HEATEC TEC-NOTE

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Don't be fooled about insulation

Don't be fooled by all the claims for insulation on asphalt tanks used in the HMA industry. Here are some facts to help you better understand insulation properties. Focus on Figure 1. It contains important keys to understanding the issues.

Two types of insulation are commonly used on asphalt storage tanks. They are fiberglass blanket and mineral wool blanket. Both materials are equally effective in reducing heat loss from liquid asphalt stored inside storage tanks at 300 degrees F. This assumes both types of insulation have the same thickness and are properly installed.

Importance of thickness

Increasing insulation thickness increases its effectiveness and reduces heat loss. Thicker insulation is especially cost effective up to about 6 inches (see Figure 2). So, it pays to have insulation 6 inches thick rather than anything less.

Unfortunately, certain tank sales representatives have misinformed equipment buyers about insulation. They claim that the 3 inches of insulation on their tanks have insulating properties equal to 6 inches of insulation on Heatec tanks.

This is simply not true. That claim does not stand up to an examination of information published by highly reputable manufacturers of insulation, including the manufacturer of the very insulation they use.

Sorting out the facts

It should be noted that data sheets published by insulation manufacturers are intended mainly for engineers experienced

Figure 1. Comparison of insulations used on asphalt storage tanks.

Type of Insulation	Thickness	Thermal Conductance (at 200°F mean temperature)		Thermal Resistance	
		k (conductivity) (for 1" thickness)	C (conductance) (for total thickness)	R-value (R=1/k) (for 1" thickness)	R-value (R=1/C) (for total thickness)
Owens-Corning 701M fiberglass blanket. Heatec uses 6 inches (two layers of 3 inches) around all of our asphalt storage tanks (See Figures 3 and 4)	1"	0.350	0.350	3	3
	2"	—	0.175	—	6
	3"	—	0.117	—	9
	4"	—	0.088	—	11
	6"	—	0.056	—	17
Fibrex mineral wool tank wrap. Our competitor uses one layer of 3 inches around their asphalt storage tanks.	1"	0.360	0.360	3	3
	2"	—	0.180	—	6
	3"	—	0.120	—	8
	4"	—	0.090	—	11
	6"	—	0.060	—	17

NOTES:

1. The term k refers to the amount of heat transferred through insulation 1-inch thick. It is Btu per hour, per square foot, per degree F temperature difference, per inch of thickness of insulation. Temperature difference is the difference between the temperature on one side of the insulation and that on the opposite side of the insulation.
2. The term C (conductance) refers to the amount of heat transferred through the *total* thickness of insulation. It is Btu per hour, per square foot, per degree F temperature difference, per specified thickness of the insulation.
3. The difference between k (conductivity) and C (Conductance) has to do with insulation thickness. C has the same value as k when the insulation is 1-inch thick.
4. R-values refer to the *resistance* to heat transfer, which is just the opposite of conductance. The R-value for 1 inch insulation is 1 divided by k. The R-value for *total* thickness is 1 divided by C. (R-values are commonly known as reciprocals of k and C and shown as 1/k and 1/C).
5. All values shown above are for a *mean* temperature of 200°F. This is the appropriate mean temperature for asphalt stored at 300°F. Please note that values of conductance (k and c) do vary significantly with mean temperature. Those values are smaller for lower mean temperatures and larger for higher temperatures. So, it is essential to know the correct mean temperature and use the same temperature for all comparisons. Moreover, since R-values are calculated as reciprocals of k and C, they too relate to a specific temperature. This means that R-values cannot be compared with each other unless all are based on values of k and C for the same temperature. Otherwise R-values are meaningless.

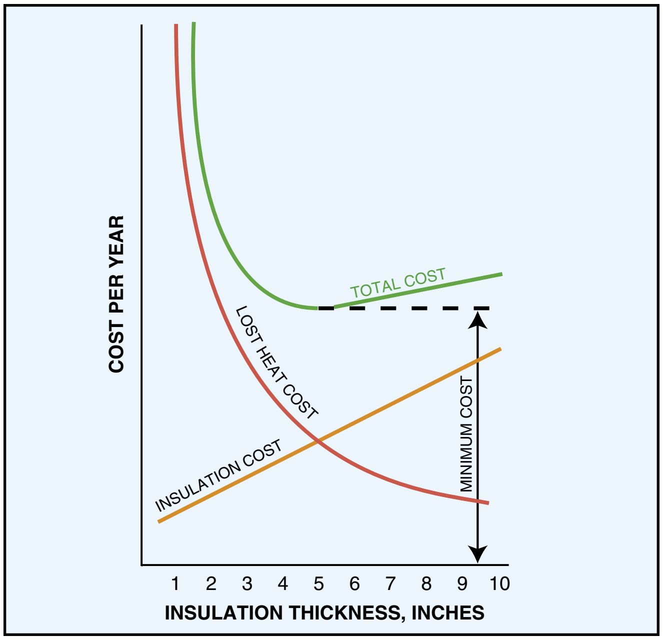

Figure 2. Insulation thickness vs cost.*

in heat transfer. Inexperienced persons may find these sheets difficult to understand and a bit confusing. So, to make sure we correctly understand the data sheets published by the manufacturer of the insulation we use, we consulted with Bill Tolliver, Product Technical Leader with Owens Corning. We also consulted with our own top engineer. The main source for our explanations and definitions is the Thermal Insulation Handbook by Turner and Malloy. To calculate heat loss we used NAIMA 3E Plus 3.2 computer program from North American Insulation Manufacturers Association.

