, perimeter boards, insulated concrete form, inverted roof, shutter-box insulation, industrial packaging</td>
</tr>
<tr>
<td>RF43W</td>
<td>0.4-0.7</td>
<td>22</td>
<td>22-50</td>
<td>High and medium density moulded board, heating panels, insulated concrete forms, decorative elements</td>
</tr>
</tbody>
</table>

*: first expansion using a discontinuous pre-foamer

Table 1: Range of INEOS Styrenics EPS RF grades and typical applications

An equivalent RF-n range of products is also available, using polymeric FR in place of HBCD.

Further detailed information on specific materials is available in the relevant Product Data Sheet.

2 Advantages of using reduced-pentane INEOS Styrenics EPS RF grades

Due to their reduced pentane content, these speciality RF grades offer time-saving, cost-saving, product quality and environmental advantages, including:

- significantly reduced cycle times by 15-35%, making them ideal for thicker mouldings and/or high density applications (≥ 20 kg/m³)
- provide flexibility during processing as they can be matured from 0-24 hours without significantly affecting its processing characteristics
- offer more uniform expansion, and better internal fusion than the standard grades
- allow to obtain minimum achievable densities of 14-20 kg/m³ depending on the factors such as the fraction used, the pre-foam expander type and the expansion pressure
- some 2 %wt more of raw material
- emit 30 %wt less pentane
- production of foams with improved mechanical properties vs. normal flame retardant EPS grade
3 Foam properties of reduced pentane INEOS Styrenics EPS RF grades

The foam properties of a reduced low-pentane flame retardant INEOS Styrenics EPS grade RF23W are depicted in Figures 1-3 below:

![Figure 1: Bending strength of RF23W (EN 12089)](image1)

![Figure 2: 10% Compressive strength of RF23W (EN 826)](image2)
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The use of reduced pentane INEOS Styrenics EPS grade does not impair the foam properties. On the contrary, it leads to an even higher bending and 10% compressive strengths in comparison to a standard flame retardant material particularly at higher moulded foam densities. The thermal conductivity of these foams is also maintained if not improved in the lower density range (< 16 kg/m3) applications.

Further comparative study showed that foam blocks produced from a RF grade reaches its dimensional stability after demoulding much faster than a conventional flame retardant EPS material, and these even when pre-foam beads only after 4 hours maturing are used in the production of these blocks. Consequently, blocks made from reduced pentane grades can be cut earlier.

RF grades lead to mouldings with low water up take, due to their optimised bead surface treatment. The water absorption values after 28 days of total immersion (EN 12087) obtained with moulded samples of RF33W at 30 kg/m3 are < 1 volume%.

4 Processing of INEOS Styrenics EPS RF grades

Safety and handling procedures for reduced pentane RF materials are the same as for the normal EPS grades.

4.1 Pre-expansion

INEOS Styrenics EPS RF grades are typically expanded to a density of 14-50 kg/m3. Both continuous or batch pre-expanders can be used. Batch pre-expansion allows a more accurate control of density, which is particularly helpful for higher density (> 35 kg/m3) application. In batch pre-expansion, steam pressure is adjusted to obtain the target density, but is typically 0.25-0.5 barg.

4.2 Colouring

INEOS Styrenics EPS RF grades beads can be coloured using the available EPS colouring technique.

4.3 Maturing

RF grades provide flexibility during processing as they can be matured from 0-24 hours without significantly affecting its processing characteristics. Maturing times of pre-expanded INEOS Styrenics EPS RF grades are typically 24 hours. Care needs to be taken with longer maturing times, since this can adversely affect both the moulding and foam properties.
4.4 Moulding
INEOS Styrenics EPS RF grades can be moulded on the existing machineries, be it for block or contour moulding applications. By ensuring a good bead-to-bead fusion in the foam through optimal moulding conditions, it is possible to obtain better mechanical foam properties. To optimise their processing and application properties, please consult our product data sheets and talk to an INEOS Styrenics technical representative before you try out RF grades.

5 Fire behaviour
The INEOS Styrenics EPS RF grades meet the DIN 4102: B1 fire requirements.

6 Typical applications of INEOS Styrenics EPS RF grades
- Internal insulation
- External insulation
- Floor insulation
- Roof insulation
- L’entrevois (between cellar/floor)
- Insulated Concrete form (ICF)
- Perimeter Platte

The data used in this bulletin are typical values, based on laboratory results, current knowledge and experience. This bulletin does not attempt to predict the results customers can expect on their equipment.

INEOS STYRENICS International SA, Avenue des Uttins 3, CH-1180 Rolle, Switzerland.
Phone + 41 21 627.7040, Fax: + 41 21 627.7045
E-mail: info@ineosstyrenics.com
www.ineosstyrenics.com
INEOS STYRENICS RF.03
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