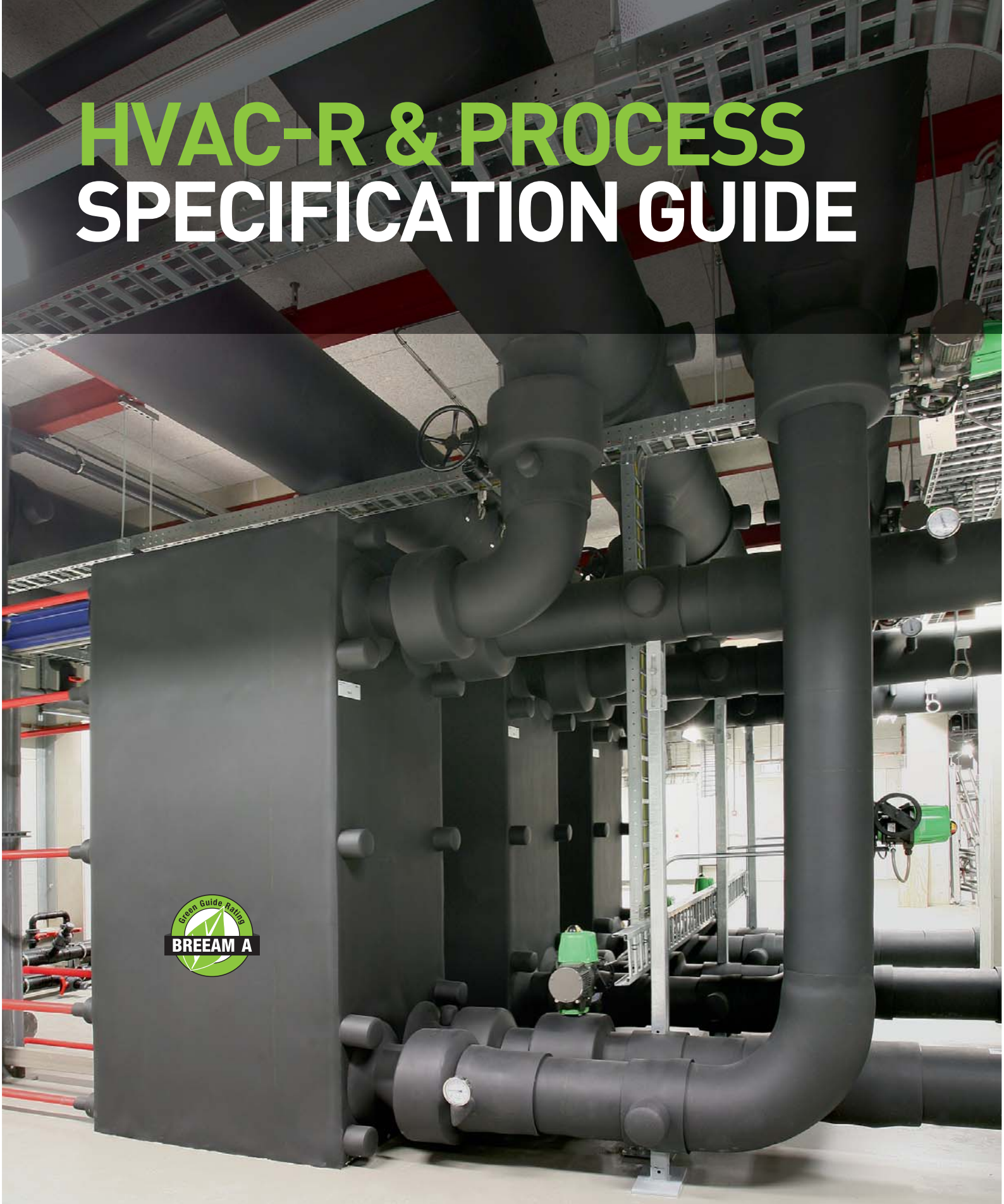
HVAC-R & PROCESS
SPECIFICATION GUIDE



MAKING A DIFFERENCE
AROUND THE WORLD.

armacell®

Armaflex HVAC-R & Process Specification Guide

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PIONEERING FLEXIBLE INSULATION

In 1954, Armacell invented Armaflex, the first flexible insulation product. In doing so a new branch of industry – flexible technical insulation – was created that Armacell has been shaping ever since. Armaflex is now the world's best-known brand for flexible technical insulation, and the brand name is eponymous in the building materials industry.

ENERGY SAVING

Armaflex insulation materials are among the few products that save more energy than is used for their production; saving 140 times more energy than it takes to manufacture. In light of rising energy prices, stricter energy conservation laws and the rapid pace of climate change, Armacell believes that the insulation of building equipment and industrial installations will play an ever more important role in future.

ADVANCED INSULATION

Armacell is a world leader in the manufacture of flexible insulation foams for the insulation of mechanical equipment in HVAC, plumbing and refrigeration applications and process lines in industrial and oil & gas systems.

Today, Armacell employs more than 2,800 people worldwide, with 23 manufacturing plants in 16 countries on four continents. With production facilities in China, Thailand, India, Brazil, Saudi Arabia and South Korea, Armacell has long been a pioneer in exploring new geographical markets and is focused on further growth in emerging countries.

INNOVATIVE SOLUTIONS

In addition to conventional thermal insulation materials, Armacell offers a wide range of covering systems, fire-protection and noise-control solutions, pre-insulated systems and the accessories to match.

TECHNOLOGY LEADER

In recent years, Armacell has also developed new insulation systems for oil & gas processes – a key growth market for the Group – and low-smoke products that are setting new standards in the industry. Being a technology leader in flexible technical insulation materials, Armacell holds more than 200 active patents worldwide.

CPD PRESENTATIONS

A series of free CIBSE approved Continuous Professional Development seminars are available for consulting engineers and specifiers of M&E services, with presentations including:

- An Introduction to Mechanical Services Insulation
- Environmental assessments for nitrile rubber insulation materials
- Building Regulations guidance for specifying HVAC-R insulation

INSULATION THICKNESS CALCULATIONS

The relaunched ArmWin thermal insulation calculation program is now available to download from our website and as an app to determine the correct insulation thickness required for condensation control, minimising heat loss / heat gain and maintaining process temperatures to meet building regulations and the relevant industry standards.

BIM OBJECTS

Armacell in the UK is the first flexible insulation manufacturer to make BIM objects available for our elastomeric product ranges. These data-rich objects allow Armaflex products to be easily incorporated into 3D building models and are free to download from the NBS National BIM library.

ARMACELL PREMIUM REWARDS

Thermal insulation contractors can now earn extra rewards on purchases of Armaflex and Arma-Chek products. A range of premium gifts can be collected by registering at www.armacell-premium.com and entering ibonus barcodes printed on eligible products. Barcodes can also be scanned in to register ibonus points using the Armacell Premium app, available from the itunes and Google Play stores.

ENVIRONMENTAL & QUALITY STANDARDS

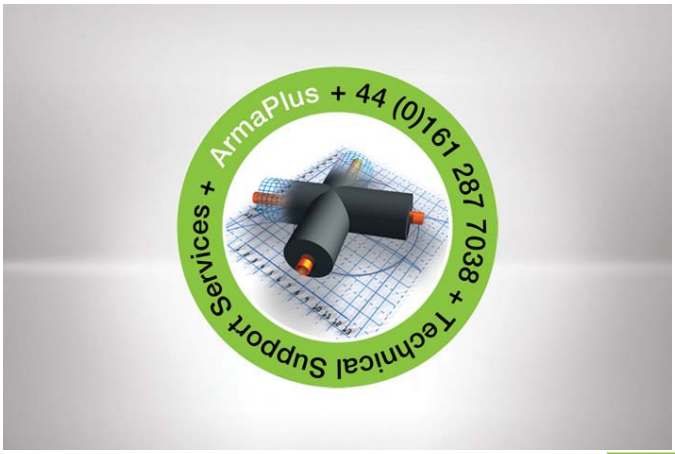
The BRE (Building Research Establishment) has now added pipe insulation products to their Green Guide to Specification, with Armaflex nitrile rubber insulation materials receiving an A rating. Environmental Product Declarations (EPDs) are also available for Armaflex materials, meaning that under MAT 04 a tier 2 points uplift to 2.75 points is achieved with a zero ODP and GWP rating. Armacell are the first insulation manufacturer to meet CE marking requirements and are ISO 14001 & 9001 certified. See page 42 for further details.

ARMAPLUS TECHNICAL & APPLICATION SUPPORT

A dedicated technical support line provides specification and calculation advice Monday to Friday for the UK & Ireland.

Armacell accredited training courses are also available monthly at our Oldham training school. One to three day courses are available depending on the level of knowledge required.

For example, more complex applications such as large diameter pipework and pattern developments for fittings and covering systems are covered as part of the three day training course. Dates of upcoming training days and the applications covered are listed on the ArmaPlus section of our website.



Application Areas

REFRIGERATION, CHILLED WATER & AIR CONDITIONING SERVICES

Chilled water air conditioning systems are used in applications that need large cooling capacity, such as supermarkets, industrial processes and commercial air conditioning systems for offices and factories. The systems pump cool water to load terminals and back to chillers via supply and return piping in a closed circuit to distribute cool air to the occupied spaces within the building.

Similarly refrigeration and gas based air conditioning systems work by piping refrigerant through a closed loop including a compressor, condensor, expansion valve and evaporation coils.

For industries and commercial buildings with large cooling capacity requirements, refrigeration and air conditioning systems account for a significant proportion of overall site energy costs. Against these high costs, the correct use of insulation can significantly improve system efficiency, with thermal performance and condensation prevention the key considerations.

Moisture condensing from the air onto cold pipe surfaces can cause damage to surrounding materials and equipment. The incorrect choice of insulation, with an open or partially open cell structure reliant on an external vapour barrier can quickly become saturated and lose thermal performance. Once moisture diffuses into the material through gaps or holes in the external vapour barrier subsequent energy efficiency losses, corrosion, mould growth and ultimately reduction of the service life of equipment will result.

Armaflex flexible, closed cell products, such as AF/Armaflex Class 0 manufactured in the UK, prevent such moisture ingress owing to their superior water vapour diffusion resistance value of ≥10,000 μ (mu value). Armaflex provides an integral barrier to water vapour ingress with no external foil vapour barrier required like with mineral wool or phenolic foams alternatives.

AF/Armaflex Class 0 also offers a market leading thermal conductivity for a flexible product, with a value of 0.033 W/(m • K). The combination of an industry leading water vapour resistance and low thermal conductivity value ensures the long-term reliability of the material. The addition of Microban® anti-mocrobial protection to prevent mould and bacteria growth, makes AF/Armaflex the leading choice for insulating cold systems around the globe.

Armaflex materials are fully vapour sealed using specially formulated Armaflex contact adhesives to fuse adjoining sections of the closed cell insulation together. This means that adhered seams and joins do not represent the thermal bridges or water vapour bridges they might do with other materials. If a cross section of a sealed piece of Armaflex is cut, then no join is visible such is the fusion of the cells, acting as one seamless installation.

In summary not all insulation materials are suitable for cold applications and the specification of a single insulation material for an entire project can have adverse consequences. Primarily, insulation used on cold lines must effectively prevent condensation and should achieve the following characteristics:

- **AN EFFECTIVE WATER VAPOUR BARRIER**
  Without an effective and integral water vapour barrier, condensation can directly diffuse through to the cold surface of the pipe.

- **NON-WICKING CELL STRUCTURE**
  Open cell pipe insulation materials are protected by an external water vapour barrier. Once moisture is able to penetrate through gaps or holes in the system it is able to migrate throughout the whole material, a process known as "wicking" which accelerates corrosion and mould growth.

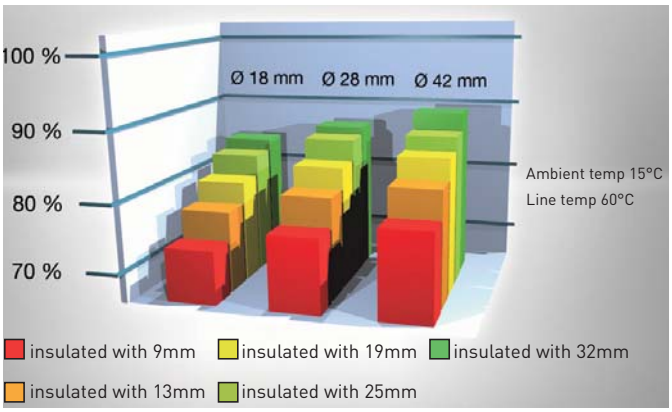
- **NO THERMAL BRIDGING**
  When valves, pipe hangers and flanges are left un-insulated condensation and significant energy losses will occur at these "thermal bridges". Flexible materials which can insulate all of the pipework and associated equipment can eliminate condensation at these points.

- **LOW ENVIRONMENTAL IMPACT VALUES**
  To reduce carbon emissions only insulation with low ODP and GWP values are acceptable. Armaflex has a zero ODP and GWP, an independently verified Environmental Product Declaration and a BREEAM Green Guide A rating to certify it's low environmental impact. The lifecycle assessment of Armaflex reveals 140 times more energy is saved through its use than is required for its production.

- **LONG-TERM STABILITY OF VALUES**
  Insulation thermal properties typically vary over time. It is usually essential that the material prevents condensation over the lifetime of the installation and this requires integral resistance to moisture vapour in order to maintain highly stable thermal values.

HEATING & PLUMBING

The insulation of central heating pipework can reduce heat losses by as much as 87% and make a significant contribution to improving boiler efficiencies.



The insulation of cold water pipes is also important to protect against pipes freezing in sub zero temperatures. The scale of damage and cost of water pipes freezing can be substantial, particularly where pipes are located outside or in unheated spaces. Where water risers enter properties from the mains water supply they can be exposed to sub-zero temperatures and will eventually freeze. As pipes freeze the water expands and the pressure exerted is enough to either burst pipes or to break pipe connections apart.

Cold water pipe insulation plays an important role in preventing these problems by greatly slowing the rate of freezing. For a guide to choosing the right thickness please see the frost protection thickness tables on page 67-70.

To save energy central heating system pipework should also be insulated, with a payback period on energy bills of less than one year. Armacell also makes a range of pre-formed elbows and T pieces for quick and easy insulation of common pipe sizes.

RENEWABLE SYSTEM PIPEWORK

Heat lost from pipework that connects solar panels to hot water cylinders and heat pumps to underfloor heating, radiators or fan coil units reduces the overall efficiency of the system meaning less energy is harnessed.

Pipework extends relatively long distances from solar collectors to hot water cylinders and since the insulation is located outside it needs to be UV stable and resistant to damage by birds and vermin. Armacell has pioneered the pre-insulated Armaflex DuoSolar twin return and feed pipe coils for this application with a tough, UV reistant outer covering ideal for solar hot water systems.

Where ground and air source heat pump flow and return feeds are above ground and connect to the main plant unit, insulation should be applied to maximise system efficiency. HT/Armaflex (high temperature) provides a robust and UV resistant option for this application.

HVAC DUCTWORK

In large commericial premises and public buildings, heated and cooled air is distributed using ductwork systems including warm air return, supply, and exhaust systems. Rectangular ductwork is used for the main supply of heating and cooling systems, with circular ductwork and flexible hose sections used to branch off supply and return ducts to specific rooms.

To maintain the desired temperature of heated or cooled air, the large surface areas of rectangular and circular ductwork require insulating to prevent heat losses or heat gain. Ductwork can also be a condensation risk and a source of unwanted noise and air pollutants that can contribute towards 'sick building' syndrome, causing problems such as viral infections, fatigue and a wider loss of productivity. The wrong choice of insulation can contribute to these problems in terms of condensation damage and pollutants in the form of dust, fibres and mould growth.

Armaflex provides a dust and fibre free, and formaldehyde free duct insulation option with Ozone Depletion and Global Warming Potential ratings of 0. Pairing excellent thermal values with a closed cell structure, Armaflex can meet the energy efficiency targets for ductwork without any risk of impacting upon the indoor air quality or contributing towards sick building syndrome.

Armaflex has added Microban® anti-bacterial protection to restrict mould growth, making them an obvious choice for improved air quality in schools, hospitals and offices. The fibre free materials are also easy to handle and work with, with no dust mask or gloves required.

In addition flexible closed cell foams have excellent acoustic properties and can be used as a combined thermal and acoustic insulation solution.

The following factors should be considered when selecting insulation for use on ductwork:

- **DUCTWORK AND BUILDING COMFORT**
  Many modern buildings are air tight and rely on re-circulating filtered but stale air. Almost all gases remain within the envelope and ventilation ductwork is an essential part of removing any contaminants and maintaining occupant comfort. However it can also provide an inconvenient means of spreading unwanted noise and air pollution throughout a building. It is important to specify insulation products which can isolate any structure borne noise and absorb airborne sound.

- **INDOOR AIR QUALITY AND MOULD GROWTH**
  Our air is always contaminated with pollutants, these pollutants include not only naturally generated gases such as carbon dioxide but also volatile organic chemicals, industrial fibres, acidic particles of dust and spores of mould and bacteria. Whilst breathing these may not result in any immediate signs of ill health they may all contribute towards "building related symptoms". Selecting dust & fibre free insulation on ductwork systems can minimise any potential contribution to indoor air pollution.

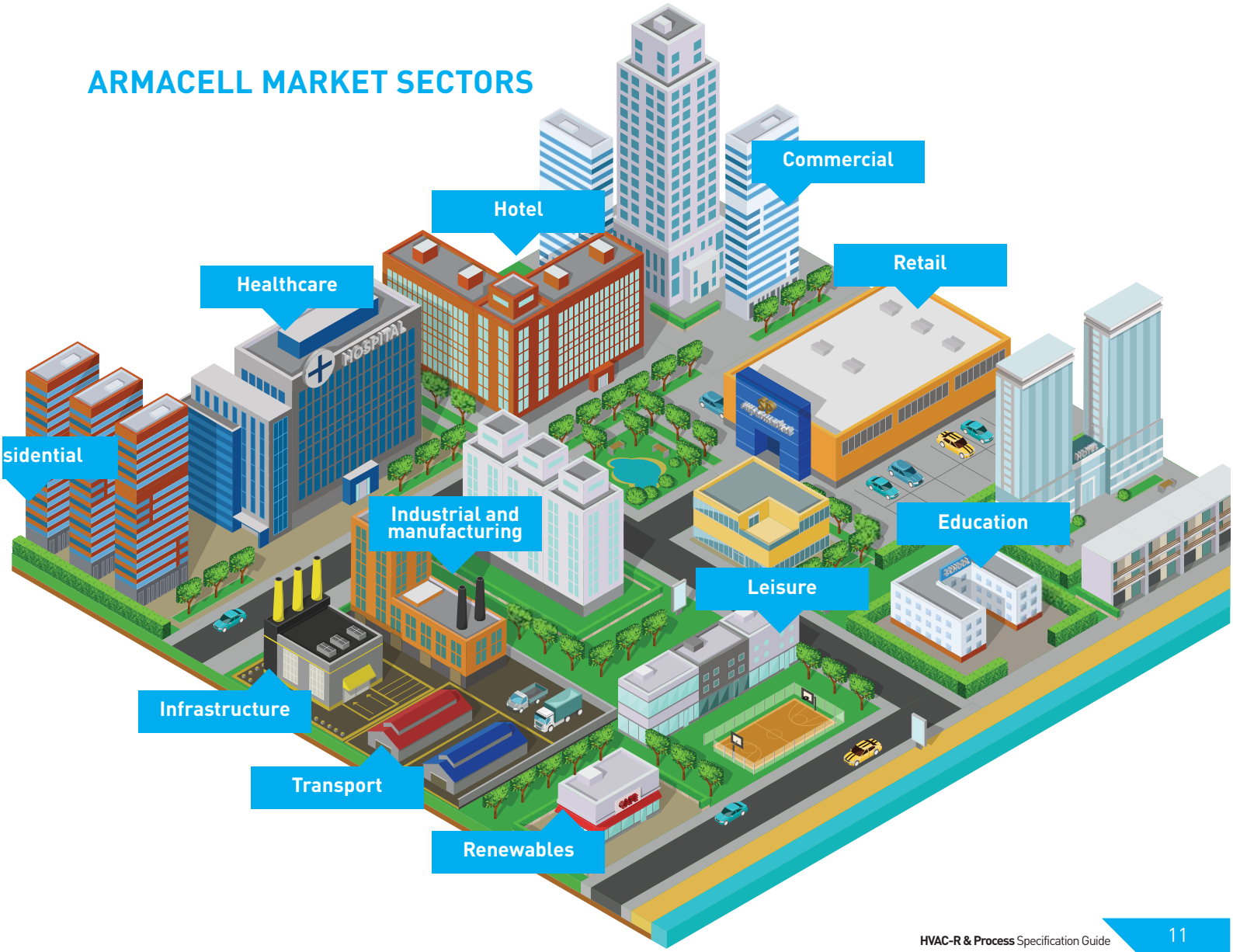
Market Sectors & Building Types

COMMERCIAL & LEISURE

Insulating heating and air conditioning pipework in commercial offices and large public buildings helps to minimise energy waste. Offices are big users of energy thanks largely to the building services that keep the office space at just the right temperature.Throughout the year offices utilise both heating and cooling systems in a diverse range of configurations. The most common and efficient set-up remains to locate a large capacity boiler and chiller in a central plant room and connect every area of the office using an array of pipe and ductwork. Cooled air ductwork and chilled water pipework operates at temperatures between 0 °C and 10 °C and commercial heating pipework normally operates at temperatures of around 75 °C. Operating for long hours and over long pipe runs, the cumulative energy loss is high.

Insulation should be present along all pipe and ductwork in commercial office buildings to prevent these energy losses.

ARMACELL MARKET SECTORS



DATA CENTRES

Data centres form a critical part of today's business infrastructure and modern refrigeration and air conditioning systems play an essential part in ensuring server rooms and data cabinets remain cool.

Computer servers generate vast quantities of heat and employ extensive runs of pipework with liquid cooling systems to control and maintain room temperatures between 21 - 25°C regardless of external temperatures.

Using a closed cell insulation with an in-built resistance to water vapour diffusion on chilled water and refrigerant pipework help to prevent the ambient air from condensing onto the lines, especially important to prevent when electrical equipment is nearby. For this reason it is also important to use a dust and fibre free product that is non-corrosive in the event of fire. Non-halogen (NH/Armaflex) and reduced smoke versions of Armaflex (Armaflex Ultima) are available to provide this protection.

Energy saving is also a main priority when it comes to the insulation requirements for chilled water pipework in data centres. After years of continued rapid growth, data centre power consumption now accounts for over one per cent of all power generated in developed economies, with cooling equipment using 35 per cent of this total energy consumption. This figure continues to escalate, growing at a rate of between 5% and 10% a year as server processing power speeds increase.

Most large scale data centres use computer room air conditioning systems (CRAC) to transmit cool air into cold aisles between racks. The cool air is then pulled through the server racks carrying the heat from the computer equipment into a hot aisle and ultimately back in the CRAC.

These pipes must always be insulated to prevent this excess heat energy returning to the server room. In general these pipes will also be operating at below ambient temperatures and should be protected against condensation.

SCHOOLS & HOSPITALS

We may not always be able to see pollutants in the air we breathe but microscopic dust and fibres, along with biological particles such as mould spores and pollen, are always present in varying amounts. Even in small quantities these can aggravate respiratory problems and cause discomfort to the building occupants.

People understand the impacts of pollution on outdoor air but indoor air pollution and out gassing from building materials is often overlooked. This is ironic since we spend up to 90% of our time indoors and the risk is related to our overall exposure.

INDOOR AIR QUALITY

When building occupants strive for fresh air they are rallying against the poor indoor air quality yet often building designers fail to hear this call. Many modern buildings are air tight and rely on re-circulating filtered but stale air. Almost all gases remain within the envelope.