Figure 1 makes comparisons easy

Please examine Figure 1. It shows conductance values based on data sheets from two insulation manufacturers. They are presented in a way easily understood. You can readily compare the appropriate properties of insulation we use with those our competitor uses.

As you can see from Figure 1, fiberglass conducts virtually the same amount of heat as mineral wool. But 6 inches of either material conducts only *half* as much heat as 3 inches of either material. So the difference is in the thickness—not in the type of material.

Thus, the claim that 3 inches of insulation is equal to our 6 inches of insulation is *false*. Moreover, the heat loss for the competitor's tank is over 178 million Btu/yr more than ours. The energy savings from using our tanks quickly pay for the extra insulation thickness.

Totaling up heat loss

Conductance is used to determine how much heat a tank loses and is the basis for the information in Figure 5. This figure compares the total amount of heat lost by tanks using insulation of several thicknesses for one year. The figure also shows the amount of fuel it would take to make up for the amount of heat lost. Carefully compare the differences in the amounts of fuel required.

Figure 3. Heatec vertical asphalt storage tanks are insulated on top and bottom as well as sides.

Figure 4. Heatec tanks have 6-inches of Owens Corning fiberglass insulation on sides (2 layers of 3-inches).

Figure 5. Heat & fuel loss/year

Heat & fuel loss	Tank with 3-inch insulation	Tank with 4-inch insulation	Tank with 5-inch insulation	Tank with 6-inch insulation
Btu	361,971,031	273,598,535	219,998,325	183,869,071
Gallons No. 2 fuel	2,742	2,073	1,667	1,393
Ccf Natural gas	4,000	3,023	2,431	2,032

30,000 gallon storage tank. Maintain AC temperature at 300 degrees F. Annual hours of operation is 8760.

Figure 6. Fuel Costs.										
	Type of fuel	Amount of fuel used				Total fuel cost				Savings 6” vs. 3” insulation
		Tank with 3-inch insulation	Tank with 4-inch insulation	Tank with 5-inch insulation	Tank with 6-inch insulation	Tank with 3-inch insulation	Tank with 4-inch insulation	Tank with 5-inch insulation	Tank with 6-inch insulation	
1 year	No.2 fuel gallons	2,742	2,073	1,667	1,393	$2,742	$2,073	$1,667	$1,393	$1,349
	Natural gas Ccf	4,000	3,023	2,431	2,032	$2,760	$2,086	$1,677	$1,402	$1,359
10 years	No.2 fuel gallons	27,422	20,727	16,667	13,929	$27,422	$20,727	$16,667	$13,929	$13,493
	Natural gas Ccf	39,997	30,232	24,309	20,317	$27,598	$20,860	$16,773	$14,019	$13,579
20 years	No.2 fuel gallons	54,844	41,454	33,333	27,859	$54,844	$41,454	$33,333	$27,859	$26,985
	Natural gas Ccf	79,994	60,464	48,618	40,634	$55,196	$41,720	$33,547	$28,037	$27,158
No. 2 fuel cost = $1.00 per gallon. Natural gas cost= $0.69 per Ccf										

Totaling up costs and savings

Total cost savings really becomes significant when you add them up for several years. Figure 6 shows costs for one, ten and twenty years. As you can see tanks with progressively thicker insulation save more on fuel costs than those with less insulation. The difference between 6 inches and 3 inches is the most significant.

Why R-values are used

Now let’s discuss the use of thermal resistance (R-values) to compare insulating properties. It’s important to understand that no scales or units for *thermal resistance* have been named or established.* R-values are simply numbers obtained by dividing 1 by k or C. Well then, what good are R-values? Why use them at all?

The answer is that it is easier for most people to compare insulation properties using R-values than using k or C values. This is simply because R-values usually always include whole numbers, whereas k and C values are usually always fractional numbers less than one.

Most people have difficulty comparing three place decimals for values less than one. So, dividing 1 by k and C nearly always produces some whole numbers. (We can just round off any fractions to the nearest whole number.) Consequently, it’s easier to understand that one insulation 6 inches thick with an R-value of 22 is twice as effective as another insulation only 3 inches thick with an R-value of 11. The C values for those two insulations are 0.045 and 0.090 respectively—not easy to compare. But no matter whether you compare C values or R-values of the two, one is twice the value of the other, so their *ratios* are the same. It’s just easier to compare whole numbers.

Figure 7. R-values on packages of insulation at a building supply store.

Precautions for using R-values

Now there are some important precautions for comparing R-values. If you go to a building supply store and shop for insulation you will likely see R-values printed on the packaging (see Figure 7). These will enable you to readily compare one insulation with another. The differences are due mainly to different thicknesses. But please be aware that *these* R-values are all for the *building* trade, so comparisons are valid only for that industry. The same is true for engineering handbooks that list properties of various materials used in the *building* industry.

