

### **3. HOT INSULATION**

#### **3.1 GENERAL NOTES**

Equipment or pipe work with an operation temperature greater than 55°C in case of metallic surfaces and 65°C in the case of non-metallic surfaces should be insulated so that the surface temperature after insulation (cold surface temperature) does not exceed 55°C.

It is recognised that temperatures of 60°C or greater will result in extreme discomfort to personnel and therefore a maximum cold surface temperature of 55°C should be considered as prudent.

If the fluid inside the pipe or vessel is likely to remain static for long periods when the ambient temperature is below the freezing point of the fluid, it is important that this shall be stated. Also, the fluid in small diameter pipes may be especially susceptible to freezing, particularly if the rate of flow is intermittent or slow, it may be necessary to consider the use of supplementary means of heating, possibly only in local areas, like heat tracing.

#### **3.2 SELECTION OF HOT INSULATION MATERIALS**

The objective is to select a material, which will serve the insulation purpose at the lowest cost. This can be a complicated procedure.

In addition to the factors listed in section 2.2 careful considerations should be given to insulation thickness. On pipe work an over-specification of thickness creates a needless increase in the cost of the outer protection.

When a multi-layer system of insulation is envisaged, the selection of materials is interdependent on the type of protection and the calculations as set out in Annex 2 paragraph 5.2. For example, an aluminium protection will result in a higher cold surface temperature and a lower heat. (Aluminium protection has a low emissivity and therefore radiates less heat).

Where constant load supports are involved, the mass of the insulation system becomes critical and must be kept within the tolerances of such constant load supports. Where used for internal linings of ventilation ductwork the thermal insulating material itself should be non-combustible as defined in BS 476: Part 4

#### **3.3 HOT INSULATION MATERIALS**

Common to all these materials, it is recommended that their use be limited to conditions of 90% of the manufacturer's limiting temperatures in order to safeguard against temperature surge at start-up operations of plant.

Please note: Information provided in the following tables is generic information suitable for feasibility studies and cost estimates.

Actual figures may differ from manufacturer to manufacturer and must be confirmed with the individual manufacturer.

### 3.3.1 HOT INSULATION MATERIALS

CALCIUM SILICATE	
1	<b>Density (and range, if applicable)</b>
2	<b>Thermal Conductivity</b>
	Thermal conductivity (W/mK) at density indicated below
	Mean temp °C      240 kg/m <sup>3</sup>
	100      0,054
	150      0,058
	200      0,063
	250      0,068
	300      0,074
	350      0,082
3	<b>Service Temperature range</b> 1000°C
4	<b>Reaction to Fire Characteristics</b>
	a. Combustibility to BS476 part 4      Non Combustible
	b. Surface spread to flame to BS476 part 7
	Insulant (if appropriate)      Class 1
	Composite finish (if appropriate)      Class 1
	Foil faced products (if appropriate)      Class 1
	c. Building Regulations
	Insulate (if appropriate)      Class 0
	Composite finish (if appropriate)      Class 0
	Foil faced products (if appropriate)      Class 0
5	<b>Water Vapour Transmission</b>
	Insulant (if appropriate)      N/a
	Composite finish/foil faced product (if appropriate)      N/a
6	<b>Mechanical Properties</b>
	a. Compressive strength      600kN/m <sup>2</sup> at 1,5% deformation
	b. Flexural strength      550 kN/m <sup>2</sup>
	c. Tensile strength      N/a
7	<b>Thickness Range</b> Available from 25 to 100mm
8	<b>Forms available</b> Lags, Sections, Slabs

#### TYPICAL USES AND APPLICATIONS

Steam, superheated steam and hot water pipe work, fitments and vessels. Oven construction – furnace-backing insulation. Used in power generation, petrochemical and general industrial applications on process plant and heating insulations. Suitable for use in food processing industries.