Carefully specifying pipe and duct insulation materials can minimise the contribution to indoor air pollution and so attention should always be taken when selecting your insulation.

As a closed cell, dust and fibre free product which inhibits the growth of mould and microbes, Armaflex is the ideal insulation for school and hospital environments.

Whereas other insulation materials may be designed specifically for warm or cold service pipe or ductwork, Armaflex can be used for hot water and chilled water pipes to effectively save energy whilst also preventing condensation and mould growth.

MANUFACTURING & FOOD PRODUCTION INDUSTRIES

Process industry equipment including pipework, ducts, vessels, valves and flanges should be insulated to help ensure that steam, hot water, hot gasses or cold liquids and gases are delivered at controlled levels. Elastomeric thermal and acoustic insulation systems are suitable for both high and low temperature process applications and easy to fabricate Armaflex sheet or tubes (up to 114mm diameter) can be used to minimise heat loss/gain, improve process efficiencies, control condensation and provide mechanical impact and personnel protection.

When insulating pipework in food and beverage production locations it's important to ensure that insulation is safe and free from dust, fibres, mould and other contaminants.

Preventing the growth of dangerous mould and bacteria is especially important and all surfaces in food production locations, including the exposed surface of insulation, must be easy to clean and maintain.

Closed cell foams with Microban® have a natural advantage over sponge like open cell foams and in food preparation locations closed cell foams can be covered with an additional cleanable surface such as Arma-Chek Silver or Armaflex Tuffcoat.

OIL & GAS

One of the greatest challenges for insulation of marine, offshore and heavy industrial environments is the issue of Corrosion Under Insulation which causes pipe and metal cladding systems to rust and decay, resulting in expensive production stoppages and maintenance schedules.

Closed cell insulation and non-metallic covering systems provide an excellent alternative for thermal and acoustic insulation and protection against mechanical impact, chemicals and salt water. Prefabricated fittings are also available to cut down on-site installation times in hazardous and process critical environments.

Oil & Gas application areas where multi-layer, light weight and IMO certified Armaflex systems are specified include; fixed platforms, semi-submersible platforms, drill rigs and ships, tension leg platforms, spar platforms, gravity-based structures, offshore accommodation platforms, marine vessels, floating Production Systems (FPS), Floating Production Storage & Offloading (FPSO), Floating Liquefied Natural Gas (FLNG), ammonia plants, ethylene plants, LNG import and export terminals, LNG storage tanks, LPG, NGL, Butadiene and Polypropelene storage facilities

RAIL VEHICLES

Low smoke density insulation materials are vital in allowing people to escape from transport vehicles and passenger buildings in the event of a fire.

Although major incidents involving fires in carriages or transport terminals are rare, designing in safety remains a key priority for the industry. The single largest issue is ensuring that people can escape to safety and low smoke density insulation can make the difference between life and death in these situations. Closed-cell insulation products specified in the marine and rail sectors provide low smoke protection against energy losses and condensation for refrigerant pipework, air ducts and other components.

The new European rail standard EN 45545-2 defines tighter requirements for the fire behaviour of materials and components. Depending on where they are used, materials are assigned to requirement set categories R1 to R26. The various operating and design classes provide the basis for the hazard levels (HLs) which in turn define the requirements of the classification system. There are a total of three hazard levels (HL1 to HL3). HL3 is the highest level and makes the greatest demands of the materials used.

As a result of the new harmonised standards Armacell has extended our range of flexible, closed-cell insulation materials for railway vehicle construction. These are able to achieve hazard level HL2 or 3 and can even be installed in sleeping cars and couchettes, which are operated on underground track sections or in tunnels. The range, which includes halogen-free and covered insulation materials, has very good fire properties and develops extremely little smoke.

SHIP BUILDING

One of the biggest challenges of insulating in marine and ship building environments is the risk of Corrosion Under Insulation (C.U.I.).

Traditionally, the insulation used within these harsh and often humid environments, has been open cell fibrous materials with a metal cladding or covering. In these conditions the materials often fail and the cladding systems can rust and fall apart leaving the open cell insulation exposed. This results in an ineffective water vapour barrier and increased risk of corrosion where water vapour soaks and migrates through the insulation to attack the pipe. Corrosion damage can then spread throughout the pipe work, especially when salt water is involved since the risk of corrosion under insulation increases dramatically. Pipe maintenance can cost millions with lines needing to be shutdown and replaced.

Armacell IMO approved systems based on closed cell Armaflex insulation and non-metallic coverings can prevent these problems and provides a light-weight more cost-effective solution.

Armaflex Products

AF/ARMAFLEX CLASS 0

AF/Armaflex Class 0 is the market leading elastomeric foam rubber insulation, manufactured in the UK and renowned in the HVAC-R industry for over 50 years.

AF/Armaflex Class 0 is available in 2m tubes from 6mm up to 114 diameter and 6, 9, 13, 19, 25 and 32mm wall thickness. 15m tube coils and AC coils (up to 75m long) are also available in addition to flat sheets or 1m wide rolls for insulating larger pipes, ducts and vessels. Tubes and sheet are available with a self-seal backing to simplify and speed up installation times and AF/Armaflex Class 0 maybe used on mild steel, stainless steel, carbon steel, copper and plastic pipework.

The key advantage of Armaflex products is their closed cell structure and high resistance to water vapour diffusion (mu factor ⩾10,000) combined with a low thermal conductivity (0.033 W/(m • K). This means that energy losses can be minimised on heating and hot water services whereas on cold services condensation can be easily controlled, with water vapour pressure not able to penetrate the material.

The microcell structure is consistent throughout the entire insulation layer, meaning no external vapour barrier is required. Other materials used on cold applications such as mineral wool and phenolic insulation products are reliant on an external vapour barrier to prevent water vapour diffusion. If this vapour barrier is compromised, or the insulation system has gaps, condensation can spread through the insulation and lead to loss of thermal performance, corrosion problems and consequential damage to the surrounding buildings and equipment.

The flexible nature of Armaflex makes it easier to fully insulate and cover building services equipment, with fittings fabricated from tube or sheet material to cover bends, t-pieces, valves, brackets, ducts, tanks and vessels. By sealing with compatible Armaflex adhesives the system becomes seamless to water vapour and ensures no gaps for heat loss to occur. Once two sections of Armaflex are vapour sealed together, the adjoining cells merge together to form a seamless join.

Armaflex nitrile rubber products are easy to cut, with no fibres or dust particles released into the environment, making it ideal for ductwork applications and assisting with improved indoor air quality. The addition of Microban® antimicrobial additives during the manufacture of Armaflex also helps to prevent bacterial development and spread.

Armaflex Green Guide Rating

The BRE (Building Research Establishment) has recently added pipe insulation products to their Green Guide to Specification, with Armaflex nitrile rubber insulation materials receiving an A rating. AF/Armaflex has a zero ODP and GWP rating and Armacell production is ISO 14001 certified.

For more information see the environmental considerations section on page 42.

PRODUCT TECHNICAL DATA

Brief Description	Flexible closed-cell insulation material for use on hot & cold water services, chilled water, heating systems, air conditioning ductwork and refrigeration pipework	
Colour	Black	Test method
Service temperature	Maximum: +110°C (+85°C for flat surfaces)	EN 14706, EN 14707 & EN 14304
	Minimum: -50°C	
Thermal Conductivity at 0°C	0.033 W/(m·K) (tubes 6-19mm & sheets 3-32mm)	EN 12667 & EN ISO 8497
	0.036 (W/(m·K) (tubes 25-32mm)	
Water vapour diffusion resistance	μ ≥10,000 (tubes 6-19mm & sheets 6-25mm)	EN 12086 & EN 13469
	μ ≥ 7,000 (tubes 25-32mm & sheets 32-50mm)	
Fire performance	Class O	BS 476 part 6
	Class 1	BS 476 part 7
	B_L-s3,d0 (tubes)	EN 13501-1
	B-s3,d0 (sheets)	
Approvals	FM Approved	
UV resistance	UV protected with Armafinish 99 paint	
Health aspects	Dust & fibre free	
Antimicrobial behaviour	In-built Microban® antimicrobial protection. Actively protects against bacteria & mould growth	
Environmental aspects	Zero ODP and GWP	
Green Guide rating	A	

ARMAFLEX ULTIMA

Minimal smoke density is crucial for people safety in the event of a fire. In a fire it is not usually the flames that kill, but the smoke with 95% of fire fatalities due to smoke inhalation.

The European fire classification takes this fact into account and when assessing the fire behaviour of building products the smoke density and the production of burning droplets are tested as well as the flammability.

With the innovative, patented Armaprene technology Armaflex Ultima is the first elastomeric product to achieve the fire class B/B_L-s1,d0 meaning that the flame-resistant insulation material develops significantly less smoke than a standard product available as a complete system range.

In addition to the standard and self-adhesive 9, 13, 19, 25 and 32mm thick tubes and sheets, there is also an Ultima version of the tried-and-tested Armafix pipe support, now manufactured with a load-bearing segment made of recycled PET.

B/B_L-s1,d0

HIGH FLAMMABILITY
LOW SMOKE DEVELOPMENT

D s1 d0

LOW FLAMMABILITY
HIGH SMOKE DEVELOPMENT

B s3 d0

Armaflex® Ultima

LOW FLAMMABILITY
LOW SMOKE DEVELOPMENT

B s1 d0

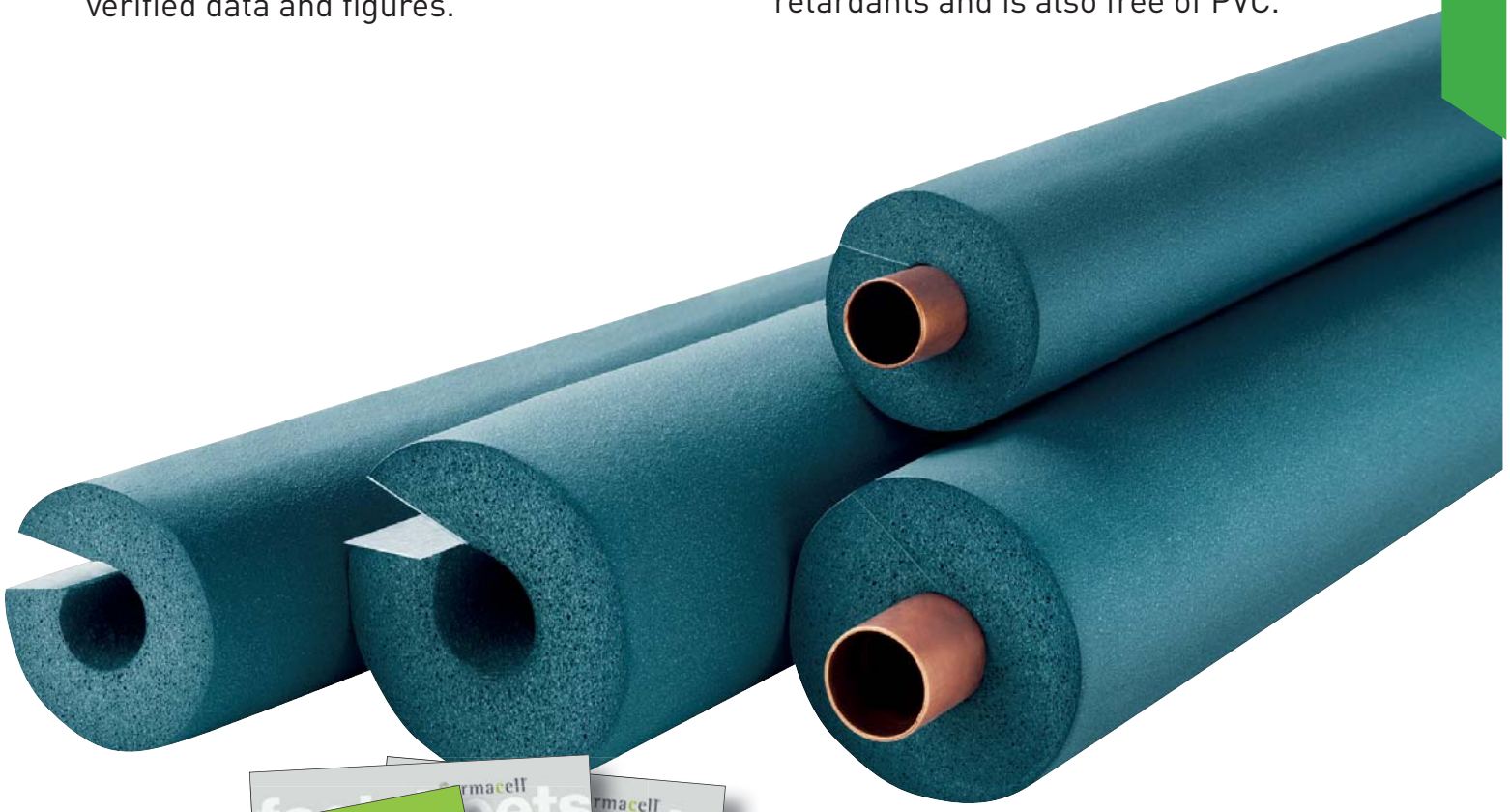
Armaflex Ultima is not only the safest elastomeric product on the market in terms of preventive fire safety, it also offers the highest protection in terms of ecological and health benefits.

Today Armacell is the only manufacturer of flexible technical insulation materials to publish environmental product declarations based on an independent life cycle assessment (LCA). Environmental product declarations (EPDs) are becoming more and more important in the construction industry since they provide a transparent, independent and reproducible analysis of the environmental impacts of construction products with independently verified data and figures.

As a 'sustainability passport' EPDs form the basis for designing green buildings

in accordance with certification schemes such as LEED, BREEAM, HQE or DGNB.
A high degree of transparency is provided for architects and specifiers, with detailed product information for designing sustainable mechanical services insulation systems.

At the same time, the EPD assessments spur Armacell on to continuously improve the environmental performance of our products. For example, Armaflex Ultima achieves the highest fire classifications without the use of brominated flame retardants and is also free of PVC.



YOU CAN DOWNLOAD THE ARMAFLEX ULTIMA EPD AND FACT SHEETS FOR BREEAM, LEED, DGNB AND HQE AT WWW.ARMACELL.COM/EPD

ARMA-CHEK SILVER

Arma-Chek Silver is the high performance AF/Armaflex insulation combined with a UV resistant aluminium finish for indoor and outdoor installations. The UV-resistance of Arma-Chek Silver is weather tested according to ISO 4892, with the samples exposed to simulated weather for at least 15,000 hours, which equals an estimated 15 years of outdoor application.

Also, unlike traditional metal cladding, Arma-Chek Silver recovers to its original shape after pressure is exerted on to the surface. This property prevents lasting dents and ensures a durable installation.

As a pre-covered system with self-seal closure, Arma-Chek Silver saves installation time compared with traditional cladding with elbows and T-pieces offering you additional installation time savings. The pre-formed parts match the Armaflex tubes for a complete system. Watch the Arma-Check Silver video on youtube to see the difference!

ARMAFLEX TUFFCOAT

The Tuffcoat flexible polymeric covering available from Armacell is pre-applied onto AF/Armaflex Class 0 tubes and sheet to provide additional protection against mechanical impact. Tuffcoat is UV resistant for use outdoors and is also suitable for use on underground pipework, including mains cold water and ground source heat pump pipes.

Offering the long-term energy saving and condensation control benefits of AF/Armaflex Class 0 insulation, Tuffcoat is wash-down waterproof and easy to clean, with added Microban® antimicrobial protection making it ideal for food manufacturing, hospital and school applications.

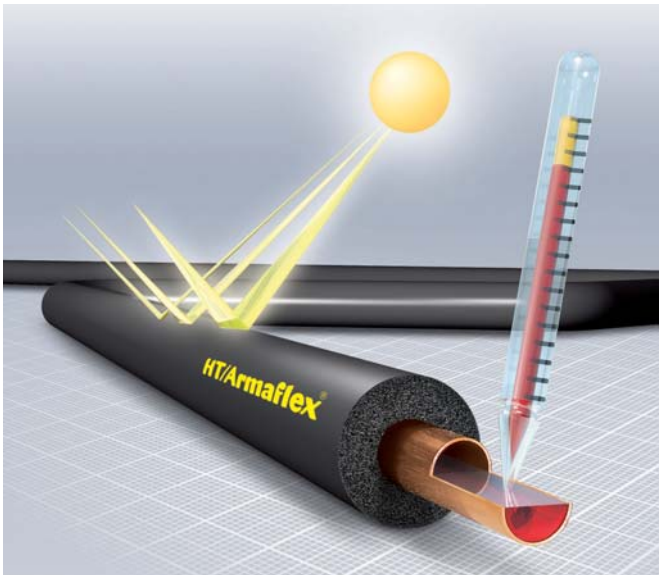
Available in a black or white PVC covering (other colours available on request) Armaflex Tuffcoat tubes are supplied in 1m lengths with a self-seal section on the outer covering to provide an overlap join on the Armaflex tube.

For outside applications no additional painting is necessary and protection against bird or rodent damage is provided.

HT/ARMAFLEX

HT/Armaflex is a flexible, closed cell EPDM rubber insulation material with resistance to UV radiation for thermal insulation of pipes, vessels, ducts and solar panels, motor vehicles, hot gas lines, steam and dual temperature lines.

HT/Armaflex is suitable for applications up to 150 °C with a thermal conductivity value 0.042 W/(m•K) @40 °C.



NH/ARMAFLEX

NH/Armaflex is a halogen free, flexible closed-cell insulation material with certification for use in marine environments, data centres, rail and military sectors.

The minimal amounts of smoke and acid gas emitted in the event of a fire make it suitable for use in marine and transport applications, clean rooms and server rooms.

- Zero halogens (chloride, bromide) acc. to DIN / VDE 0472, part 815. Fulfills DIN 1988 Parts 2 and 7. Safety and Environment
- ODP zero GWP zero
- Reduced toxicity and corrosive effects on people and equipment
- Prevents stress corrosion cracking of stainless steel
- Fibre dust free material with low thermal conductivity: λ0 °C ⩽ 0.040 W/(m•K)
- Excellent protection against water vapour diffusion
- IMO certified, UL and FM-approved

ARMAFLEX DUCT

Armaflex Duct Alu is a black, closed-cell insulation material with a bright silver foil finish especially produced for thermal and acoustic insulation of air-conditioning ducts.

Armaflex Duct insulation reduces heat losses and the closed-cell structure prevents water vapour transmission, thus avoiding the risk of corrosion on ductwork.

The flexible sheet is available with self-adhesive backing for insulation of rectangular and cylindrical air ducts:

- Prevents condensation with closed cell structure to prevent water vapour transmission
- Structure-borne noise control
- 1.5m wide sheet size manufactured to fit ducting segments
- Easy to install and repair
- Dust & fibre free
- Smooth surface for easy cleaning and aesthetic finish

ARMACOMFORT AB ALU

A comfortable maximum noise level for a hotel or apartment bedroom is 40 db (A). A PVC drain pipe with a flow rate of 2 l/s of water will emit 57 db (A) into the room, causing an unwanted disturbance to neighbouring rooms and occupants.

For this application Armacell has introduced the product ArmaComfort® AB Alu, especially designed to provide absorption and damping performance and reduce the noise from drainage and waste water pipes in large apartment and residential buildings, offices, hotels, hospitals, schools and private homes.

The ArmaComfort® AB Alu sheet combines excellent acoustic performance with a B-s1, d0 fire performance suitable for commercial buildings:

- Weighted sound reduction index (Rw) up to 28 dB when pipe and elbows are insulated
- Multilayer product consisting of a 2mm thick, foil faced acoustic EPDM-EVA barrier with 4 kg/m^2 weight and a 10mm polyurethane foam layer for decoupling
- The aluminium foil is pressure bonded to the decoupling foam
- Excellent durability on cast iron and plastic rain water and waste water drainage pipes
- Minimal space required and highly flexible for ease of installation
- Application guide and cutting templates available at www.armacell.co.uk

Surfaces within enclosures where drainage pipes are located must have a Class 0 or Euroclass B rating and the casing to the enclosure requires a minimum of 30 minutes fire resistance.

The superior fire performance (B-s1,d0) meets these requirements and the material is highly flexible for ease of installation. For more information on the Part B building regulation requirements for insulation of drainage pipe enclosures please see page 53.

Watch the new ArmaComfort video on youtube to find out more.

ARMAFLEX PROTECT

Armaflex Protect tubes and sheet provide a flexible fire seal and insulation for non-combustible, combustible and pipes containing combustible medium for use through fire-resistant walls and ceilings (R30 to R 120).

The Armaflex Protect insulation provides an R-120 fire protection barrier for heating, plumbing and refrigeration of non combustible pipes up to 323 mm diameter and combustible pipes up to 75 mm.

Armaflex Protect fulfils the fire protection requirements irrespective of adjoining insulation to offer:

- One solution for hot and cold applications
- Suitable for steel, copper and plastic pipes
- Covers rigid-walls, ceilings and light-walls
- Quick and easy installation
- Up to 120 minutes fire resistance according to EN13501
- Compatible with all Armaflex insulation products
- Provides structure borne noise reduction
- Installation training available from Armacell

ARMAPROTECT 1000

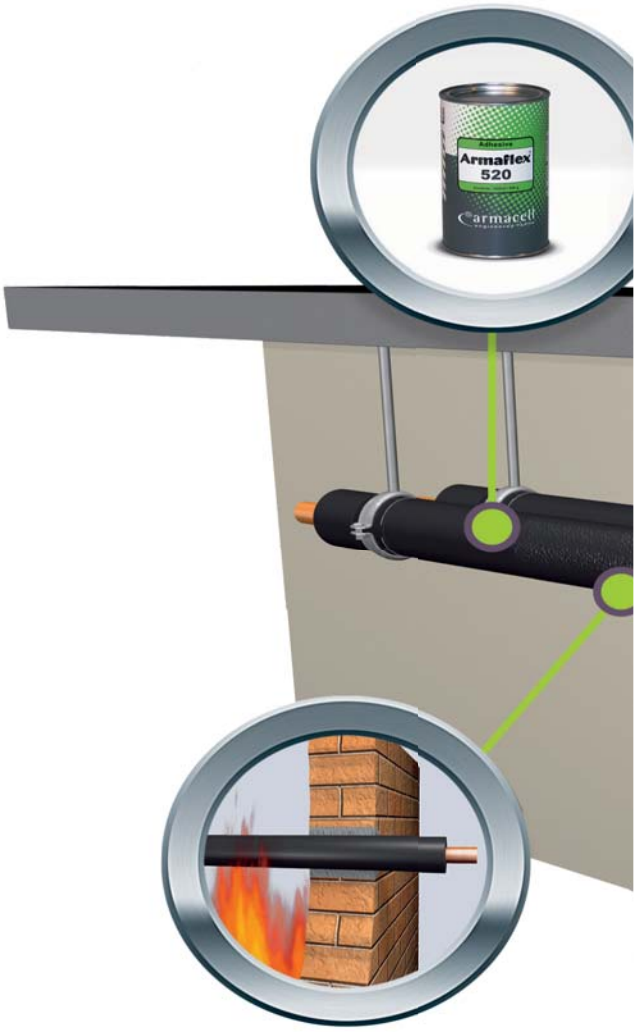
Armaprotect 1000 Firestop Filler is a practical, ready-to-use, mortar with excellent fire-protection, thermal insulation and noise control properties.

It is self-hardening and very easy to apply by hand.

For use to seal around gaps, with no formwork required and easy to apply in tight spaces.

ARMAFLEX ADHESIVES & TAPES

A full range of contact adhesives and tapes for compatibility with all types of Armaflex, including specially formulated adhesives for sealing Armaflex Ultima and HT/ Armaflex and reduced solvent, non-drip RS 850 Adhesive for working at height or in confined spaces.



