MICROTHERM® products are available in many different forms which are usually sized and shaped to the customer’s specification.

Table 1.
The Range of MICROTERM® Products

**MICROTERM® Panel**
A powder / filament mixture consolidated within a glass cloth cover to produce a firm flat panel.

**MICROTERM® Slatted Panel**
Single strips of MICROTERM® hinged together by a stitchline to give flexibility.

**MICROTERM® Block**
A powder / filament mixture consolidated into a slab or rigid block which can be bandsawn and shaped.

**MICROTERM® Moulded Form**
A powder / filament mixture moulded in a die or supporting structure to a pre-determined form.

**MICROTERM® Quilted Panel Types**
A MICROTERM® Panel sewn through on a lattice to give a flexible sheet. This MICROTERM® product is available in a variety of forms.

**MICROTERM® MPS**
A powder / filament mixture moulded into standard curved shapes ready to be fitted to pipes.

**MICROTERM® VIP**
An evacuated, low temperature thermal barrier panel with microporous core.

Note: Specific brochures are available for the more specialised MICROTERM® product forms.
**Product Description.**

MICROTHERM® Insulation is a high performance thermal insulation manufactured from carefully formulated mixtures of finely divided amorphous silica, metal oxides and glass filament. This forms a microporous structure designed to minimise the transmission of heat over a large temperature range. The thermal performance of MICROTHERM® Insulation can be three or four times better than other more conventional insulation products (see Graph 1.)
MICROTHERM® Insulation is used in the glass industry. MICROTHERM® Panel and Slatted Panel are shown here fitted in the floor of a Forehearth and the inside face of a Feeder Bowl Casing.

The woven glass cloth applied to this shaped piece of MICROTHERM® Insulation provides a tough skin to make the insulation easier to handle.

Product Description (Continued)

MICROTHERM® Insulation is manufactured in a wide range of shapes and forms, at densities between 130 and 400 kg/m³, to adjust the rigidity and flexibility to suit the application. It may also be encapsulated in heat resistant fabrics and other coatings.

The unique low thermal conductivity properties of MICROTHERM® Insulation are retained whether it is used in air or other gases. And of course, because of their low thermal conductivity and density, MICROTHERM® products can be slimmer, lighter in weight and more energy efficient than conventional insulations.

First class thermal efficiency does not come at the expense of inconvenience or complexity in fitting. MICROTHERM® Insulation is simple to use and the results obtained from its use are reliable and repeatable. MICROTHERM® Insulation is easy to apply because pieces can be tailor-made to give precise size and shape.

On the few occasions when site cutting of MICROTHERM® Insulation is necessary, guidance on the most effective methods for doing so is available in our separate leaflet, “On Site Cutting”.

Full descriptions of the technical performance specifications and uses of each of the products are contained in separate brochures.

Grades

Two basic grades of MICROTHERM® Insulation are available for general industrial applications: MICROTHERM® Super G and MICROTHERM® Super G Hydrophobic.

MICROTHERM® Super G
This is the normal formulation accounting for the majority of applications. The maximum temperature for continuous exposure is 1000°C.

MICROTHERM® Super G Hydrophobic Grade
This grade uses a formulation which resists water penetration. The maximum temperature for continuous exposure is 1000°C although the hydrophobic properties degrade over time at temperatures lower than this.

Other specialised MICROTHERM® insulation grades are available to suit particular applications.

Coatings and Coverings

The most widely used covering material for MICROTHERM® Insulation is a woven glass cloth. This provides a tough, temperature-resistant skin making the insulation easier to handle.

Other specialised coatings and coverings are available to suit particular applications.
Thermal Conductivity.

Definitions

The effectiveness of a material as a thermal insulator can be expressed in terms of its thermal conductivity, or \( \lambda \).

A substance with a small \( \lambda \) is a good insulator of heat; one with a large \( \lambda \) is a poor heat insulator i.e. a good conductor.

The most effective insulation will have a very low \( \lambda \) value which does not increase significantly over a wide temperature range. As can be seen from Graph 1 (page 3), MICROThERM\textsuperscript® Insulation has a very low thermal conductivity which is almost independent of mean temperature - in contrast with the other material classes presented.

This behaviour is illustrated in an expanded form in Graph 2 for MICROThERM\textsuperscript® Super G along with the accompanying table of data obtained on representative batches of production material.

Typical Curve for the Thermal Conductivity of MICROThERM\textsuperscript® Super G (Density 240 kg/m\textsuperscript{3}).

The low thermal conductivity of MICROThERM\textsuperscript® Insulation allows this electric storage heater to retain its heat over an extended period of time whilst maintaining extremely thin dimensions.

