lagging 101

Understand the difference between lagging and jacketing for better job planning.

By Gary J. Bases

Precipitator hopper completely insulated and lagged.

Lagging is commonly misunderstood in the insulation industry. There are many people in the insulation industry who may not agree, but I believe that there is a big difference between lagging and jacketing materials. I have spent over twenty-five years learning, working and teaching in this very diverse field. In my opinion, the following information is greatly needed to help readers understand what lagging really is and why it is different from jacketing.

Partially insulated and lagged precipitator with the gas inlet nozzle unfinished.

Lagging is the finishing material (steel or aluminum) used to cover many types of insulation, especially on large flat surfaces such as boiler walls, flues, ducts, precipators, selective catalytic reduction systems, baghouses, windboxes or fans. Also known as cladding or sheet metal, lagging ranges in thickness from .032-inch to .063-inch and usually does not include a vapor barrier. If the lagging material were to be installed by a union craftsman, the work would be designated to the Sheet Metal Workers Union.

When referring to lagging, confusion can occur when the term jacketing is used. Jacketing is NOT lagging. Jacketing is a lighter gage product used as a finish material (usually over pipe insulation). Jacketing, too, refers to a steel or aluminum material but ranges in thickness from .010-inch to .024-inch. A factory-applied moisture barrier is usually included on the back or underside of jacketing. If the jacketing were to be installed by a union craftsman, the work would be designated to the Asbestos Workers Union.

So lagging is a much thicker finishing material that is installed by a different craft from those who install a jacketing material. So now that you understand the basic fundamental difference between jacketing and a lagging material, the next step is for you to understand lagging design. Lagging should be considered first even though it will be done last. So let's design a lagging and insulation system.

Insulation and Lagging Design

Rule 1: Review the area to be insulated and look at the stiffener size and pattern. Make sure the insulation design will allow the lagging to keep an even flow and pattern (rib direction).

First, plan how to install the outer lagging on the insulated area before considering insulation. Aesthetics, water drainage (for outdoor application) and foot traffic should also be considered.

Example:

Let's assume you are going to insulate (and lag) a rectangular flue that is 20 feet x 10 feet and has stiffeners of 4-inch angles. Two mid-span 5-inch C-channels are around the perimeter. The minimum insulation requirement is 4-inch Intermediate Temperature Board Class IV B meeting ASTM C-612 eight-pound density. The outer lagging requirement is .032-inch rib aluminum flashed with .040-inch aluminum. The temperature of the gas is 650° F. Lastly, this is an outdoor application and the flue is visible to the highway.

Here are two options when you don't consider the lagging design first.

1. Put 4-inch single layer insulation against the flue plate, hump the 5-inch C channels, add 1-inch insulation on the top of the 4-inch stiffeners to prevent heat transfer, then install your outer lagging in contact with the insulation.
   - or -
2. Place 4-inch insulation against the flue plate, hump the C channels and 4-inch angles, apply plasterer's lath over the insulation, and install the lagging outside the C channels and 4-inch angles utilizing a Z-bar system.

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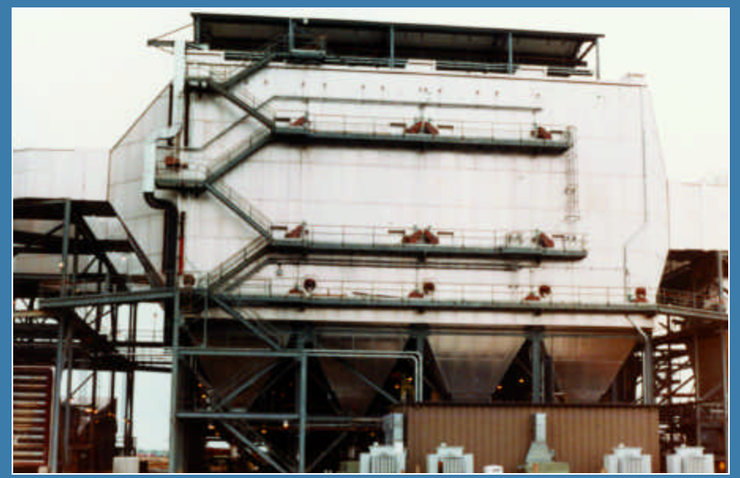
Precipitator and flues before insulation and lagging is installed



Precipitator and flues after insulation and lagging were installed

Both approaches may appear to be the best methods from an economical standpoint. However, from a lagging standpoint, they don't measure up. In either case, you have an irregular surface that breaks the lagging sheets up and causes a water splash on the top surface of the flue at the C-channel. These approaches would also cause an uneven flow and pattern to the lagging and so would not be aesthetically pleasing.

Solution:

Increase the insulation thickness to 6-inches using 4-inches on the first layer and 2-inches on the second layer. This would bury all stiffeners and channels to give a flat surface on which to install the outer lagging. The chance of water splash on the top surface has been eliminated and the flue has a very aesthetically pleasing look.

