Styrofoam®
Thermal Insulation for
Hot & Cold Climates
The Arabian Chemical Company (Polystyrene) Ltd. is a joint venture of E.A. Juffali and Brothers and The Dow Chemical Company. The ACC plant located in Jeddah Industrial Estate, is the latest of more than 27 manufacturing facilities scattered worldwide and specialized in the manufacturing of a range of Dow's extruded polystyrene rigid foam thermal insulation under the trade names Styrofoam*, Roofmate*, Wallmate* and Floormate*.

These products play a major role in the field of energy conservation programs as well as satisfying the need to contribute to the achievement of self-sufficiency of the Kingdom of Saudi Arabia as well as other Gulf Countries in the field of construction products.

This brochure provides technical information about Styrofoam*, Roofmate*, Wallmate* and Floormate* and their applications with particular emphasis on climatic conditions of the Middle East.

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Need for Thermal Insulation

Increasing energy costs and availability problems emphasize the need for immediate energy conservation even in the oil producing countries. An effective way of saving energy is to improve the thermal insulation of buildings. This is particularly important in hot climates where the energy demand for cooling by air conditioning is very high. In addition to the need for energy saving, high insulation standards are justified by improved comfort levels and increased building life. A well-insulated building will have a higher value.

Product Description

Styrofoam* thermal insulation boards were developed by The Dow Chemical Company in 1947. Since then, advance processes, products and application research and development work has taken place in the U.S.A., Canada, Japan and Europe. Today, a variety of grades of Styrofoam*, tailored to many applications and industries, is available in various sizes and with various edge treatments.

Extruded polystyrene foam is used in many parts of the world under widely differing climatic conditions. For example, Styrofoam* has been successfully used in the Middle East at ambient temperatures of more than +40°C (+104°F), while, at the other extreme, Styrofoam* has been used in Alaska to protect the delicate permafrost at temperatures as low as -50°C (-58°F) along 200 km of gravel road servicing the Trans Alaska Oil Pipeline.

Styrofoam* is manufactured by a continuous extrusion process which imparts a characteristic closed cell structure giving the product its unique physical properties. Extruded polystyrene rigid foam has a high resistance to water absorption and good mechanical properties. The manufacturing process, combined with the inherent qualities of the inert component thermo plastic material gives Styrofoam* predictable long-term performance and high insulating value.

<table>
<thead>
<tr>
<th>Product Description</th>
<th>Major Applications</th>
<th>Board Dimensions (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Styrofoam SM</strong></td>
<td>Extruded Polystyrene rigid foam with skin. It is available with or without tongue and groove edge treatment.</td>
<td>Thermal insulation board for: - Walls - Floors (residential) - Pitched roofs - Perimeter 1 - Ceilings of agricultural buildings</td>
</tr>
<tr>
<td><strong>Floormate 500 &amp; 700</strong></td>
<td>Extruded Polystyrene rigid foam with skin with high density and high compressive strength. It is available with or without shiplap edge treatment.</td>
<td>Floors&lt;br&gt;Cold stores 2&lt;br&gt;Parking decks 2</td>
</tr>
<tr>
<td><strong>Styrofoam HD 300</strong></td>
<td>Extruded Polystyrene rigid foam with skin with higher density and higher compressive strength. It is available with or without shiplap edge treatment.</td>
<td>Thermal insulation board for applications which require high compressive strength, such as: - Parking decks 2 - Low temperature space floors (Cold Stores) 2</td>
</tr>
<tr>
<td><strong>Walimate</strong></td>
<td>Extruded Polystyrene rigid foam with skin. It is available with or without tongue and groove edge treatment.</td>
<td>Thermal insulation board for: - Walls - Tile backing - Core material for sandwich panels - Low temperature space</td>
</tr>
<tr>
<td><strong>Roofmate</strong></td>
<td>Extruded Polystyrene rigid foam with skin. It is available with and without shiplap edge treatment.</td>
<td>Thermal insulation board for: - Roofs - Floors - Perimeter 1</td>
</tr>
</tbody>
</table>

1 - Perimeter insulation: Protection boards for underground/basement walls waterproofing membrane.
2 - Refer to technical data on page 12

* Trademark of The Dow Chemical Company
The closed cell structure of Styrofoam* extruded polystyrene foam

Specifications

To ensure that you obtain Styrofoam* range of products, request the following specifications:

**Roofmate***
Extruded polystyrene rigid foam with skin, colored blue throughout, according to DIN 18164, Part 1, June 1979, Type WS, or according to ASTM standard C 578-95, as manufactured by DOW.