CERAMIC FIBRE (BLANKET)			
1	<b>Density (and range, if applicable)</b>	64 to 192 kg/m <sup>3</sup>	
2	<b>Thermal Conductivity</b>	Thermal conductivity (W/mK) at density indicated below	
	Mean temp °C	64 kg/m <sup>3</sup>	96 kg/m <sup>3</sup> 128 kg/m <sup>3</sup>
	100	-	0,041      0,030
	300	-	0,079      0,06
	600	0,18	0,14      0,12
	800	0,27	0,22      0,18
	1000	0,42	0,36      0,28
3	<b>Service Temperature range</b>	1250°C	
4	<b>Reaction to Fire Characteristics</b>	Non Combustible	
	a. Combustibility to BS476 part 4		
	b. Surface spread to flame to BS476 part 7		
	Insulant (if appropriate)	Class 1	
	Composite finish (if appropriate)	Class 1	
	Foil faced products (if appropriate)	Class 1	
	c. Building Regulations		
	Insulate (if appropriate)	Class 0	
	Composite finish (if appropriate)	Class 0	
	Foil faced products (if appropriate)	Class 0	
5	<b>Water Vapour Transmission</b>	542 µg/m/Nh	
	Insulant (if appropriate)	0,001g/(s. MN)	
	Composite finish/foil faced product (if appropriate)	(At 128 kg/m <sup>2</sup> )	
6	<b>Mechanical Properties</b>	2,5kN/m <sup>2</sup> at 10% deformation	
	a. Compressive strength	N/a	
	b. Flexural strength	65 kN/m <sup>2</sup>	
	c. Tensile strength		
7	<b>Thickness Range</b>	Available from 6 to 50mm	
8	<b>Forms available</b>	Lags, Sections, Slabs	

#### TYPICAL USES AND APPLICATIONS

Refractory grade material suitable for use to 1400°C. Available in form of loose wool, non-woven blankets, papers, boards, preformed shapes, textiles and wet mixes. Use for thermal and acoustic insulation within process industries such as motor, petrochemical and power generation. Also fire protection of commercial buildings and offshore structures.

### 3.3.2 HOT INSULATION MATERIALS

CELLULAR GLASS			
1	<b>Density (and range, if applicable)</b>		
2	<b>Thermal Conductivity</b>		
	Thermal conductivity (W/mK) at density indicated below		
	Mean temp °C	120 kg/m <sup>3</sup>	135 kg/m <sup>3</sup>
	-100	0,034	
	0	0,038	0,044
	10	0,040	0,046
	100	0,081	
3	<b>Service Temperature range</b> -260 to 430°C		
4	<b>Reaction to Fire Characteristics</b>		
	a. Combustibility to BS476 part 4	Non Combustible	
	b. Surface spread to flame to BS476 part 7		
	Insulant (if appropriate)	Class 1	
	Composite finish (if appropriate)	Class 1	
	Foil faced products (if appropriate)	Class 1	
	c. Building Regulations		
	Insulate (if appropriate)	Class 0	
	Composite finish (if appropriate)	Class 0	
	Foil faced products (if appropriate)	Class 0	
5	<b>Water Vapour Transmission</b>		
	Insulant (if appropriate)	Zero µg/m/Nh	
	Composite finish/foil faced product (if appropriate)	N/a	
6	<b>Mechanical Properties</b>		
	a. Compressive strength	700kN/m <sup>2</sup>	
	b. Flexural strength	400 kN/m <sup>2</sup>	
	c. Tensile strength	N/a	
7	<b>Thickness Range</b> Available from 40 to 160mm		
8	<b>Forms available</b> Board, Pipe shells, Slabs, Vessels segments		

#### TYPICAL USES AND APPLICATIONS

Industrial: tank bases, vessels, piping and equipment, cold stores and marine applications. Buildings: roofs, floors, walls (internal and external), car park decks, soffits