ARMAFIX PIPE SUPPORTS

Available to match AF/Armaflex, Armaflex Ultima, NH/Armaflex and as a low cost solution (Armafix X) Armafix pipe supports provide Euroclass B-s3, d0 and high resistance to water vapour transmission (μ 10.000)

- Now with 100% recycled ArmaFORM PET inserts with closed cell comb structure for improved load bearing capacity
- Built-in vapour barrier prevents thermal bridging and reduces risk of condensation
- Easy installation thanks to self-adhesive closure

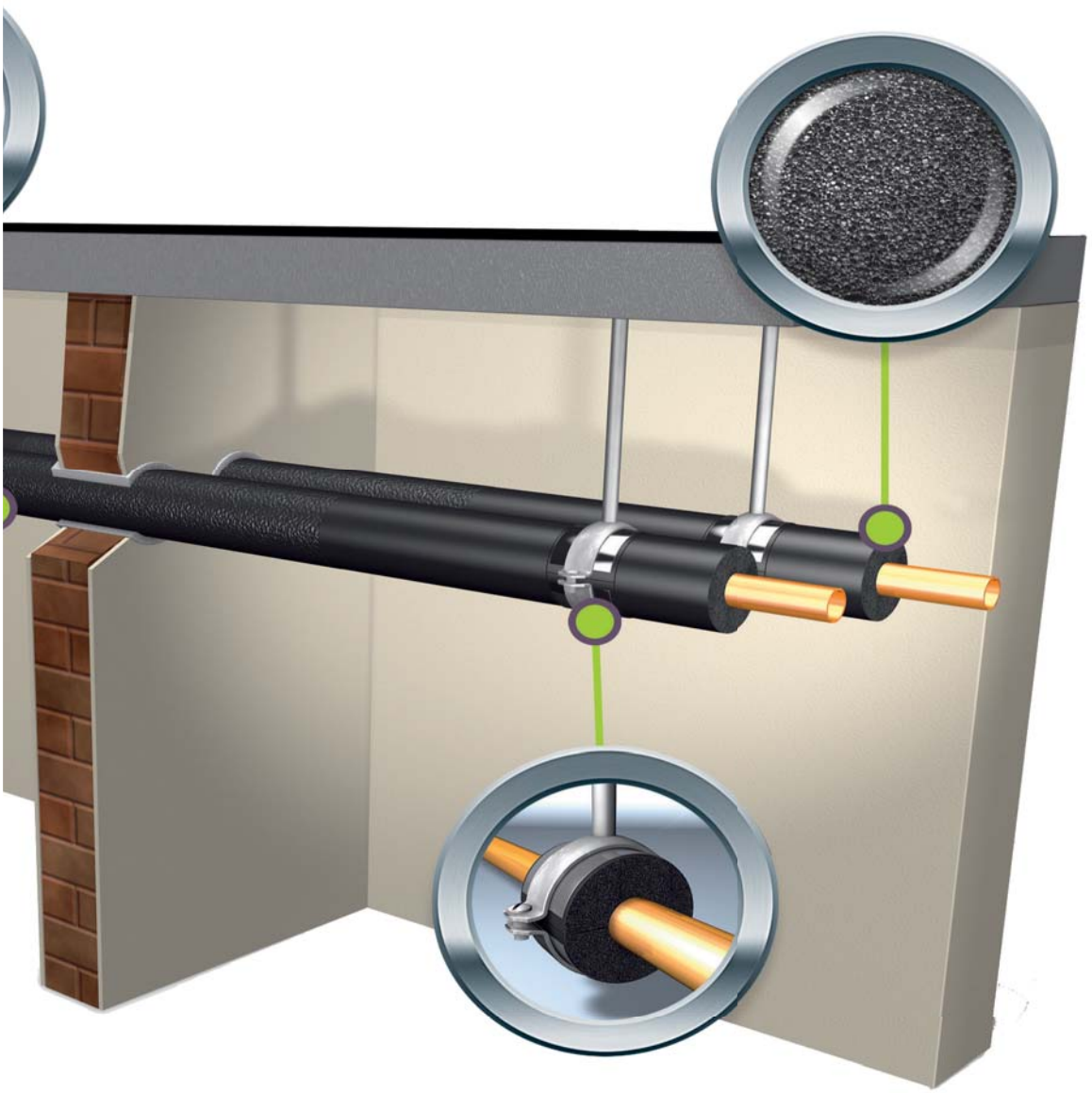
Armafix supports thermally isolate the pipe and bracket and when used as part of a system with Armaflex tubes or sheet, provide long-term reliability for cold applications. With its closed cell structure acting as a built-in water vapour barrier and self-adhesive tape to secure the seams on both sides, thermal bridging and condensation are prevented to ensure energy is not lost at fixings points. Armafix has a quick and easy three step installation process to achieve a professional result whilst also saving time and money.

COMBI-PACK

The Armafix pipe supports are also available in convenient combination packs, including pipe supports with matching clamps.

DUCT SUPPORT

Armafix AF duct supports are available to thermally decouple duct work from hanging brackets. The supports are 2 metres long, providing a tailored solution for duct sizes.



HVAC-R Pipe Insulation Comparison	Armaflex Nitrile Rubber
Thermal Conductivity	0.033 w/(m • K) @ 0 °C = AF/Armaflex Class 0
Mu Value (Water Vapour Transmission)	10,000 μ = AF/Armaflex Class 0
Fire Performance	B-s1 d0 / Class 0 = Armaflex Ultima
Installation Considerations	Dust & fibre free, no PPE required
Maximum service temperature	AF/Armaflex Class 0 = +110 °C or HT/Armaflex +150 °C
Minimum service temperature	-50 °C
External Water Vapour Barrier	Not required
Green Guide Rating	A
EPD Certification	According to ISO 14025 and EN 15804. Tier 2, earns point uplift of 0.75 in Green Guide
Acoustic Performance	Sound Absorption
BIM Objects Available	Yes
CPD Presentations	Yes - CIBSE Approved
Loyalty Rewards	Armacell Premium
Pipe Insulation Calculation Tool / App	ArmWin
Dedicated Technical Support	Yes
Easy to vapour seal material to prevent gaps	Yes
Formaldehyde free	Yes
Flexible products for fabricating valve and elbow covers and fittings	Yes
Compatible pipe supports available	Yes

Phenolic (based on declared values)	Mineral Wool (based on declared values)
0.025 w/(m • K) @ 10 °C	0.034 w/(m • K) @ 10 °C
Not stated	Not stated
B-s1 do / Class 0	A2-s1, d0
PPE recommended	PPE recommended
110 °C	250 °C
-50 °C	0 °C, not advised below ambient
Foil faced external vapour barrier - required for condensation	Foil facing, not suitable for cold services
A	Not published
No	No
Not stated	Sound Absorption
Yes	Yes
Yes	Yes
No	No
No	No
Yes	Yes
No	No
No	May be used in binder
No	No
Yes	No

Key Technical Considerations

WHY INSULATE?

Inadequate insulation is a leading cause of energy waste. Insulation also protects pipework and systems, increasing its efficiency & lifespan.

Insulating mechanical services is important for a number of reasons:

- Energy & cost saving
- Condensation control
- Frost protection
- Personnel protection
- Noise reduction

In many situations, a substantial amount of the cost of insulation can be repaid within three months, with a small outlay required by the beneficiary of the insulation.

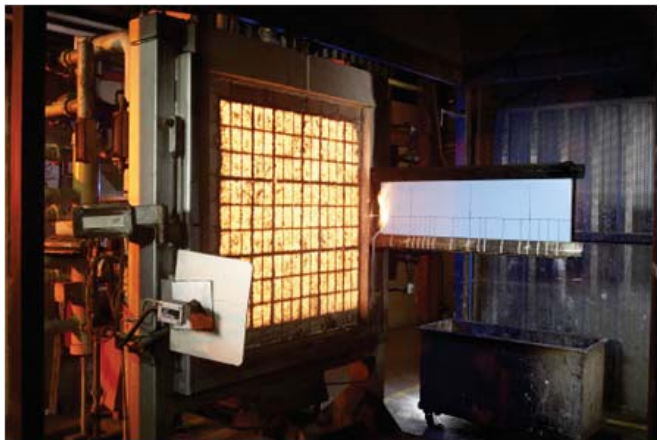
In addition, from the time the insulation cost has been recovered the savings continues, adding to profits at the same rate, year after year, for the lifetime of the insulation.

BUILDING REGULATIONS & CLASS 0 FIRE PERFORMANCE

Thermoplastics, such as Tubolit, consist of threadlike or cross-linked macromolecules. Under the influence of heat, they soften and become pliable at which point they can be formed into any desired shape. Depending on their chemical structure, they burn with differing intensity, smoke emission and formation of residue. The melting temperature is approximately 100 °C.

Elastomers, such as Armaflex, are characterised by high elasticity in a broad temperature range. The molecular structure of elastomers resembles a three-dimensional, meshed network.

Like all organic insulation materials, elastomeric foams are combustible. However, Armaflex achieves a good fire performance in order to meet building regulations. Due to the three-dimensional structure of their molecules they do not drip in practical fire conditions; so it is possible to rule out the possibility of fire spreading by these means.



Moreover, the material is self-extinguishing and does not propagate fire horizontally or vertically. There is also no possibility of the material self-combusting.

UK National Fire Classifications

The UK fire ratings are determined by the BS 476 fire testing standards:

- **BS 476 Part 7: Surface Spread of Flame**
  This test classifies a material as being Class 1, 2, 3 or 4 depending on the results of the test

- **BS 476 Part 6: Fire Propagation**
  This test determines whether a rating of Class 0 is achieved for a material. The material must first have been tested to BS 476 Part 7 and achieved a rating of Class 1 before it can be tested to Class 0

Each nation sets its own regulations and fire performance criteria for construction products. For the UK and Ireland the following documents give the requirements for fire safety:

National Building Regulation	Building Regulation Document
England The Building Regulations 2010	Approved Document Part B - Fire Safety
Wales The Building Regulations 2010	Approved Document Part B - Fire Safety
Scotland Building (Scotland) Regulations 2004	Technical Handbook Section 2 - Fire
Northern Ireland Building Regulations (Northern Ireland) 2004	Technical Booklet E - Fire Safety
Ireland Building Regulations 1997-2014	Technical Guidance Document B - Fire Safety

Traditionally the UK has determined the fire performance of construction products according to the British Standards BS 476 series, with a Class 0 fire rating the required level for non-domestic projects. However, the introduction of CE marking for building materials has brought new fire classifications under EN 13501-1.

Currently it is possible to demonstrate performance against either the National or European standards. Each fire document of the UK & Ireland Building Regulations now references the National classes and European classes as a means of compliance for fire ratings. So as per table 10 below from Approved Document B, where a Class 0 requirement is needed a Euroclass B would also be suitable.

Table 10 Classification of linings

Location	National Class (1)	European Class (1) (2)
"Small rooms with area no more than: a. 4m2 in residential accomodation b. 30m2 in non-residential accommodation."	3	D-s3, d2
Other rooms (including garages)	1	C-s3,d2
Circulation spaces within dwellings	1	C-s3, d2
Other circulation spaces, including the common areas of blocks of flats	0	B-s3, d0

Notes:

1. The National classifications do not automatically equate with the equivalent classifications in the European column, therefore, products cannot typically assume a European class, unless they have been tested accordingly.
2. When a classification includes 's3, d2', this means that there is no limit set for smoke production and/or flaming droplets/particles.

Characteristic parameters for the behaviour of construction products

EUROCLASS FIRE RATINGS

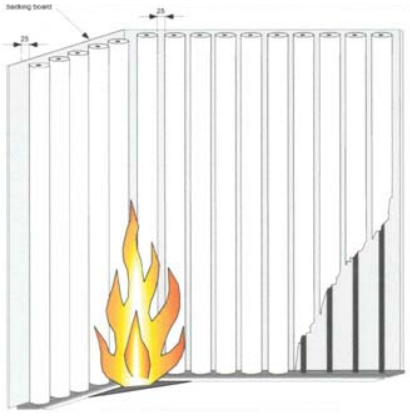
The fire safety of construction products in the EU is determined by the Euroclasses according to the EN 13501-1 standard.

The main properties determining the Euroclass for a specific product discloses if and how fast a product contributes to the fire.

The European system is similar to the national classification, but also measures smoke production and flaming droplets. The products are classified as A1, A2, B, C, D, E or F (with A1 being the highest).

A1 and A2 are considered to be non-combustible or limited combustibility, generally for inorganic materials such as mineral wool and foamed glass insulation.

Since Armaflex is produced from organic material, the highest rating possible is Bs1, s2 or s3 (with s1 being minimal smoke production) and flaming droplets are classified as d0, d1 or d2 (d0 being zero flaming droplets). For example the fire classification of Armaflex Ultima is Bs1-d0 for minimal smoke development and zero flaming droplets.



National Class	National Test Standard	Euroclass	European Test Standard
Non-Combustible	BS 476:Part 4	A1	EN ISO 1182 & EN ISO 1716
Limited Combustibility	BS 476:Part 11	A2	"EN ISO 1182 or EN ISO 1716 & EN 13823"
Class 0	BS 476: Part 6 & 7	B	EN 13823 &EN 11925-2
Class 1&2	BS 476: Part 7	C	EN 13823 &EN 11925-2
Class 3	BS 476: Part 7	D	EN 13823 &EN 11925-2
Class 4	BS 476: Part 7	E	EN 11925-2
Unclassifiable	No Test	F	No performance determined

FIRE RESISTANCE

As pipes and ducts pass through fire rated walls or floors they provide an opening, which can then be a weakness when preventing the passage of fire from one compartment to another.

Therefore, any pipes and ducts that penetrate the wall / floor require insulation products that meet the same level of fire resistance. Fire resistance means that structural elements such as wall or flooring elements can withstand a fully developed fire and fulfil requirements of insulation, integrity and/or load bearing capacity. The fire resistance rating is given as a time in minutes, i.e a rating of R90 would provide 90 minutes fire resistance.

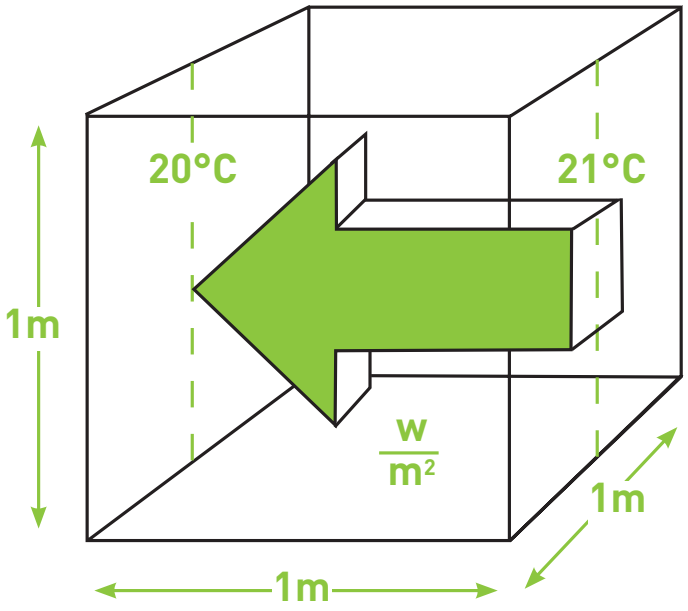
In circumstances where pipes or ducts penetrate through a fire rated wall or floor Armaflex Protect should be installed at the section where it passes through. Armaflex Protect provides a fire resistance of R120 for up to 120 minutes.

THERMAL CONDUCTIVITY

Thermal conductivity is the heat in joules which, per unit of time, flows through $1m^3$ of a material (heat flow density) when the temperature difference is 1 K.

Thermal conductivity is a key characteristic of insulation. Thermal conductivity is a material property representing the ability of the material to conduct heat.

Since it is a material property it is not based on thickness, however thermal conductivity values can be used to calculate thickness requirements. Put simply materials with low thermal conductivities have a high thermal resistance and are therefore good insulators.

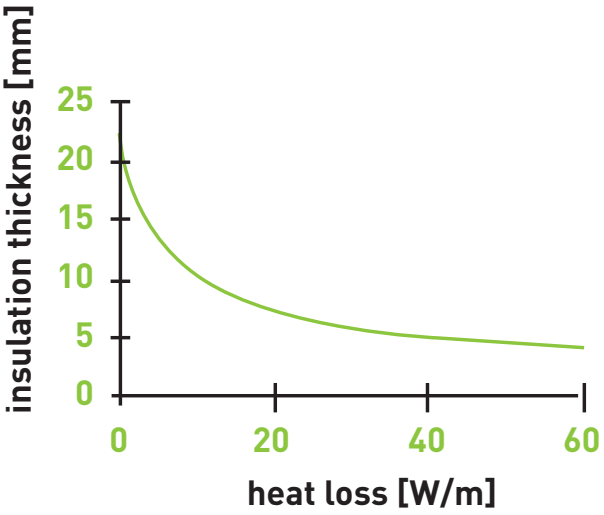


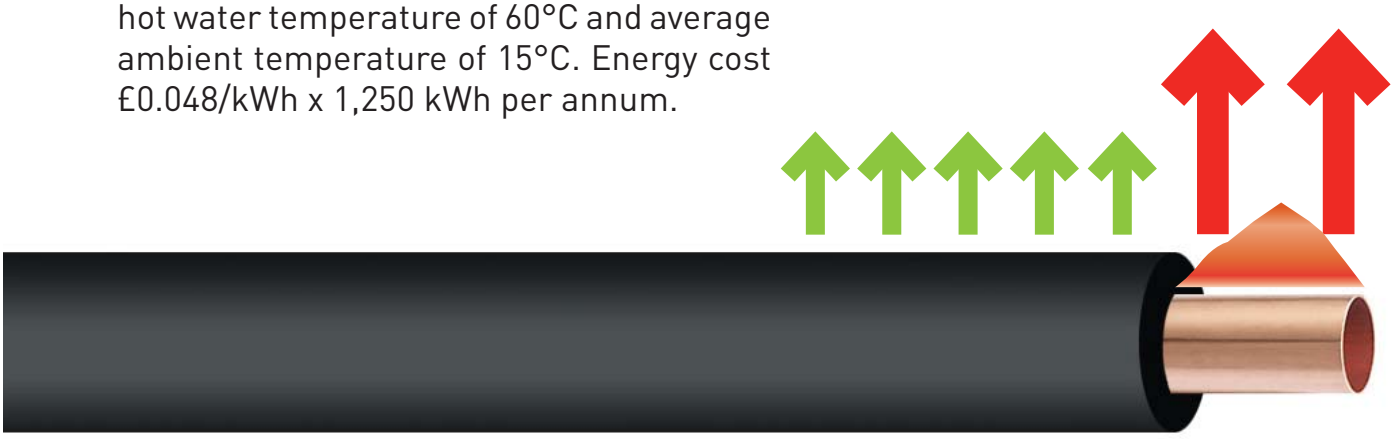
HEAT LOSSES

If left un-insulated, heating system pipework can lose a vast amount of heat and energy over its lifespan.

Installing pipe insulation is therefore a key method in getting quick and easy energy savings with a rapid payback.

A typical 3 bedroom household saving is estimated at £60 per year on pipe insulation alone - based on 100m of 15mm pipework insulated with 19mm thick Armaflex tube, hot water temperature of 60°C and average ambient temperature of 15°C. Energy cost £0.048/kWh x 1,250 kWh per annum.

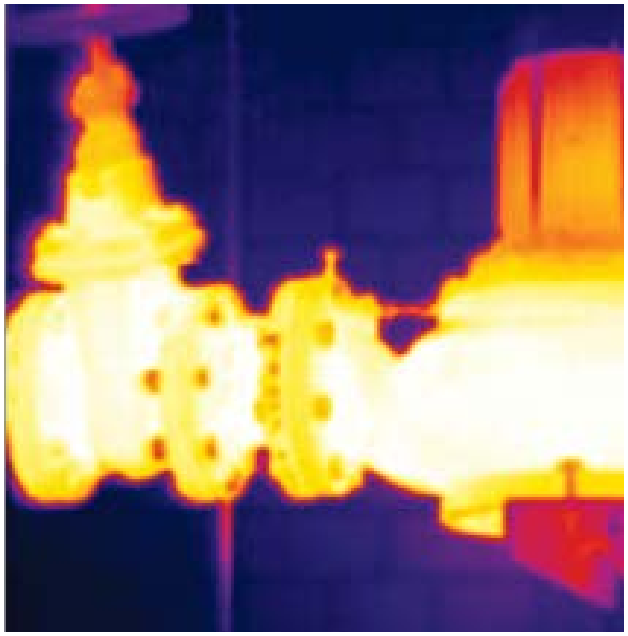




INSULATING VALVES, FITTINGS & SUPPORTS

Valves and fittings can often be left un-insulated due to the complexity of installing insulation. Leaving these un-insulated can account for 30% of the heat lost from the system.

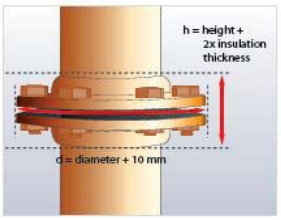
However, this needn't be the case with Armaflex since it is flexible and easy to install. The Armaflex application guide (available in the download section of www.armacell.co.uk) provides all the patterns required to insulate different types of valves, flanges and fittings.



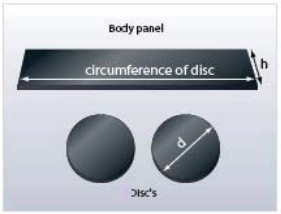
Flange boxes

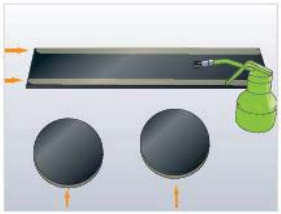
The following section shows the installation techniques for insulating flanges.

In chilled-water or refrigeration applications it is advisable to pack the gaps between the nuts with strips of Armaflex insulation.



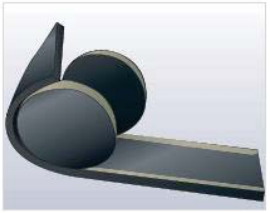
Using a pair of callipers, determine the diameter of the flange face. Add 10 mm to this measurement. Measure the length of the flange (incl. bolts) and add 2x the insulation thickness of the sheet used.

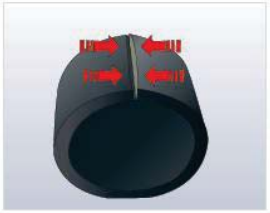




Transfer these measurements to a piece of Armaflex sheet. Mark two concentric circles with dividers. Repeat on a second piece of sheet. Cut out two Armaflex discs.

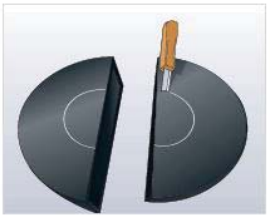
Determine the circumference of the disc.





Roll the body panel up and around the end discs, do not stretch during application. Check alignment throughout.

Place the edge to the edge of the adjoining seam opposite.