Material thickness shall be according to the drawings and have the following properties:

1. Thermal conductivity of 0.028 W/m·K (0.21 Btu/in·ft·h·°F) when tested at 10°C (50°F) in accordance with DIN 52612 or ASTM C 518.
2. Compressive strength of 300 kPa (43 psi) average, when tested according to DIN 53421 or ASTM D 1621.
3. Water absorption of ≤1% in volume average when tested in accordance with ASTM D 2842.
4. Water vapor permeability of 0.4-0.6 perm-inch average when tested in accordance with ASTM C 355.

**Roofmate SL***
Same specifications as for Roofmate* but with shiplap profile on all four edges.

**Styrofoam SM***
1. Thermal conductivity of 0.029 W/m·K (0.21 Btu/in·ft·h·°F) when tested at 10°C (50°F) in accordance with DIN 52612 or ASTM C 518.
2. Compressive strength of 250 kPa (36 psi) average, when tested in accordance with DIN 53421 or ASTM D 1621.
3. Water absorption of ≤1% in volume average when tested in accordance with ASTM D 2842.
4. Water vapor permeability of 0.6 perm-inch average when tested in accordance with ASTM C 355.

For other properties, refer to table on page 12.

**Walminate CW***
Extruded polystyrene rigid foam, colored blue throughout, according to DIN 18164, Part 1, June 1979, Type W, or according to ASTM standard C 578-95, as manufactured by DOW. Material thickness should be as indicated in the drawings and have the following properties:

1. Thermal conductivity of 0.029 W/m·K (0.21 Btu/in·ft·h·°F) when tested at 10°C (50°F) in accordance with DIN 52612 or ASTM C 518.
2. Compressive strength of 210 kPa (30 psi) average, when tested in accordance with DIN 53421 or ASTM D 1621.
3. Water absorption of ≤1% in volume average when tested in accordance with ASTM D 2842.
4. Water vapor permeability of 1 perm-inch average when tested in accordance with ASTM C 355.

**Floormate* 500 and Floormate* 700***
Floormate* is one of the Styrofoam Plan range of insulation products manufactured by DOW to suit specific applications.

Floormate* insulation boards have been developed specifically for use in floor applications since they possess the following unique physical properties:

- High compressive strength.
- High water absorption resistance.
- Low thermal conductivity.
- Good handling characteristics.

1. Thermal conductivity of 0.027 and 0.026 W/m·K respectively when tested at 10°C (50°F) in accordance with DIN 52612 or ASTM C 518.
2. Compressive strength of 500 kPa (70 psi) and 700 kPa (100 psi) average respectively, when tested according to DIN 52612 or ASTM D 1621.
3. Design load for traffic 120 kPa (20 psi) and 160 kPa (23 psi) averages respectively.
4. Water absorption of ≤1% in volume average when tested in accordance with ASTM D 2842.
Styrofoam HD 300*

Extruded polystyrene rigid foam, colored blue throughout, according to DIN 18164, Part 1, June 1979, Type WS, or according to ASTM C 578-95, as manufactured by DOW.

Material thickness shall be according to the drawings and have the following properties:

1. Thermal conductivity of 0.026 W/m·K (0.18 Btu·in/ft²·hr·°F) when tested at 10°C (50°F) in accordance with DIN 52612 or ASTM C 518.

2. Compressive strength of 700 kPa (100 psi) average, when tested in accordance with DIN 53421 or ASTM D 1621.

3. Water absorption of ≤1% in volume average when tested in accordance with ASTM D 2842.

4. Water vapor permeability of 0.4 perm-inch average when tested in accordance with ASTM C 355.

The Upside-Down Roof Concept

The upside-down roof concept is as simple to use, as it is effective. With a conventional roof, the waterproofing membrane is laid above the thermal insulation, but with the upside-down roof, the sequence is reversed. The roofing membrane is laid directly onto the roof deck, followed by Roofmate SL* boards with shiplap edges as an insulating layer, with separation layer laid over it, and then the final layer can be gravel or paving slabs.

The efficiency of the upside-down roof concept has been proven in extensive tests and in practical application over periods exceeding 40 years in Europe, Canada and the USA and 25 years in the Middle East.

Advantages of Roofmate SL:

In the upside-down roof, the insulation material is exposed to temperature extremes, thermal cycling, mechanical stresses (e.g. live loads, construction site traffic), and high relative humidity.

The insulation material must be able to withstand such conditions and should, therefore, possess the following characteristics:

1. Closed-cell and homogeneous structure
2. Negligible low moisture absorption
3. Long-term high insulation efficiency
4. Good mechanical strength
5. Resistance to ageing and rotting
6. Good dimensional stability
7. High resistance to thermal cycling

Numerous laboratory tests and more than 40 years of practical experience have shown that Roofmate*SL reliably meets all these requirements.

