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insulation

The Official Magazine of the National Insulation Association
JULY 2021

outlook

- p. 8** **WET INSULATION:**
Definitions &
Ramifications
- p. 18** **SCHOOLS & HOSPITALS:**
Efficient & Healthy
Buildings
- p. 30** **FINISHING-UP:**
Protecting Insulation
Material

**Meeting
Commercial Building
Performance Goals**

THE GREAT COVER-UP:

Protective Finish Systems for Mechanical Insulation

By Darrell Peil

In commercial occupancy facilities, mechanical systems are frequently insulated to provide energy savings, control noise, and retard condensation formation on and in plumbing and HVAC piping, duct, and equipment. To a lesser extent, insulation will be used on fire sprinklers to prevent freezing and keep heat tracing from operating for inordinate amounts of time. For the purposes of this article, commercial occupancy facilities are buildings meant for routine use by the general public, designed with the objective to make the building environment comfortable for the occupants, with the activities taking place in those facilities a secondary consideration (in contrast to industrial facilities, where process activities are the priority). Typical uses included in this classification of buildings are automotive retail and service, food and beverage service, multi-unit retail, animal care, health care/medical use, education, offices, religious activity, public safety, amusement, transportation, and recreation.

In these facilities, one part of the mechanical insulation system is the finishing system that serves several important functions for the entire insulation envelope.

Quite often finishing systems are referred to as jacketing, as adding jackets of varying materials is possibly the most common way to provide protection of the insulation material. Protective finish systems also can take other forms. Common protective finishes for mechanical insulation systems in commercial buildings are the focus of this article. Industrial protective finish systems many times are similar, but may be more involved in installation and accessories because of the services that are expected and designed for.

In recent years, new materials and methods have been introduced to supplement more traditional finishing practices. Certain protective finishing practices have gained favor over others as the industry has evolved. Historical or traditional protective finish practices still have relevance in the industry and work well for their original intended applications. Much as one insulation material is not suitable for every use, one protective finish system does not solve all needs.

The mechanical insulation system is composed of the entire assembly of all its parts, plus the practices employed in selecting and assembling the system components.



The two most significant components of the typical commercial mechanical insulation system are the insulation material itself and the protective surfacing or finishing system that is applied to the insulation material. The finishing method for a mechanical insulation system is a subsystem of the entire assembly, and is extremely important to imparting longevity of the entire insulation envelope. As important to the entire system as the insulation material is, the protective finish system used to cover the insulation material protects the entire insulation system and provides long-lived performance. As such, significant attention should be given to selection and installation of the finish of the insulation envelope, much like the consideration given to the insulation material itself.

The insulation material provides the primary function of energy flow control—thermal energy or acoustical energy. The insulation material should be selected with the functions in mind that are primary to the insulation itself, with cost/performance/benefit evaluations incorporated in the process. The protective finish system provides the primary functions of protecting the insulation envelope from contamination, as well as from physical damage from impacts and compressive forces, and provides moisture resistance (in the form of vapor and liquids). Other functions provided by the protective finish are to provide cleanability, weathering resistance, fire resis-

tance, enhanced acoustical control, and aesthetic appearance.

The protective finish system can be factory applied, field applied, or a combination of both methods. An example of a factory-applied protective finish is the facing materials applied to fibrous insulations, such as laminated vapor retarders known as Foil-Skrim-Kraft (FSK) and All-Service Jacket (ASJ). An example of a field-applied protective finish system would be a more robust jacket material, like PVC, metal, or glass reinforced plastic (GRP). An example of a common combination protective finish system is an insulation material that has a factory-applied vapor-retarder jacket plus a field-applied jacket. The most common example is fiber glass pipe insulation with a factory-applied ASJ or premium ASJ, additionally covered with PVC or metal jacket. In this instance, the ASJ or premium, polypropylene-surfaced ASJ provides initial handling and installation protection, and vapor-retarder properties, while the additional PVC or metal jacket provides added impact damage and/or moisture and weathering resistance, sanitation ability, and enhanced finished appearance.

In the area of fire safety, most of these protective finish materials have been tested for surface-burning characteristics using ASTM E84 or UL723 for test result indices of 25 or less for flame spread and 50 or less for smoke-developed indices. Some variants of these products may not meet these indices, commonly

required for commercial occupancy facilities. It is incumbent upon the specifier and user to verify this important property for each material selected for the protective finishing system.

Common materials used to provide a protective finish for mechanical insulation systems include the following.

