COMPARING THE THERMAL PERFORMANCE OF INSULATION COATINGS VS. TRADITIONAL INSULATION

TECHNICAL BULLETIN

INTRODUCTION

The primary function of thermal insulations is to reduce the rate of heat transfer. Industrial insulation coatings are often promoted by manufacturers as a viable alternative to traditional insulations. While this viability may be true in some applications, the performance characteristics of coatings and traditional insulations are dramatically different. The distinguishing factor is that traditional insulations meet a broader range of safety requirements by reducing heat transfer and meeting safe-to-touch requirements. This bulletin compares the advantages and disadvantages of using thermal insulation coatings versus traditional insulation products based on third-party testing.

WHAT ARE INSULATION COATINGS?

Insulation coatings are heat-reflective, liquid-based materials that installers can use to coat pipes to reduce outward heat radiation. Thermal coatings are typically used in areas where space is highly restrictive and where application temperatures are lower than 350°F. In some applications, coating can be used to meet safe-to-touch specifications. When high thermal performance is required, thermal coatings do not have the same insulating capabilities as traditional insulations.

THERMAL PERFORMANCE TESTING

The thermal performance of traditional insulation materials such as fiber glass, mineral wool, expanded perlite and calcium silicate are tested in accordance with ASTM C518[1], which essentially measures heat flow. The lower the heat flow, the more effective the insulation. This test method is not applicable to thermal coatings because they are too thin and many layers would be required to gain sufficient thickness to test the coatings. Consequently, in 2008, a test method was developed by an accredited independent laboratory at the request of the North American Insulation Manufacturers Association (NAIMA)[2] and used by the American Society of Heating Refrigeration and Air conditioning Engineers (ASHRAE)[3] in 2013. Both the NAIMA and ASHRAE studies compared the thermal measurements of a bare, uninsulated thermal pipe test assembly to an assembly with an insulation coating applied to the surface of the pipe. Heat flow was calculated by comparing the heat input, end loss, heat flux and surface temperature of the bare pipe to that of the coated pipe.

Using this test method, NAIMA compared two insulation coating types to half-inch thick fiber glass pipe insulation with pipe and ambient temperature differences from 500°F to 3500°F. ASHRAE tested three insulation coatings with the same temperature difference from 1250°F to 3000°F. The coatings consisted of either ceramic particles suspended in a white coating or nano-particles suspended in a translucent coating. The coatings were applied by installers under the direction of the manufacturer's installation instructions or by the company that sold the coating.

RESULTS

Heat flows as a function of pipe and ambient temperature differences for uncoated pipe, coated pipes and a pipe insulated with half-inch of fiber glass insulation are shown in Table 1. Results of the NAIMA thermal testing show that the heat flows for the coatings (A 53, A 113, B 23.5, B 59.5) were one-sixth as effective than the half-inch fiber glass. Efficiencies of these systems are shown in Table 2. The NAIMA report shows that the half-inch thick fiber glass insulation provides an efficiency of 86% while the best coating had an efficiency of 77% at a temperature difference of 50°F.

Table 1 - Heat Flow Comparison of Uncoated Pipes, Coated Pipes, and Fiber Glass Covered Pipes vs Temperature Difference.

Temp Difference (˚F)	Uncoated Pipe (BTU/ft² h)	A 53 (BTU/ft² h)	A 113 (BTU/ft² h)	B 23.5 (BTU/ft² h)	B 59.5 (BTU/ft² h)	FG ½" (BTU/ft² h)
50	127.2	113.0	29.2	85.2	56.4	18.0
100	269.1	236.2	104.2	195.4	123.3	51.0
150	450.1	397.7	184.0	323.6	208.1	86.6
200	670.1	597.6	268.4	469.5	310.9	125.0
250	929.2	835.8	357.5	633.4	431.6	166.1
300	1227.3	1112.4	451.4	815.0	570.2	209.8
350	1564.4	1427.3	549.9	1014.6	726.9	256.2
Ambient temperature approximately 900˚F (courtesy of NAIMA)						

Table 2 - Efficiency Comparison of Uncoated Pipes, Coated Pipes, and Fiber Glass Covered Pipe vs Temperature Difference.

Temp Difference (˚F)	A 53 (BTU/ft² h)	A 113 (BTU/ft² h)	B 23.5 (BTU/ft² h)	B 59.5 (BTU/ft² h)	FG ½" (BTU/ft² h)
50	11%	77%	33%	56%	86%
100	12%	61%	27%	54%	81%
150	12%	59%	28%	54%	81%
200	11%	60%	30%	54%	81%
250	10%	62%	32%	54%	82%
300	9%	63%	34%	54%	83%
350	9%	65%	35%	54%	84%
Note Efficiency = (Uncoated pipe heat flow - coating heat flow)/Uncoated pipe heat flow					

[1]ASTM C518 - "Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus."

[2]NAIMA Facts #81 "Thermal Performance of Coatings Used to Insulate Pipes, Ducts and Equipment." 7/2010. Article referenced with permission from NAIMA.

[3]ASHRAE Research Report 1550-RP "Thermal Performance of Selected Insulating Coatings on Piping and Ductwork." 8/2013.

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INSTALLATION OF THERMAL COATINGS

In most cases, the insulated surface must be prepared prior to applying the coating. At a minimum, the surface must be clean and dry, but in some cases it must also be primed.

Manufacturers also recommend applying the material in set thicknesses and often times no thicker than 20 mils per layer. Based on the NAIMA report, which showed required thicknesses as high as 113 mils of coating, six layers must be applied with drying time (up to four hours) between each layer. Drying times can be affected by the ambient temperature and relative humidity particularly with water-based coatings. Coverage rates can also vary due to overspray, which reduces yield.

The NAIMA study advises designers and interested parties to consider the following regarding thermal coatings:

- Standard application procedures include protecting insulation materials against water incursion to maintain thermal performance and corrosion resistance.
- A minimum of two coats are required, and each coat must dry completely prior to applying a new layer which can take up to four hours to dry. In comparison, traditional preformed insulations typically require only a single-layer application.
- Coatings may be suitable for use in areas that are difficult to insulate to lower the burn potential (safe-to-touch applications).

The ASHRAE report confirms the NAIMA study and adds the following:

- Each layer of coating was approximately 10 mils thick, and the coatings were tested in thicknesses that ranged from 36 mils to 243 mils.
- In some cases the coating either blistered or shrank which compromised the performance of the coating.
- The product tested at 36 mils did not exhibit the blisters and shrinkage that the thicker samples exhibited.

When application and drying times are considered, the installed cost and installation time of an insulation coating is dramatically higher than half-inch thick fiber glass applied in a single layer. Furthermore, the coating cannot provide the same thermal performance as the fiber glass pipe insulation.

PERSONAL PROTECTION

Industrial insulation applications often call for the safe-to-touch industry standard, which requires the surface temperature of the pipe to be below 140°F. The ASHRAE study has found that coatings have a difficult time meeting this requirement at reasonable thicknesses. Safer and more cost-effective solutions, such as traditional insulations, should be used to protect individuals from hot pipes and equipment.

CONCLUSION

The primary function of industrial insulation is to provide reliable and cost-effective thermal performance and personnel protection. As confirmed in both the ASHRAE and NAIMA studies, insulation coatings have limitations when it comes to installed cost, installation time, durability and reliable thermal performance. Their uses are fraught with installation challenges that require sufficient surface preparation, uniform application and sufficient drying time between layers. In contrast, traditional insulations provide outstanding thermal performance, quick installation and are tested specifically to ensure long-term thermal performance, personnel protection, and durability.

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