Advantages of the Upside-Down Roof Concept:

- The waterproofing membrane is protected from extreme thermal stresses, high ultraviolet exposure as well as from mechanical stresses occurring during construction and subsequent use.
- The life expectancy of the waterproofing membrane is substantially increased.
- Maintenance costs are significantly reduced.

Temperature measurements have shown that the waterproofing membrane in the upside-down roof is much better protected against temperature peaks than in the conventional flat roof.

The illustration below shows the approximate annual temperature at the roof membrane with typical monthly maximum and minimum values both for the upside-down roof and for the conventional roof.

The significantly reduced temperature variation at the roofing membrane in the upside-down roof reduces the ageing of the membrane and thus prolongs its service life.

Up to the present over 300 million square meters of Roofmate SL* boards have been laid using the upside-down roof concept in Europe and over 30 million square meters in the Middle East.
1. The Dow Chemical Company firmly believes that it is in everyone's interest: client, architect and contractor, that the specialist roofing contractor responsible for laying the waterproofing membrane carries out the total upside-down roof build up.

2. It is advisable to ensure that the total build up is completed as soon as the waterproofing membrane is laid.

**Dark Membrane, Loose-Laid and Ballasted**

In loose-laid, ballasted applications, the dark roofing membrane over the foam is exposed to direct sunlight until the ballast is installed. This direct exposure prior to ballasting may vary from a few hours to a few weeks.

DOW experience has shown that when the foam is exposed to both sunshine and an outdoor air temperature over 32°C (90°F), distortion of the foam can occur in as little as 30 minutes.

To prevent this phenomenon from occurring, the following precautionary measure can be taken:

During hot weather, temporarily place white opaque polyethylene film on top of the dark single ply membrane to keep it cool until the ballast can be placed (ask for Dow Technote 501a). The film can be held down with tires or other temporary ballast. The film can be reused by moving it along as the permanent ballast is installed. This film should keep the membrane well below the maximum use temperature of the foam insulation.

### Recommendations

**Installation**

**Protection Layer**

The protection layer against ultraviolet radiation, wind uplift and buoyancy, usually consists of gravel with a corn diameter of 15-30 mm (1/2" - 1 1/4").

In order to achieve a sufficient degree of protection against ultraviolet radiation, the gravel layer should have a minimum depth of 50 mm (2").

Instead of gravel, paving slabs with a minimum thickness of 40 mm (1 1/2") can be installed when using 50 mm (2") thick Roofmate SL* boards. For each 10 mm (3/8") increase in Roofmate SL* thickness the paving slab thickness should be increased by 5 mm (3/16").

The wind uplift resistance of upside-down roofs is considered equal to loose-applied conventional flat-roof constructions with similar surface protection.

In particularly exposed areas, paving slabs should be applied instead of gravel, either along the perimeter of the roof (min. 2 m wide or over the entire surface).

### Chart Below Shows Variations in the Water Proofing Membrane Temperature in the Upside-Down Roof and in the Gravel Ballasted Conventional Roof (Monthly Average Maximum and Minimum Day and Night Values).

<table>
<thead>
<tr>
<th>Roofmate SL* thickness</th>
<th>mm</th>
<th>up to 50</th>
<th>60</th>
<th>70</th>
<th>80</th>
<th>100</th>
<th>120</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>in.</td>
<td>up to 2</td>
<td>23/8</td>
<td>23/4</td>
<td>31/8</td>
<td>4</td>
<td>43/4</td>
</tr>
<tr>
<td>Depth of gravel layer</td>
<td>mm</td>
<td>up to 50</td>
<td>60</td>
<td>60</td>
<td>70</td>
<td>80</td>
<td>90</td>
</tr>
<tr>
<td></td>
<td>in.</td>
<td>up to 2</td>
<td>23/8</td>
<td>23/4</td>
<td>31/8</td>
<td>4</td>
<td>43/4</td>
</tr>
</tbody>
</table>
Upside Down Roof
Gravel Protection

1. Concrete pavers loose laid
2. Separation layer (Typar)
3. Roofmate SL
4. Waterproofing membrane *
5. Screed to fall
6. Roof deck

Upside Down Roof
Concrete Pavers

1. Concrete pavers loose laid
2. Separation layer (Typar)
3. Roofmate SL
4. Waterproofing membrane *
5. Screed to fall
6. Roof deck

Upside Down Roof
In Situ Concrete Slab

1. Reinforced in-situ concrete
2. Separation layer (Typar)
3. Roofmate SL
4. Waterproofing membrane *
5. Screed to fall
6. Concrete roof deck

* When single layer PVC-plastic membranes are used, a protection layer has to be applied between the Roofmate boards and the membrane.
Drainage

With the normal gravel-topped specification, water percolates down through the gravel, over and between the insulation boards, until it reaches the waterproofing membrane where it then drains off to the roof outlets. On terrace decks, water will drain from the top surface of the terrace and Roofmate* and from the roof membrane.