Consequently, that same insulation would have much *lower* R-values when used on an asphalt tank. That’s because temperatures encountered on asphalt storage tanks are radically different from temperatures encountered in the building trade. Thus, the R-values shown on the packaging at a building supply store are *not* valid for our industry.

*From Thermal Insulation Handbook, 1981, by Turner and Malloy

To obtain true R-values for asphalt storage tanks it is first necessary to determine values for k or C based on temperatures involved in storing liquid asphalt as shown in Figure 1. The reciprocals of those values would then provide the appropriate R-values.

A look at claims for R-values

In the past Heatec has countered R-value claims made by competitors for their insulation by citing *better* R-values for thicker insulation on our products. Even though our R-values were taken from data sheets published by the insulation manufacturer, they were in reality intended for the building trade. They were not based on temperatures encountered in storing asphalt. However, those values made fair comparisons because the competitors also appeared to use R-values for the building industry.

We are now told that R-values used in the building trade vary according to test methods used by the manufacturer and other factors such as reflective facings, etc. So to get the true R-value for an insulation, ignore the ones published for the building industry and calculate it by taking the reciprocal of conductance C. And make sure to use the value of C based on the appropriate temperatures for asphalt tanks.

Be aware that R-values values for insulation on asphalt storage tanks are *significantly lower* than R-values for the same insulation when used as building insulation. Again, this is due to the temperature differences. It doesn't mean the insulation is inferior.

Incidentally, heat loss calculations are always based on conductance C. The heat loss calculations in all of our technical papers have always been based on C. Actually, you can't use R-values to calculate heat loss because—as stated earlier—R-values are not units of thermal resistance. Again, R-values are useful only for comparing one insulation to another within the same context.

Strange claims

Claims for insulation made by another one of our competitors appear to be inexplicable. In March 1998 they simply said their tanks had 4 inches of firm fiberglass insulation. In January 2000 they claimed their insulation was high-efficiency R-15 rated firm fiberglass equivalent to 5" of standard fiberglass. In November 2002 they claimed their insulation was high-efficiency R-15 rated firm fiberglass insulation equivalent to 6" standard fiberglass. We don't understand the magic of how the R-value for the same 4 inches of insulation is equal to 5 inches at one time and equal to 6 inches another time.

Moreover, it is interesting to note that their so-called *high-efficiency* fiberglass of R-15 is lower than the R-17 rating for 6 inches of Owens Corning 701M fiberglass that we use (see Figure 1). Furthermore, 6 inches of our 701M has a notably higher R-value than 4 inches of the same material. We think anyone considering purchase of their tanks should demand an explanation of their claims.

What about density?

Another area of concern has to do with *density* of the insulation. Don't be misled by any claim concerning the effect of insulation density on heat loss. Density refers to the weight of a specified volume of insulation, such as pounds per cubic foot. And *within* a particular type of insulation material, density may indeed reduce conductivity, but only to a minor extent. Density has more to do with the mechanical properties (not thermal properties) of the insulation.

So, density is not the basis for selecting insulation to reduce heat loss. Again, *conductivity* is the key factor in choosing an insulating material. Conductivity takes density into account. So you can ignore density for heat loss comparisons.

Always separate fact from fiction

If you obtain quotations from various manufacturers for asphalt storage tanks you will likely find some questionable claims. We hope this document will alert you to that possibility and arm you with enough information to recognize suspicious claims. Compare claims with the information shown in Figure 1 to see if they match.

As already noted, you get 6 inches of insulation on Heatec asphalt storage tanks. We think the costs shown in Figure 6 will convince you that it pays to insist on a full 6 inches of insulation. If so, it would be appropriate to insist that all bidders provide quotes for tanks with no less than 6 inches of insulation.

Notes on calculations

1. Thermal conductance for insulation on the Heatec tank is for Owens Corning Type 701 M (ASTM C 553) from data sheets issued by the manufacturer.
2. Thermal conductance for insulation on the competitor tank is for Fibrex mineral wool tank wrap (ASTM C 1393) from data sheets issued by the manufacturer.
3. The asphalt storage tank used for calculations is a vertical tank with a capacity of 30,000 gallons. It is a steel cylinder with a painted metal skin that covers the insulation. It uses 1696 square feet of insulation total, including top and bottom.
4. Calculations of Btu heat loss were made using NAIMA 3E Plus 3.2 computer program. NAIMA is North American Insulation Manufacturers Association. Assumptions: 80°F ambient temperature. 10 mph wind velocity.
5. A low heating value (LHV) of 132,000 Btu per gallon (LHV) was used for No. 2 fuel.
6. Ccf stands for 100 cubic feet. The net heating value of one cubic foot of natural gas is 905 Btu. However, natural gas is normally billed at its gross heating value, which is approximately 1,000 Btu per cubic foot.
7. A cost of $0.69 per Ccf was used for natural gas. This is approximately equal to $1.00 per gallon for No. 2 fuel.

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