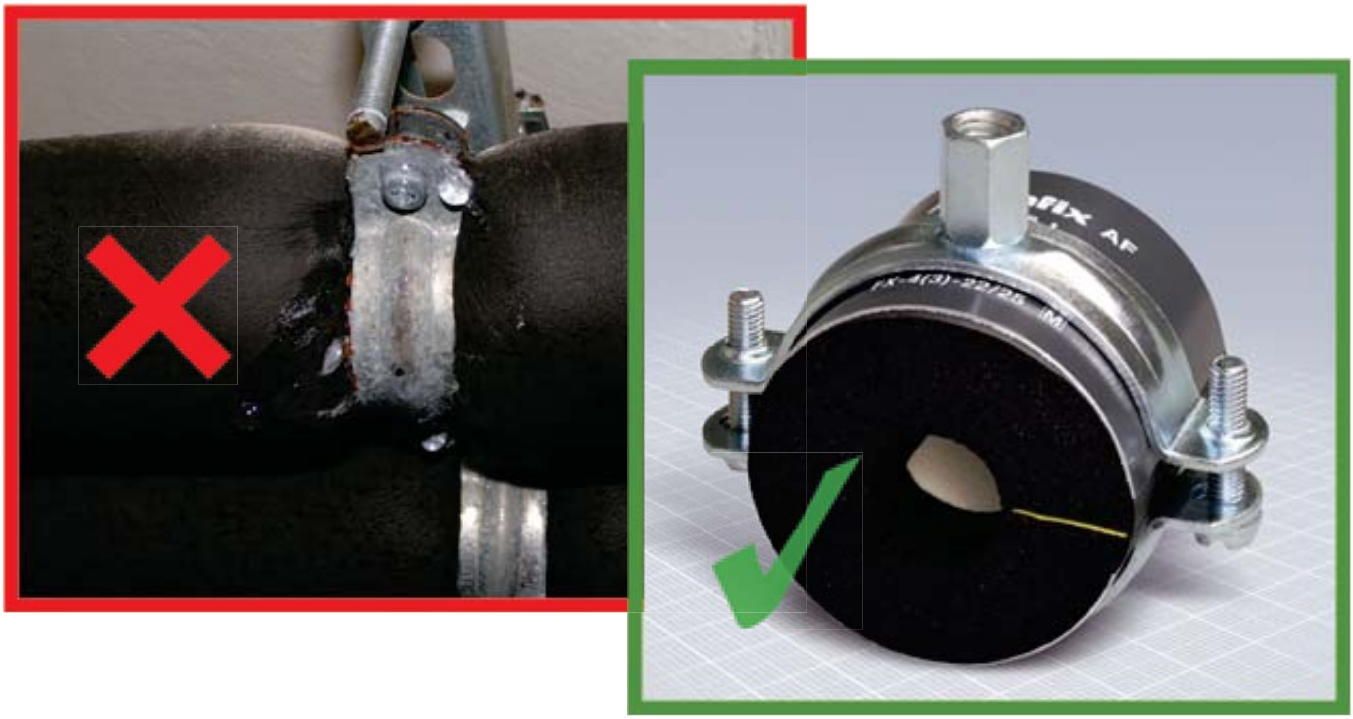
Using a small sharp knife cut out the insulated pipe diameter.

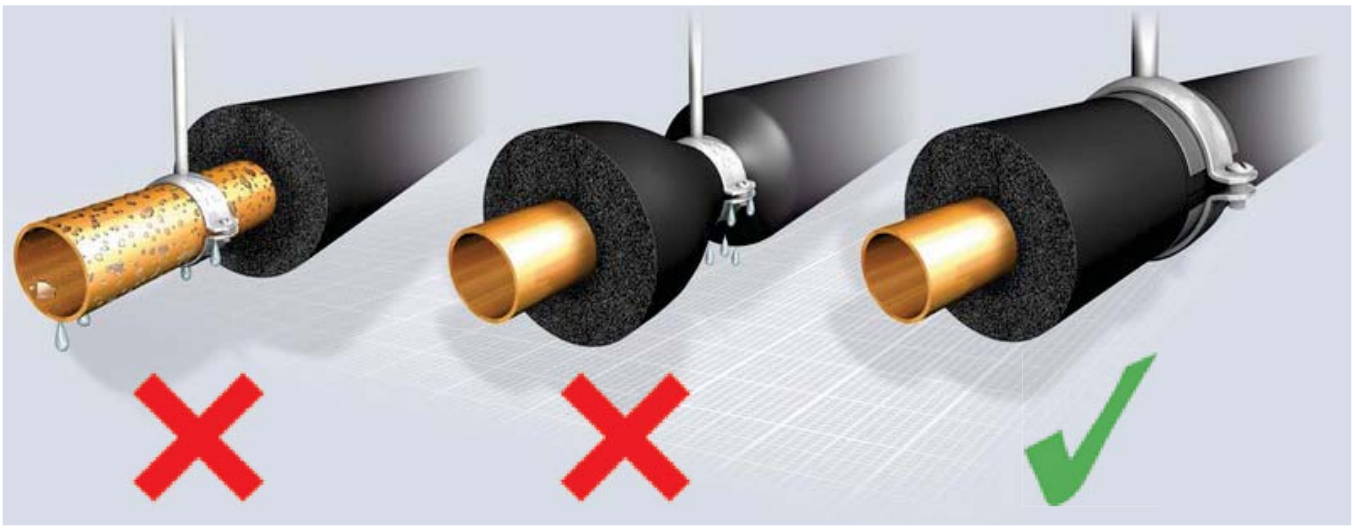
To finish fit the two halves of the flange box around the flange and wet seal all seams and joints to the insulated pipe branch.

PIPE SUPPORTS

Pipe supports can be a weak point when insulating HVAC-R systems. They create a thermal bridge, which can mean unnecessary heat losses on hot applications.

On cold applications the issue of un-insulated pipe supports leads to secondary damage. If the support is attached directly to the pipe rather than using an insulated support (such as Armafix AF or Armafix X) then condensation problems will arise. BS 5970 guidance recommends the use of insulated pipe supports of the same thickness as adjoining insulation on all refrigeration, chilled and cold water pipework due to the condensation risk.





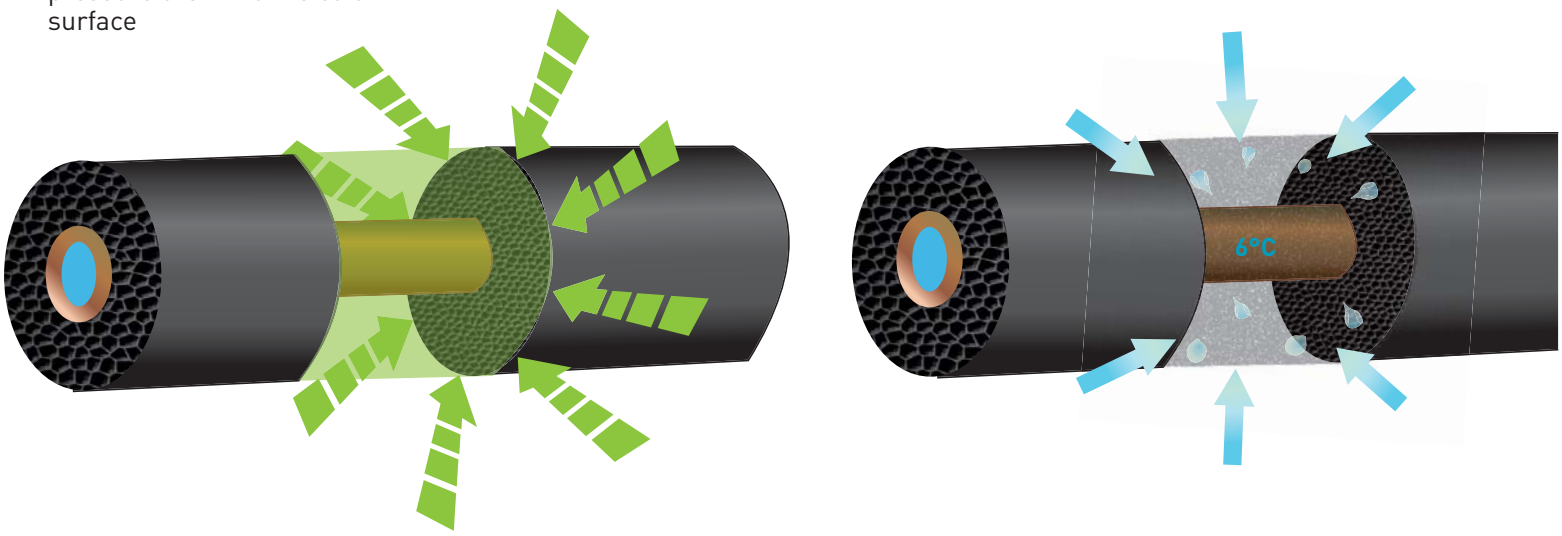
MOISTURE RESISTANCE

The most important task of low-temperature insulation is to prevent condensation, since with every volume percentage increase in moisture content the thermal conductivity and insulation effect deteriorates. A reliable insulation system must therefore protect against water ingress and keep diffusion processes to a minimum.

The amount of moisture which is able to penetrate the insulation as a result of vapour diffusion depends on the water vapour diffusion resistance (μ-factor) an insulation material has. The lower the μ-factor of an insulation material, the more the moisture content – and therefore the energy losses – will increase over the years. Moisture in the insulation can also lead to issues of pipework corrosion.
It is essential to bear this in mind when selecting an insulation material.

Armaflex materials with a high resistance to diffusion and high flexibility reduce the risks of moisture penetration when compared to other materials. The resistance to diffusion is not applied in a thin (and therefore easily damaged) layer, but built up continuously – cell for cell – throughout the entire thickness of the material. Furthermore, all shaped and straight parts of the installation can be insulated in a form-fitting manner. Gap-free insulation of all installations and careful bonding of all seams and butt joints guarantees that the required resistance to vapour diffusion is achieved through-out the system.

Interstitial water vapour pressure drawn to the cold surface

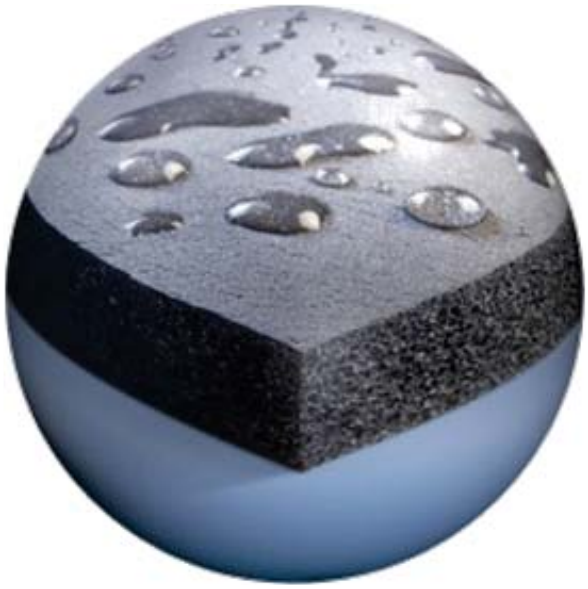


The water vapour diffusion resistance factor (μ) indicates how many times larger the resistance of a material to water vapour diffusion is than that of a stationary layer of air of equal thickness at the same temperature and μ is without dimension.

Technical insulation with high μ-value reduces the possibility of moisture penetration into insulation and decreases the change in thermal conductivity value.

Water Vapour Diffusion Resistance (μ)
Solving the problem with Armaflex:

- Considerably improved reliability is achieved if a highly flexible, closed-cell insulation material with a high water vapour diffusion resistance throughout the insulation thickness is used
- The vapour barrier is not concentrated on a thin (sensitive and relatively inflexible) foil, but is built up over the entire insulation thickness
- The resistance to water vapour diffusion permanently reduces diffusion phenomena to a minimum. A separate vapour barrier is unnecessary
- The highly flexible foam fits around even the most complicated of objects, and it can be bonded over the entire insulation thickness at critical points (e.g. penetrations, junctions, etc. where there could be a weakness for moisture ingress)
- The insulation maintains thermal performance over time



AF/Armaflex insulation inspected after 20 years with μ and λ values preserved

CONDENSATION CONTROL

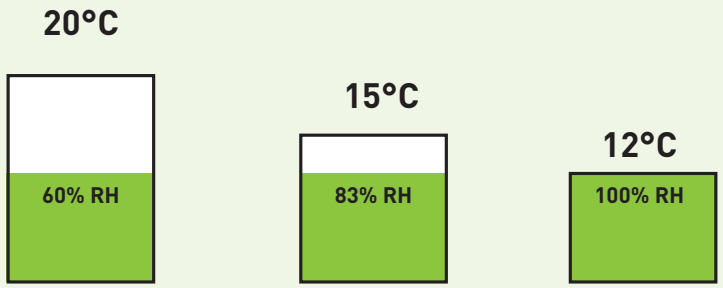
Services operating below ambient temperatures experience problems from water vapour condensing on the surface of the insulation or on the pipework, leading to corrosion issues and water damage.

Armaflex is perfectly suited to refrigeration and cold applications since the closed cell structure provides an integral vapour barrier against moisture ingress.

Armaflex does not require any additional vapour barrier and due to its:

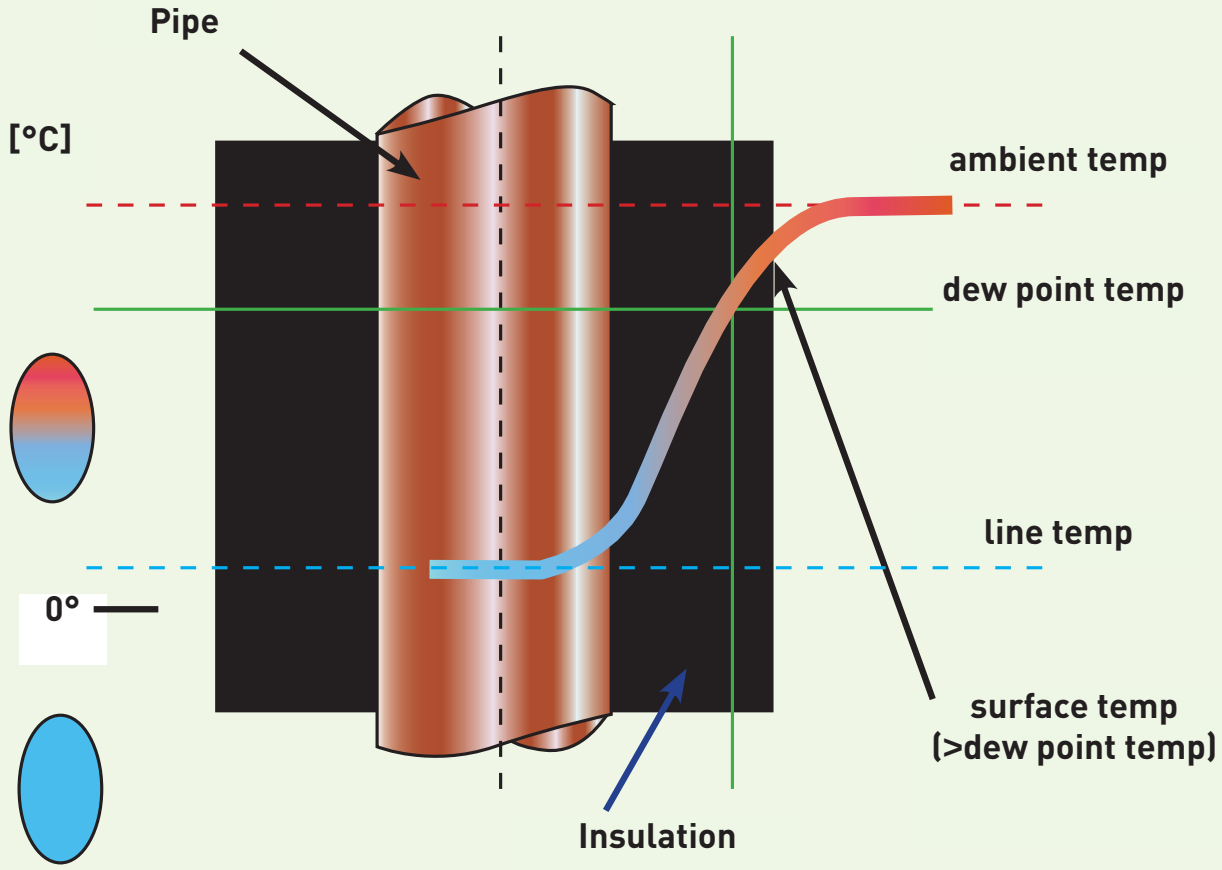
- Low thermal conductivity
- High water vapour resistance (μ-value)
- High emissivity outer surface
- Easy to seal joints and seams
- Compatible range of Armafix pipe supports

Effects of cooling air on temperature and relative humidity

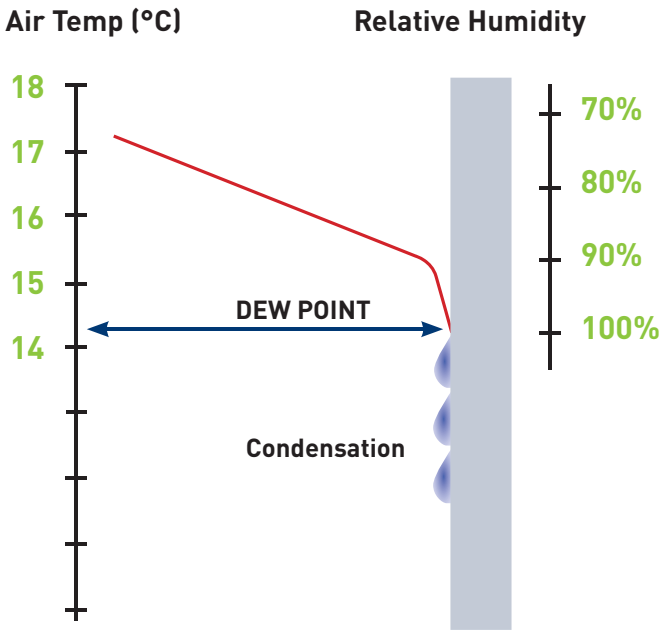


TEMPERATURE (0C)	WATER VAPOUR (g/kg dry air)	RELATIVE HUMIDITY
20	8.7	60%
15	8.7	83%
12	8.7	100%

The insulation surface must be above the dew point temperature to prevent condensation:



SURFACE CONDENSATION



Air is a mixture of various gases and in general air always also contains water in its gaseous form. This water vapour is "invisible". At a certain temperature and a certain relative humidity the air can absorb a defined amount of water vapour.

Normally air only contains a certain percentage of the maximum possible moisture and this is stated as the relative humidity.

The amount of water vapour that air can hold depends on the temperature. Warm air can absorb more water vapour than cold air. As the temperature drops, the relative humidity rises.

If air is continually cooled, at a certain temperature it will be 100% saturated with water vapour. This temperature is known as the dew point and is when condensation occurs.

Where pipes operate at below-ambient temperatures water vapour can condense on the surface. This moisture is known to contribute towards many different types of corrosion so preventing the formation of condensation on pipework is a key consideration.

To prevent condensation, the insulation thicknesses used on cold pipes must be sufficient to ensure that the temperature on the surface of the insulation material never falls below the dew point.

The most important tasks of low-temperature insulation are to prevent condensation and minimise energy losses over the entire service life of an installation.

When selecting and determining the thickness for low-temperature insulation, it is necessary to bear in mind that over the service life energy losses can increase dramatically as a result of moisture penetration.

A reliable insulation system must therefore provide protection against inadmissible moisture penetration. With every % volume increase of moisture content the thermal conductivity increases and the insulation effect deteriorates. The results are not only higher energy losses but also a drop in the surface temperature. If this falls below the dew-point temperature, condensation occurs. It is only possible to guarantee that the surface temperature remains above the dew point even after many years of operation, if the thermal conductivity of the insulation material does not increase significantly as a result of moisture penetration

Follow-up costs can be:

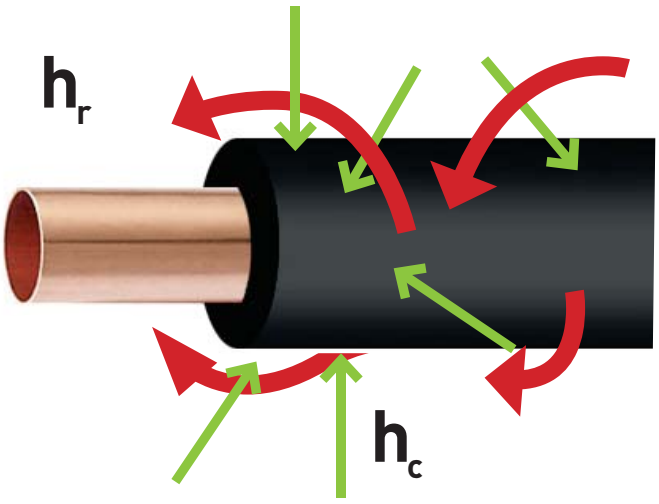
- Expense of repairing damage
- Wet ceilings
- Spoilt goods
- Disruptions to production processes
- Rise of energy losses due to wet insulation
- Removal of corrosion

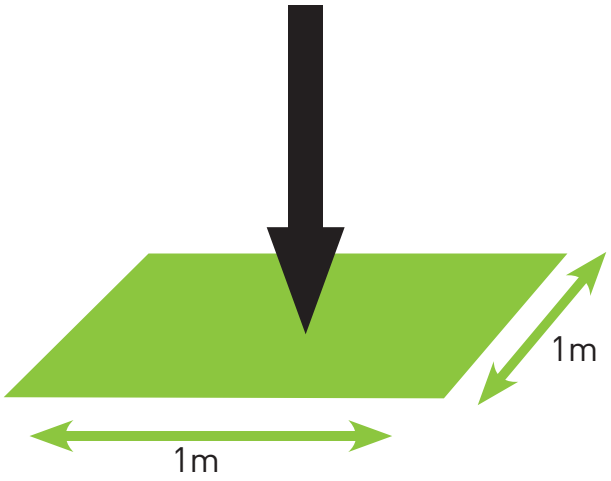
OUTER SURFACE TEMPERATURE OF INSULATION ≥ **DEW POINT TEMPERATURE**

SURFACE COEFFICIENT OF HEAT TRANSFER AND EMISSIVITY

The surface coefficient of heat transfer (h) is the heat flow in W between 1 m² of surface and the surrounding medium when the temperature difference in the direction of heat flow is 1 K. The surface coefficient of heat transfer comprises two elements:

- hcv = heat transfer through convection
- hr = heat transfer through radiation





$$h = h_r + h_{cv} \quad [w/m^2K]$$

The surface coefficient refers to the reflectance of the insulation surface. A reflective finish, such as alu foil gives a low emissivity whereas a black finish, such as Armaflex, is known to be a high surface coefficient / high emissivity surface.

The reflectance of the insulation surface has an effect on the thermal performance, a low emissivity surface can provide an additional 10% energy saving. But on cold services it is beneficial to have a black, high emissivity surface in order to keep the surface of the insulation above the dew point.

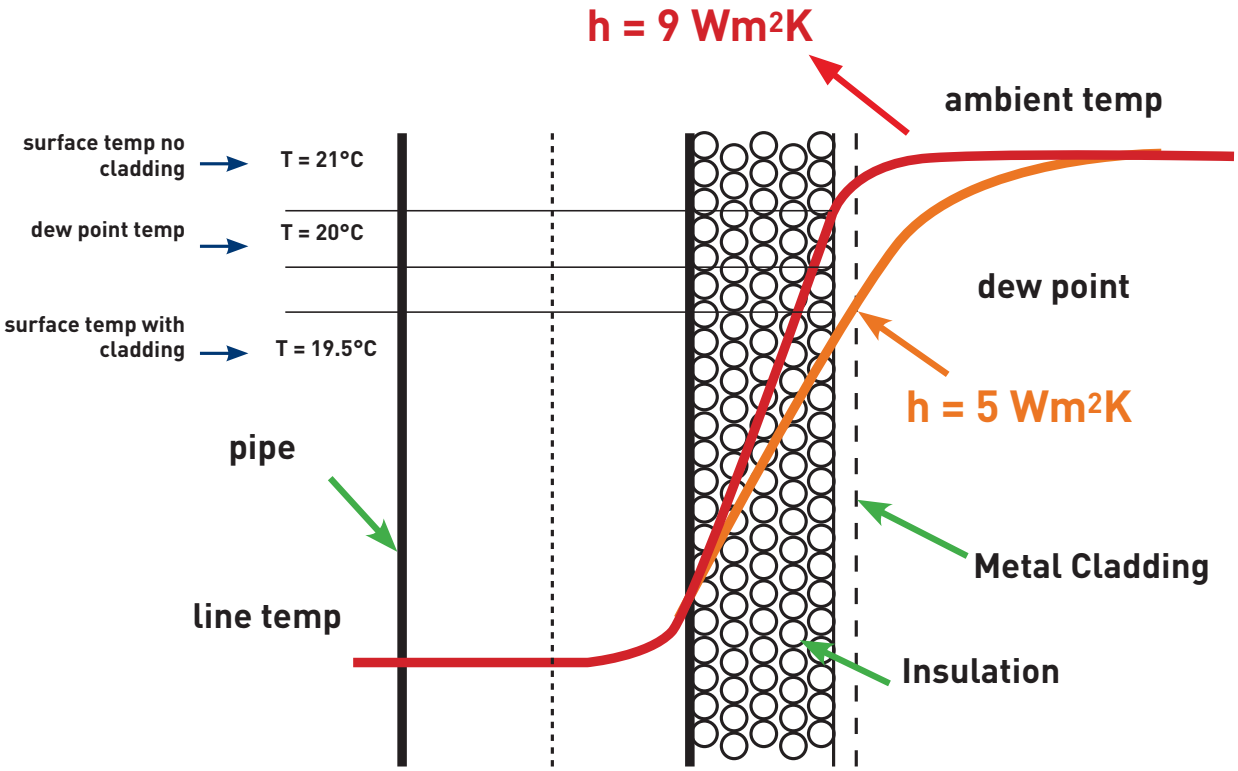
9 $\frac{w}{m^2K}$ 7 $\frac{w}{m^2K}$ 5 $\frac{w}{m^2K}$

The table below shows the effect the surface coefficient of heat transfer has on the thickness required to prevent condensation.