Vapor-Retarder and Basic Factory-Applied Laminate Jackets

These products are typically referred to as ASJ, FSK, and PSK (for Polypropylene-Skrim-Kraft) jacket. There are many other similar thin laminations typically used to face metal building fiber glass blanket insulation. The required performance and physical properties for these products is detailed in ASTM C1136 Standard Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation. These protective finish systems are typically intended to provide light-duty protection to keep contaminants out of the insulation envelope. The most important function they serve is to impart water vapor resistance to the insulation envelope for below-ambient operation systems, like domestic cold water or chilled- water piping. The other prime function for these jackets is to provide a high-quality, durable installation method for holding insulation materials on the system being insulated. They also provide a neat, clean aesthetic appearance where the systems are exposed to occupant view.

Woven Fabric and Mastics

Pasted/lagged woven cloth membranes and mastic/pasting adhesive systems have been in use for many decades. At one time, canvas cloth was provided as a factory-applied finish for fiber glass pipe insulation, with the intent that the insulation mechanic would use the appropriate mastic to close and size the pipe insulation. These types of finish systems employ a woven fabric, made from glass or cotton fiber in various weights per square yard and weave types, combined with a mastic designed for pasting or lagging the fabric to the insulation system. Unbleached, unsized cotton canvas is available at 4, 6, and 8 ounces per square yard. Fiber glass lagging fabric for commercial work is typically in the 8 to 9 ounce per square yard weight range, with cloth for powerhouse or boiler room installations being much heavier. Lighter fabrics have been used commercially for duct systems, fitting finishes, and exposed piping. A canvas and mastic finish is still somewhat common in education facilities, especially in service areas like utility closets and hallways. Heavier fabrics are used in more severe service areas, such as mechanical rooms, and for boiler and chiller plants at larger campus-type environments that use distributed energy, including shipboard applications such as cruise ships, ferry boats, or high-occupancy tour vessels.

Fiber glass cloth applied over fiber glass or calcium silicate was a common finish in university powerhouse applications and K–12 school boiler room applications for decades. This kind of finish, because of surface emissivity, allows for thinner insulation applications, while still providing the energy control desired. The final finish is typically a coat of paint to match the rest of the facility, or to color-code systems, and provide resistance to airborne dust, dirt, and ash.

The fabric imparts added strength to the surface, resisting impacts and punctures more robustly than the factory-applied vapor-retarder facing alone. The fabric in certain systems also acts to reinforce the mastic. The mastics used for pasting the fabrics are breather-type mastics and do not provide water vapor resistance. These kinds of finishes are typically applied to hot systems, but they can be useful on cold work, being commonly used on domestic cold-water sys-

tems or air conditioning duct systems and equipment. An additional coat of vapor-retarding mastic can be applied if vapor retardancy is desired. Unbleached cotton lagging canvas will shrink and size with the application of pasting or lagging mastics, making a smooth surface when dried completely. Bright white pasting/lagging mastic makes a clean appearance. Fiber glass fabrics do not shrink and size themselves and must be applied so that they are well smoothed out, with all air pockets worked out when the installation is still wet. Air pockets will provide an area for the finish system to detach from the insulation. Fittings and shapes other than pipe or flat duct are accomplished by cutting and shaping the fabric in the field, pasting it in place with the selected pasting mastic. Various ASTM standards and test methods apply to both the fabrics and mastics used for this kind of protective finish for the properties important to each material.

PVC Jacketing

PVC jacketing is another protective finish that has been widely and successfully used for decades. PVC jacketing has evolved as the preferred protective finish for insulated systems that require frequent cleaning, such as food and beverage service areas and restrooms. PVC jacketing of the correct thickness has the ability to be chemically sealed with a solvent that fuses two layers, or the overlap, together. Food and beverage service, health care, fitness/recreational, and retail grocery businesses are particularly suited for PVC jacketings because of the products' ability to resist contamination, keep water out of the system, be washed repeatedly, and be easily wiped down if washing is not desired—all while providing a neat, sanitary appearance. Bright white had been the only mainstream color since the product was targeted to the clean environment, but as the use of PVC has become more widespread, colored PVC jacketing, in a wide range of colors, has become far more common. The product is provided in rolls, cut-and-rolled, heat-set to a specific diameter for pipe insulation sizes, in pre-formed fitting covers, and in special shapes required for unique installations. The material is supplied in thicknesses from 10 mil to 40 mil, and in 35 1/2" or