<table>
<thead>
<tr>
<th>Temperature</th>
<th>Thermal Conductivity (Density 240 kg/m\textsuperscript{3})</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hot Face (°C)</td>
<td>Cold Face (°C)</td>
</tr>
<tr>
<td>160</td>
<td>40</td>
</tr>
<tr>
<td>352</td>
<td>48</td>
</tr>
<tr>
<td>536</td>
<td>64</td>
</tr>
<tr>
<td>720</td>
<td>80</td>
</tr>
<tr>
<td>908</td>
<td>92</td>
</tr>
</tbody>
</table>

Table 3.

Conversion Factors

<table>
<thead>
<tr>
<th>( W/(m \cdot K) )</th>
<th>kcal/(m²°C)</th>
<th>Btu in/(h ft²°F)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.86</td>
<td>6.93</td>
</tr>
<tr>
<td>1.163</td>
<td>1</td>
<td>8.06</td>
</tr>
<tr>
<td>0.144</td>
<td>0.124</td>
<td>1</td>
</tr>
</tbody>
</table>

Table 2.
Thermal Conductivity Measurement.

The fundamental property of thermal conductivity is not easy to determine accurately since it requires precise measurements of temperatures and temperature gradients, material thicknesses, and effective areas.

We employ two different types of test equipment for measuring thermal conductivity:

- Cylindrical Cell Test Apparatus
- Guarded Hot Plate Apparatus

Both of these deliberately generate large temperature gradients across the sample in order to simulate realistic operating conditions prevailing in, say, night storage heaters and furnaces. Measurement systems which use small temperature differences are employed by some laboratories. These can give lower apparent $\lambda$ values at a given mean temperature but the results are normally not so relevant in practical situations.

Performance in Vacuum and in Gases Other Than Air

There may be demanding applications where even the extremely good insulation performance of MICROThERM® is still not adequate. By operating the insulation at lower than atmospheric pressure, and hence minimising residual gaseous conduction, the thermal conductivity can be reduced by a factor of two or more across a wide temperature range (Graph 3). Unlike most other insulation materials, this improvement in thermal conductivity is maintained up to, and beyond, 10mbar. Operation of MICROThERM® in gases other than air will also affect its thermal conductivity. Results are shown for performance in hydrogen, helium (high thermal conductivity gases), argon and krypton (low thermal conductivity gases).

Performance of MICROThERM® Super G in Different Atmospheres.

![Graph 3.](image)
The Effect of Density on the Thermal Conductivity of MICROThERM® Super G.

Graph 4.

Effect of Density on Thermal Conductivity

The thermal conductivity of MICROThERM® Insulation is not greatly affected by product density in the range 200 - 400 kg/m³, as illustrated in Graph 4. The shallow minimum in the curve represents the density at which the optimum balance between the various mechanisms of heat transfer occurs. The position of the minimum depends on the mean temperature, shifting to higher densities as the temperature increases.

Thermal Calculations

This service is available from our Sales Engineering Department for single layer or composite insulation systems. As an example, the curves in Graph 5 show the calculations for MICROThERM® Super G Panel applied to a flat vertical surface assuming a cold face emissivity of 0.9 (typical of a painted surface). Ambient temperature is assumed to be 20°C.

Heat loss through MICROThERM® Super G Panel.

Graph 5.

In the steel industry, a tundish is lined with MICROThERM® Panels to help shield it from 1600°C molten steel which it is designed to hold continuously.
Chemical Composition

Typical calculated figures for the inorganic chemical constituents of MICROTERM® Block are shown in Table 4.

Note that the composition of non-standard grades of MICROTERM® Insulation may differ from that described. Information about these is available where necessary.

MICROTERM® Insulation is often supplied with a glass cloth covering. A typical analysis is given in Table 5. The cloth is generally sewn with glass thread treated with silicone oil and sometimes coated with P.T.F.E.

Thermal Shrinkage

Maximum Operating Temperature

In most applications, MICROTERM® Super G can be used against a hot face of 1000°C for a very long period. At this temperature a small amount of shrinkage occurs as shown in Graph 7. If insulation panels are applied over a large area at this temperature, it is best to apply the insulation in two layers with an overlap at butt joints.

MICROTERM® Super G will withstand short periods at higher temperatures - 1100°C for short term use and 1200°C for brief exposure, for example in a fire situation. However, in the presence of some chemicals, particularly alkali metal compounds, shrinkage may be accelerated.

At temperatures around 800°C colour changes can be detected in MICROTERM® Insulation. This can be useful in assessing the temperature to which a piece of the insulation has been exposed, but otherwise it is of no significance.