The draining outlet should, therefore, have a connection at the membrane level, and at the top terrace and Roofmate* top surface levels.

The slope should be in accordance with general roofing practices and should be designed with a minimum fall of 1:40. Roofmate* samples, taken from dead level roofs after up to 10 years of service, have shown good performance.

Separation Layer

A water permeable filter synthetic fabric, preferably of non-woven polyester or polypropylene base (Dupont Typar** 136 gr/m² to 200 gr/m² etc.), should be installed with a 30 cm. overlap on top of Roofmate SL* boards. The filter fabric will prevent fine particles of gravel, which might damage the membrane, from being washed down into the board joints and below the Roofmate SL* boards.

Filter fabric with sufficient long-term strength will also help to prevent buoyancy problems in case of unequal gravel distribution or reduced gravel depth.

**Trademark of Dupont

Installation of Roofmate SL* Boards

Roofmate SL* boards should be applied loose, with tight staggered joints over the waterproofing membrane.

Waterproofing Membrane

The waterproofing membrane should be of good quality, non-rotting material.

In order to protect single layer high-polymeric membranes from mechanical damage caused by rough concrete surfaces, a protection sheet should be installed underneath.

Roofing membranes containing solvents, which could attack Roofmate* plastic foam, should not be used.

Roofmate SL* boards should not be laid directly over microscopic materials such as rag based felt.

Roofers Associations, membrane manufacturers and other experts should be consulted for suitable membrane specifications.

The roof-deck surface should be smooth to prevent damage of the waterproofing membrane.

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**Roof Drainage**

1. Gravel layer 15 - 30 mm (5/8"-1 1/4")
2. Separation layer (Typar)
3. Roofmate SL
4. Waterproofing membrane
5. Screed to fall
6. Concrete roof deck
Interior Wall Insulation

The above photo shows a plaster board laminate (Wallmate GB) being fixed to the interior wall surface.

Interior thermal insulation is used for:
- Building with special exterior finishes.
- Building with intermittent air conditioning.
- Insulating existing buildings.

For the interior lining of buildings, Wallmate-CW* and Styrofoam SM* can be used.

Where bonding of Styrofoam SM* or Wallmate CW* is necessary, suitable solvent free adhesives should be applied.

The interior lining should be covered with a thermal barrier equivalent to a minimum of 9.5 mm thick gypsum plasterboard or 8mm thick cement board.

1) Interior wall finish:

Two possible alternatives, either:

a) Modified gypsum lime or cement plaster 20 mm thick applied to a plaster carrier (an expanded metal rib lath - EMRL). The plaster carrier is mechanically fixed to the wall through Wallmate CW*. Application of plaster and installation of EMRL should be in accordance with plaster manufacturer's instructions. (For further details and technical advice, consult your nearest ACC office).

b) Gypsum wallboard (min. 9.5 mm thick), cement boards (min. 8 mm thick).

2) Styrofoam SM* or Wallmate CW*, fixed with a compatible adhesive or mechanically by means of metal studs or wood battens. The metal rib lath is installed over the insulation and fixed to the wall through the insulation by means of screws. Alternatively, Styrofoam* Plasterboard Laminate or Wallmate* with Gypsum Board (WMGB) as one factory assembled composite element can be installed using same methods described above.

3) Structural Wall: Brick or concrete wall, with a smooth, dry, clean and dust-free surface.

4) Interior gypsum or cement plaster.

Cavity Wall Insulation

Cavity wall insulation is an advantage where an exterior brick finish is required, and for both periodically and permanently air-conditioned buildings.

1. Interior plaster.

2. Structural wall (usually concrete or Masonry Concrete Unit (MCU). The wall should be smooth and clean.

3. Wallmate CW* boards are installed with the long edge horizontal and fixed to the inner wall either mechanically, with the aid of wall ties, or bonded along the board joints with a suitable adhesive.

4. Outer brick wall and inner wall are connected with wall ties. Local building practices should be observed for wall tie specifications and number per square meter of wall area.
fixed to external face of walls using either plastic dowel with 50 mm diameter disc head or with compatible solvent free adhesive.

2) As part of a complete Exterior Insulation and Finish System (EIFS) comprising:

a) Polymer modified base coat with fiberglass reinforcement fully embedded in this coat.
   b) Acrylic or Silicone base finish Stucco coat.

System by Sto of Germany and offered on turnkey basis by The Arabian Chemical Company (Polystyrene) Ltd. This system is a completely crack free finish.

