NBR vs. EPDM Based Elastomeric Insulation Materials

Polymer Comparison
Physical Property Characteristics

Historically, elastomeric insulation has been manufactured from an NBR (Nitrile Butadiene Rubber)/PVC polymeric blend. K-FLEX USA standard black elastomeric insulation products (tube and sheet**)** are produced from a UV-retardant NBR polymeric blend. Around 1990, elastomeric insulation based on the polymer EPDM (Ethylene Propylene Diene Methylene) was introduced. Both products are flexible closed cell foams, so many of the key insulation properties, such as thermal conductivity and ease of fabrication in the field, that result from them being an elastomeric product with a closed cell structure are similar. However, many of the physical characteristics of the materials are determined by the base polymer, including high temperature resistance, low temperature flexibility, oil resistance, and coefficient of friction. A comparison of physical properties of the insulation materials based on an NBR Polymeric Blend vs. EPDM illustrates the similarities and differences, and the best applications for each.

Similarities:

Thermal Conductivity:
Since NBR- and EPDM-based products have a closed cell structure, their thermal conductivities are similar. k-value at 75°F mean ranges from 0.245-0.28 Btu-in/(h-ft²-°F).

Flame and Smoke Properties:
NBR polymeric blend- and EPDM-based insulation products have a flame and smoke rating of 25/50 or less through 2" thickness when tested according to ASTM E84.

Corrosion Resistance:
NBR polymeric blend- and EPDM-based insulation products, when installed properly, do not contribute to the corrosion of copper or low temperature stainless steel piping applications. For high temperature stainless steel (above 100°F) it is recommended that the stainless steel be protected with a corrosion resistance coating when using either product. Alternatively, a non-halogenated specialty product such as NBR based K-Flex ECO can be used on stainless steel to a maximum 250°F without additional protection.

Water Resistance
NBR polymeric blends and EPDM-based closed cell insulation products are resistant to moisture. In some laboratory tests, EPDM-based materials have shown a slight advantage in this area but both products would be considered to have excellent water resistance. With that said, neither product would be recommended for burial below the water table or for unprotected installation on outdoor ducts where water will pond. This is because continuous exposure to water over a long period of time will result in water intrusion into the closed cell structure and the eventual collapse of the cells, resulting in degradation of the thermal conductivity properties of the product.

Water Vapor Transmission Resistance
The water vapor transmission (wvt) values for NBR polymeric and EPDM-based insulation products are both low and are considered to be low transmittance materials.

Size Offering:
NBR polymeric blend and EPDM-based insulation products are offered in similar size ranges.

Environmentally Friendly
NBR polymeric blend- and EPDM-based products are both environmentally-friendly products. Both products are fiber-free, non-particulating, non-porous, mold resistant, and CFC-free with zero ozone-depleting units. Both products are considered to be low VOC and acceptable for clean room applications, and both products are formaldehyde free.

Differences:

Temperature Limits
High Temperature: The temperature resistance (operating high temperature) of an elastomeric product is primarily determined by the base polymer. High temperature resistance is usually a function of exposure temperature and time – the higher the temperature, the shorter the time until the degradation of the polymer becomes significant. Because the degradation process is a function of time and temperature, the determination of the high temperature limit for a product is an approximation. There is no specific test method to determine this value, but rather several test methods that determine loss in tensile strength or elongation after a set aging period at a specific temperature. Other physical properties, such as shrinkage at elevated temperatures, should also be considered. With the above as a background, the industry has generally agreed upon the high temperature limit for an EPDM-based product to be 300°F and for a NBR polymeric blend to be 220°F – 300°F, depending on the specific formulation of the product.

Both materials could take spikes above these temperatures with minimal effect on their primary function, i.e. heat loss or gain, and both would tend to show some signs of degradation when exposed to temperatures below these maximum recommended values over a long period of time. The EPDM product would resist hardening at high temperatures better than the NBR-based product in applications such as solar hot water and low pressure steam. However, shrinkage would still be a factor that would have to be evaluated and would be more a function of the closed cell structure and the permeability of the material than its resistance to hardening. A typical test method/specification requires shrinkage be less than 7% after aging the product for 7 days at the maximum recommended use temperature.

