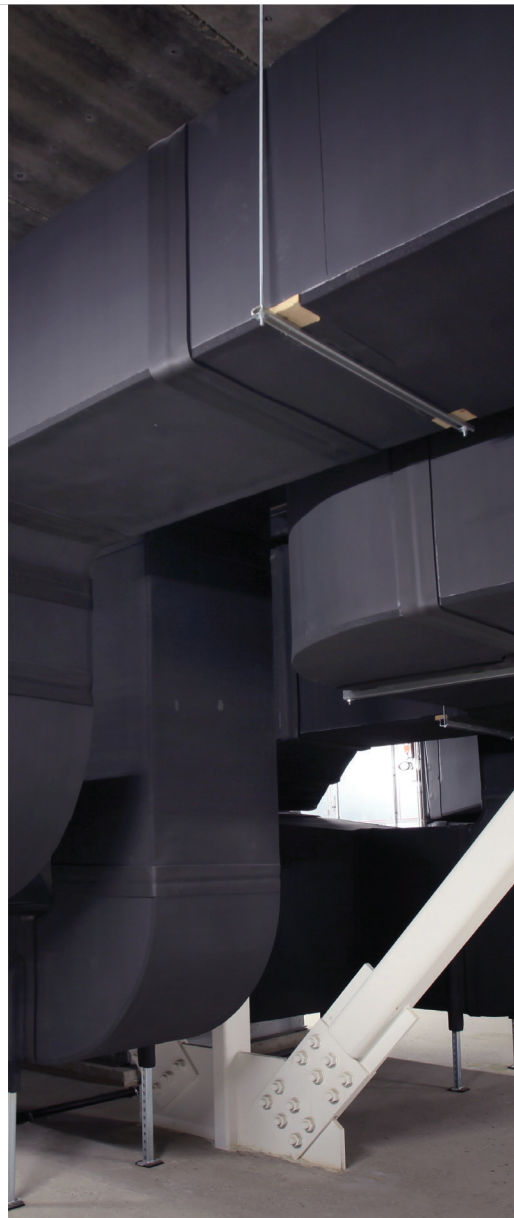


WHITE PAPER

# HVAC Duct Insulation:

An All-Inclusive Approach to  
Design Considerations

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MAKING A DIFFERENCE AROUND THE WORLD

## HVAC Duct Insulation: An All-Inclusive Approach to Design Considerations

**Ventilation ducts are an essential part of a building's mechanical equipment and are necessary for creating a pleasant living climate. It is important that the system, and the insulation used, do not impair a healthy living environment, and do not cause any additional risk in terms of fire and fire propagation. Particular attention should also be paid to Indoor Air Quality (IAQ) and the functionality of the insulation to ensure a robust system design.**