In this case a high surface coefficient (black Armaflex at 9 W/m²K) requires almost half the insulation thickness of a low surface coefficient (metallic cladding at 5 W/m²K) because the surface temperature remains above the dew point.

Relative humidity	Surface coefficient of heat transfer (W/m2K)		
	9	7	5
55%	Min. 3.6mm	Min. 4.7mm	Min. 6.5mm
65%	Min. 6.6mm	Min. 8.4mm	Min. 11.8mm
75%	Min. 11.7mm	Min. 15.1mm	Min. 21.1mm

6°C line temperature
24°C ambient temperature
Based on a flat surface



ENVIRONMENTAL CONSIDERATIONS

⅓ CO2 EMISSIONS

40% ENERGY USE

25% WATER CONSUPTION

40% USE OF NATURAL RESSOURCES

60% OF ELECTRICITY USE consumed in residential and commercial buildings

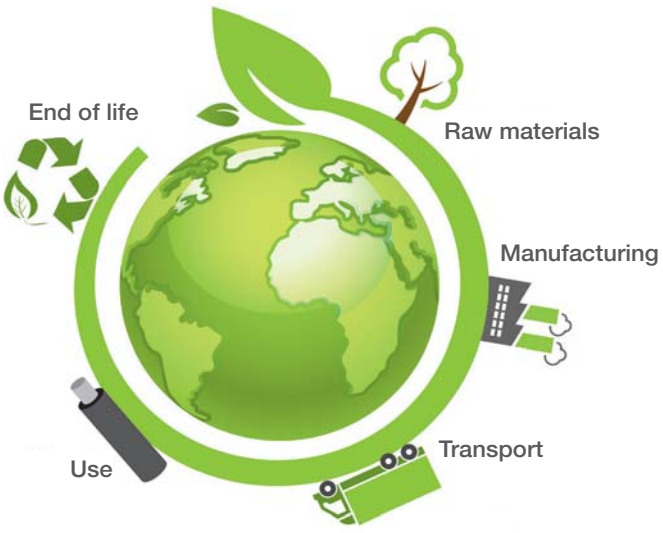
Construction is one of the most raw-material and energy-intensive industries. The building sector is the single largest consumer of raw materials worldwide and the greatest producer of greenhouse gas emissions.

Some 30% of all raw materials are used to build and maintain buildings. 30 to 40% of greenhouse gases result from the construction, use or disposal of buildings. In the industrial nations a huge amount of energy is used in transport and industry, but the building sector accounts for the majority – around 40% of European energy consumption!

In view of advancing climate change, the shortage of finite resources and rapid urbanisation throughout the world, it is becoming more and more important that buildings are planned and built with sustainability in mind.

Green buildings not only emit less CO2, they can also be operated more economically and sold more profitably.

There are numerous public and private initiatives on both a national and international level to tackle these environmental issues. BREEAM and LEED in particular have gained significance throughout the world in recent years and in many countries have become the recognized standard with national chapters and country-specific versions. Especially for larger construction projects of international companies, endeavours are now made to attain BREEAM certification.



BREEAM GREEN GUIDE RATING

BREEAM (the Building Research Establishment's Environmental Assessment Method) has now added pipe insulation products to their Green Guide to Specification, with nitrile rubber insulation products including Armaflex materials, receiving an A rating.

The Green Guide ratings compare the environmental impact of construction products on a scale of A+ to E, with A+ referring to products with the lowest environmental impact and E rated products having a high impact. An A rating for nitrile rubber insulation validates the low environmental impact of Armaflex, helping specifiers to deliver sustainable buildings.

Green Guide ratings are determined by a number of factors, taking into account the whole lifecycle of the product, from manufacture to disposal.

The Green Guide assesses the following twelve impact categories:

1. Climate Change	7. Nuclear Waster
2. Water Extraction	8. Waste Disposal
3. Mineral Resource Extraction	9. Fossil Fuel Depletion
4. Stratoshpheric Ozone Depletion	10. Eutrophication
5. Human Toxicity	11. Photochemical Ozone Creation
6. Ectoxicity to Freshwater and Land	12. Acidification

HOW ARE THE RATINGS USED?

BRE's Environmental Assessment Method (BREEAM) provides a system for assessing the environmental performance of buildings, with buildings certified as a Pass, Good, Very Good, Excellent or Outstanding, depending on the overall credits achieved for the building.

There are a number of sections within the BREEAM scheme where credits are available, with Green Guide ratings for building products relevant to the **Materials** section. Here BREEAM credits can be achieved for the building by specifying products with a good Green Guide rating.

Mat04 under the Materials section deals with insulation products:
"To recognize and encourage the use of thermal insulation which has a low embodied environmental impact relative to its thermal properties."

ENVIRONMENTAL PRODUCT DECLARATIONS (EPDs)

BREEAM also awards a points uplift for products that have an independently verified third party Environmental Product Declaration (EPD). Armacell publishes environmental product declarations which are based on an independent lifecycle assessment (LCA). Comparing the primary energy input identified in the LCA with the energy saving achieved, shows that Armaflex insulation materials save 140 times more energy than is needed for their manufacture, transport and disposal.

The table below shows the points award for each Green Guide rating and the EPD uplift:

Green Guide Rating	Points	EPD Tier 1 max points uplift	EPD Tier 2 Max Points uplift
A+	3	1	0.75
A	2	1	0.75
B	1	1	0.5
C	0.5	0.5	0.25
D	0.25	0.25	0.125
E	0	0	0

Tier 1 = 3rd party verified, cradle-to-grave EPD

Tier 2 = 3rd party verified, cradle-to-gate or cradle-to-gate with options EPD

Armacell has independently verified EPDs compliant with ISO 15804 and ISO 14025 for AF/Armaflex Class 0, AF/Armaflex, Armaflex Ultima, HT/Armaflex and NH/Armaflex (see www.armacell.com/epd). The EPDs are classed as 'cradle-to-gate with options' (Tier 2). **So with a generic Green Guide rating of A and an EPD Tier 2 uplift, Armaflex products achieve 2.75 points.** Armacell also has ISO 14001 certification to meet the requirements under Mat03 Responsible Sourcing of Materials.

A summary for the ratings for nitrile rubber insulation products is given in the table below:

Application Type	Product Type	Element Number	Summary Rating
Domestic heating & hot water	Nitrile rubber pipe insulation	1635800004	A
BOTD Hot Water	Nitrile rubber pipe insulation	1636810004	A
BOTD Heating	Nitrile rubber pipe insulation	1637820004	A
BOTD Chilled Water 10°C	Nitrile rubber pipe insulation	1638830004	A
BOTD Chilled Water 5°C	Nitrile rubber pipe insulation	1639840004	A
BOTD Chilled Water 0°C	Nitrile rubber pipe insulation	1640850004	A

The generic Green Guide ratings can be found online at www.thegreenguide.org.uk.

Armaflex products have a GWP and ODP rating of zero. The gas given off in the manufacture of Armaflex is nitrogen, which makes up the majority of air. The GWP and ODP certificates are independently verified by Bureau Veritas, available on request. Our Tubolit polyethylene foam insulation has a GWP of 3 and an ODP of zero. The blowing agent used is Isobutane, which has a negligible ODP and GWP having 3.3 times the GWP of carbon dioxide.

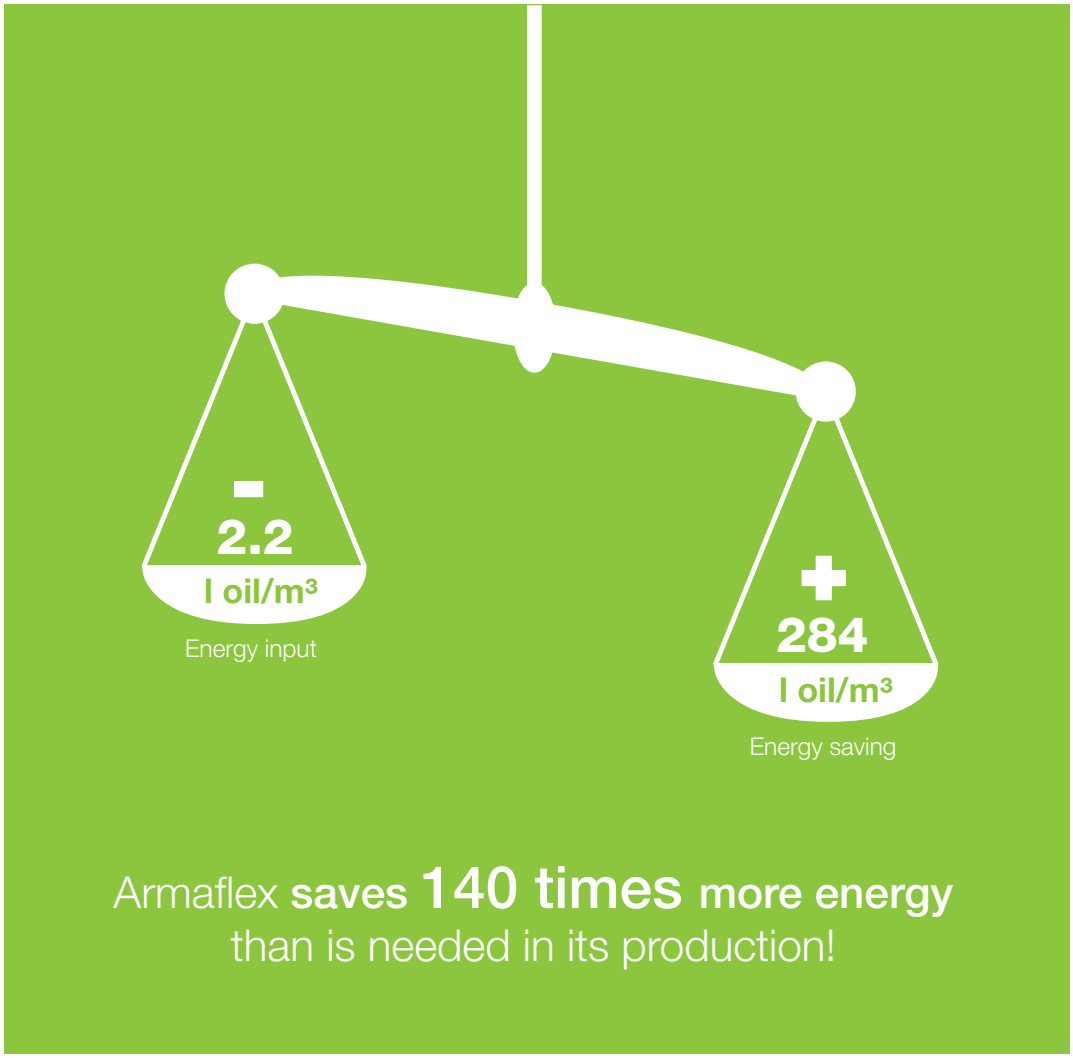
Types of environmental declarations (eco labels according to ISO standards):
Type 1 Declarations are made by a third party (according to ISO 14024) affirming compliance with pre-determined, multi-attribute, life-cycle based environmental performance requirements (e.g. German 'Blauer Engel' or 'US Green Seal').
Type 2 Declarations reflect environmental performance claims made by a product manufacturer (according to ISO 14021). The performance criteria have not been independently verified (e.g. US 'GreenGuard' or 'Energy Star').
Type 3 Declarations (according to ISO 14025) present in a consistent manner objective, quantifiable, life-cycle based environmental product information which has been independently verified by a third party. Also known as environmental product declarations (EPDs).

Comparison of types of environmental declaration			
Type	LCA Required	Confirmed by independent organisation	Informative value
Type 1 - Label	-	Yes	Average
Type 2 - Claim	-	-	Average
Type 3 - EPD	Yes	Yes	Very High

Armaflex products are long-lasting products and results show that when installed and used correctly it is possible to assume a reference service life (RSL) of 50 years and more. The RSL is practically only restricted by the service life of the equipment or building. The insulation performance hardly changes throughout the service life and the insulation effect can only be impaired by improper application during the installation or building phase.

Armacell is the first manufacturer of flexible technical insulation materials to present third party validated environmental product declarations (EPDs) which are based on an independent life cycle assessment (LCA).

Environmental Product Declarations (EPDs) are becoming more and more important in the construction industry since they provide a transparent, independent and reproducible analysis of the environmental impacts of construction products. With this 'sustainability passport' we support the trend towards green building and commit ourselves to a level of product transparency which is currently unique in our industry. The environmental product declarations certified by the "Institut für Bauen und Umwelt e.V." (IBU) not only make statements on the primary energy requirement, they also contain information about the extent to which the products contribute to the greenhouse effect, acidification, over-fertilization, damage to the ozone layer and smog.



Comparing the energy input for manufacturing 1 kg of Armaflex with the energy saving achieved during its in-use phase shows an outstanding energy balance:

- Armaflex saves 140 times more energy than is required for its production
- The energy input needed to manufacture Armaflex is paid off after just 50 days
- If the CO2 emissions are considered, a similar picture emerges: during its use Armaflex prevents the emission of 150 times more greenhouse gases than are released during its production - with a service life of 20 years (cold applications) and 30 years (heating applications), based on conservative assumptions
- This can also be expressed in terms of cost benefits or cost savings over the entire service life of Armaflex insulation materials. Amortisation calculations for typical applications have shown that the cost of the insulation material used has been recovered after just one to two years

Since an LCA can only provide very specific information on an individual manufacturer's products, the results cannot be transferred to the products of other FEF manufacturers. Deviations in the raw materials used or the production process as well as the very different manufacturing footprints of the providers have a significant impact on the data. The system of the LCA and EPDs inevitably requires information to be restricted to specific products and/or the manufacturer.

armacell®

BREEAM COMPLIANCE PRODUCT CARD

Technical insulation

Armacell

Armacell are manufacturers of Armaflex, closed cell foam based on synthetic rubber with antibacterial protection Microban®. Armaflex is used to insulate and protect pipes, vessels and ducts incl. elbows, fittings, flanges etc.
Armacell also manufacture acoustic foam insulation products.

BREEAM New Construction 2014

BREEAM is a multi-criteria scheme to assess and certify buildings. It emphasises sustainable development by promoting green, healthy and eco-friendly buildings. Features of the building which may be assessed are: materials, quality of indoor environments and energy efficiency etc. Nowadays it has become a standard in the construction industry

BREEAM compliance product card for Armacell was prepared to help designers, architects, engineers, consultants and developers to provide clear information and to facilitate choosing the correct product. Appropriate BREEAM categories related to Armacell product features were chosen and checked. Armacell product compliance and contribution to BREEAM Categories are presented below.

Product compliant | Product contributes to a better rating | Product non-compliant

BREEAM Category	Issue ID	BREEAM Requirement	Credits	Product Compliance
Life cycle cost and service life planning	Man 02	A life cycle cost and service life planning analysis of the building components and elements should be carried out in order to obtain their full information through all the life cycle.	4**	Armaflex life cycle information may be part of the building analysis. The following data may be useful: - life cycle durability: restricted to the service life of the equipment or the whole building (>50 years), - restrictions: temperature range: -50°C to +110°C or -50°C to +150°C for high temperature HT/Armaflex, - recycling: non-recyclable, - costs: during installation and utilization (no costs concerned with exploitation, amortization, depreciation), - advantages for building system: cost savings for heating/cooling, More information may be found in Environmental Product Declarations[1].
Indoor air quality: Minimising sources of air pollution	Hea 02	Building should meet appropriate formaldehyde and VOC emission levels at product and post construction stage.	5**	Sampling, testing and evaluation of Armaflex and adhesives were performed according to ISO 16000-9. Insulation meets exemplary level emission limits[2]. - Formaldehyde ≤ 0.01 mg/m³ - Total volatile organic compounds ≤ 0.3 mg/m³ - Total semi-volatile organic compounds ≤ 0.1 mg/m³ - Category 1A and 1B carcinogens ≤ 0.001 mg/m³
Acoustic performance	Hea 05	An acoustic indoor performance should be carried out by a suitably qualified acoustician in accordance to requirements and for each stage of investment: design and post construction. Noise levels should meet those set out in the relevant regulation and guidance document.	4**	Armaflex can impact on building services acoustic insulation. The following data may be useful: - reduction of structure borne sound transmission: < 28 dB(A) - weighted sound absorption coefficient α_w < 0.45 ArmaSound RD can impact on building services acoustic insulation. The following data may be useful: - weighted sound absorption coefficient α_w 0.15 - 0.60 - noise reduction coefficient NRC < 0.75 ArmaComfort can impact on building services acoustic insulation. The following data may be useful: - reduction of structure borne sound transmission: < 14 dB(A) - weighted sound reduction index R_w < 28 Tubolit AR Fonowave & Fonoblok can impact on building services acoustic insulation. The following data may be useful: - Fonowave reduction of structure borne sound transmission: < 11 dB(A) - Fonobloc reduction of structure borne sound transmission: < 15 dB(A)
Responsible sourcing of materials	Mat 03	Construction products should be responsibly sourced. A responsibly sourced confirmation should be provided in the form of third party certification.	4*	Armacell products are responsibly sourced, which is confirmed in our ISO 14001 certification (available on request)[3].
Insulation	Mat 04	To recognise and encourage the use of thermal insulation which has a low embodied environmental impact relative to its thermal properties. Products with a positive Green Guide rating should be used.	1*	Nitrile rubber insulation materials, such as Armaflex, achieve a Green Guide rating of A. A number of our Armaflex products are also covered by a tier 2 EPD according to ISO 14025, which can be used to provide a points uplift when calculating the Insulation Index. The details on the ratings and relevant Green Guide element numbers can be found at www.thegreenguide.org.uk
Material efficiency	Mat 06	In order to minimise materials environmental impact more efficient materials should be used during building design, procurement, construction, maintenance and end of life.	1**	The product as part of the building energy system has the following efficiency features: - a service life of more than 50 years - it may be damaged only by extraordinary impacts - varied ranges (2m tubes, coils and sheet). Material waste is reduced.
Reduction of noise pollution	Pol 05	To reduce the likelihood of noise arising from fixed installations on the new development affecting nearby noise-sensitive buildings. A noise impact assessment in compliance with BS 7445 should be carried out for building within 800m.	1**	Armaflex can impact on building services acoustic insulation. The following data may be useful: - reduction of structure borne sound transmission: < 28 dB(A) - weighted sound absorption coefficient α_w < 0.45 ArmaSound RD can impact on building services acoustic insulation. The following data may be useful: - weighted sound absorption coefficient α_w 0.15 - 0.60 - Noise reduction coefficient NRC < 0.75 ArmaSound Industrial Systems can be used to reduce noise levels from pipework according to ISO 15665.
Thermal comfort	Hea 04	A thermal comfort analysis should be carried out to assess if the indoor environment maintains comfortable conditions for building users in terms of appropriate thermal comfort levels according to CIBSE AM11 Building Energy and Environmental Modelling.	3**	The product is part of systems inside the building. For energy efficiency the main parameter of the AF/Armaflex Class O product is thermal conductivity λ0°C < 0.033 W/(m·K). Armaflex low thermal conductivity together with its high water vapour diffusion resistance means it provides energy savings and reductions in heat losses over the whole lifetime of the heating/cooling system. It helps to reduce the energy output of the system, which can also prolong its service life.
Reduction of energy use and carbon emissions	Ene 01	An energy performance assessment should be carried out to assess building energy consumption, to an Energy Performance Ratio (ERP), during operation in comparison with the following requirements: notional building and BREEAM best practice building.	12**	
Energy efficient cold storage	Ene 05	Greenhouse gas emissions from cold storage should be reduced by improving their energy efficiency.	2**	
Energy efficient equipment	Ene 08	Encourage the use of energy efficient equipment to ensure optimum performance and energy savings.	2**	

Detailed information please refer to the documents provided by the manufacturer:
[1] Environmental Product Declarations are available for AF/Armaflex Class O, Armaflex Ultima, HT/Armaflex, NH/Armaflex, AF/Armaflex and SH/Armaflex. Available from www.armacell.com/epd
[2] Eurofins Product Testing A/S attestation and test report data
[3] ISO 14001 certificates are available for manufacturing site in Oldham (UK), Munster (Germany), Środa Śląska (Poland) and Begur (Spain) as well as for our main polymers production.

* Armacell products have a direct impact on the following categories. While using Armacell products, with other appropriate products, the credits stated above or part of these credits may be achieved.
** Armacell products have an indirect impact on the following categories. Using Armacell products with other appropriate products may contribute to achieving the credits stated or part of these credits.
** Credits are Building type dependant.

www.armacell.com/uk

ACOUSTICS

KEY TERMS

- **Sound** is a mechanical oscillation which is perceived by the human ear in the frequency range of 16 Hz to 16,000 Hz
- **Frequency** is the number of oscillations per second. The pitch rises as the frequency increases. The most important range for building acoustics lies between 100 Hz and 3,150 Hz
- **Airborne sound** is sound transmission through the air (e.g: human voices, TV & radio). Sound waves spread through the air
- **Structure borne sound** is transmission through a buidling structure
- **Decibel (DB)** is a relative unit and represents the ratio between two acoustic quantities on a logarithmic scale
- **Decibel (A), dB (A)** weights the sound level according to frequencies. In this way it is possible to achieve a measurable representation of noise as it is perceived

UNDERSTANDING THE NATURE OF NOISE:

The noise given off by a particular source can usually be categorised into one of the following forms:

- **Structure-borne noise**
  This is the sound generated by a vibrating source or impact event. The acoustic energy created by these vibrations is transmitted into the structure of a building (e.g. floors, walls, pipe-work etc) or into mechanical elements (e.g. metal frames, panel work, supports etc) This energy travels through solid structures and is released as air-borne noise at different locations within the building or mechanical system.
- **Air-borne noise**
  This is the sound that travels through the air and into the surrounding environment. In closed environments such as rooms and enclosures, air-borne sound may reverberate and increase the levels of noise both in and outside the contained space.

Most forms of noise will contain contributions from both air-borne and structure-borne sound. Although measures can be taken to limit structure-borne components, such as by isolation and damping, air-borne sound can only be treated with the use of absorbing materials. Open cell foams such as ArmaSound and ArmaComfort have an extremely high absorption performance per unit thickness, offering a solution for the most demanding applications.

In many cases, acoustic materials provide a low cost method of controlling noise and if correctly applied, will have significant effect on reducing the overall noise level.