Designing an insulation system means thinking about lagging. Analyzing the flow and pattern of the lagging surface based on the choice of insulation design is the first step. The labor and material costs for these choices must then be done. When analyzing labor costs to hump a stiffener versus burying the stiffener, the results are surprising. It is more cost effective to bury stiffeners (even up to 7-inch channels) rather than humping or using an inner support (i.e. 22ga sheet metal or road mesh) over the top of them. Therefore, your insulation design solution to bury all the stiffeners means having an even flow and pattern to the lagging surface while also making it cost effective.

Once you have established a lagging and insulation design, now choose a lagging attachment system.

Lagging Attachment Systems

Rule 2: Review your choices of lagging attachments carefully.

There are many good lagging support or attachment systems from which to choose. The following examples are some of the most commonly used systems in the power industry.

Please note that all lagging systems discussed are based on the following design parameters in conjunction with the example being discussed above:

Example:

The insulation type will be a mineral fiber type composed of rock, slag or glass. The outside surface temperature will be 130° F with an ambient air of 80°F and an external

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wind velocity of 50 feet per minute. The fasteners shall be spaced to withstand a 30 #/ sq. ft. suction or pressure wind loading and all areas are to be considered outdoors.

Ground installation of insulation and lagging on a precipitator hopper.

H-bar system – This system uses a pre-fabricated support system. The H-looking steel channel is manufactured much like the continuous gutters used in the housing industry. They are pressed out of flat materials into the form of a channel. These H-looking steel channels are then attached to the external surface of the stiffeners and form a picture frame that the insulation sits in. The lagging will then be attached (screwed) to the framework. This is a good system to use because the lagging and insulation utilize the same attachment. Unfortunately, when the temperature is above 450°F such as in our example, there is a heat transfer at the connection of the lagging and the frame that exceeds the 130°F surface temperature requirement. Therefore, use of this system would not be recommended.

Field fabrication of pre-insulated lagging panels.

Knurled stud and drive plates with sub-girt and the Z clip design – These systems support the lagging independently from the insulation supports. The 5/16-inch diameter studs are knurled on one end and are attached to the flue plate. A drive plate is driven onto the knurled end of the stud by using a mallet or hammer. A sub-girt (3-inch wide 18-gage channel) is screwed into the drive plate. The lagging is then attached to the sub-girt. The Z clip is a prefabricated channel in a Z shape that is also attached to the flue plate. The lagging is screwed to the Z clip. The draw back for using either of these independent lagging support systems would be the stud/clip length and the material/labor cost. Based on our insulation design choice above and the stiffener pattern of the flue, the stud or Z clip would have to be 6 inches. The labor costs are higher due to installing both insulation and lagging supports.

Insulation pins and sub-girt system – This system utilizes 10-gage insulation pins and a perforated 3-inch wide sub-girt to attach the lagging. Insulation pins are laid out so the lagging will have sufficient support based on the wind-loading span. After the insulation has been installed (impaled) over the insulation pins a sub-girt channel will be installed by using an insulation speed clip. The lagging will be screwed into the sub-girt. The labor cost is cheaper because the insulation and lagging will be supported by the same support system.

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Pre-insulated lagging panels that are properly stored and weather protected, ready for installation.

Field installation of pre-insulated lagging panels require special material handling requirements.

Pre-insulated lagging panel system – This system consists of a shop-or-field fabricated lagging sheet lined on the backside with insulation. This insulated lagging sheet or panel will then attach to the outside of the stiffeners directly or to a sub system made from angle iron. Unfortunately, when dealing with 4-inch thick mineral wool 8-pound density insulation, the weight and size of the lagging panel can become a problem. An average lagging panel could weigh as much as 300 pounds and will be very difficult to handle and install. Clearances may also have to be watched due to the entire system being installed outside the stiffeners. Hence, this is not a preferred system for our flue design.

(Please note that the systems described above only scratch the surface of the many different types of lagging and insulation attachment systems available when using a mineral fiber product. Many other types of insulation such as calcium silicates and perlite along with some of the class V mineral fiber products present their own unique requirements for insulation and lagging system and will be discussed at another time.)

As you can see, the lagging systems are directly linked to the insulation systems and stiffener arrangements. Whether you are the designer or installer, the lagging system should be a prime consideration when selecting an insulation system. Referring back to the original design example, it would appear that the attachment system of choice, based on labor and material cost, would be the insulation pin and sub-girt design.

After design, it is important to consider lagging application.

Lagging Tools of the Trade

Rule 3: Know the tools of the trade used in installation.