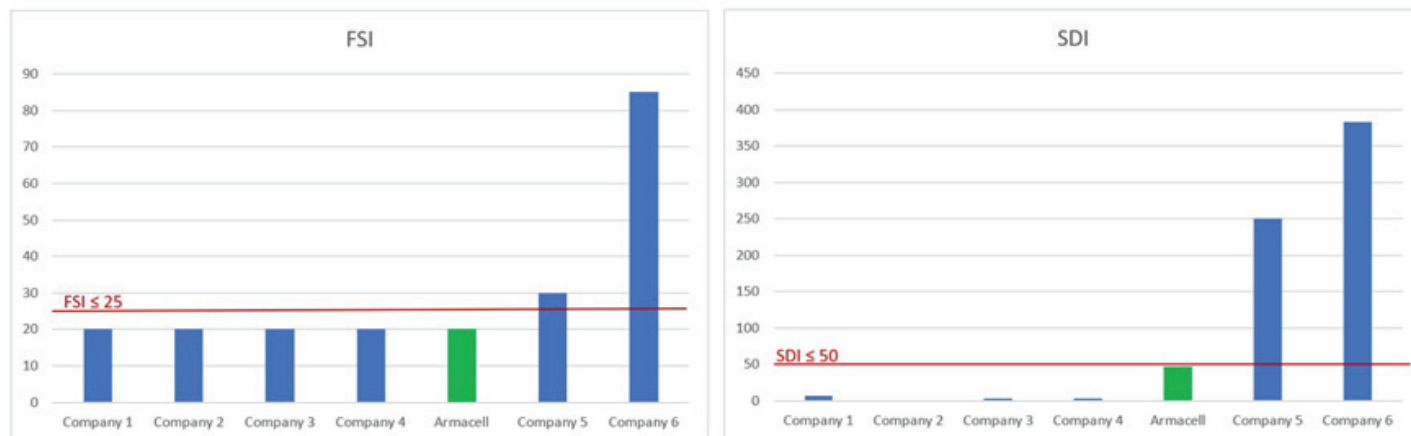
## FIRE PERFORMANCE OF DUCT INSULATION

In principle, insulation materials installed in ventilation ducts must not increase the risk of a fire breaking out or contribute to the spread of a fire. This is undoubtedly an important topic, but it is also a topic that is very often misused for marketing purposes. Specifically, fiberglass-based products are often presented in a way that implies that there are no safety concerns regarding fire behavior due to the non-combustible nature of mineral fiber. Additionally, these presentations often reference self-initiated and commissioned tests of competitive materials. This approach is problematic in several respects. First, the fire behavior and possible health risks of the various insulation materials are not treated and presented in a differentiated manner. Second, carrying out privately commissioned tests and using them for marketing purposes is extremely dubious.

If a manufacturer or a manufacturer association carries out tests on competing material to use these results to emphasize the alleged advantages of their own product portfolio, credibility is already excluded. The organization which commissions these studies strategically selects the products to be tested from his own portfolio and from that of his competition. In addition, there is an option to select the test results obtained to support the narrative of the commissioning customer. Test results that support the expected narrative are used, while test results that do not support the narrative can be discarded. In most cases, serious errors are found in the test setup with competitor materials. Often system components are not selected to be compatible, non-system compliant components are used, or the manufacturer's instructions for mounting and application guidelines are not followed. The test results obtained in this manner are useless.

However, based on our own market research, Armacell is aware that there are insulation materials on the market that do not or do not always meet the declared properties. As a result of discussions with the fiberglass manufacturing association, the North American Insulation Manufacturers Association (NAIMA), Armacell has decided to work together with NAIMA on a test program that provides a neutral and unbiased assessment of products sold in the market regarding the declared fire properties. The declared fire properties are determined according to ASTM E84 test standard in conjunction with the mounting and fixing standard ASTM E2231-19. The formal name of ASTM E84 is the Standard Test Method for Surface Burning Characteristics of Building Material. The purpose of this test is to observe the flame spread along a sample to determine the relative burning behavior of the material. There are several ASTM E84 references in the International Mechanical Code (IMC) that set limits to the Flame Spread Index (FSI) and Smoke Development Index (SDI) in specific applications. Most relevant to the study, the IMC sets stringent FSI and SDI limits for duct insulation products located in plenum spaces to ensure occupant safety from dangerous fire spread and smoke in the event of fire.

As a cornerstone of the jointly agreed testing program, an independent testing laboratory was commissioned to carry out the program to ensure that the respective manufacturers have no possibility of influencing the sample selection. This independent testing laboratory purchased the products to be tested directly from the market and 1-inch duct liner products were defined as the test standard. The agreed upon test program contains specifications that ensure that the respective associated system components were purchased and that the test setup follows the respective manufacturer's guidelines. Results of the test program are shown in the below graphs.



*Comparison study of different duct liner products (fiberglass and elastomeric).*

*The results shown are the results that were achieved in compliance with the agreed NAIMA/Armacell test program, and the test conditions specified thereof. Tests have been performed by Intertek York. Each test result consists of three single tests.*

As a result of this round-robin test, it could be concluded that most of the duct products sold in the market comply with the declared properties. This also confirms that Armacell products comply to ASTM E84 test standard with very good results as tested by Intertek, a Nationally Recognized Testing Laboratory. Nevertheless, two manufacturers were also identified whose products exceeded the compliance requirements of the FSI/SDI, sometimes to a dramatic extent.

While fiberglass products generally performed well in the round-robin study, it must be emphasized that fiberglass products contribute to flame propagation. Although the fiberglass is inorganic and non-flammable, the addition of organic binders introduces flammable substances into the fiberglass product. This also explains why elastomeric-based products are in no way inferior to fiberglass in terms of fire behavior and especially fire propagation.