GLASS MINERAL WOOL			
1	<b>Density (and range, if applicable)</b> 10 to 80 kg/m <sup>3</sup>		
2	<b>Thermal Conductivity</b>		
	Thermal conductivity (W/mK) at density indicated below		
	Mean temp °C	16 kg/m <sup>3</sup>	48 kg/m <sup>3</sup> 80 kg/m <sup>3</sup>
	-20	0,031	0,028 0,028
	10	0,037	0,030 0,031
	20	0,040	0,032 0,032
	50	0,047	0,035 0,035
	100	0,065	0,044 0,042
3	<b>Service Temperature range</b> - 200 to 450°C		
4	<b>Reaction to Fire Characteristics</b>		
	a. Combustibility to BS476 part 4	Non Combustible	
	b. Surface spread to flame to BS476 part 7		
	Insulant (if appropriate)	Class 1	
	Composite finish (if appropriate)	Class 1	
	Foil faced products (if appropriate)	Class 1	
	c. Building Regulations		
	Insulate (if appropriate)	Class 0	
	Composite finish (if appropriate)	Class 0	
	Foil faced products (if appropriate)	Class 0	
5	<b>Water Vapour Transmission</b>		
	Insulant (if appropriate)	N/a	
	Composite finish/foil faced product (if appropriate)	0,001g/(s. MN)	
6	<b>Mechanical Properties</b>		
	a. Compressive strength	1 to 8 kN/m <sup>2</sup> at 5% deformation	
	b. Flexural strength	N/a	
	c. Tensile strength	N/a	
7	<b>Thickness Range</b> Available from 15 to 150mm		
8	<b>Forms available</b> Blown Fibre, Pipe Sections, Rolls, Slabs		

#### TYPICAL USES AND APPLICATIONS

Glass mineral wool is available in a wide range of forms ranging from flexible rolls to rigid slabs and preformed pipe sections. It is particularly suitable for thermal and acoustic applications in the H & V sector and is also used as both a thermal and an acoustic insulation in transport, shipping, building and industrial applications.

### 3.3.3 HOT INSULATION MATERIALS

<b>GLASS MINERAL WOOL NEEDLE MAT (E-GLASS TEXTILE TYPE)</b>	
1	<b>Density (and range, if applicable)</b> 130 kg/m <sup>3</sup>
2	<b>Thermal Conductivity</b>
	Thermal conductivity (W/mK) at density indicated below
	Mean temp °C      130 kg/m <sup>3</sup>
	0      0,035
	50      0,045
	100      0,056
	250      0,073
	350      0,096
	500      0,141
3	<b>Service Temperature range</b> - 200 to 750°C
4	<b>Reaction to Fire Characteristics</b>
	a. Combustibility to BS476 part 4      Non Combustible
	b. Surface spread to flame to BS476 part 7
	Insulant (if appropriate)      Class 1
	Composite finish (if appropriate)      Class 1
	Foil faced products (if appropriate)      Class 1
	c. Building Regulations      Class 0
5	<b>Water Vapour Transmission</b> N/a
6	<b>Mechanical Properties</b>
	a. Compressive strength      N/a
	b. Flexural strength      N/a
	c. Tensile strength      N/a
7	<b>Thickness Range</b> Available from 5 to 25mm
8	<b>Forms available</b>
<b>TYPICAL USES AND APPLICATIONS</b>	
Mechanically bonded E-Glass needle mat can be used in various acoustic and thermal insulation applications.	
E-Glass needle mat is ideal as infill for high temperature, flexible, thermo-acoustic removable insulation jackets, mats, flange and valve covers.	
It is also used for heat treatment and stress relief blankets, exhaust systems, stacks and silvers. The product is non-resin bonded and is able to withstand extreme vibration without stakeout.	