System Components

5. Concrete slab.
6. Wall ties.

Exterior Insulation

Exterior Insulation is the most efficient way of thermally insulating building due to the fact that it is not interrupted at structural elements like columns, beams and slabs which create thermal bridges if uninsulated. Exterior insulation can be installed in two ways:

1) Behind mechanically fixed marble or granite panels. Thermal insulation boards shall be

1. Brick masonry or concrete wall
2. Adhesive to fix insulation to Substrate
3. Extruded Polystyrene insulation boards
4. Cement free, fibre reinforced, base coat
5. Sto Glass Fibre Mesh reinforcing mesh
6. Stolit** polymer modified finish coat

**Trademark of STO
Floor Insulation

In the Middle East, where soil temperatures, even at a depth of 3 meters (10 feet), can reach 33°C (91°F), floor insulation is particularly important. Good floor insulation helps to reduce heat flow through the floor into air-conditioned buildings.

**Floormate** is an ideal thermal insulation material for this application because it has:
- High compressive strength
- High resistance to water absorption and moisture penetration
- Low thermal conductivity

**Floormate** boards can be used as a working slab:

1. Floor finish
2. Concrete screed
3. Concrete slab
4. Damp-proof membrane, if required (e.g. polyethylene sheet)
5. **Floormate** boards, loose laid
6. Soil (well compacted)

Styrofoam SM or Floormate boards can also be laid above the concrete slab:

1. Floor finish
2. Concrete screed
3. Vapor barrier
4. **Floormate** boards, loose laid
5. Damp-proof membrane (e.g. polyethylene sheet)
6. Concrete slab
7. Soil (well compacted)

Special floor applications

Special floor applications cover cold store and parking deck floors. The Dow Chemical Company have designed **Floormate** products with specific compressive strength to suit each application and loading criteria. Please consult ACC (PS) nearest sales office for your next cold store or parking deck project.