Many types of materials may be used to control both structure-borne and air-borne noise.

These materials may be split into the following four categories:

- Sound Absorption **– Absorbers**
- Sound Transmission Loss **– Barriers**
- Vibration Isolation **– Decouplers**
- Vibration Damping **– Dampers**

Primarily, absorption and transmission loss (barrier) materials control air-borne noise while damping and isolation materials control structure-borne noise.

DUCTWORK ACOUSTICS

Both structure-borne and air-borne noise with the HVAC system will travel along the connecting duct network. If left untreated, there will be little attenuation of this noise, even over large distances.

There are typically four ways in which the noise from ductwork may transfer into the living or working space:

- Air-borne propagation noise
- Break-out & break-in noise
- Duct wall vibration
- Acoustic bridging

INTERNAL LINING

Internally lining ductwork using a sound absorbing material is the most effective way of reducing both air-borne and breakout noise. In addition, any sufficiently visco-elastic material applied inside the duct wall will also restrict vibration.

The Armacell range of elastomeric insulation materials are particularly well suited to internally lining ductwork. Being dust and fibre free there is no risk of fibre migration and no need to face or encapsulate Armaflex or ArmaSound RD materials.

Armaflex is also uniquely resistant to bacteria and mould growth owing to the in-built Microban anti-microbial protection.

COMBINED THERMAL & ACOUSTIC LINING

It is standard practice to insulate ductwork internally for acoustic performance and externally for thermal efficiency. Armaflex materials can however meet both thermal and acoustic requirements through internally lining ductwork.

By eliminating the need for an additional external insulation layer, this approach results in a significant reduction of material and labour.

ELIMINATING ACOUSTIC BRIDGING

Wherever a direct physical connection exists, structure-borne sound, or vibration from the duct can pass to other parts of the building structure.

So called 'acoustic bridges' are prevented by the introduction of resilient materials, like high density Armaload sections between points of direct contact with the duct. In the worst cases all acoustic treatment can be rendered ineffective as the noise follows the 'path of least resistance'. This can reduce the effectiveness of all other acoustic treatments applied to the duct.

Products	Breakout Noise	Propagation Noise	Duct Wall Vibration	Acoustic Bridging
AF/Armaflex Class O		✓		
ArmaSound RD		✓	✓	
ArmaSound Industrial Systems	✓			
ArmaSound Barrier			✓	
Armaload				✓

ENCLOSURE ACOUSTICS

Compressors, pumps, air-conditioning units, heat pumps, generators and motors all generate large volumes of nuisance noise. Treating these pieces of equipment using acoustic enclosures or cabinets is a highly effective way of reducing the levels of noise experienced.

When contained within any enclosure the noise associated with equipment exists in 4 distinct fields:

- **Internal airborne noise**
- **External breakout noise**
- **Enclosure wall vibration**
- **Structure borne mounting vibration**

LINING ENCLOSURES

Internal lining of enclosures prevents the build up of reverberant noise within the enclosure. This improves conditions inside the enclosure and also reduces the volume of energy able to break out from the enclosure.

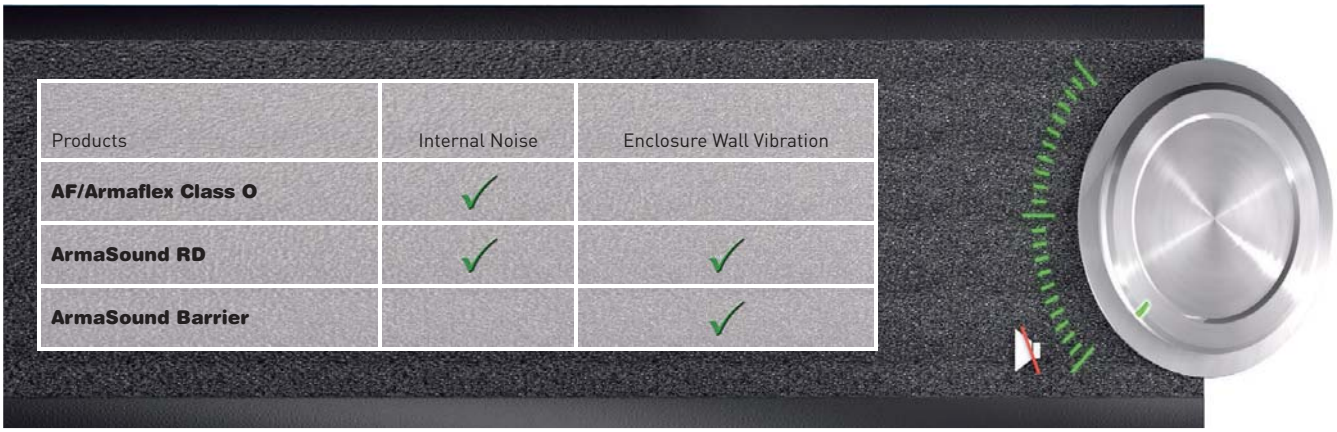
As such lining enclosures proves to be doubly effective – reducing noise both inside the enclosure and immediately around it. Often the effect is even greater as lining materials also help to restrict enclosure wall vibration.

SELECTING A SOUND ABSORBING LINING

Space may be restricted and so the need for good absorption as low thicknesses should be considered. Beyond acoustic performance alone the health of any operative working with an enclosure must be considered, as must the potential that linings may come into contact with oils or other chemicals.

Armacell manufactures a number of high performance sound absorbing materials suitable for internally lining enclosures. Due to the dust and fibre free nature of Armacell products, all of these materials are easily fitted in a single step without the need for additional facings and with no risk of fibre migration.

Products	Internal Noise	Enclosure Wall Vibration
AF/Armaflex Class O	✓	
ArmaSound RD	✓	✓
ArmaSound Barrier		✓



INDUSTRIAL PIPEWORK

Heavy industrial pipework represents a major source of noise contamination on and around industrial sites. Reducing this noise is a legal requirement.

The best way of preventing noise breakout is to apply a fully integrated, high performance, acoustic pipe insulation system – such as the ArmaSound Industrial Systems. Aside from acoustic performance, this system also fulfils several roles as thermal insulation and a barrier against pipe corrosion.

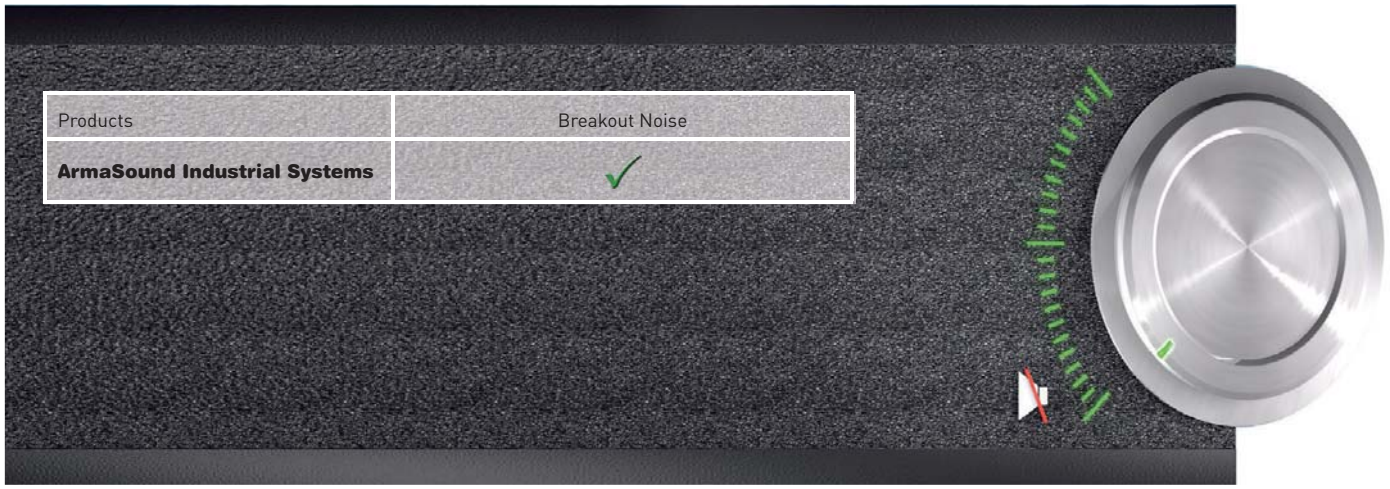
ArmaSound Industrial Systems prevent noise breakout from industrial pipework and offer improved environmental stability when compared to traditional methods:

- Firstly, the use of a closed cell layer applied to the surface of the pipe minimises water ingress and the risk of corrosion under insulation (CUI)

- Armacell's systems do not contain metallic coverings which may be susceptible to rust and/or galvanic corrosion. Instead, our systems use Arma-Chek R which is a tough, flexible elastomeric protective coating. The covering also provides a higher degree of compliance during installation to ensure better flexibility and improve sealing properties. The use of flexible elastomeric coverings also reduces low-frequency re-radiation effects that may be observed in practical application

- The combination of a closed and open cell structure allows for a high degree of thermal insulation performance to be achieved. All components within ArmaSound Industrial Systems fulfil both acoustic and thermal roles, eliminating the redundancy associated with traditional approaches. Using an elastomeric covering reduces re-radiation effects resulting from residual transference of acoustic vibration into the outer surface.

Additional acoustic benefits are realised around pipe supports and hangers through further reduction of structurally transmitted vibration. The combination of closed and open-cell technology, with an additional barrier covering, offers significant benefits for noise control engineers, specifiers and contractors. In particular, high thermal and acoustic performance is combined with the reduced risk of under insulation and galvanic corrosion.



WASTE WATER PIPEWORK

In any hotel or large residential complex the irregular sound of flushing water or rain dripping can impede a good nights sleep.

This noise can be heard due to the way in which waste water pipes are routed within the building. Water flow reverberates within the pipe and the amplified noise breaks out – partly through the pipe wall itself but primarily through the coupling points.

Coupling points act as acoustic bridges through which noise can travel in the form of vibrations, exciting other surfaces to vibrate and creating a "loadspeaker" effect. As a result waste water pipework can be highly effective at radiating nuisance noise throughout a building.

DECOUPLING PIPEWORK

Introducing a visco elastic resilient layer between the pipe and the structural connection points has the effect of decoupling the acoustic bridge – significantly reducing the breakout noise.

Armacell manufactures materials able to decouple waste water pipework and minimise the nuisance noise they can carry.

ArmaComfort AB Alu, Tubolit AR Fonoblok and Tubolit AR Fonowave are thin and highly cost effective decoupling materials that are proven to reduce noise breakout from waste water pipework. Aside from decoupling, these materials also perform a role damping vibration in the pipe wall – reducing the overall noise breakout.

NOISE FROM PLASTIC WASTE WATER PIPEWORK

Waste water pipework is typically made of either iron or plastic. The material of which the pipe is made will influence the level of noise break out.

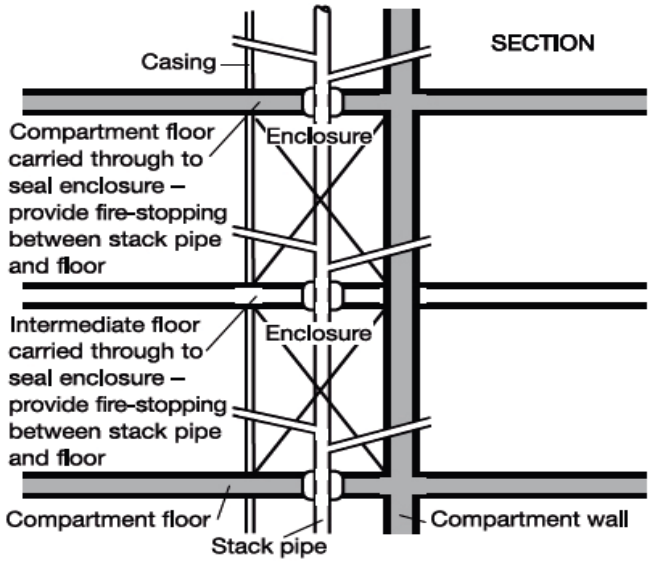
Due to the lower mass, reducing noise breakout from plastic waste water pipes is more difficult than reducing noise breakout from iron waste water pipes. This is why Armacell has developed Tubolit AR Fonowave and ArmaComfort AB Alu. By incorporating a ridged contacting surface, Tubolit AR Fonowave is more effective at reducing noise breakout from plastic waste water pipes.

	Tubolit AR Fonowave for plastic pipes		
Volume flow Q (l/s)	Without insulation	With insulation	Difference
	db (A)	dB (A)	dB (A)
0.5	28	17	11
1.0	31	22	9
2.0	34	25	9
4.0	38	31	7
	Tubolit AR Fonoblok for cast iron pipes		
Volume flow Q (l/s)	**without insulation**	**with insulation**	**Difference**
1.0	30	16	14
2.0	34	19	15
4.0	38	24	14

UK REGULATIONS

To meet the UK requirement for a Class 0 or Euroclass B surface material to be used within enclosures, the high performance ArmaComfort AB Alu insulation combines excellent acoustic properties with superior fire performance (B-s1,d0). Where pipes are located in an enclosure a minimum 30 min fire resistance is required. Fire stopping such as ArmaProtect 1000 is also required around openings in the floors or walls.

Diagram 38 taken from Approved Document B gives further information:



Notes:

1. The enclosure should:
   a. be bounded by a compartment wall or floor, an outside wall, an intermediate floor, or a casing (see specification at 2 below);
   b. have internal surfaces (except framing members) of Class 0 (National class) or Class B-s3, d2 or better (European class)
   Note: When a classification includes 's3, d2', this means that there is no limit set for smoke production and/or flaming droplets/particles);
   c. not have an access panel which opens into a circulation space or bedroom;
   d. be used only for drainage, or water supply, or vent pipes for a drainage system.
2. The casing should:
   a. be imperforate except for an opening for a pipe or an access panel;
   b. not be of sheet metal;
   c. have (including any access panel) not less than 30 minutes fire resistance.
3. The opening for a pipe, either in the structure or the casing, should be as small as possible and fire-stopped around the pipe.

The 12mm thick ArmaComfort lagging is supplied in 2m long x 1m wide sheets. The material is highly flexible for ease of installation. The multilayer foam consits of an acoustic aluminium faced 2mm thick epdm-eva barrier with 4 kg/m² of weight and a decoupling polyurethane foam of 10mm. It is specially designed for use in commercial buildings such as apartments, office buildings, hotels, hospitals, school buildings, retirement homes, shopping centres and conference centres to provide:

- Extraordinary acoustic performance for increased comfort
- Optimal reduction of airborne noise and structural noise
- Class 0 / Euroclass B fire performance
- Thin acoustic solution
- Easy to apply

Products	Breakout Noise	Acoustic Bridging Plastic Pipes	Acoustic Bridging Cast Iron Pipes
ArmaComfort AB Alu	✓	✓	✓
Tubolit Fonowave		✓	
Tubolit Fonoblok			✓

CORROSION UNDER INSULATION

Defined simply, Corrosion Under Insulation (CUI) describes any type of corrosion that occurs due to moisture build up within the insulation system. CUI usually occurs between 0°C and 120°C and is particularly critical above 60°C.

CUI is insidious: It is hard to see – without first removing the insulation – and facilities can have hundreds of kilometres of pipework that need to be manually inspected. It is also a serious problem that can shut plants down – often at the cost of millions of dollars per day. In extreme cases, corrosion has been known to trigger catastrophic safety incidents.

The World Corrosion Organisation estimates that corrosion costs the global economy $2.2 trillion.

Armacell offers insulation that satisfies the requirements of ASTM C692 – known as the 'drip test procedure' and offers low leachable chlorides when tested in accordance with ASTM C871 or EN 13468. Armacell's insulation materials are also pH neutral.

CUI is often difficult to identify because it is hidden beneath insulation and jacketing until it becomes a more serious problem...

HOW DOES CUI OCCUR?

- Insulation covering is breached
- Water ingress into the insulation
- Water and oxygen reach the metal surface

As well as CUI, water ingress can lead to weight gain and a significant reduction in both thermal and acoustic performance.

Insulation often requires replacement within a few years at high costs per linear metre.

The highest incidence of leaks in the refining and chemical industries are due to CUI and not process corrosion and between 40% and 60% of piping maintenance costs are CUI related. The problems caused by CUI have led to some industry sectors moving away from mineral wool insulation.

Materials that are open cell or have poor resistance to moisture can have a dramatic effect on the corrosion of pipework. As a closed cell insulation, Armaflex drastically reduces the risk of CUI due to the insulation itself being a vapour barrier.

The cost of replacing the pipework outweighs the cost of the insulation. So it is important to get the correct insulation specified to begin with.

Austenitic Stainless Steel (types 304 & 316) can be sensitive to corrosive attack by soluble inorganic chlorides in the presence of oxygen and moisture, especially when, at the same time, the alloy is highly stressed. This is known as stress corrosion cracking (SCC).

Chloride ions will always be present in the "normal building site environment" and may be deposited on the stainless steel surface during the handling and installation of all insulating materials. The presence of an insulation material, of any generic type, is more likely to concentrate chloride ions at the stainless steel surface. DIN 1988 limits the soluble chloride ion content of insulation products to 0.05% in order to protect against SCC. All Armaflex products meet the DIN 1988 requirements.

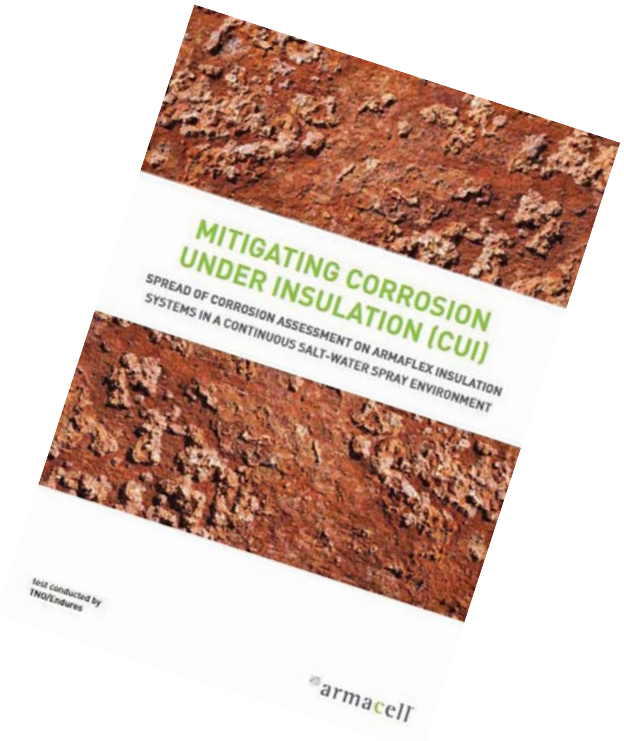
The stress corrosion reaction is not usually significant at temperatures below about 50°C, but can be severe in the temperature range 50°C to 105°C. The most likely time that moisture may be present on the surface is when the plant is restarted after shut down.

BS 5970 recommends that a barrier of aluminium foil, not less than 0.06mm thick, be applied to austentic stainless steel surfaces ensuring that it is fitted to shed water - with an overlap of at least 50mm at the joints - prior to the insulation. The standard also recommends, as an alternative to aluminium foil, that specially formulated anti-corrosive paints may be used for this type of application. However, the paint manufacturer's instructions should be followed closely and the temperature limitations of the paint should not be exceeded.

The Armacell recommendation is that where austenitic stainless steel is insulated then it is advisable to carry out the precautions outlined above irrespective of the operating temperature.

Providing that good installation practice is followed to minimise the risk of surface contamination etc., the practical benefits of using Armaflex insulation are:

- Closed cell structure with a very high resistance to water vapour transmission
- Ease of installation so that all seams and joints may be sealed using Armaflex Adhesive
- Armaflex should be sealed on to the pipe at any open ends to prevent the ingress of moisture



see www.armacell.com/oilandgas for more details

Thickness Tables & Building Regulations

Insulation thickness required for condensation control based on BS 5422 tables 4&5*.			
Pipe size (mm)	AF//Armaflex Class 0	Phenolic foam with foil vapour barrier	Mineral Wool with foil vapour barrier
	λ = 0.033 at 0°C	λ = 0.025 at 0°C	λ = 0.034 at 0°C
	ε = 0.9	ε = 0.5	ε = 0.5
10	19	30	35
12	19	30	40
15	19	30	40
22	25	35	45
28	25	40	50
35	25	40	55
42	25	45	55
54	25	45	60
67	25	50	65
76.1	32	50	65
108	32	55	75

Note:

ε = 0.05 - Low emissivity surface, i.e. alu foil or stainless steel cladding

ε = 0.9 - High emissivity surface, i.e. black Armaflex

PART L AND COMPLIANCE GUIDE

Armaflex insulation can be used on heating, hot and cold water services to meet Part L of the Building Regulations. Part L states that the insulation should comply with the requirements of the Domestic Building Services Compliance Guide or the Non-Domestic Building Services Compliance Guide. These are second tier documents to Part L, which give the recommended minimum provisions for the following:

Domestic Building Services Compliance Guide:

- Max. permissible heat loss allowable on heating and hot water pipes

Non-Domestic Building Services Compliance Guide:

- Max. permissible heat loss on hot water and low, medium & high temperature heating
- Max. permissible heat gain on cold water supply pipes
- Condensation control

Each nation publishes their own building regulation documents to outline energy performance criteria and the requirements for pipe insulation, as shown below:

Building Regulation	Section of Building Regulation	Referenced Document
England & Wales	Part L1A & L1B (Dwellings)	Domestic Building Services Compliance Guide
	Part L2A & L2B (Buildings other than dwellings)	Non-Domestic Building Services Compliance Guide
Northern Ireland	Technical Booklet F1	Domestic Building Services Compliance Guide
	Technical Booklet F2	Non-Domestic Building Services Compliance Guide
Ireland	Technical Guidance Document L	BS 5422
Scotland	Technical Handbook Section 6 - Domestic	Domestic Building Services Compliance Guide for Scotland
	Technical Handbook Section 6 – Non-Domestic	Non-Domestic Building Services Compliance Guide for Scotland

BS 5422

WHAT IS BS 5422?

BS 5422 is a British Standard often referred to in specification work for insulation used on building services.

The standard gives the physical characteristics and recommended thicknesses that the insulation should be specified to.

The standard has a number of tables with recommended thicknesses in order to:

- Conserve energy
- Protect against freezing
- Control condensation on refrigeration & cold applications
- Protect personnel from exposure to extreme surface temperatures
- Control process or service temperatures
- Limit effects of system on indoor building temperature

Thickness tables are given in different sections of the document. The different sections relate to different applications or reasons for insulating.

THE SECTIONS ARE:

- Refrigeration (Section 6)
- Chilled and cold water applications (Section 7)
- Central heating, air conditioning and direct hot water supply installations in non-domestic applications (Section 8)
- Central heating and hot water services for domestic applications (Section 9)
- Process pipework and equipment applications (Section 10)
- Protection against freezing (Section 11)

The following tables give the thickness of AF/Armaflex Class 0 to meet BS 5422

REFRIGERATION:

Temperature of Content (°C)										
Pipe OD [mm]	0°C		-10°C		-20°C		-30°C		-40°C	
	ε = 0.05	ε = 0.9	ε = 0.05	ε = 0.9	ε = 0.05	ε = 0.9	ε = 0.05	ε = 0.9	ε = 0.05	ε = 0.9
21.3	13	9	19	13	25	19	32	19	38	25
33.7	19	9	25	13	32	19	32	25	38	25
60.3	19	9	25	19	32	19	38	25	44	32
114.3	19	9	25	19	38	25	44	25	50	32
168.3	19	13	32	19	38	25	44	32	51	32
273.0	19	13	32	19	38	25	50	32	57	32
508.0	19	13	32	19	44	25	50	32	64	38
610.0	19	13	32	19	44	25	50	32	64	38

BS 5422 table 2 & 3.