<table>
<thead>
<tr>
<th>Typical Percentage of Constituents</th>
<th>For MICROTERM® Super G</th>
</tr>
</thead>
<tbody>
<tr>
<td>SiO₂</td>
<td>59.74</td>
</tr>
<tr>
<td>TiO₂</td>
<td>37.09</td>
</tr>
<tr>
<td>Al₂O₃</td>
<td>1.65</td>
</tr>
<tr>
<td>ZrO₂</td>
<td>0.32</td>
</tr>
<tr>
<td>Fe₂O₃</td>
<td>0.36</td>
</tr>
<tr>
<td>Cr₂O₃</td>
<td>0.07</td>
</tr>
<tr>
<td>CaO</td>
<td>0.01</td>
</tr>
<tr>
<td>MgO</td>
<td>0.32</td>
</tr>
<tr>
<td>Nb₂O₅</td>
<td>0.12</td>
</tr>
<tr>
<td>V₂O₅</td>
<td>0.20</td>
</tr>
<tr>
<td>Cl</td>
<td>0.02</td>
</tr>
<tr>
<td>P₂O₅</td>
<td>0.02</td>
</tr>
<tr>
<td>K₂O</td>
<td>Trace</td>
</tr>
<tr>
<td>Na₂O</td>
<td>0.32</td>
</tr>
</tbody>
</table>

Table 4.

<table>
<thead>
<tr>
<th>Typical Percentage of Constituents</th>
<th>For Glass Cloth</th>
</tr>
</thead>
<tbody>
<tr>
<td>SiO₂</td>
<td>54.2</td>
</tr>
<tr>
<td>Al₂O₃</td>
<td>15.2</td>
</tr>
<tr>
<td>CaO</td>
<td>17.3</td>
</tr>
<tr>
<td>MgO</td>
<td>4.7</td>
</tr>
<tr>
<td>Na₂O</td>
<td>0.6</td>
</tr>
<tr>
<td>B₂O₅</td>
<td>8.0</td>
</tr>
</tbody>
</table>

Table 5.

Graph 6.

Heat flow through MICROTERM® Super G Panel.
Shrinkage Measurement

In our extreme full soak thermal shrinkage tests, discs of MICROThERM® Insulation (110mm diameter x 25mm thick) are suspended in a furnace at the specified temperature and the change in linear dimensions are measured over time. The percentage shrinkage in thickness is greater than in diameter because of the orientation of the reinforcing filaments within the MICROThERM® Insulation structure. However, in the application of MICROThERM® Insulation, it is the diametral or planar shrinkage that is of greatest significance since only one face is exposed to the high temperature.

Thermal Changes to Glass Cloth

When the standard glass cloth material, used as a covering on some MICROThERM® products, is exposed to temperatures above 500°C, its mechanical properties begin to degrade. Above 800°C melting is evident and, as this occurs, the cloth can become separated from the MICROThERM® core.

The main consequence of these thermal changes to the glass cloth is that the strength and handleability of the insulation tends to revert to what it would have been without the glass cloth covering - the insulation performance is not altered in any way. Since MICROThERM® Insulation is usually held between metal sheets or refractory materials, deterioration of the glass cloth is normally not an important issue.

Other specialised coatings and coverings are available to suit particular applications.
Mechanical Properties.

Flexural Strength and Tensile Strength

The mechanical properties of MICROTERM® Insulation are important in some applications. One of the most appropriate indicators of robustness of the insulation is its behaviour in a three or four point bend test, although a form of indirect tensile strength testing may also be used.

The Effect of Density on the Flexural Strength of of MICROTERM® Block

![Graph 8. The Effect of Density on the Flexural Strength of MICROTERM® Block](image)

The flexural strength figures shown above in Graph 8 are for Block material.

Non-encapsulated MICROTERM® Super G tested to DIN 51048 part 2 yields a flexural strength of 200kN/m² at a density of 350kg/m³.

Resistance to Compression.

MICROTERM® Insulation products are normally supplied at the lowest density which can be handled satisfactorily, consistent with optimum overall performance. When greater resistance to compression is required, higher densities can be supplied. Depending on the product type, the normal density range is from 200 to 350 kg/m³.

The extent to which MICROTERM® Insulation recovers after a compressive load has been removed depends on the MICROTERM® Insulation grade and the way in which the material has been used. Information on this is available on request.
Combustibility.

MICROTHERM® Super G meets the requirements of BS476, DIN4102 and UL94V-0 for non-combustibility.

Encapsulants like glass cloth contain very small amounts of combustible materials.

Specialised applications may require particular coatings to be applied to the MICROTHERM® Insulation. The combustibility of these coatings may be greater than that of the MICROTHERM® Insulation. Information on coatings is available on request.

MICROTHERM® materials are excellent fire barriers to protect steel, aluminium or composite structures. Our Sales Engineering Department can provide you with copies of the relevant certificates on request.
Effect of Moisture and Humidity.

MICROTHERM® Insulation normally has a moisture content of 1 - 3% by weight. This can increase if it is stored in damp conditions. The presence of a small amount of absorbed water does not affect the performance of MICROTHERM® Insulation but in some applications provision must be made for this water to escape as it is driven out by exposure to heat.