**Trademark of The Dow Chemical Co.**

The photograph shows **Floormate** boards being laid over the blinding concrete with damp-proof membrane.
<table>
<thead>
<tr>
<th>Property (Typical)</th>
<th>Standard</th>
<th>Unit</th>
<th>Roofmate* SL*</th>
<th>Wallmate* CW-TG</th>
<th>Floormate* 500 / 700</th>
<th>Styrofoam* SM-TG</th>
<th>Styrofoam* HD 300-SL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Density, min.</td>
<td>DIN 53420</td>
<td>kg/m³</td>
<td>32 - 35</td>
<td>26 - 28</td>
<td>38 / 45</td>
<td>30</td>
<td>45</td>
</tr>
<tr>
<td></td>
<td>ASTM D 1622</td>
<td>lb/ft³</td>
<td>2 - 2.2</td>
<td>1.6 - 1.7</td>
<td>2.4 / 2.8</td>
<td>1.9</td>
<td>2.8</td>
</tr>
<tr>
<td>Thermal conductivity at 10°C (50°F)</td>
<td>DIN 52612</td>
<td>W/m • K</td>
<td></td>
<td>0.028</td>
<td>0.029</td>
<td>0.027 / 0.026</td>
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</tr>
<tr>
<td>mean temperature of test</td>
<td>DIN 52616</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.026</td>
</tr>
<tr>
<td>mean temperature 23.9°C (75°F)</td>
<td>ASTM C 177-97 or</td>
<td></td>
<td></td>
<td>0.20</td>
<td>0.21</td>
<td>0.19 / 0.18</td>
<td>0.21</td>
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<tr>
<td></td>
<td>ASTM C 518-98</td>
<td></td>
<td></td>
<td></td>
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<td>0.18</td>
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<tr>
<td>Compressive strength at 10% deflection</td>
<td>DIN 53421</td>
<td>kPa</td>
<td>300</td>
<td>210</td>
<td>500 / 700</td>
<td>250</td>
<td>700</td>
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<tr>
<td></td>
<td>ASTM D 1621-95</td>
<td>psi</td>
<td>43</td>
<td>30</td>
<td>70 / 100</td>
<td>36</td>
<td>100</td>
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<td>Water absorption by submersion</td>
<td>DIN 53428</td>
<td>% by Vol.</td>
<td></td>
<td>0.2</td>
<td>0.2</td>
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<tr>
<td></td>
<td>ASTM D 2642</td>
<td>% by Vol.</td>
<td></td>
<td>≤ 1</td>
<td>≤ 1</td>
<td>&lt; 1</td>
<td>&lt; 1</td>
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<tr>
<td>Water vapour diffusion resistance factor</td>
<td>DIN 52615</td>
<td></td>
<td>100 - 200°</td>
<td>80 - 150</td>
<td>150 / 220</td>
<td>100 / 220</td>
<td>150 / 220</td>
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<tr>
<td></td>
<td>ASTM E 96-00</td>
<td>Perm-inch</td>
<td></td>
<td>0.4 - 0.6</td>
<td>1.0</td>
<td>0.6 / 0.4</td>
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<tr>
<td>Capillarity</td>
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<td></td>
<td>none</td>
<td>none</td>
<td>none</td>
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</tr>
<tr>
<td>Heat stability/compressive creep</td>
<td>DIN 18164</td>
<td></td>
<td>WD</td>
<td>W</td>
<td>WD</td>
<td>WD</td>
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<tr>
<td></td>
<td>20 kPa, 80°C Type</td>
<td></td>
<td>WD</td>
<td>W</td>
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<td>WD</td>
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<tr>
<td></td>
<td>2.8 psi, 176°F</td>
<td></td>
<td>W</td>
<td>WS</td>
<td>WS</td>
<td>WS</td>
<td>WS</td>
</tr>
<tr>
<td></td>
<td>40 kPa, 70°C Type</td>
<td></td>
<td>W</td>
<td>WS</td>
<td>WS</td>
<td>WS</td>
<td>WS</td>
</tr>
<tr>
<td></td>
<td>5.6 psi, 158°F</td>
<td></td>
<td>W</td>
<td>WS</td>
<td>WS</td>
<td>WS</td>
<td>WS</td>
</tr>
<tr>
<td>Linear coefficient of thermal expansion</td>
<td>DIN 52328</td>
<td>°C</td>
<td>70 • 10⁻⁶</td>
<td>70 • 10⁻⁶</td>
<td>70 • 10⁻⁶</td>
<td>70 • 10⁻⁶</td>
<td>70 • 10⁻⁶</td>
</tr>
<tr>
<td>and contraction (Heating soaking conditions)</td>
<td></td>
<td>°F</td>
<td>39 • 10⁻⁶</td>
<td>39 • 10⁻⁶</td>
<td>39 • 10⁻⁶</td>
<td>39 • 10⁻⁶</td>
<td>39 • 10⁻⁶</td>
</tr>
<tr>
<td>Irreversible dimensional variation (Result of laboratory test with temperature changes up to 60°C (140°F))</td>
<td>none</td>
<td>%</td>
<td>&lt; 0.2</td>
<td>&lt; 0.2</td>
<td>&lt; 0.2</td>
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<td></td>
</tr>
<tr>
<td>Fire classification (Germany)</td>
<td>DIN 4102</td>
<td>Building material class</td>
<td>B2 (difficult to ignite)</td>
<td>B2</td>
<td>B2</td>
<td>B2</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>82 (difficult to ignite)</td>
</tr>
<tr>
<td>Unibeneve Laboratories (UL) classification according to ASTM E 84 Standard Test Method for Surface Burning Characteristics of Building Materials under designation ASTM C 578-95</td>
<td>Flame spread</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>155</td>
</tr>
<tr>
<td></td>
<td>Smoke developed</td>
<td>165</td>
<td>165</td>
<td>165</td>
<td>165</td>
<td>165</td>
<td>165</td>
</tr>
</tbody>
</table>

1-7 For explanations see pages 13, 14 & 15.
8- Thickness related - the thinner the product, the higher the resistance factor (µ)
*Trademark of The Dow Chemical Co.
Technical Data

1. Properties

The properties of Styrofoam* products shown on page 12 are typical values obtained by ASTM, DIN and other suitable testing procedures. These values are based on a vast number of audit data over the whole product thickness range compiled over an extensive period of time. Some applications may require special emphasis on a particular foam property. In those cases, adequate safety factors must be provided.

2. Thermal conductivity

The thermal characteristics of plastic foams depend mainly on the thermal conductivity of the cell walls and the cell gas, as well as radiation and convection. The cell gas is the most significant factor in determining the overall heat transfer characteristics. The thermal conductivity of some plastic foam will vary due to changes in the composition of the cell gas with time. The change in the cell gas composition is generally called "ageing".

DOW recommends that long-term aged thermal conductivities should be used for design purposes. The thermal conductivities quoted in this brochure are tested at 10°C (50°F) according to DIN 52612 & 52616 and at temperature of 24°C (75°F) according to ASTM C-177-97 & C-518-98.

Since, in hot climate areas the ambient air and external building surface temperatures are higher than in Europe, thermal conductivities for an ageing temperature of 38°C (100°F) should be taken into account.