Relative Humidity = 70%

Ambient temperature = 20°C

Note:

ε = 0.05 - Low emissivity surface, i.e. alu foil or stainless steel cladding

ε = 0.9 - High emissivity surface, i.e. black Armaflex

Temperature of Content (°C)										
Pipe OD (mm)	0°C		-10°C		-20°C		-30°C		-40°C	
	ε = 0.05	ε = 0.9	ε = 0.05	ε = 0.9	ε = 0.05	ε = 0.9	ε = 0.05	ε = 0.9	ε = 0.05	ε = 0.9
21.3	25	19	32	25	44	25	50	32	57	38
33.7	32	19	38	25	44	32	57	32	57	38
60.3	32	19	44	25	50	32	57	38	69	44
114.3	38	25	50	32	57	38	69	44	75	50
168.3	38	25	50	32	64	38	75	44	82	50
273.0	38	25	51	32	64	38	76	50	89	57
508.0	38	25	57	32	69	44	82	50	96	57
610.0	44	25	57	32	69	44	89	50	96	57

BS 5422 table 4 & 5

Relative Humidity = 80%

Ambient temperature = 25°C

CHILLED & COLD WATER:

Cooled pipework should be insulated along its whole length in order to provide the necessary means of limiting heat gain. Control should be maximised and heat gain to uninsulated pipes should only be permitted where the proportion of the cooling load relating to distribution pipework is proven to be less than 5% of total load.

CONDENSATION CONTROL:

Temperature of Content (°C)						
Pipe OD (mm)	10°C		5°C		0°C	
	ε = 0.05	ε = 0.9	ε = 0.05	ε = 0.9	ε = 0.05	ε = 0.9
17.2	19	9	19	13	25	19
21.3	19	9	25	13	25	19
26.9	19	13	25	13	25	19
33.7	19	13	25	19	32	19
42.4	19	13	25	19	32	19
48.3	19	13	25	19	32	19
60.3	19	13	25	19	32	19
76.1	19	13	25	19	32	19
88.9	19	13	32	19	32	19
114.3	19	13	32	19	38	25
139.7	25	13	32	19	38	25
168.3	25	13	32	19	38	25
219.1	25	13	32	19	38	25
273.0	25	13	32	19	38	25
323.9	25	13	32	19	38	25
355.6	25	13	32	19	38	25
406.4	25	13	32	19	38	25
457.0	25	13	32	19	38	25
508.0	25	13	32	19	38	25
610.0	25	13	32	19	44	25

BS 5422 table 6 & 8

Relative Humidity = 80%

Ambient Temperature = 25°C

CONDENSATION CONTROL:

Temperature of Content (°C)						
Pipe OD (mm)	10°C		5°C		0°C	
	ε = 0.05	ε = 0.9	ε = 0.05	ε = 0.9	ε = 0.05	ε = 0.9
10.0	13	9	19	13	25	13
12.0	13	9	19	13	25	19
15.0	19	9	19	13	25	19
22.0	19	13	25	13	25	19
28.0	19	13	25	13	32	19
35.0	19	13	25	19	32	19
42.0	19	13	25	19	32	19
54.0	19	13	25	19	32	19
76.1	19	13	25	19	32	19
108.0	19	13	32	19	38	25

BS 5422 table 7 & 9
Relative Humidity = 80%
Ambient Temperature = 25°C

HEAT GAIN:

Temperature of Content (°C)									
Pipe OD (mm)	10°C			5°C			0°C		
	W/m	ε = 0.05	ε = 0.9	W/m	ε = 0.05	ε = 0.9	W/m	ε = 0.05	ε = 0.9
17.2	2.48	19	25	2.97	19	25	3.47	25	32
21.3	2.72	19	25	3.27	25	32	3.81	25	32
26.9	3.05	19	25	3.58	25	32	4.18	32	38
33.7	3.41	19	25	4.01	25	32	4.60	32	38
42.4	3.86	19	25	4.53	25	32	5.11	32	38
48.3	4.11	19	32	4.82	25	32	5.45	32	38
60.3	4.78	25	32	5.48	32	38	6.17	32	44
76.1	5.51	25	32	6.30	32	38	6.70	38	44
88.9	6.17	25	32	6.90	32	38	7.77	38	44
114.3	7.28	25	32	8.31	32	38	9.15	38	44
139.7	8.52	25	32	9.49	32	38	10.45	38	50
168.3	9.89	25	32	10.97	32	38	11.86	38	50
219.1	12.27	25	32	13.57	32	44	14.61	38	50
273.0	14.74	25	32	16.28	32	44	17.48	38	50

BS 5422 table 10 & 11
Ambient Temperature = 25°C

DUCTWORK:

Ducting should be insulated along its whole length in order to provide the necessary means of limiting heat gains and/or heat losses from ducts. Where ducting may be used for both heating and cooling duties at different periods during its lifecycle, the provisions for chilled ducting should be adopted, since these are the most onerous. The following table indicates the maximum heat loss/gain per unit area required to meet these provisions. As with pipes, additional insulation may be required to provide adequate condensation control.

Min. air temp inside duct (°C)	ε = 0.05	ε = 0.9
15°C	13	9
10°C	25	13
5°C	32	19
0°C	44	25

BS 5422 table 12

Ambient Temperature = 25°C

Relative Humidity = 80%

Warm Air Duct			
Max. Permissible Heat Loss (W/m)	**ε = 0.05**	**ε = 0.44**	**ε = 0.9**
16.34	32	38	44
Dual Purpose Duct			
Max. Permissible Heat Gain (W/m)	**ε = 0.05**	**ε = 0.44**	**ε = 0.9**
6.45	50	64	64

BS 5422 table 13 & 14

Warm Air Duct:

Line Temperature = 35°C

Ambient Temperature = 15°C

Dual Purpose Duct:

Line Temperature = 13°C

Ambient Temperature = 25°C

NON-DOMESTIC HEATING & HOT WATER:

Pipework serving space heaters and hot water systems should be insulated in all areas outside of the heated building envelope. In addition, pipes should be insulated in all voids within the building envelope and within spaces that will normally be heated if there is a possibility that those spaces might be maintained at temperatures different to those maintained in other zones. The guiding principles are that control should be maximised and that heat loss from un-insulated pipes should only be permitted where the heat can be demonstrated as 'always useful'.

Pipe OD (mm)	Hot Water			LTHW		
	W/m	ε = 0.05	ε = 0.9	W/m	ε = 0.05	ε = 0.9
17.2	6.60	25	32	8.90	32	32
21.3	7.13	32	32	9.28	32	38
26.9	7.83	32	38	10.06	38	44
33.7	8.62	32	38	11.07	38	44
42.4	9.72	32	38	12.30	38	44
48.3	10.21	38	44	12.94	44	50
60.3	11.57	38	44	14.45	44	50
76.1	13.09	38	44	16.35	44	50
88.9	14.58	38	44	17.91	50	51
114.3	17.20	38	50	20.77	50	57
139.7	19.65	44	50	23.71	50	57
168.3	22.31	44	50	26.89	50	57
219.1	27.52	44	50	32.54	50	57
273.0	32.40	44	50	38.83	50	57

BS 5422 table 15, 16, 17 & 18

Hot Water:

Line Temperature = 60°C

Ambient Temperature = 15°C

LTHW:

Line Temperature = 75°C

Ambient Temperature = 15°C

DOMESTIC HEATING & HOT WATER:

Pipe OD (mm)	W/m	ε = 0.05	ε = 0.9
8	7.06	9	9
10	7.23	13	13
12	7.35	13	19
15	7.89	19	19
22	9.12	19	25
28	10.07	19	25
35	11.08	25	25
42	12.19	25	25
54	14.12	25	32

BS 5422 table 19 & 20

Line Temperature = 60°C

Ambient Temperature = 15°C

PROCESS & INDUSTRIAL PIPEWORK:

Pipe OD (mm)	W/m	ε = 0.05	ε = 0.9
17.2	12.79	25	32
21.3	14.04	25	32
26.9	15.42	32	32
33.7	17.25	32	32
42.4	19.15	32	38
48.3	20.42	32	38
60.3	23.17	32	38
76.1	26.21	38	44
88.9	28.73	38	44
114.3	33.89	38	44
139.7	38.74	38	44
168.3	43.99	44	44
219.1	53.38	44	50
273.0	62.87	44	50

BS 5422 table 21

Line Temperature = 100°C

Ambient Temperature = 20°C

WATER SUPPLY REGULATIONS & FROST PROTECTION

Water Supply (Water Fittings) Regulations 1999 - Frost Protection

Min. Class 0 Armaflex (mm)		
Pipe OD (mm)	**Normal Conditions**	**Extreme Conditions**
Copper:		
15.0	24.0* (25)	29.3* (32)
22.0	14.7 (19)	17.3 (19)
28.0	8.3 (9)	9.8 (13)
35.0	4.2 (9)	5.1 (9)
42.0	2.2 (9)	2.8 (9)
54.0	0.6 (9)	1.0 (9)
76.1	0.0 (9)	0.0 (9)
Steel:		
21.3	16.9* (19)	21.9* (25)
26.9	16.8 (19)	21.0 (25)
33.7	9.7 (13)	12.1 (13)
42.4	5.3 (9)	6.7 (9)
48.3	2.5 (9)	3.3 (9)
60.3	1.0 (9)	1.6 (9)
76.1	0.0 (9)	0.1 (9)

NORMAL CONDITIONS:-

Inside the building and within the envelope of the insulation where heat is normally provided.
Line temperature = 7°C
Ambient temperature = -6°C
Evaluation period = 12 hrs (*8 hrs)
Permitted ice formation = 50%

EXTREME CONDITIONS:-

Inside the building but outside the envelope of the insulation, i.e. above the thermal insulation in a loft space, under a suspended ground floor. Area's without heating services, inside the structure of the building.
Line temperature = 2°C
Ambient temperature = -6°C
Evaluation period = 12 hrs (*8 hrs)
Permitted ice formation = 50%

ENERGY SAVING

A small investment will have a big savings impact upon energy costs and reduce CO2 emissions.

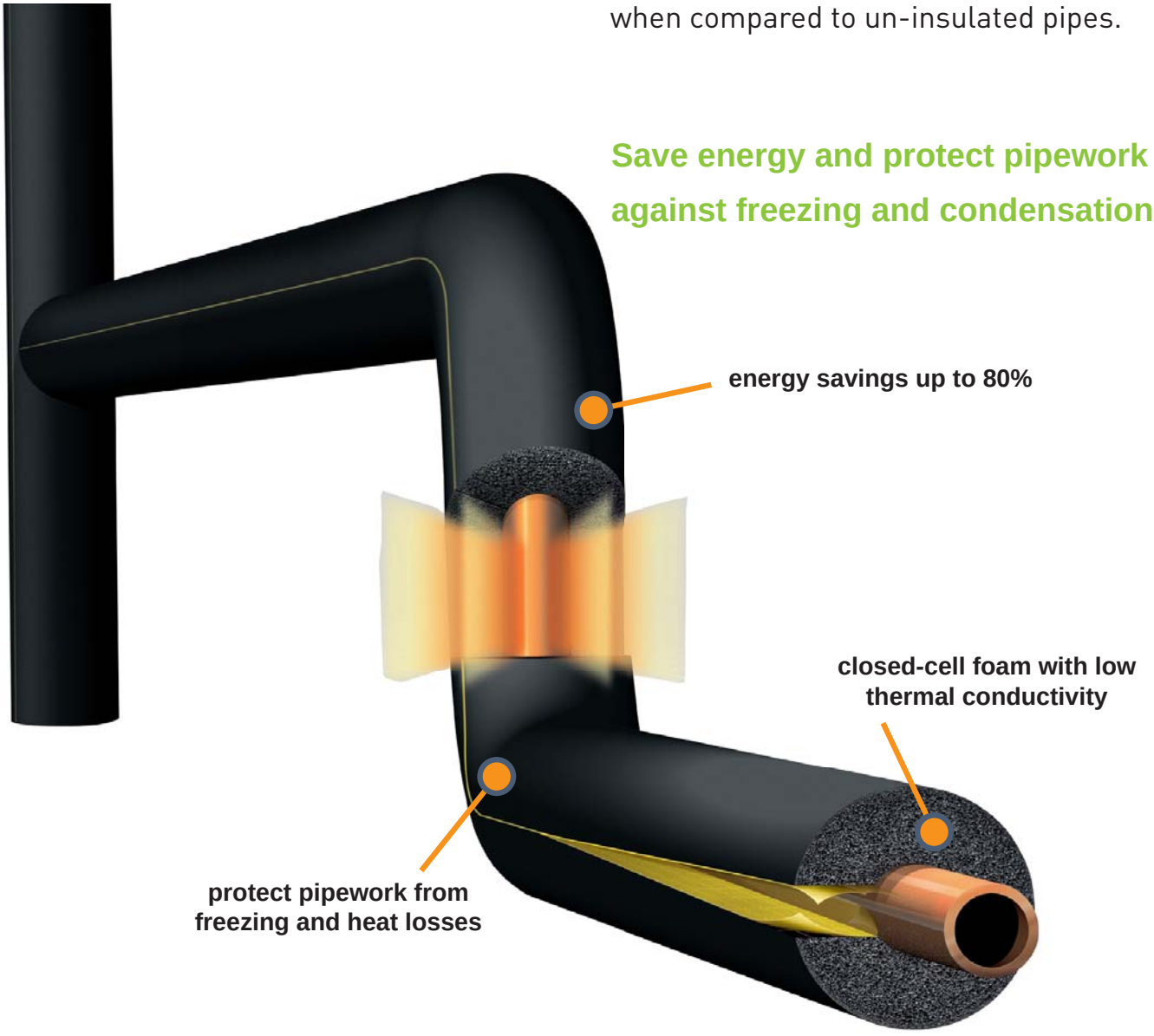
The waste of energy has a highly negative impact in today's environment and is something that we can all help to reduce economically by using pipework insulation. Given the thickness requirements in current legislation to meet environmental thickness tables, and the design structure of many UK and Irish buildings, in many cases it is not physically possible to install the specified insulation thickness.

For existing pipework installations, having limited space between pipework to install insulation is very often the reason not to install it. Typical examples of this are in locations such as service shafts, under floors, suspended and enclosed ceiling structures, visible pipework.

The easiest and quickest method to insulate already existing pipework is to use nitrile rubber insulation material. This highly flexible non-fibrous insulation material makes safe application easy, especially in areas of limited available working space.

Elastomeric insulations biggest asset is its excellent thermal efficiency. For example, with AF/Armaflex Class 0 you can save up to 87% energy in typical domestic applications when compared to un-insulated pipes.

Save energy and protect pipework against freezing and condensation



ENERGY SAVING - HOT WATER SERVICES

Energy savings compared to un-insulated pipes

Pipe OD (mm)	AF/Armaflex Class 0 Thickness				
	9mm	13mm	19mm	25mm	32mm
6	59.3%	63.3%	67.3%	70%	72.7%
10	68%	72%	75.6%	78%	80%
12	70.3%	74.3%	77.7%	80%	82%
15	72.8%	76.5%	80%	82.1%	84%
22	76%	79.8%	83.1%	85.1%	86.7%
28	77.6%	81.3%	84.6%	86.6%	88.1%
35	78.7%	82.4%	85.7%	87.7%	89.1%
42	79.6%	83.2%	86.5%	88.4%	89.9%
48	80.1%	83.8%	87%	88.9%	90.3%
54	80.5%	84.1%	87.3%	89.3%	90.7%
60	80.8%	84.5%	87.6%	89.6%	91.1%
76	81.5%	85.1%	88.3%	90.2%	91.6%
80	81.6%	85.3%	88.4%	90.3%	91.8%
89	81.8%	85.5%	88.6%	90.5%	92%
108	82.1%	85.8%	89%	90.9%	92.3%
114	82.2%	85.9%	89.1%	91%	92.4%
133	82.5%	86.2%	89.3%	91.2%	92.6%
140	82.5%	86.2%	89.4%	91.3%	92.7%
159	82.7%	86.4%	89.6%	91.4%	92.9%
168	82.8%	86.4%	89.6%	91.5%	92.9%
219	83%	86.7%	89.9%	91.8%	93.2%
267	83.2%	86.9%	90.1%	91.9%	93.3%
273	83.2%	86.9%	90.1%	92%	93.4%

Line temperature: 60°C

Ambient temperature: 15°C

INSULATION THICKNESSES TO PREVENT PIPE FREEZING

Given a -6°C ambient temperature and an initial water temperature of 7°C Armacell has calculated (in accordance with BS EN ISO 12241) the following freezing times of pipework when Armaflex is used. Local water supply regulations recommend providing at least 12 hours protection.

COPPER PIPE:

AF/Armaflex Class 0 Thickness				
Pipe OD (mm)	**13mm**	**19mm**	**25mm**	**32mm**
Total Freezing Time (Hours)				
10.0	2.9*	3.4*	3.8*	4.2*
12.0	4.2*	4.8*	5.4*	5.9*
15.0	6.1*	7.2*	8.1*	9.0*
22.0	11.3*	13.6	15.5	17.5
28.0	15.1	18.4	21.1	23.9
35.0	20.9	25.8	30.0	34.3
42.0	27.0	33.7	39.4	45.4
54.0	36.5	46.1	54.5	63.3
67.0	44.5	56.6	67.5	79.0
76.1	57.1	73.0	87.5	102.9
108.0	85.9	111.6	135.2	160.7

MDPE PIPE:

AF/Armaflex Class 0 Thickness				
Pipe OD (mm)	**13mm**	**19mm**	**25mm**	**32mm**
Total Freezing Time (Hours)				
20.0	6.8*	8.2*	9.3*	10.4*
25.0	10.4*	12.6	14.4	16.3
32.0	13.7	16.8	19.5	22.2
40.0	18.9	23.6	27.6	31.6
50.0	24.9	31.3	36.9	42.8
63.0	32.4	41.1	48.9	57.2
75.0	46.9	60.1	71.9	84.6
90.0	60.8	78.4	94.4	111.6
110.0	79.6	103.3	125.3	149.0
125.0	86.2	112.4	136.8	163.3

*Where the indicated protection from freezing provided by AF/Armaflex Class 0 is less than the recommended 12 hours, Armacell recommends trace heating be used.

INSULATION THICKNESSES TO PREVENT PIPE FREEZING

Given a -6°C ambient temperature and an initial water temperature of 7°C Armacell has calculated (in accordance with BS EN ISO 12241) the following freezing times of pipework when Armaflex is used. Local water supply regulations recommend providing at least 12 hours protection.

STEEL PIPE:

AF/Armaflex Class 0 Thickness				
Pipe OD (mm)	**13mm**	**19mm**	**25mm**	**32mm**
Total Freezing Time (Hours)				
17.2	5.2*	6.2*	6.9*	7.8*
26.9	10.5*	12.8	14.7	16.6
33.7	13.9	17.2	20.0	22.8
42.4	19.2	23.9	28.1	32.3
48.3	26.4	33.0	38.9	45.0
60.3	34.5	43.7	51.9	60.5
76.1	47.7	61.0	73.1	85.9
88.9	62.4	80.4	96.8	114.4
114.3	78.8	102.5	124.4	148.2

*Where the indicated protection from freezing provided by AF/Armaflex Class 0 is less than the recommended 12 hours, Armacell recommends trace heating be used.

INSULATION THICKNESSES TO PREVENT PIPE FREEZING

Given a -6°C ambient temperature and an initial water temperature of 7°C Armacell has calculated (in accordance with BS EN ISO 12241) the following freezing times of pipework when HT Armaflex is used. Local water supply regulations recommend providing at least 12 hours protection.

COPPER PIPE:

HT Armaflex Thickness			
Pipe OD (mm)	**13mm**	**19mm**	**25mm**
Total Freezing Time (Hours)			
10.0	2.7*	3.1*	3.4*
12.0	3.8*	4.4*	4.9*
15.0	5.6*	6.5*	7.4*
22.0	10.3*	12.3	14.0*
28.0	13.8	16.7	19.1
35.0	19.1	23.4	27.2
42.0	24.7	30.6	35.7
54.0	33.4	41.9	49.4
67.0	40.7	51.5	61.2
76.1	52.3	66.4	79.3
108.0	78.8	101.6	122.6

MDPE PIPE:

HT Armaflex Thickness			
Pipe OD (mm)	**13mm**	**19mm**	**25mm**
Total Freezing Time (Hours)			
20.0	6.2*	7.4*	8.4*
25.0	9.5*	11.4*	13.0
32.0	12.5	15.2	17.6
40.0	17.4	21.4	24.9
50.0	22.8	28.5	33.5
63.0	29.7	37.4	44.4
75.0	43.1	54.7	65.2
90.0	55.7	71.3	85.6
110.0	73.0	94.1	113.6
125.0	79.1	102.4	124.1

*Where the indicated protection from freezing provided by HT Armaflex is less than the recommended 12 hours, Armacell recommends trace heating be used.

INSULATION THICKNESSES TO PREVENT PIPE FREEZING

Given a -6°C ambient temperature and an initial water temperature of 7°C Armacell has calculated (in accordance with BS EN ISO 12241) the following freezing times of pipework when HT Armaflex is used. Local water supply regulations recommend providing at least 12 hours protection.

STEEL PIPE:

HT Armaflex Thickness			
Pipe O.D (mm)	13mm	19mm	25mm
Total Freezing Time (Hours)			
17.2	4.7*	5.6*	6.3*
26.9	9.6*	11.6*	13.3
33.7	12.8	15.7	18.1
42.4	17.6	21.7	25.4
48.3	24.1	30.0	35.3
60.3	31.6	39.7	47.0
76.1	43.7	55.5	66.3
88.9	57.2	73.1	87.7
108.0	61.2	78.9	95.2
114.3	72.3	93.3	112.8

*Where the indicated protection from freezing provided by HT Armaflex is less than the recommended 12 hours, Armacell recommends trace heating be used.

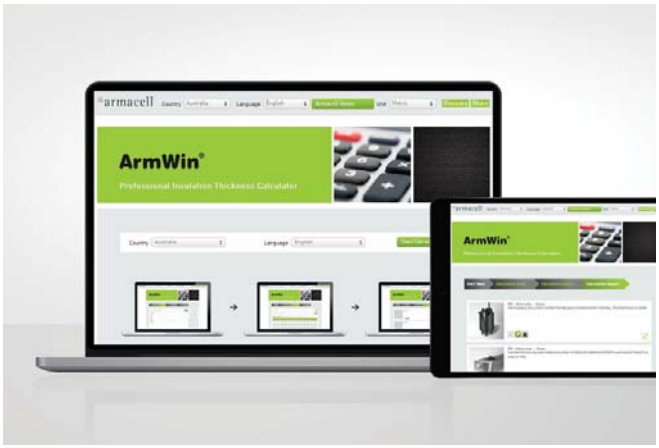
TECHNICAL CALCULATION TOOLS

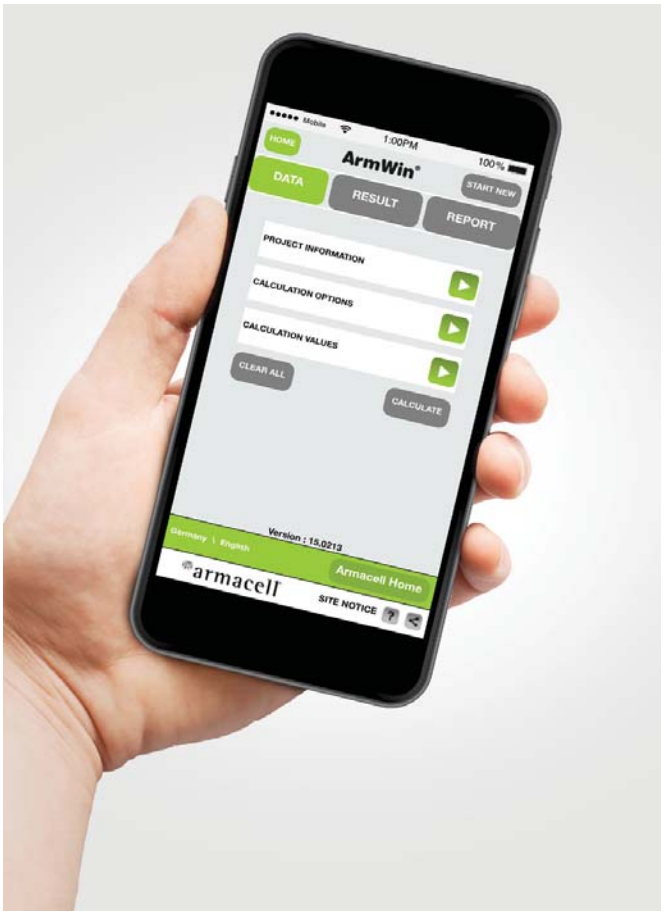
ARMWIN

Armacell have a free online and downloadable program called ArmWin used for calculating insulation thicknesses. ArmWin is based on the same calculation methods given in EN ISO 12241.