According to Roy Morris, an independent lagging expert and superintendent, "Understanding the tools of the trade used for installing lagging will help avoid problems associated with labor." The following are some of the most commonly used tools when installing lagging:

Sheet Metal (Lagging or Cladding) Work –

- Slip Form Roll – used for forming curved surfaces
- Cut Off Shear – used to squares to begin lay out work
- Bench or Table – used for material handling and for a lay out area
- Slitting Shear – used for cutting difficult widths of material
- Hand Brake (10 foot long) – used to form all flashing
- Lock Former – used for making special seams
- Rotary Tools – used for crimping, edging and beating
- Drills and Nut Receivers – used for attaching sheet metal
- Tin Snips – used for trimming sheet metal around penetrations
- Tape Measure and Leveler – used for lay out and installation
- Electric Saw – used for cutting sheet metal

Compare the above with this partial list of tools commonly used for installing insulation and jacketing:

Insulation and Jacketing Work –

- Stud Welding Gun – used for installing weld pins
- Chalk and Line – used to ensure straight lines for welding pin attachment
- Pencil Grinder – used for removing surface rust prior to weld pin installation
- Knife – used for cutting mineral wool type insulation

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A poorly designed and/or installed lagging and insulation system with ponding.

• Hand Saw – used for cutting hard block type insulation

• Tin Snips – used for trimming sheet metal around penetrations

Morris concludes, "There is quite a difference between the tools used for installing insulation/jacketing and lagging. This difference is reflective of the labor application. All of the above tools are used for installing insulation and lagging and require the skill of experts to meet insulation and lagging design requirements. From a distance, a lagging job can look good, but the key is to make sure that you have a properly designed system that is not losing energy or heat."

Lagging Up Close

Rule 4: Lagging must be installed correctly.

As you know, lagging is attached to a sub-system by using sheet metal screws. The sheet metal screws are zinc coated and have a neoprene washer bonded to a stainless steel washer and have a hex head. The lagging screws are installed properly when they are pulled down (screwed) tight. A screw is considered "loose" when you can wiggle the washer with your fingertips. Unfortunately, it is not always easy to get a close look at the lagging to check on the screws.

Unlike the screws, some areas can be viewed at a distance to determine if it has been installed correctly. For example, lagging must be sloped properly to prevent water from ponding, or sitting. Ponding water on your lagging can eventually penetrate the lagging system.

Another problem is foiling. Foiling occurs when the lagging is too thin for the application. When pressure is applied to the lagging during installation (screw locations, bends, openings) crinkling can occur in the lagging. Depending upon the surface area of application this can be quite pronounced. This pressure and the crinkling it causes looks a lot like reused aluminum foil.

Serious problems can be avoided if close attention is paid during the installation. So far, you have carefully chosen the lagging design based on the aesthetics, flue configuration and cost. There is more to learn if you expect to reach your contract commitments and goals.

Labor will make up 65 percent or more of your installation cost. Therefore, it is imperative that you understand the local labor force and who is responsible for installing the attachment system and the lagging material.

A lagging sheet metal screw improperly installed. It is not screwed down tight to the lagging surface.

Labor Definitions

Rule 5: Know your craft labor differences.

Good job planning up front will have long-term dividends especially when dealing with labor. You must remember, it is not the term (jacketing or lagging) but the thickness that will determine what craft will be responsi-

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ble for installation. Consequently, it is important to pay attention to the thickness of the material.

A well-planned project means understanding your labor. This is especially true if your project is to be done by union craftsmen. Each union or craft has its own unique job classifications and by-laws.

Craft jurisdiction--A claim to exclusive control over the type of work performed by its members in a given territory. It implies that the union has the exclusive right to organize employees performing the work of that trade within a definite geographical area.

Jurisdictional dispute--A dispute between two or more rival unions competing for the same work.

Each union, to prevent jurisdictional disputes, writes up an agreement that defines crafts and area jurisdiction pertaining to its union and craft. However, this does not in itself prevent a jurisdictional dispute. An agreement or amendment to the disputing unions must be written and agreed upon to clarify a particular dispute. For example—

A dispute occurred between the Boilermaker Union Local 27 and 363 and the Asbestos Workers Union Local 1. The dispute was over which union will claim the installation of fasteners used for installing insulation. Insulation requires a fastener and this fastener must be welded to the surface of the would-be insulated surface. The two sides reached an agreement that the Boilermaker will do all stick welding (sometimes called tack welding) on all Boilermaker installations for the purpose of fastening insulation (i.e. boiler and furnace membrane walls).

This information is critical if your project includes insulating and lagging a boiler that has membrane tube walls and an "insulation pin and sub-girt system" as the lagging attachment. Any labor dispute will result in time wasted and/or money lost if it occurs while a job is in progress. If your project is to be done by union craftsmen, be sure to keep close contact with the locals in your area. Plan ahead to establish work responsibilities that coincide with the local and international agreements.

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A properly designed and installed lagging system is aesthetically pleasing.

Lagging First and Last

Rule 6: Think lagging first and last.

Whether you intend to sublet or self-perform an insulation and lagging project, remember lagging first. If little consideration is given to lagging in the beginning of the design process, the result may be lagging that is improperly installed and/or aesthetically displeasing. Knowing your lagging material and related components will help minimize the possibility of problems (labor or design) and enhance your chances for a profitable contract. Although lagging may be the last thing to be installed, it should be one of the first things to consider when designing your insulation system.

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Photos courtesy of Gary Bases.

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