48" lengths or widths. Some forms of white PVC jacketing are UV resistant and can be installed on systems exposed to the sun. It is important to confirm this property with the jacketing supplier. Colored PVC jacketing is not UV resistant and is intended for indoor use. The most common reason for using colored PVC is to color-code systems for rapid identification of system services by facility personnel. Some users wish to match particular color schemes used in a facility to achieve a desired aesthetic effect. This finish is lightweight and reasonably fast to install. Various ASTM standard test methods are used to demonstrate the physical properties important to all PVC products and characteristics important to the use of PVC as a protective finish. While PVC provides excellent resistance to liquid, it is not considered a good vapor retarder in severe mechanical systems services such as refrigeration piping. Corrosion of the jacket is not a concern since PVC is a polymer product. These products typically do not retain dents from impacts and compressive loads. This will allow the underlying insulation to recover full thickness if it is a type of insulation that has that ability.

UV-Cured GRP/FRP Jacketing

Even though this material type may appear to be a newer introduction to the market, this protective finish system has been in use in the North American mechanical insulation industry for 40 or more years and is another kind of protective finish system that has polymers as the primary constituent of the product. Glass reinforced plastic (GRP) or fiber reinforced plastic (FRP) has evolved in terms of forms available, physical properties, application practices, and applications that use this protective finish. The product consists of a polyester-based composite material that is reinforced with fibers—typically fiber glass—to provide added strength. The material is formed in uncured rolls with a high level of flexibility and conformity in its uncured state. GRP/FRP is hardened when subjected to UV light, either artificially introduced inside a building with UV lamps or outdoors when subjected to sunlight. When cured, this protective finish is extremely hard, durable, and provides a certain level of flexibility desired in many applications,

especially in the powerhouse/boiler-chiller room environment or commercial marine applications.

This is another protective finish system that is highly suited to distributed energy facilities because of its durability and resistance to deleterious forces such as water, impact damage, and weather. Since the product is UV-cured, a protective coating is applied to build UV resistance for longevity. This coating is factory or field applied but must be included for proper durability. Factory fabrication of system components is becoming more routine to provide the most satisfactory finished product in forms that the insulation industry is accustomed to, which makes this system attractive for cost factors and project completion schedules. Uncured rolls of product may be supplied in special instances where the purchaser and producer agree that site-cured installation is the best practice to be followed. Like PVC and fabric/mastic protective finish systems, GRP/FRP materials have multiple ASTM test methods used to demonstrate the key properties important to this kind of product in general and specific to protecting insulation and insulated systems. The impact resistance and recovery, heat resistance, fire resistance, water and water vapor resistance, chemical resistance, and weight considerations are standout properties of these materials. Like PVC, corrosion of this jacket is not a concern since it is polymer-based, too. Installation practices mimic those of other rigid-finish materials like PVC and metal.

Synthetic Rubber Jacket

Another protective finishing product entry to North America in recent years, but one that has a strong history elsewhere, is synthetic rubber sheet. It is supplied in rolls in thicknesses of 40 mils (1 millimeter) and 80 mils (2 millimeters). No fittings or special shapes are supplied, so all special configurations need to be fabricated and fitted from plain, flat material. These products got their start as rubber roofing, with properties that made them highly suitable to protecting structures and assemblies from weather deterioration. Some North American specifications currently require a rubber roofing membrane, typically ethylene propylene diene monomer (EPDM) roofing, to be used on insulated rooftop piping and duct work. In

lieu of EPDM, chlorosulfonated polyethylene (CSPE) synthetic rubber protective finish material has been introduced, formerly known under the E.I. DuPont trade name of Hypalon®. Another type of rubber being offered is a blend of EPDM and CSPE synthetic rubber. CSPE has been used quite widely as roofing and for other weatherproofing applications. Both EPDM and CSPE synthetic rubbers are highly waterproof vapor barriers, UV resistant (intended to provide 25-year-plus extreme sunlight exposure protection), highly chemically resistant, flexible, resilient to impacts, and completely non-corroding. These products do not typically retain dents from impacts and compressive loads, allowing the underlying insulation to recover full thickness if it is an insulation type that has that ability. Synthetic rubber protective finishes may not provide the same impact resistance that more rigid protective finishes will provide. The ability to puncture these materials is easier than the more rigid products. For physical and performance properties, multiple standardized tests are used for the individual characteristics sought, but no single ASTM standard specification exists for these materials.