In addition to the product specific parameter of the change of the thermal conductivity of plastic foams, there are also two other important influencing factors:

A. Mean temperature

B. Water absorption (see pages 14 and 15) and see current test method for comments.

There are still serious problems to be solved before full implementation of ASTM-Methods (C177-97 and C 518-98) becomes practical. Therefore, traditional methods are still being used by the industry to determine the thermal resistance of thick, low-density insulation.

3. Compressive Strength

The compressive strength of thermal insulation materials is determined by short-term standard test methods. The data given in the table refer to a deflection of 10% or yield value within 10% deflection. For structural applications involving continuous high compressive load (parking decks and cold stores), non-uniform loads or high temperature, provide an adequate safety factor or design stress levels to minimize deformation of the foam board with time.

The compressive strength data have been generated at a temperature of 24°C (75°F). At higher temperatures, these values are reduced. For example, the short-term compressive strength of Roofmate* at 40°C (104°F) is reduced by approximately 10%, but the longer term deformation of Roofmate* at 40°C is increased at a higher rate compared to the test temperature of 20°C (68°F). See below deformation under load versus time).

Deformation under Load vs. Time
(Roofmate boards, 50 mm thick)
The mechanical properties will not be affected adversely at lower temperatures down to -40°C (−40°F). The modulus of elasticity of vertical compression of Roofmate™, Styrofoam SM™ and Floormate 350™ is higher than 7000 kPa (996 psi).

Design of parking decks and cold-store floors should involve structural engineers to check necessary long term compressive strength of Styrofoam™ to achieve loading criteria without deformation of the insulation boards which support the load of the concrete slab on which dynamic and static loads are applied.

4. Water Vapor Diffusion Resistance Factor

The water vapor diffusion resistance factor is the ratio of water vapor diffusion resistance of a material to that of still air having the same thickness and temperature.

5. Water Resistance Properties

In any application, thermal insulation materials must remain dry in order to maintain their thermal resistance. It should be noted that the thermal conductivity of water is 24 times greater than that of air. Therefore, resistance to water absorption is an important factor to be considered in the selection of insulation materials. The high temperature and relative humidity in many areas of the Middle East require that thermal insulation materials have high resistance to water vapor transmission.

Extensive testing has been carried out to quantify the capability of various insulation materials to resist moisture absorption. It should be recognized that conditions which cause water absorption in thermal insulation materials in practical applications are varied and complex. Simple laboratory water absorption tests are useful as guidance to the selection of insulation materials suitable for use where water or water vapor is present.

One of the simplest test methods in order to determine moisture absorption is ASTM D 2842, which involves submerging the insulation material in water and measuring the water pick-up by volume over a specific period.

Test results for Styrofoam SM™ are shown in the figure below:

A test method, which determines the water absorption of thermal insulation materials under more realistic conditions, is the German water-diffusion test, which simulates, to some extent, climatic conditions as prevailing in the Middle East. In this test, the foam specimen is subjected to moisture and temperature gradient (10°C per cm foam thickness up to 60 mm thick material.)

The high resistance to water absorption of extruded polystyrene foam results from its closed-cell structure and the inherent resistance of the base polymer to water.
6. Heat Stability/Compressive Creep

WD: Foam compression after 2 days at 80°C (176°F) and 20 kPa (2.8 psi) will not exceed 5% versus the compression at 23°C (73°F).

WS: Foam compression after 7 days at 70°C (158°F) and 40 kPa (5.7 psi) will not exceed 5% versus the compression at 23°C (73°F). Min. density: 30 kg/m³ (1.9 lb/ft³).

Styrofoam* thermal insulation has a maximum use temperature of 75°C (167°F). When this temperature is exceeded for even a short period of time, Styrofoam* insulation can start to distort (i.e., curl or expand).

7. Fire Performance

DOW extruded polystyrene foams contain a flame-retardant additive to inhibit accidental ignition from a small fire source. However, these foams are combustible and can burn. They are classified as B2-materials according to DIN 4102 and as Type A (additive) according to British Standard BS 3837. These classifications are based on a small scale fire test and may not reflect the reaction of the materials to actual fire conditions. These materials should not be exposed to open flame or other ignition sources on site, during storage, installation and use.

The ballasted upside-down Roof, incorporating a loading layer of either gravel or concrete paving slabs, achieves the following:

1. An EXT. FAA rating when tested to BS476:part 3:1958
2. Class A Roof covering rating when tested according to U.L.I. Test # 790 (ASTM E 108)
3. Roof is qualified against Spreading Fire (or Flying Fire) and radiating heat when gravel layer has minimum thickness of 50 mm according to DIN 4102 part 4.

Styrofoam* products can also be manufactured to comply with Underwriters Laboratories (UL) classification in accordance with ASTM E-84 Standard Test Method under Designation C 578-95 for Surface Burning Characteristics of Building Materials. (Refer to table on page 12).

