GLASTHERM®

THERMAL INSULATING MATERIALS

878-GT-TB

TECHNICAL BULLETIN

The installation or upgrading of mold base or press platen insulation is one of the highest-returning investments a molding operation can make today. Properly insulated molds require less energy to operate. Adequate insulation also facilitates temperature regulation within the tool.

GLASTHERM® brand thermal insulating sheet is an excellent choice for mold insulation applications. Glastherm sheet offers significant advantages when compared with other materials such as mica, asbestos concrete or calcium silicate. Glastherm sheet is an efficient thermal barrier. It is strong in order to resist the effects of molding pressure and rough handling. It is resistant to oil and water absorption, and is completely asbestos-free.

MOLD INSULATION

A major profit constraint in the molding and casting of rubber, plastics and metals continues to be the cost of energy. Managers who are concerned with the current and forecasted price of electricity, natural gas, and oil are focusing on methods which will reduce energy consumption. Installing or upgrading thermal insulation in curing presses and molds is one relatively easy and inexpensive way to achieve important energy savings.

In order to cure or "freeze" a resin or compound, molding equipment is almost always dependent upon heated or cooled zones. Glastherm sheet reduces energy consumption by minimizing a wasteful flow of energy between these zones.

In the past, little or no insulation has been used in or around molds. Where it was used, the insulation was often a thin sheet of asbestos-reinforced concrete (e.g., Transite®). Although inexpensive, asbestos-reinforced concrete is a poor thermal barrier and is so brittle that it is easily damaged. It readily absorbs oil and water, further reducing its value as an insulating material. Asbestos concrete also tends to compress after a period of time in use. This can be a problem where parallelism between mold halves is important. Alternatives to asbestos concrete, such as calcium silicate (e.g., Marinite®) and mica, also have drawbacks. Calcium silicate is highly absorbent and has very poor compressive strength. Mica has poor long-term compressive strength and is expensive.

Insulating material for today's needs must have:

- low thermal conductivity
- high compressive strength at process temperatures
- excellent control of thickness dimension
- no asbestos or other toxic materials
- ability to withstand rough handling during mold changes

Glastherm sheet provides all of these features. It is a fiberglass reinforced, mineral filled sheet bonded together with heat resistant thermosetting resins. This highly durable composite is then precision finished to close dimensional tolerances. It has less than half the thermal conductivity of asbestos concrete and is rugged enough to provide years of service.

When installed on the base of a mold, Glastherm sheet will reduce heat transfer between mold and press platen. This also results in more even temperatures within the mold. Another benefit, in the case of heated molds, is that less plant ventilation will be needed.

GRADES OF GLASTHERM SHEET

Two grades of Glastherm insulating sheet are currently available. Both offer a combination of high physical strength and low thermal conductivity.

Glastherm Grade S Sheet

A general purpose insulating sheet with an economical combination of thermal and physical properties. Recommended for processes where the continuous operating temperature does not exceed 425°F. Grade S is particularly suited to the rubber molding industry.

Glastherm Grade HT Sheet

A thermal insulating sheet with superior strength and heat resistance for applications with continuous use temperatures up to 550°F. Designed for plastics and zinc die cast mold requirements.

GLASTHERM INSULATING SHEET PAYS FOR ITSELF

Installing or replacing the platen insulation in a press often represents a considerable expense in material, labor, and downtime. Is this cost justified?

Yes, and in most cases the investment will be returned in less than one year.

Primary savings are derived from reduced energy loss, but savings can also be realized through more uniform temperature gradients in the mold, shorter start-up times, longer seal life on hydraulic presses, longer heater or chiller life, and reduced plant air circulation requirements (due to heat loss from the mold into ambient air).

The best way to determine savings is to measure energy consumption before and after installing Glastherm insulating sheet. People who have done this generally support a 100% return on investment. A large rubber molder reported that one-inch-thick insulation reduced steam consumption by 35%. For him, this resulted in an annualized savings of more than $1,000.00. Another molder found that upgrading from 0.250 inch Transite to one inch Glastherm would cut his energy loss in half and provide a better than 400% annual return on investment over ten years. Actual savings for any given press/mold combination depend on many factors. Among these are:

- thicknesses of Glastherm sheet installed
- area of the mold base
- air flow in the press room
- operating temperature of the mold
- mass of the press
- ratio of total mold surface to the base

In general, any amount of insulation is far superior to a steel against steel situation; and, up to a point, the more insulation the better. There have been installations of up to five inches of Glastherm sheet, but we feel that a half-inch to one inch sheet provides a good balance between initial cost and energy savings.