Flexible Laminated Protective Jackets

These products were introduced to the North American market in relatively recent history as a way to provide the protection desired in lighter services in out-of-the-way locations, especially outdoors on duct and piping systems. Significant market acceptance was rapid from the construction industry because of the benefits provided for the typical commercial project. This category of protective finish materials is formed from layers of polymer film and foil in varying numbers of layers and thicknesses and provides a very durable finish, either indoors or outdoors. These products are typically offered in silver, white, and black, with a smooth surface or embossing to enhance the appearance of the finished installation. Some products are provided with an acrylic-based or butyl asphaltic rubber-based pressure-sensitive adhesive, while some do not have a pressure-sensitive adhesive. Like the rubber sheet products, flexible laminated protective jackets are supplied in rolls, from which all configurations are cut and fit. Seaming and complet-

ing the protective function of keeping liquids out of the system is accomplished by using matching tapes placed over butting seams. The selection of thickness to be used depends on the severity of service expected and durability required to provide the performance and protection desired. These products are typically highly resistant to weathering and compressive damage, long-lived, high-level performance vapor barriers, and easy to install. This category of products has a wide range of offerings so material selection, including finishes and performance properties, is highly important.

Some products in this category are detailed in performance and physical property requirements by ASTM C1775 Standard Specification for Laminate Protective Jacket and Tape for Use over Thermal Insulation for Outdoor Applications.

Metal Jacketing

Metal jacketing has existed in the mechanical insulation industry for several decades, but it typically had been reserved for industrial service applications. However, it grew in popularity as owners desired enhanced appearance; manufacturers introduced more prefabricated shapes for fittings, to make installations faster and more cost competitive; and more robust materials were desired. Metal jacketings are supplied in rolls 36" and 48" wide; flat sheet; box-ribbed; or corrugated sheet to lend strength and rigidity for large areas; and preformed metal fitting covers, along with a range of installation accessories. The metals supplied can be galvanized steel, painted steel, aluminum, or stainless steel. Typical for commercial applications are either smooth or embossed surface finishes for enhanced finish appeal. Aluminum has been supplied in thicknesses from .010" to .040". Commercial applications typically use product thicknesses of .016", .020", and .024". Stainless steel jacket for commercial applications is typically supplied in product thicknesses of .010" or .016". Greater metal thicknesses and stainless steel have been gaining in popularity as owners try to extend the longevity and durability of all portions of facilities, including mechanical systems. Design consideration, in terms of thicknesses of the insulation system, should be given to achieving the goals for the

mechanical insulation system at large, since uncoated metal products present low emissivity values that can impact thickness significantly.

Another important note is that metal jacketing finish systems are not manufactured or marketed as vapor retarders. On below-ambient systems, a vapor-retarder system must be completed and intact before applying this type of finish system. The same caution applies to most of these materials, except those meant specifically for vapor retardancy.

Typical areas of a commercial facility that will use metal as the protective finish are in piping, duct, and equipment (indoors and outdoors); in the occupied facilities; or in the service facilities like powerhouses, mechanical rooms, and dock facilities. Rolled aluminum and stainless steel protective finish material performance and physical properties are included in ASTM C1729 and ASTM C1767. There are many variations in these standard specifications, so it is important to detail the type, grade, and class when using these designations.

A Growing and Evolving Market

The range of protective finish systems broadly applied in the commercial building arena has grown over the years as more selections have been developed and become more readily available. This has enhanced the choices in the market. Owner, engineer, and architectural preferences and needs have evolved, which has created the market demand to allow these developments. The next push in facilities management that will start driving selections is resiliency, and this is one function that is specifically the purview of protective finish systems for mechanical insulation. More durable installations will be desired as critical facilities' owners and operators look for ways to provide resiliency for their facilities. Sustainability has been the most recent major impact on selections, and most of these selections can enhance sustainable projects in different areas.

Materials and methods have evolved and will continue to evolve for this important function and component in a mechanical insulation system. The limitations that existed years ago have been eliminated for the most part. Many of the needs or desires expressed can be met with products that have been

introduced or enhanced over time. The industry keeps working to deliver on those desires.

It is key to recognize that a mechanical insulation system is made up of components, and the final performance of the system is delivered by the combination of those components. The insulation material and the protective finish system are the two major components that create the system. Differing combinations of these two key components can deliver the same desired end result or widely varying end results, depending on the desired performances. It is not just the protective finish or just the insulation, but the entire system that achieves performance goals. An example of this concept is compressive resistance of an insulation system and the system's ability to withstand damaging impacts or compressive forces. A high compressive strength insulation in combination with a low-strength protective finish can be replaced with a lower compressive strength insulation combined with a high-strength protective finish to deliver the same long-lasting result, imparting other system properties and performances that are desirable for the installation. Mechanical insulation needs a system approach to design, with intentional focus on all elements to yield the desired end result. The great cover-up is one important part of the whole! ☺



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