<b>MELAMINE FOAM (FLEXIBLE)</b>	
1	<b>Density (and range, if applicable)</b>
2	<b>Thermal Conductivity</b>
	Thermal conductivity (W/mK) at density indicated below
	Mean temp °C      11 kg/m <sup>3</sup>
	10      0,034
	20      0,035
	40      0,039
	50      0,040
	80      0,046
3	<b>Service Temperature range</b> 10 to 150°C
4	<b>Reaction to Fire Characteristics</b>
	a. Combustibility to BS476 part 4      Combustible
	b. Surface spread to flame to BS476 part 7
	Insulant (if appropriate)      Class 1
	Composite finish (if appropriate)      Class 1
	Foil faced products (if appropriate)      Class 1
	c. Building Regulations      Class 0
	Insulate (if appropriate)      Class 0
	Composite finish (if appropriate)      Class 0
	Foil faced products (if appropriate)      Class 0
5	<b>Water Vapour Transmission</b>
	Insulant (if appropriate)      350 µgm/Nh
	Composite finish/foil faced product (if appropriate)      0,001g/(s. MN)
6	<b>Mechanical Properties</b>
	a. Compressive strength      5 to 20 kN/m <sup>2</sup> at 10% deformation
	b. Flexural strength      N/a
	c. Tensile strength      120 kN/m <sup>2</sup>
7	<b>Thickness Range</b> Available from 10 to 50mm
8	<b>Forms available</b>
<b>TYPICAL USES AND APPLICATIONS</b>	
Fibre free insulation suitable for use on L.T.H.W. and M.T.H.W. heating services. Applications in market such as food processing, breweries, pharmaceuticals, electronics and hospitals. Specified as combined thermal and acoustic insulant in petrochemical sector.	

### 3.3.4 HOT INSULATION MATERIALS

PERLITE EXPANDED		
1	<b>Density (and range, if applicable)</b>	50 to 150 kg/m <sup>3</sup>
2	<b>Thermal Conductivity</b>	
		Thermal conductivity (W/mK) at density indicated below
	Mean temp °C	80 kg/m <sup>3</sup>
	20	0,057
3	<b>Service Temperature range</b>	-250 to 1000°C
4	<b>Reaction to Fire Characteristics</b>	
	a. Combustibility to BS476 part 4	Non Combustible
	b. Surface spread to flame to BS476 part 7	
	Insulant (if appropriate)	Class 1
	Composite finish (if appropriate)	N/a
	Foil faced products (if appropriate)	N/a
	c. Building Regulations	
	Insulate (if appropriate)	Class 0
	Composite finish (if appropriate)	N/a
	Foil faced products (if appropriate)	N/a
5	<b>Water Vapour Transmission</b>	
	Insulant (if appropriate)	N/a
	Composite finish/foil faced product (if appropriate)	N/a
6	<b>Mechanical Properties</b>	
	a. Compressive strength	N/a
	b. Flexural strength	N/a
	c. Tensile strength	N/a
7	<b>Thickness Range</b>	Available from 25 to 300mm
8	<b>Forms available</b>	

#### TYPICAL USES AND APPLICATIONS

Loose fill granular material can be used as structural insulation in domestic roof spaces. Suitable for use below -180°C as it contains no organic materials. Can be used in plasterboard manufacture and insulating renders, concretes and refractory materials.

ROCK MINERAL WOOL		
1	<b>Density (and range, if applicable)</b>	60 to 160 kg/m <sup>3</sup>
2	<b>Thermal Conductivity</b>	
		Thermal conductivity (W/mK) at density indicated below
	Mean temp °C	60 kg/m <sup>3</sup> 80 kg/m <sup>3</sup>
	10	0,033      0,033
3	<b>Service Temperature range</b>	- 200 to 900°C
4	<b>Reaction to Fire Characteristics</b>	
	a. Combustibility to BS476 part 4	Non Combustible
	b. Surface spread to flame to BS476 part 7	
	Insulant (if appropriate)	Class 1
	Composite finish (if appropriate)	Class 1
	Foil faced products (if appropriate)	Class 1
	c. Building Regulations	
	Insulate (if appropriate)	Class 0
	Composite finish (if appropriate)	Class 0
	Foil faced products (if appropriate)	Class 0
5	<b>Water Vapour Transmission</b>	
	Insulant (if appropriate)	N/a
	Composite finish/foil faced product (if appropriate)	0,001g/(s. MN)
6	<b>Mechanical Properties</b>	60kg/m <sup>3</sup> 80kg/m <sup>3</sup>
	a. Compressive strength	7,5      10.5
	b. Flexural strength	
	c. Tensile strength	N/a
7	<b>Thickness Range</b>	Available from 20 to 120mm
8	<b>Forms available</b>	Loose fill, Mats, Pipe section, Rolls, Slabs, Wired mattresses (available without a variety of facings)

#### TYPICAL USES AND APPLICATIONS

Thermal and acoustic insulation and fire protection of plant, equipment and building structures in the marine, offshore, H & V, heavy industrial, commercial, institutional and domestic sectors.