It is theoretically possible to calculate the savings offered by Glastherm sheet. The number of variables involved make it a complex calculation. Nevertheless, a simple illustration of the principles involved is useful in visualizing the potential savings offered by Glastherm sheet. Figure 1a depicts a vertical clamp compression press with a heated mold. If thermal transfer through the mold base clamps and tie rods were ignored, the situation would be like that shown in Figure 1b. Here a block of steel, representing a

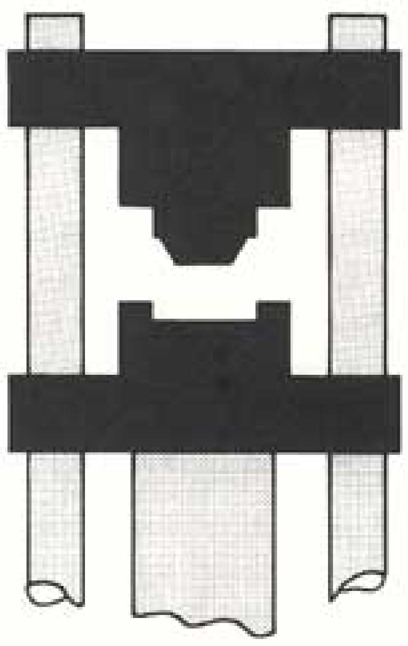

Figure 1a

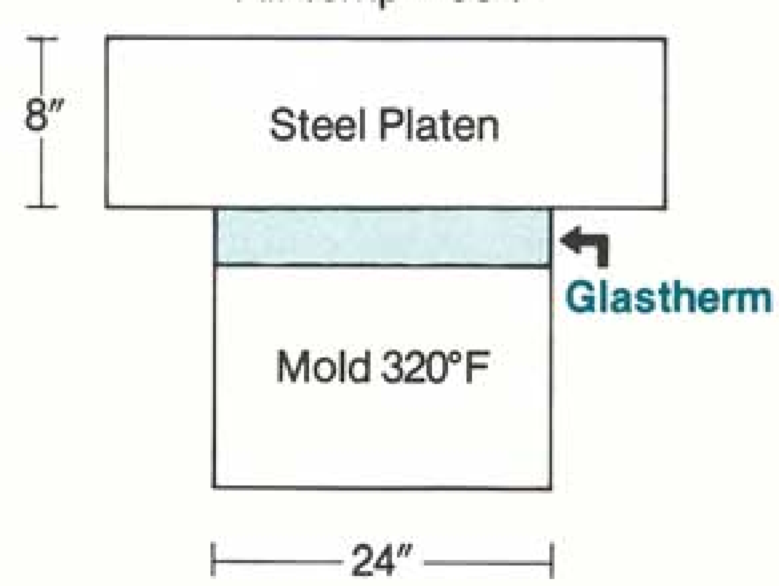

Figure 1b

heated mold, is separated by insulation from another block of steel representing the unheated press platen. Heat flows from the warm body through the insulation and the steel to the surrounding air. The change in that heat flow as a result of various types and thicknesses of insulation can be calculated as follows:

Table 1

$$\triangle q = A \left(\frac{K_p}{r_p} - \frac{K_I}{r_I} \right) \triangle T$$

where

$\triangle q$ = reduction in heat flow (Btu/hr)

A = mold base area (ft^2)

K_p = thermal conductivity of platen (Btu/hr/ft^2/°F/in)

r_p = thickness of platen (in)

K_I = thermal conductivity of insulators (Btu/hr/ft^2/°F/in)

r_I = thickness of insulation (in)

$\triangle T$ = difference in temperature between mold and air (°F)

In this illustration, 8 in. has been used as the platen thickness and 4 ft^2 for the mold base. The thermal conductivity (K factor) of steel is 300 Btu per hr/ft^2/°F/in. The K factor of Glastherm Grade HT is 1.9. A simple comparison of the two K factors gives an indication of the value of Glastherm sheet as mold base insulation. Steel is 150 times more heat conductive than Glastherm. The calculation for a ½ in. piece of insulation would be as follows:

Table 2

A = 4 ft^2

K_p = 300 Btu/hr/ft^2/°F/in.

r_p = 8 in.

K_I = 1.9 Btu/hr/ft^2/°F/in.

r_I = 0.5 in.

$\triangle T$ = 320°F-90°F=230°F

$$\triangle q = 4 \left(\frac{300}{8} - \frac{1.9}{0.5} \right) 230 = 31{,}004 \text{ Btu per hr.}$$

Thus, the installation of a ½ in. Glastherm sheet insulator between the mold and the platen would reduce heat transfer by 31,004 Btu's per hour. In a three-shift operation running 240 days per year, this could amount to a savings of more than $600.00 per year for a steam heated mold. For an electrically heated mold, this same energy savings would translate to more than $2000 per year.