Low Temperature:

Low Temperature: Insulations based on NBR polymeric blends can be flexible down to -20°F to -40°F, but are listed as having a lower temperature limit of -297°F. The difference in the 2 values is that most insulation applications are static applications, meaning flexibility once the product is installed is not critical. The lower temperature flexibility and lower temperature limits of NBR polymeric blends meet or exceed the requirements of common installation practices and refrigerant line temperatures. EPDM-based materials would have a lower flexibility limit (down to -60°F). For low temperature applications where flexibility is important (i.e. a line that cycles from hot to extreme cold (-40°F to -60°F)) or for installation of materials in very cold temperatures, EPDM-based products may have an advantage. The coefficient of linear thermal expansion (COLTE) should be considered when installing *any* insulation material in very cold temperatures.

UV / Weather Resistance

Both NBR polymeric blends and EPDM-based insulation products are UV-resistant. EPDM-based materials would be "technically" classified as being more UV-resistant than NBR-based insulation products. However, with that said, one must consider two factors:

1. Outdoor applications generally require more than just UV resistance. UV resistance is only one factor when considering outdoor weathering. Mechanical abuse, either from maintenance workers or wildlife, such as birds, is a real issue in addition to UV resistance. The skin of an elastomeric insulation product is not designed to withstand this type of abuse.
2. EPDM-based insulation products do have better UV resistance than NBR-based insulation materials when tested in laboratory conditions, but the question is whether it is sufficiently better to meet the expectation of the application. Both products will eventually breakdown in severe exposure applications without added protection. EPDM-based products may prolong the life of the application slightly, but if the expectation is for the insulation to last for an extended period of time (10 years) with minimal maintenance, jacketing must be used.

For moderate UV exposure / low abuse applications (i.e. insulating the suction line from the heat pump to the house), no additional UV protection is needed for either type of product. For severe UV exposure applications or where mechanical abuse is prevalent (i.e. roof top applications), it is required (based on the diversity of conditions and the expectations of the installation) to, at a minimum, apply a protective coating or jacket to an insulation product. Protective coatings reduce premature aging attributed to UV and other weather-related elements, such as wind, rain, snow, and ice. These coatings adhere very well to the NBR-based materials. Coatings may not adhere as well to an EPDM-based product (as a result of it being a non-polar material) and should be checked before using. Jacketing provides a lower maintenance option with the added advantage of providing abuse protection from maintenance personnel and wildlife.

It is critical to note that requirements for protection of insulation installed outdoors are subject to code requirements, and regardless of the manufacturer's stated performance, installation must comply with all applicable codes adopted by the authority having jurisdiction (AHJ). Refer to technical bulletin TA82 for additional information.

Ease of Installation

NBR polymeric insulation products have proven themselves to be easy to install in the field. They are not only flexible but are easy to cut / fabricate. Because of their low coefficient of friction, there is no knife drag. Their stiffness is designed to allow the product to be flexible, yet easy to slide on a pipe or die cut.

NBR polymers are in the polar polymer family and, as such, they are very adhesive and coating receptive – providing a foam-tearing bond. EPDM-based products on the other hand could be considered to be more difficult to install because of a higher coefficient of friction that creates more knife drag and a more "rubbery/springy" nature that makes sliding on a pipe and die cutting more difficult. As ease of installation is somewhat of a subjective characteristic, it should be evaluated by the installer.

Strength Properties

NBR polymeric blend insulations have excellent tensile strength, tear resistance, abrasion resistance, and compression-set resistance. These strength properties make the insulation easier to install and more durable over time. EPDM-based products generally have poor tear and abrasion resistance. They also tend to have a higher coefficient of friction making them more susceptible to tearing.

Air Permeability:

Air will not easily permeate the cell walls of NBR polymeric blend foams. EPDM on the other hand is more permeable. At higher temperatures, air permeability could result in EPDM shrinkage. Shrinking appears in the form of wrinkled skin surface and shortened lengths. The effect of this shrinking is added stress on the sealed joints which could fail, resulting in exposed pipe / tubing, and creating an area for condensation or water intrusion.

Conclusion:

NBR polymeric-based flexible closed cell insulation products have been on the market for more than 40 years. During this time, they have proven their effectiveness in conserving energy and preventing condensation on a wide variety of applications in a temperature range from -297°F to +300°F. EPDM-based insulation products have been on the market for about 10 years. Based on the physical property differences between the NBR- and EPDM-based products, the EPDM insulation materials may have greater applicability in extreme temperature applications (i.e. installation in extreme cold or applications between 250°F – 350°F intermittent). Issues such as installation ease (ability to cut the product or slide the product on a pipe) should be evaluated for acceptability. Each product type should be evaluated based on the specific physical properties versus the specific application requirements.

For more information on K-Flex USA insulation products, please contact the K-Flex USA technical department or visit www.kflexusa.com.