### 3.3.5 HOT INSULATION MATERIALS

ROCK MINERAL WOOL (HIGH DENSITY)				
1	<b>Density (and range, if applicable)</b>			
2	<b>Thermal Conductivity</b>			
	Thermal conductivity (W/mK) at density indicated below			
	Mean temp °C	100 kg/m <sup>3</sup>	120 kg/m <sup>3</sup>	160 kg/m <sup>3</sup>
	10	0,033	0,033	0,034
	50	0,037	0,037	0,038
	200	0,064	0,060	0,059
3	<b>Service Temperature range</b> -200 to 900°C			
4	<b>Reaction to Fire Characteristics</b>			
	a. Combustibility to BS476 part 4	Non Combustible		
	b. Surface spread to flame to BS476 part 7			
	Insulant (if appropriate)	Class 1		
	Composite finish (if appropriate)	Class 1		
	Foil faced products (if appropriate)	Class 1		
	c. Building Regulations			
	Insulate (if appropriate)	Class 0		
	Composite finish (if appropriate)	Class 0		
	Foil faced products (if appropriate)	Class 0		
5	<b>Water Vapour Transmission</b>			
	Insulant (if appropriate)	N/a		
	Composite finish/foil faced product (if appropriate)	0,001g/(s. MN)		
6	<b>Mechanical Properties</b>			
		100 kg/m <sup>3</sup>	140 kg/m <sup>3</sup>	200 kg/m <sup>3</sup>
	a. Compressive strength	13	14,5	16
	b. Flexural strength	N/a		
	c. Tensile strength	N/a		
7	<b>Thickness Range</b> Available from 20 to 120mm			
8	<b>Forms available</b> Loose fill, Mats, Pipe Sections, Preformed pipe bends, Profiled Panels, Rolls, Slabs, Wired mattresses (available with or without a variety of facings)			

#### TYPICAL USES AND APPLICATIONS

Thermal and acoustic insulation and fire protection of plant, equipment and building structures, etc. in the marine, offshore, heavy industrial and process plant sectors. The higher density gives improved mechanical properties and lower thermal conductivities at high mean temperatures.

VERMICULITE				
1	<b>Density (and range, if applicable)</b> 50 to 150kg/m <sup>3</sup>			
2	<b>Thermal Conductivity</b>			
	Thermal conductivity (W/mK) at density indicated below			
	Mean temp °C	96 kg/m <sup>3</sup>	101 kg/m <sup>3</sup>	104 kg/m <sup>3</sup> 109 kg/m <sup>3</sup>
	10			0,066
	30		0,067	
	60	0,075		
	150	0,083		
3	<b>Service Temperature range</b> 0 to 1300°C			
4	<b>Reaction to Fire Characteristics</b>			
	a. Combustibility to BS476 part 4	Non Combustible		
	b. Surface spread to flame to BS476 part 7			
	Insulant (if appropriate)	Class 1		
	Composite finish (if appropriate)	N/a		
	Foil faced products (if appropriate)	N/a		
	c. Building Regulations			
	Insulate (if appropriate)	Class 0		
	Composite finish (if appropriate)	N/a		
	Foil faced products (if appropriate)	N/a		
5	<b>Water Vapour Transmission</b>			
	Insulant (if appropriate)	350 µgm/Nh		
	Composite finish/foil faced product (if appropriate)			
6	<b>Mechanical Properties</b>			
	a. Compressive strength	N/a		
	b. Flexural strength	N/a		
	c. Tensile strength	N/a		
7	<b>Thickness Range</b> Available from depends upon form and application			
8	<b>Forms available</b>			

#### TYPICAL USES AND APPLICATIONS

Loose fill granular insulant used in loft insulation, steel works and foundries, hazardous goods packaging, insulating concretes, plasters and building boards (both general purpose and fire resistant) to insulate mechanical fittings when bonded with silicate solutions to form suitable shapes.