A four square foot piece of ½ in. Glastherm sheet typically costs less than $100.00. The calculation in Table 3 represents the maximum potential savings, but even if the actual savings derived from the use of Glastherm sheet were half of this, the annual return on investment would be *more than 300% for steam and 1500% for electric.* At this rate the entire cost, including labor, could be recovered in well under a year.

Table 3

Steam

At 320°F, steam has a heat content of 1185 Btu's per pound. The cost of generating steam varies, but $4.25 per thousand pounds is a typical average.

This does not include the cost of capital tied up in the steam plant. Electric utilities include capital investment costs in their price, which explains the wide cost range between steam and electricity.

$$\frac{\text{31,004 Btu per hr}}{\text{1185 Btu per lb}} = \text{26.2 lbs/hr}$$

26.2 lbs/hr x 24 hrs x 240 days/yr = 150,703 lbs/yr

$$\frac{\text{150,703 lbs}}{1000} \times \$4.25 = \$640.49 \text{ Annual Savings}$$

$$\frac{\$640.49 \text{ Savings}}{\$100 \text{ Investment}} = 640\% \text{ Return On Investment or less than a two month payback}$$

Electric

3413 Btu = One kilowatt hour. The national average cost of one kWh in mid-1986 was 7.23¢

$$\frac{\text{31,004 Btu per hr}}{\text{3413 Btu/kWh}} = \text{9.08 kWh}$$

9.08 kWh x 24 hrs x 240 days = 52,324 kWh

52,324 kWh x $.0723 kWh = $3783.05 Annual Savings

$$\frac{\$3783.05 \text{ Savings}}{\$100 \text{ Investment}} = 3{,}783\% \text{ Return On Investment or less than one month payback}$$

The calculation in Table 3 can be made for various thicknesses of Glastherm sheet using Table 4.

Table 4

Glastherm Sheet Thickness	Energy Savings △q (Btu/hr.)	Steam	Electric
¼″	27,508	$568.27	$3,356.48
½″	31,004	640.49	3,783.05
¾″	32,169	664.56	3,925.24
1″	32,752	676.60	3,996.34
1¼″	33,102	683.82	4,039.00
1½″	33,335	688.64	4,067.43
1¾″	33,501	692.07	4,087.75
2″	33,626	694.65	4,102.98

APPLICATION

Glastherm insulating sheet is intended primarily as a thermal barrier between mold bases and press platens. It is also recommended for the sides of molds to prevent energy loss to the surrounding air. In selecting the appropriate grade, one should be careful not to exceed recommended clamp pressures and temperatures listed in table 5. When calculating the size of a mold base, consider only the area in actual contact with the Glastherm sheet. Holes or relieved areas must be deducted from the total area. If it is necessary to place a small mold in a large tonnage press, the clamp pressure should be adjusted to avoid overstressing the insulation.

Note: Care should be used in locating electric heaters near Glastherm sheet. Experience has shown that electric heaters can create localized hot spots in mold bases which exceed the maximum service temperature of Glastherm sheet.

Table 5

MAXIMUM RECOMMENDED OPERATING PRESSURES

Operating Temperature	Pressure (psi) Grade S	Grade HT
75°F	22,500	24,500
250°F	12,000	16,000
300°F	8,000	13,500
350°F	7,000	11,000
400°F	5,750	9,000
450°F	NR	8,500
500°F	NR	8,000
550°F	NR	7,500

NR=Not Recommended

Recommended operating pressures are based on 50% of the compressive strengths in Table 6.

FABRICATING GLASTHERM SHEET

General Machining Principles

Special equipment is rarely needed for fabrication of Glastherm sheet; conventional metal-working machinery is usually sufficient. Hard, wear-resistant tools will give better service and yield longer life. Diamond or tungsten-carbide tools will be more satisfactory and more economical for long-term use than regular or high-speed tools. Regular steel tools should be used only for experimental work or short runs.

The most important principle is to cut, *not hog,* the material. Never force the tool; instead, let it cut its way. Do not allow the tool to "rub" without taking a definite "bite" because the tool will dull more rapidly. Use negative top rake on the cutting tools. Stock is best removed by the shearing action of the tool.

Drilling

Drilling Glastherm sheet requires considerably less power than drilling steel. Holes may be drilled by

1. diamond-grit edged hole saws,
2. tungsten-carbide drills, and
3. high-speed steel drills.

A fluid coolant is not recommended when drilling Glastherm sheet. The use of a fluid tends to produce a flute-jamming "mud" that will clog the hole and require excessive cleanup. If a coolant is needed, the most practical system is an air blast directed toward the tip of the drill; this also tends to clear chips from the hole. If an air blast is used, a dust pick-up system should be used in conjunction with it.