The use of organic binders in the open-cell fiberglass structure introduces another significant risk of fires starting or spreading, namely the risk of glowing and/or smoldering fires. This risk is well known, and some insulation manufacturers do not like to discuss it or even ignore it in discussions regarding fire-related properties. Continuous glowing combustion is a self-propagating combustion process without flaming that may occur inside porous materials, for example: thermal insulation products based on fiberglass. With these products, internal heat build-up occurs due to the continuing exothermic processes initiated by the original exposure to an ignition source. This heat build-up may cease with time if the insulation allows the excessive heat to escape. If not, the temperature continues to rise within the product eventually causing ignition of the product. Insulation is usually installed behind interior room linings and in cavities behind large surface areas. Continuous glowing combustion fires occurring within the insulation develop slowly and therefore pose a risk because they might remain undetected for a long period of time (up to several hours). These products possibly act as an ignition source with a large area for adjacent products/items resulting in a developing flaming fire.



*Duct insulation products offered by Armacell comply with ASTM E84 with 25/50 (FSI/SDI) classification and they do not have a risk for glowing combustion.*

## INDOOR AIR QUALITY

Additional design considerations should be made when evaluating insulation for use in duct ventilation systems. Any impairment of the room air caused by the insulation material must be ruled out. To maintain adequate indoor air quality, the insulation material must not release any particles or substances into the room air. Furthermore, the insulation material should be antifungal and antibacterial to protect the integrity of the air quality.

Choosing closed-cell insulation instead of open-cell insulation can make a difference. Open-cell structure insulation, like fiberglass, readily absorbs water allowing for mold and other microbial growth. For this reason, these materials often have a thin moisture retarder applied on the surface, but the moisture retarder is easily damaged during installation and maintenance leaving the entire insulation system susceptible to mold growth. Closed-cell insulation, like ArmaFlex®, does not absorb water. Therefore, mold growth cannot occur beneath the surface of the insulation. In addition, the smooth surface of closed-cell foam is easily cleanable so the possibility of surface mold can be eliminated by cleaning surface dirt that can act as a food source for mold. In addition, open-cell materials have an intrinsic disadvantage in that the surface and the exchange with the room air is several times larger than with closed-cell materials and the risk of greater air pollution is therefore inherent.

Another major and often overlooked risk is that open-cell materials can accumulate dust and other dirt over time, which, in combination with moisture, is the ideal breeding ground for fungal and mold growth. This is treacherous insofar as the virgin material might pass the proof of antimicrobial tests in the laboratory test, but then assumes the risk of antimicrobial contamination inevitably over the service life. There is no doubt that air distribution systems containing contaminated microbes has a significant impact on human health. It is also particularly dangerous that the microbial contamination occurring in the ventilation ducts or inside the

insulation is not visible, which oftentimes results in the unidentified cause for negative health effects. According to the April 2004 ASHRAE Journal, “Porous materials such as internal fibrous glass liner have been identified as a major source of fungal contamination.” The same article references a study in which fungal growth on fiberglass linings was found in 92% of 150 office buildings in Minnesota with IAQ problems. This particular study found that the average microbial levels in fibrous glass insulation are hundreds — and in some cases thousands — of times higher than the microbial levels found on closed-cell foam insulation under the very same environmental conditions.<sup>1</sup> Based on these facts, many experts recommend replacing fibrous glass liners with materials that are less likely to encourage fungal growth (i.e. closed-cell foam insulation) in areas where humidity is likely to exceed 70%.

Armacell duct insulation products are closed-cell, fiber free, and non-particulating, offering superior mechanical performance and ensuring a healthy IAQ for the building occupants. For added resistance to the growth of mold, the ArmaFlex duct insulation portfolio contains Microban® antimicrobial product protection, which inhibits the growth of mold and mildew in the insulation\*.