### 3.4 RECOMMENDED THICKNESS OF HOT INSULATION

NB: This should be regarded as a general guide, and depending on relative fuel cost and cost of applied insulation, the indicated thickness need not necessarily be the most economic thickness of insulation.

Criteria used in selection below:

- To achieve an approximate cold surface temperature of 55°C
- Ambient of 20°C
- Zero wind speed
- Galvanized cladding

#### 3.4.1 FIBREGLASS

3.4.1.1 FIBREGLASS FLAT SURFACES		
Operating temperature range (°C)	Fibreglass insulation density (kg/m <sup>3</sup> )	Thickness of insulation (mm)
Up to 200	24	40
201 to 250	24	40
251 to 300	47,5	70*
301 to 350	64	75*
351 to 400	64	100*
401 to 450	64	125*

Remarks: \* Non-standard thickness

Double layer recommended. With double layer, first layer should be 40 to 50mm. Second layer can be in lower density product, but this should be checked with the insulation supplier.

3.4.1.2 FIBREGLASS PREFORMED PIPE SECTION		
Operating temperature range (°C)	Nominal bore range (Mm)	Thickness of insulation (mm)
0 to 100	15 - 32	15
101 to 200		20
201 to 250		25
251 to 300		40
301 to 350		50
351 to 400		60*
0 to 100	40 - 100	20
101 to 200		25
201 to 250		40
251 to 300		50
301 to 350		60*
351 to 400		70*
0 to 200	125 - 200	25
201 to 250		40
251 to 300		50
301 to 350		70*
351 to 400		80*
0 to 200	225 - 400	35
201 to 250		40
251 to 300		50
301 to 350		70*
351 to 400		90*

Remarks: \* Non-standard thickness

### 3.4.2 ROCKWOOL

3.4.2.1 FLAT SURFACES		
Operating Temperature (°C)	Most suitable product	
	Density (kg/m <sup>3</sup> )	Thickness (mm)
50 - 199	60	25
200 - 249	60	40
250-299	80	50
300-349	80	75
350-399	100	75
400-449	120	75
450-499	120	100
500-549	160	100
550-599	160	40
(Two layers)	+120	75
600-649	160	50
(Two layers)	+120	100
650-700	160	50
(Three layers)	+120	50
	+100	100

3.4.2.2 ROCKWOOL – Preformed pipe section		
Operating temperature range (°C)	Nominal bore range (mm)	Thickness of insulation (mm)
0 to 100	15 - 32	20
101 to 200		20
201 to 250		25
251 to 300		30
301 to 350		40
351 to 400		50
0 to 100	40 - 100	20
101 to 200		25
201 to 250		30
251 to 300		40
301 to 350		50
351 to 400		60
0 to 200	125 - 200	25
201 to 250		30
251 to 300		40
301 to 350		50
351 to 400		60
0 to 200		225 - 400
201 to 250	30	
251 to 300	40	
301 to 350	50	
351 to 400	60	
0 to 200	350-400	
201 to 250		40
251 to 300		50
301 to 350		60
351 to 400		60
351 to 400		70

### **3.5 APPLICATION OF HOT INSULATION**

Pipe section, mattress or any flexible insulation may be used for pipe work. However, practical reasons preclude the use of mattress or flexible insulation where the outside diameter of the pipe or the outside diameter of any previous layer of insulation is 200mm or less.

Where mattress or materials of low density are used and metal is the protection medium, supports should be provided for the metal at not more than 1-metre intervals where the pipe work is horizontal or inclined up to 45°. Between 45° and the vertical the spacing of the supports is dependent on temperature and expansion requirements. (Refer BS 5970).

As a guide, the expansion allowances on pipe work are generally 1mm per running meter per 100°C of temperature. In all applications of insulation the material must be well butted together and in the case of multi-layer applications all joints of each subsequent layer must be staggered from the previous layer. Weld pins or clips, binding wire and strapping are used for securing the insulation as a single or composite system dependent on the circumstances.