For up to $\frac{3}{16}$″ diameter holes, grind the drill to have a slightly negative rake on the cutting lip. For *blind* holes $\frac{3}{16}$″ and larger, use a fast helix drill ground to a 90° point. For *through* holes $\frac{3}{16}$″ and larger, use a slow helix drill ground to a 55° point.

Circular Sawing

A circular saw with either a water coolant system or a dust pick-up system will render a high rate of production for straight-line cutting. Diamond-grit tooling is generally faster and more economical. The choice of blade type largely depends on individual circumstances. The blade manufacturer should be consulted about proper blade speed and the advisability of water coolant systems. If diamond-grit sawing is to be done dry, a dust collection system will prove valuable. A slotted blade should be used for dry cutting; the slots carry dust to the dustbox or pick-up nozzle.

Where coolant is used on the blade, follow standard machining practices in directing the stream on both faces of the blade to eliminate problems of blade warpage, possible breakage, and distorted cuts.

AVAILABILITY

Glastherm sheet is readily available throughout North America from Authorized Glastherm Distributors. Call Glastic for a current list. Distributors sell stock sizes and are capable of cutting and machining insulator sheets to exact requirements. Glastherm sheet is sold throughout the world by our Agents.

Glastherm sheet is manufactured in thicknesses from ¼ inch to 1 inch, and in sheet sizes of 3 ft x 6 ft and 4 ft x 8 ft. Contact your nearest Distributor for exact size availability by grade.

Table 6

TYPICAL PROPERTIES OF GLASTHERM SHEET

Property	Units	ASTM Test Method	Grade S	Grade HT
Maximum Service Temperature	°F		425	550
Thermal Conductivity	Btu/hr/ft²/in/°F	C-177	1.8	1.9
Coefficient of Thermal Expansion				
Across Thickness	10^{-5} in/in/°F	D-696	7.02	6.43
Across Surface	10^{-5} in/in/°F	D-696	1.10	1.24
Specific Heat	Btu/lb	E351-61	0.24	
Compressive Strength Force applied to surface				
@ 75°F	Psi	D-695	45,000	49,000
@302°F	Psi	D-695	16,000	27,000
@392°F	Psi	D-695	11,500	18,000
@425°F	Psi	D-695	10,000	17,500
@550°F	Psi	D-695		17,000
Force applied to edge				
@ 75°F	Psi	D-695		31,000
@425°F	Psi	D-695		3,600
Compressive Modulus	Psi x 10^6	D-695	1.8	1.8
Flexural Strength	Psi	D-790	18,000	31,000
IZOD Impact Strength	Ft lb/in	D-256	8.0	8.0
Hardness	Rockwell M	D-785	94	98
Water Absorption	% by wgt.	D-570	0.4	0.2
Density	Lbs/cu ft		115	123
Thickness Tolerance	In		±.002	±.002
Flammability		UL-94	HB	HB
Electric Strength Perpendicular @ 0.5 in	Vpm		50	50
Resistance to lubricants and hydraulic fluids			No effect	No effect

Table 7

COMPARATIVE PROPERTIES

Property	Units	Glastherm Grade S	Sheet Grade HT	Asbestos Concrete	Calcium Silicate
Compressive Strength					
@ 75°F	Psi	45,000	49,000	14,000	2350
@302°F	Psi	16,000	27,000	—	—
@392°F	Psi	11,000	18,000	—	—
@425°F	Psi	10,000	17,500	—	—
Flexural Strength	Psi	18,000	31,000	3500	900
IZOD Impact	Ft lb/in	8.0	8.0	0.6	0.25
Thermal Conductivity	Btu/hr/ft²/in/°F	1.8	1.9	4.5	0.88
Water Absorption	%	0.4	0.2	22	89.0
Hardness	Rockwell M	94	98	54	—
Density	Lb/cu ft	115	123	100	46

GLASTHERM®
THERMAL INSULATING MATERIALS

Thermal conductivity expressed in any of the units in the left-hand column can be converted into any of the units in the headings of the columns by multiplying (x) by the number which is common to the row and column.

Thermal resistivity is the reciprocal of conductivity.

		Cal/sec/ sq cm/°C cm	Watt sq cm/°C cm	Btu/ sec/sq ft/ F/in	Btu/ hr/sq ft/ F/in	Btu hr/sq ft/ F/ft
Cal/sec/sq cm/°C/cm	x	1	4.186	0.8064	2903	241.9
Watt/sq cm/°C/cm	x	0.2389	1	0.1926	693.5	57.79
Btu/sec/sq ft/°F/in	x	1.24	5.191	1	3600	300
Btu/hr/sq ft/°F/in	x	0.0003445	0.001442	0.0002778	1	0.08333
Btu/hr/sq ft/°F/ft	x	0.004134	0.01730	0.003333	12	1

GLASTIC®
A SUBSIDIARY OF KOBE STEEL

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