The thermal and mechanical properties of MICROTHERM® Insulation are not significantly affected by severe changes in temperature or humidity. Steam passes through the structure of MICROTHERM® Insulation without causing damage.

If contact with liquids or water is likely, we recommend using MICROTHERM® Super G Hydrophobic Grade.

MICROTHERM® Super G Hydrophobic Grade.

This material is based on silica particles which have been specially treated to render them, and hence the insulation, water repellent.

The treatment is so effective that MICROTHERM® Super G Hydrophobic can be totally submerged in water for 60 days without damage. During this period it slowly absorbs water, typically 10% by weight. It can then be dried and still remain water resistant. The whole MICROTHERM® Insulation structure is waterproof so it can be machined or cut. MICROTHERM® Super G Hydrophobic Grade is particularly useful in situations where large amounts of water can condense on surfaces in contact with the insulation.

If the water contains chemicals which reduce the surface tension, such as detergents, these may react with the hydrophobic coating and destroy the water resistant properties.

It should also be noted that the hydrophobicity will be lost at higher temperatures. MICROTHERM® Super G Hydrophobic will retain its water repellancy at 250°C indefinitely, at 350°C for 24 hours and at 400°C for 1 hour.

Leachable Chloride and Stress Corrosion Cracking.

Stress Corrosion Cracking (SCC) of austenitic stainless steel is a frequently encountered problem when hot stressed stainless steel has contact with solutions containing halide ions.

The likelihood of it occurring depends on many factors including the level of tensile stress in the steel surface, the operating temperatures, the halide ion concentration and the composition of the stainless steel.

A source of the halide ions can be chlorides contained in the thermal insulation material applied to the stainless steel. Even when the leachable chloride content is very low, it is possible for the chlorides to migrate to a small area of the steel to form a high concentration so that the possibility of cracking still exists. If large quantities of silica are present with the chlorides, they tend to nullify the effect of the chlorides so that the danger of SCC is considerably reduced.
Acceptability of Insulation Material on the Basis of the Plot Points of the CI and the (Na + SiO$_3$) Analysis.

The leachable chloride content of MICROTERM® Insulation is very low - less than 50 ppm. The leachable silicate of MICROTERM® Insulation is much higher - greater than 1500 ppm. Whilst it cannot be excluded that SCC occurs when MICROTERM Insulation is used, it is fair to say that the risk is at a very low level. In critical applications, periodic inspection is advisable.

The use of MICROTERM® Super G Hydrophobic Grade should also be considered. This particular grade is almost not wetted by water so leaching of chlorides within the MICROTERM® Insulation structure is reduced.

Health and Safety

MICROTERM® products are formulated from low hazard materials and considerable care has been taken to ensure that products, when used as recommended, are safe to handle as practically possible. Further information on current occupational exposure limits and control measures / precautions required to minimise personal exposure, for all grades of MICROTERM®, is provided in our Material Safety Data Sheets.

A Datapaq Data Tracker uses MICROTERM® Insulation to line stainless steel containers which hold temperature measurement equipment.
This Data Booklet has been prepared by

MICROTHERM

MICROTHERM® is a registered trademark of MICROThERM INTERNATIONAL LIMITED

MICROTHERM INTERNATIONAL Ltd.
1 Arroewe Brook Road,
Upton,
WIRRAL, CH49 1SX,
U.K.

MICROTHERM (G.B.) Ltd.
1 Arroewe Brook Road,
Upton,
WIRRAL, CH49 1SX,
U.K.
Tel : +44 ( 0 )151 606 6200
Fax : +44 ( 0 )151 606 6212
email : sales@microtherm.uk.com

MICROTHERM n.v.
Industriepark Noord 1,
B9100 SINT-NIKLAAS,
Belgium.
Tel : +32 ( 0 )3 7601 980
Fax : +32 ( 0 )3 7601 999
email : sales@microtherm.be

MICROTHERM Inc.
269, Cusick Road, McGhee Tyson Plaza, Suite C4, Alcoa
TENNESSEE 37701
U.S.A.
Tel : +1 865 681 0155
Fax : +1 865 681 0016
email : usa@microtherm.uk.com

For more information, also visit our website at

www.microtherm.uk.com

for:

✓ Our most recent information
✓ Our web-based thermal calculator
✓ The microporous principle
✓ Product datasheets
✓ Product properties
✓ Product performance
✓ Health and Safety information
✓ Information on typical applications

MICROTHERM® Insulation Performance

The information contained in this brochure is, to our best knowledge, true and accurate, but all recommendations or suggestions are made without guarantee since the conditions of use are beyond our control. We disclaim any liability incurred in connection with the use of these data or suggestions. Furthermore, nothing contained herein shall be construed as a recommendation to use any product in conflict with existing patents covering any material or its use.