Additionally, Armacell’s duct insulation products are third-party GREENGUARD Gold certified to UL’s rigorous, scientific standards confirming Armacell’s duct insulation products contribute to safer, healthier air. This standard is designed to define low-emitting materials suitable for environments where people — particularly children and sensitive adults — spend extended periods of time. IAQ has been a growing concern in the sustainable design and renovation of commercial buildings, with the objective for providing clearer, uncontaminated interior air for the building’s occupants. An increasing number of hospitals, schools and universities seeking better IAQ have decided to replace existing open-cell insulation with Armacell’s closed-cell insulation, not only for its mold-resistant properties, but also for its fiber-free, non-particulating construction. A healthier IAQ is good for occupants as well as building owners.

## FUNCTIONALITY

Within the construction of ventilation ducts, adequate insulation must be installed to not only minimize energy losses, but to also provide acoustic functionality to suppress vibrations and dampening operating noise. Lining or wrapping ducts with insulation that provides good acoustical performance will result in more comfortable occupant spaces and quieter indoor environments.

In addition to the thermal and acoustic properties, condensation control is particularly essential for the operation of a ventilation system. Any condensation that occurs not only leads to defects in the building technology itself but can also lead to structural damage. Furthermore, any condensation that occurs — especially in the case of open-cell products — leads directly to the formation of mold. Therefore, the insulation used must only show low water absorption and must be water vapor diffusion resistant. It is also important to ensure that the surfaces are easy to clean.

It is important to recognize that functionality is not only pertaining to the insulation performance at the time of installation but is maintained over the entire service life of the system. Besides the aging resistance of the materials, the sustainable integrity of the insulating material is essential. No particles or fibers should be released because of the vibrations that occur while the system is in operation.

Duct insulation products offered by Armacell, are closed-cell products with low water absorption and very good water vapor diffusion resistance. They are easy to clean, long-lasting, and do not release particles or fibers. Armacell duct insulation products are noise attenuating, and they dampen mechanical vibration in ducts. Armacell products achieve all of this while maintaining excellent thermal conductivity values that provide energy efficiencies to the mechanical system.

## ACTIONS DESIGNERS AND SPECIFIERS CAN TAKE TODAY

Specifications for insulation materials for ventilation duct insulation should be reviewed for fire, health, and functional properties. The relevant properties should be declared by the insulation manufacturer. These values should be requested from the manufacturers and should be made credible, e.g. by submitting appropriate test certificates or test reports. Armacell advocates external monitoring of the essential declared properties.



## CONCLUSION

Closed-cell, fiber-free elastomeric foam duct insulation provides proven, safe, and durable protection. Armacell's duct insulation product portfolio is compliant to industry standard fire performance, contributes positively to a building's IAQ, and delivers functional properties for longer lasting systems and greater owner peace of mind. ■

**Note:** Armacell closed-cell, elastomeric foam meets important testing criteria for fungal and bacterial resistance, including UL181 for mold growth, ASTM G21/C 1338 for fungi resistance.

**\*Microban antimicrobial product protection is limited to the product itself and is not designed to protect the users of these products from disease causing microorganisms, or as a substitute for normal cleaning and hygiene practices. Microban is a registered trademark of Microban International, Ltd.**

**GREENGUARD Certified products are certified to GREENGUARD standards for low chemical emissions into indoor air during product usage. For more information, visit [ul.com/gg](http://ul.com/gg)**

**<sup>1</sup>MICROBIAL LEVELS ON INTERIOR SURFACES OF VENTILATION DUCTWORK, CLOSED CELL FOAM VS.FIBROUS GLASS INSULATION AND GALVANIZED METAL. P. Ellringer, S. Hendrickson, Tamarack Environmental Inc., St. Paul, MN; C. Yang, P&K Microbiology Services, Inc., Cherry Hill, NJ**

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## ABOUT ARMACELL

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As the inventor of flexible foam for equipment insulation and a leading provider of engineered foams, Armacell develops innovative and safe thermal and mechanical solutions that create sustainable value for its customers. Armacell's products significantly contribute to global energy efficiency making a difference around the world every day. With more than 3,300 employees and 27 production plants in 19 countries, the company operates two main businesses, Advanced Insulation and Engineered Foams. Armacell focuses on insulation materials for technical equipment, high-performance foams for acoustic and lightweight applications, recycled PET products, next-generation aerogel technology and passive fire protection systems.

For more information, please visit:  
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