8. Chemical Resistance:

Styrofoam* is resistant to most commonly occurring construction materials like solvent-free bituminous compounds, water-based wood preservatives, lime, cement, plaster, anhydrous gypsum as well as alcohols, acids and alkalis. Certain organic materials like solvent-based wood preservatives, coal tar and derivatives (creosol, etc.) paint thinners and common solvents such as acetone, ethyl acetate, petrol toluene and white spirit will attack Styrofoam* resulting in softening, shrinkage and even dissolving with a consequent loss of performance.

9. Light Stability

Prolonged exposure of Styrofoam* to direct sunlight (UV-Radiation) will cause yellowing and deterioration of the surface cellular structure, therefore, Styrofoam* should be adequately protected. Deterioration due to limited exposure will usually not affect the insulation efficiency significantly. To prevent excessive ultraviolet exposure, a light colored protective covering should be used during storage and after installation.

In cases where any bonding of Styrofoam* surfaces is necessary, the yellow surface needs to be brushed off.

10. Acoustic Properties

Due to its rigid closed-cell structure and resonance behavior, Styrofoam* is not an effective sound absorption material. It is comparable to wood, plaster, bricks or other traditional building materials.

11. Site Handling and storage

Styrofoam* blue extruded polystyrene insulation boards should be stored on a clean, flat surface in an area free from open flammable materials. They can be stored outside, but should be protected against intense sunlight, preferably by retention in their original packaging. When stored indoors, good general ventilation should be sufficient for most conditions.

Styrofoam* insulation boards should not be exposed to flame or other ignition sources. Exposed to intense sunlight over prolonged periods, the surface of the boards degrades into fine dust.
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components. When installed, *Styrofoam* blue insulation boards should be adequately protected as directed by The Association of Extruded Polystyrene Manufacturers (USA), or the National Building Regulations (UK).

14. Maintenance (Roofs)

All roofs should be inspected regularly as part of normal maintenance procedures. Maintenance inspections should include assessment of the membrane and all outlets, gutters, flashings and other detail work.

Additionally, on upside down roofs, the inspection should confirm that neither the insulation nor the protective loading layers have been displaced. In some environments, weed growth may develop on a roof; whilst this is unlikely to be harmful on an upside down roof, it is nonetheless advisable to eradicate any weed growth using a suitable water-based weed killer.

Notice

Recommendations as to methods, use of materials and construction details are given in good faith as a service to designers and contractors based on Dow’s experience of the use of *Styrofoam*. Any drawings are meant only to illustrate the various possibilities of applications and should not be taken as a basis for design. Since the Arabian Chemical Company (PS) Ltd, as a supplier, exercises no control over the installation of *Styrofoam*, no responsibility is accepted for such drawings or recommendations. Arabian Chemical Company (Polystyrene)Ltd. legal obligation in respect of any sale of Styrofoam shall be determined solely by the terms of the respective sales contract. Anyone wishing to reproduce or publish any of the material contained herein in whole or in part should request permission from the Arabian Chemical Company (Polystyrene) Ltd.

12. Packaging

The inception of the *Styrofoam* Plant, being one of the first batch of downstream secondary industries, reflects the confidence and highlights the commitment of the Arabian Chemical Company (Polystyrene) Ltd. to Saudi Arabia & the Middle East region. The Jeddah plant has been designed and built according to the most advanced technology, to maintain customer’s satisfaction with product quality, prompt deliveries and faster response. The plant also includes the latest development in packaging. The product is bundled and shrink-wrapped with UV-stabilized, blue PE-film, which insure ease of handling during loading, unloading and storage operations and protects the boards from damage during transportation.

13. Environments

*Styrofoam* is not biodegradable in the environment and does not present any environmental hazard in the water/soil compartment. *Styrofoam* may be disposed of in approved landfills or, preferably by incineration under approved conditions. *Styrofoam* can be recycled, however it should not be mixed with other plastics. *Styrofoam* boards should be applied within the recommended temperature range. When exposed to temperatures exceeding the recommended range, *Styrofoam* products can either soften, undergo irreversible dimensional changes and eventually melt or become brittle and lose their mechanical properties. Solvent attack may occur if *Styrofoam* insulation boards are used in direct contact with materials containing volatile
Various Projects

Ap corp Headquarters - Eastern Province - Roofmate Roof on wavy roof

Al Habib Commercial Center, Al sharafia - Jeddah

Al Kamal Office Building - Jeddah, (STO System)

Makkah Construction and Development Co., First Residential & Commercial Complex

Harify Building - Jeddah Corniche

Al Khuzaima Towers - Jeddah Corniche

Hilton Hotel - Jeddah Corniche
www.acc-ps.com

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