ArmWin can be used to calculate thickness requirements for various applications, such as for heat losses, condensation control, frost protection, temperature changes and energy and cost savings.

The latest version of ArmWin is available online and as an App.





QUANTITY GUIDES

Guides are available to calculate the required amount of Armaflex and accessories to insulate your pipework.

ACOUSTIC CALCULATION TOOLS

We have calculation tools to work out typical noise reductions on internally lining ductwork with Armaflex or ArmaSound RD as well as for acoustically insulating industrial pipework to meet EN ISO 15665.

SPECIFICATION CLAUSES

01 - GENERAL

01 – 01 SCOPE

- All low and medium temperature heating pipework, domestic hot water pipework, waste water, chilled and refrigeration pipework and air-conditioning ductwork shall be insulated to prevent condensation, freezing and energy losses. Associated equipment, flanges, fittings and supports shall also be insulated.

- Acoustic insulation of engineering service pipe and ductwork to prevent nuisance mechanical service noise shall also be considered.

01 – 02 STANDARD REFERENCES

The materials, components and completed installations shall conform to applicable Standards current at the time of tendering.

Relevant standards may include:

- **BS 476** Fire Tests on Building Materials and Structures.

- **BS EN 12667** Thermal performance of building materials and products. Determination of thermal resistance by means of guarded hot plate and heat flow meter methods. Products of high and medium thermal resistance.

- **BS 3533** Glossary of terms relating to thermal insulation.

- **BS 5970** Thermal insulation of pipework and equipment in the temperature range of -100°C to + 870°C

- **BS 5422** Method for specifying thermal insulation materials for pipes, tanks, vessels, ductwork and equipment operating within the temperature range -40°C to +700°C.

- **EN 13501-1** Fire classification of construction products and building elements. Classification using test data from reaction to fire tests.

- **EN 14304** Specification of thermal insulation products for building equipment and industrial applications. Factory made flexible elastomeric foam (FEF) products.

01 – 03 SERVICES TO BE INSULATED

- All low and medium temperature heating pipework, domestic hot water pipework, waste water, chilled, cold and refrigeration pipework and air-conditioning ductwork shall be insulated to prevent condensation, freezing and energy losses. Associated equipment, flanges, fittings and supports shall also be insulated.

- Acoustic insulation of engineering service pipe and ductwork to prevent nuisance mechanical service noise shall also be considered.

- The installation work shall be carried out by suitably trained insulation contractors who hold TICA membership.

01 – 04 PIPEWORK CLEARANCES

- Shall be sufficient to allow for the full thickness of insulation specified to be applied.

- Be sufficient to allow for the application of high density insulated pipe supports between the pipe and any pipe clips or hangers. This will also include provision for acoustic de-coupling function.

01 – 05 FIRE PENETRATION SEALING

- Where service pipework passes through a fire resistant barrier, Armaflex Protect shall be applied to the pipework throughout the penetration. Armaflex Protect shall be installed as to the manufacturer's recommendations and to a thickness sufficient to match the fire resistance rating of the wall or barrier.

02 – MATERIALS

02 – 01 GENERAL

All insulation materials shall be:-

- Obtained, where available from an ISO 9001:2015 "quality systems" and ISO 14001:2015 "environmental systems" certified manufacturer.

- Shown to be formaldehyde free in order not to contribute towards the maximum long term exposure limit of 2 parts per million (as recommended by the HSE).

- Shown to inhibit the growth of mould.

- All Armaflex materials shall be installed as to the manufacturer's recommendations using the appropriate Armaflex adhesive to fully seal all seams and provide a full vapour barrier to the insulation system:

Product	Appropriate Adhesive
HT/Armaflex	Armaflex HT/625 Adhesive
Armaflex Ultima	Armaflex Ultima 700 Adhesive or Armaflex Ultima RS850 Adhesive
All other Armaflex products	Armaflex 520 Adhesive or Armaflex RS850 Adhesive

- Insulation installed in locations exposed to weather conditions shall be provided with a suitable weather resistant finish in the form of a covering of Armafinish 99 UV protective paint or Armaflex Tuffcoat, Arma-Chek R or Arma-Chek Silver products used.

- All thermal insulation shall have an ozone depletion potential (ODP) and global warming potential (GWP) of 0 as required.
- The thermal insulation must be CE marked in accordance with the relevant European standard EN 14304. Non-CE marked products should not be sold or imported for sale in the EU.

- All AF/Armaflex Class 0, Armaflex Tuffcoat & ArmaSound RD shall be manufactured in the UK by **Armacell UK Ltd** in Oldham.

03 – INSULATION

03 – 01 SELECTION

Shall be:-

FOR HOT WATER SERVICE PIPEWORK:

- AF/Armaflex Class 0 elastomeric nitrile rubber with a Class 0 fire rating when tested under BS 476 Part 6 and BS 476 Part 7 or Armaflex Ultima with Euroclass B-s1,d0 fire rating according to EN 13501-1. The material shall be CFC and H-CFC free. The material shall incorporate Microban® anti-microbial protection to actively inhibit the growth of mould.

FOR INTERNAL COLD AND WASTE WATER SERVICES PIPEWORK:

- AF/Armaflex Class 0 elastomeric nitrile rubber with a Class 0 fire rating when tested under BS 476 Part 6 and BS 476 Part 7 or Armaflex Ultima with a Euroclass B-s1,d0 fire rating according to EN 13501-1. The thickness of insulation shall be

sufficient to prevent condensation and freezing under specified conditions. The material shall be CFC and H-CFC free. The material shall incorporate Microban® anti-microbial protection to actively inhibit the growth of mould.

FOR EXTERNAL COLD AND WASTE WATER SERVICES PIPEWORK:

One of the following options:

- UV resistant HT/Armaflex elastomeric EPDM rubber. The thickness of insulation shall be sufficient to prevent freezing under specified conditions. The material shall be CFC and H-CFC free.
- AF/Armaflex Class O elastomeric nitrile rubber either painted using Armafinish 99 UV resistant paint or covered with Arma-Chek R polymeric covering.
- Armaflex Tuffcoat (AF/Armaflex Class O pre-covered with a black or white PVC film) for protection against UV, impact damage and bird attack.
- Arma-Chek Silver (AF/Armaflex Class O pre-covered with a silver PVC laminate) for protection against UV, impact damage and bird attack.

FOR INTERNAL LOW AND MEDIUM TEMPERATURE HEATING SERVICE PIPEWORK:

- AF/Armaflex Class O elastomeric nitrile rubber with a Class O fire rating when tested under BS 476 Part 6 and BS 476 Part 7 or Armaflex Ultima with at least Euroclass B-s2,d0 fire rating according to EN 13501-1. The material shall be CFC and H-CFC free. The material shall incorporate Microban® anti-microbial protection to actively inhibit the growth of mould.

FOR EXTERNAL LOW AND MEDIUM TEMPERATURE HEATING SERVICE PIPEWORK:

One of the following options:

- UV resistant HT/Armaflex elastomeric EPDM rubber. The material shall be CFC and H-CFC free.
- AF/Armaflex Class O elastomeric nitrile rubber, either painted using Armafinish 99 UV resistant paint or covered with Arma-Chek R polymeric covering.
- Armaflex Tuffcoat (AF/Armaflex Class O pre-covered with a black or white PVC film) for protection against UV, impact damage and bird attack.
- Arma-Chek Silver (AF/Armaflex Class O pre-covered with a silver PVC laminate) for protection against UV, impact damage and bird attack.

FOR INTERNAL DUCTWORK:

- AF/Armaflex Class O elastomeric nitrile rubber with a Class O fire rating when tested under BS 476 Part 6 and BS 476 Part 7 or Armaflex Ultima with at least Euroclass B-s2,d0 fire rating according to EN 13501-1. The thickness of insulation shall be sufficient to prevent condensation. The material shall be CFC and H-CFC free. The material shall incorporate Microban® anti-microbial protection to actively inhibit the growth of mould.

Or:

- Armaflex Duct Plus elastomeric nitrile rubber sheets with a Euroclass B-s3, d0 fire rating, tested according to EN 13501-1 (available in 1.5m wide format and with or without self-adhesive backing and silver foil covering – Armaflex Duct AL).

FOR EXTERNAL DUCTWORK:

One of the following options:

- AF/Armaflex Class O elastomeric nitrile rubber with Arma-Chek R protective covering.
- Armaflex Tuffcoat (AF/Armaflex Class O pre-covered with a black or white PVC film) for protection against UV, impact damage and bird attack.
- Arma-Chek Silver (AF/Armaflex Class O pre-covered with a silver PVC laminate) for protection against UV, impact damage and bird attack.

PRE-INSULATED SOLAR PIPES

- Armaflex DuoSolar is a pre-insulated stainless steel flow and return pipe with temperature sensor for connecting solar collectors to hot water storage tanks. For temperatures up to 150°C standard Armaflex DuoSolar can be used. For temperatures up to 220°C DuoSolar 220 should be used.

PIPEWORK ALREADY INSTALLED

- Where the solar pipes are already installed high temperature HT/Armaflex should be installed.

FOR HIGH TEMPERATURE APPLICATIONS (ABOVE 110°C):

HT/Armaflex is suitable for high temperature applications with line temperatures:

- Up to +125°C without further considerations

Insulation thickness for temperatures above +125°C and up to +150°C the following should be noted:

- As a result of long term exposure to high temperatures, especially above +125°C, the HT/Armaflex insulation may harden. The hardening process may have a minor effect on the overall thermal efficiency of the insulation system and a high service temperature may influence life expectancy of the insulation system. A full hardening of the material is highly unlikely if the below-mentioned insulation thicknesses are met.

In order to ensure the function and reliability of the insulation system we recommend the following minimum insulation thickness:

Service temperature in continuous or prevailing operation	≥ +125°C	≥ +135°C
Minimum recommended HT/Armaflex insulation thickness	19mm	25mm for tubes 32mm for sheets

HT/ARMAFLEX WITH RIGID CLADDING ON HOT APPLICATIONS:

- If the HT/Armaflex is additionally clad with non-elastic coverings, consideration should be given to the installation with regards to clearance and fixing of the covering in order to allow a possible expansion of the HT/Armaflex due to temperature increase. One solution is to use 50mm wide HT/Armaflex strips or HT/Armaflex tape placed longitudinally or circumferentially on the final layer of insulation to provide the necessary clearance considering the weight of the covering and the rate of temperature increase.

HT/ARMAFLEX WITH ARMA-CHEK R COVERING:

- Arma-Chek R has been developed to work in harmony with the expansion and contraction of HT/Armaflex.

- In the case of all over adhesive covering of HT/Armaflex with a non-porous covering, it will take longer for the adhesive solvents to diffuse out. In this case a curing time of one week is recommended before the application is put into operation.

APPLICATIONS ABOVE 150°C:

- If the application temperature is above 150°C a suitable insulation product, capable of being used at temperatures above 150°C, must be applied as a first layer before applying HT/Armaflex in order to reduce the interface temperature to below 150°C.

FOR PROJECTS REQUIRING NON-HALOGENATED MATERIALS:

- Non-halogen NH/Armaflex is to be used for any projects that require materials to be completely halogen free. If used externally NH/Armaflex requires UV protection in the form of two coats of Armafinish 99 paint or a covering such as Arma-Chek R.

03 – 02 THERMAL INSULATION MATERIALS

Material	Temp Range	"K" Value W/mK at mean temp	ODP Rating	GWP Rating	Fire Class	Typical material density kg/m³
AF/Armaflex Class O	-50°C to +110°C	0.033 @ 0°C	0	0	Class O	45-65
HT/Armaflex	-50°C to +150°C	0.042 @ 40°C	0	0	Class 1	60-90
Armaflex Ultima	-50°C to +110°C	0.040 @ 0°C	0	0	B-s1,d0 / B-s2,d0	50-90
Armaflex LTD	-180°C to +110°C	0.040 @ 0°C	0	0	Class 1	60-80
Armaflex Duct Plus	-50°C to +110°C	0.036 @ 0°C	0	0	B-s3, d0	45-65
Armaflex Tuffcoat	-50°C to +110°C	0.033 @ 0°C	0	0	Class O	45-65
Arma-Chek Silver	-50°C to +110°C	0.033 @0°C	0	0	Class O	45-65
NH/Armaflex	-50°C to +110°C	0.040 @ 0°C	0	0	Class 1	55-70
Armaflex DuoSolar	-50°C to +150°C	0.042 @ 40°C	0	0	Euroclass E	60-90
Armaflex DuoSolar 220	-50°C to +150°C	0.040 @ 40°C	0	0	B1	60-90
Armaflex Protect	-50°C to +85°C	0.056 @ 0°C	0	0	R120	140-310

04 – PROTECTION AND PROTECTIVE COVERINGS

04 – 01 INTERNAL COVERINGS

Shall be:

For AF/Armaflex Class O elastomeric nitrile rubber and high level insulated pipework or concealed insulated pipework:

- No additional protective covering shall be required.

For exposed pipework at low levels:

- Armaflex Tuffcoat or Arma-Chek Silver PVC coverings or Arma-Chek D woven glass fibre cloth bonded using an appropriate full contact adhesive with a minimum 50 mm overlap at all butt joints and longitudinal seams can be used. Installation shall be in all cases to the manufacturer's recommendations.

- All excess adhesive visible on the surface of the completed assembly shall be removed using an appropriate cleaning fluid such as Armaflex Cleaner.

04 – 02 EXTERNAL COVERINGS

Shall be:

For HT/Armaflex:

- No covering shall normally be required when using HT/Armaflex outdoors due to the natural in-built resistance against UV degradation.

For AF/Armaflex Class 0 elastomeric nitrile rubber:

Either:

- UV resistant Armaflex Tuffcoat or Arma-Chek Silver PVC coverings (pre-covered tubes and sheet available). Seams to be bonded using Armaflex 520 or RS850 adhesive and covered using Armaflex Tuffcoat or Arma-Chek Silver tapes respectively (Armaflex Tuffcoat mastic also recommended to provide a watertight seal for outdoor applications). All material shall be overlapped and staggered in such a way as to ensure a watershed is always provided. Installation shall be in all cases to the manufacturer's recommendations.

- All excess adhesive visible on the surface of the completed assembly shall be removed using an appropriate cleaning fluid such as Armaflex Cleaner.

- Arma-Chek Silver requires expansion gaps on hot applications or dual temperature applications to allow for the expansion and contraction of Armaflex.

Or:

- High density polymeric cladding such as "Arma-Chek R" bonded using an appropriate full contact adhesive with a minimum 50 mm overlap at all butt joints and longitudinal seams. A weather proof Arma-Chek mastic sealant shall be applied over all seams and joints. All material shall be overlapped and staggered in such a way as to ensure a watershed is always provided. Installation shall be in all cases to the manufacturer's recommendations.

- All excess adhesive visible on the surface of the completed assembly shall be removed using an appropriate cleaning fluid such as Armaflex Cleaner.

- Arma-Chek R expands and contracts with the insulation, so there is no requirement for expansion gaps.

04 – 03 METAL CLADDINGS

Metal cladding or claddings with a reflective, low emissivity surface, will have an effect on the thickness requirements, please refer to the thickness tables for the correct thickness to use.

The expansion of Armaflex during exposure to service temperatures above +40°C is a natural phenomenon. In order to accommodate the expansion behaviour of Armaflex when covered with rigid claddings, an expansion ring needs to be installed between the outer layer of insulation and the rigid cladding.

The following procedures shall be followed:

Expansion rings shall be fabricated from various thicknesses of Armaflex sheet and/or Armaflex self-adhesive insulation tape of 3mm thickness in one or more layers, depending on the required thickness. The width of the expansion rings shall be 50mm (see figure 1). The expansion ring thickness should be taken from Table 3.1.

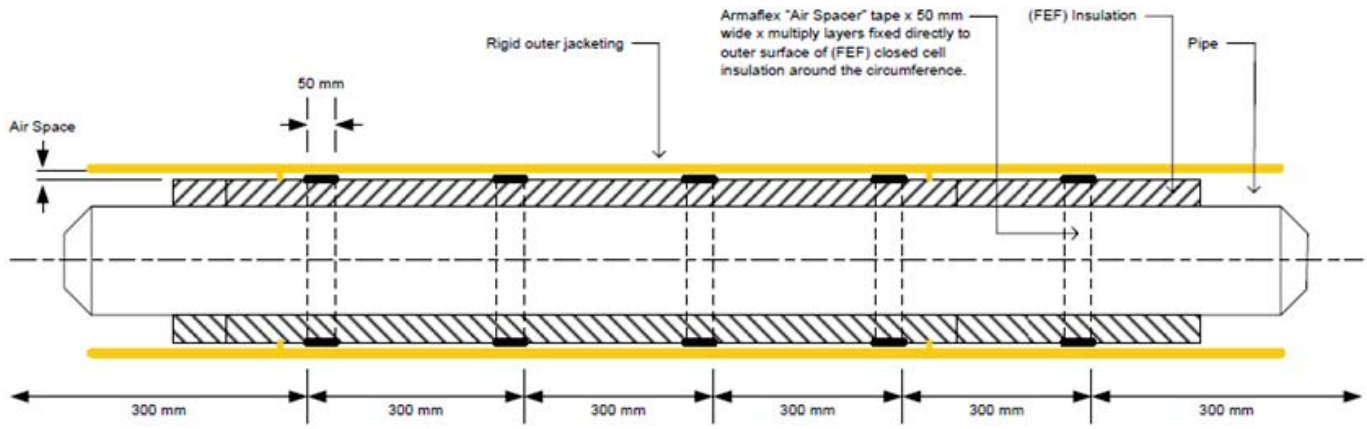


Figure 1

Table 3.1. Expansion ring thickness allowance for Thermal Insulation Expansion ring material

Nominal Pipe Size (Inch)	Operating Temperature Expansion ring thickness (mm)					
	40°c	60°c	80°c	100°c	120°c	125°c and above
1/2"	3	3	3	6	6	6
3/4"	3	3	3	6	6	6
1"	3	3	6	6	6	6
1 1/2"	3	3	6	6	6	10
2"	3	3	6	6	6	10
3"	3	3	6	6	10	10
4"	3	3	6	6	10	10
6"	3	6	6	10	10	13
8"	3	6	6	10	13	13
10"	3	6	6	10	13	13
12"	3	6	6	10	13	13
14"	3	6	10	10	13	13
16"	3	6	10	10	13	13
18"	3	6	10	10	13	13
20"	3	6	10	10	13	13
24"	3	6	10	13	13	13
>24" & Flat surface	3	6	10	13	13	13

The expansion rings shall be applied at 300mm centres throughout the entire length of the insulated piping system including all attached piping fittings. See Figure 1.

The expansion rings shall be fixed and secured with Armaflex adhesive directly around the circumference of the outer surface on the insulation. In addition, for horizontal pipes, a 50mm wide longitudinal strip shall be applied at the twelve o'clock position fitting inbetween the circumferential expansion rings

For all vertical pipe lines, the expansion rings shall be installed in the same manner as for horizontal piping, except for the longitudinal strips.

04 – 04 VAPOUR BARRIERS

Shall be:

For AF/Armaflex Class 0 elastomeric nitrile rubber and Armaflex Ultima:

Built into the insulation material. The insulation shall have a moisture resistance factor no less than 6,000 μ. No additional external water vapour barrier shall be necessary.

For HT/Armaflex:

Built into the insulation material. The insulation shall have a moisture resistance factor no. less than 3,000 μ. No additional external water vapour barrier shall be necessary.

04 – 05 INSULATION OF PIPEWORK SUPPORTS

Shall:-

In all cases have all pipe clips and hangers attached to the outside of the insulation. Metal saddles to be used to prevent crushing of the insulation. Be applied such that pipes are acoustically de-coupled from the building structure. High load bearing pipe supports of the Armafix type shall be preferred and installed to manufacturer's recommendations.

On cold lines be insulated with a thickness sufficient to prevent condensation.

04 – 06 INSULATED VALVE AND FLANGE COVER BOXES

Shall be manufactured directly from the insulation material itself according to the manufacturer's recommendations. The covering of fabricated flange or valve covers shall be the same as the insulation on the remainder of the attached service pipes.

05 – UNDERGROUND PIPES

05 – 01 INSULATED BURIED PIPES

Pressure of soil backfill on top of Armaflex will cause compression of the material, which will have an impact on the insulation wall thickness.

It is recommended that Armaflex is protected against compression by sleeving the insulated pipe into a rigid soil or waste water drainage pipe.

1. Prevent compression of flexible cellular material due to contact with the outer protective pipe by selecting a drainpipe which is sufficiently larger than the outer diameter of the insulated pipe assembly to be inserted.
2. Ensure the outer protective pipe is fully supported, e.g. by having full contact with the surrounding soil, to prevent the drainpipe breaking. Joints and connections are particularly venerable.
3. For applications buried below the water table the protective outer pipe should be fully sealed and made water tight.

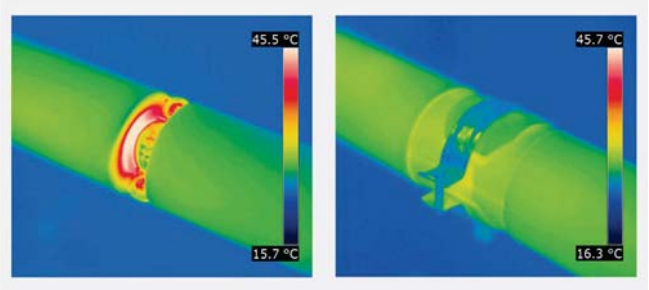
Technical Articles

IMPROVING ENERGY EFFICIENCY WITH INSULATED PIPE BRACKETS

Insulating clamps and fittings in heating and cooling systems is just as important as insulating the pipework itself. In central heating services the purpose of insulating pipework and fittings is to minimise heat loss, and heating and plumbing pipes are insulated as a matter of course according to the building regulations. However, pipe supports are often overlooked and can remain un-insulated or incorrectly insulated. Pipe brackets that are un-insulated can cause significant heat losses in a system.

The consequences of pipe brackets not being insulated can be seen in **figure 1** using a thermal imaging camera. The extent of this loss of energy can be significant, with thermal heat flow calculations for a 60°C hot water pipe in continual use, showing a heat loss of 0.06 w/k per bracket (on a 26.9mm diameter copper pipe with a 27mm insulation thickness). This can have a major effect in total energy costs of running a building, especially where a large number of supports are used.

Figure 1: Depending on the pipe diameter, the heat loss from an un-insulated pipe bracket (shown on the left) can be equivalent to that from up to 1m of un-insulated pipe.



INSULATING PIPE BRACKETS ON COLD SERVICES

The direct fixing of cold services pipework to their mounting brackets acts as a bridge for thermal gains from surrounding warmer ambient air. Since these un-insulated supports on chilled water and refrigeration pipework fall below the dew point, the cold air surrounding the brackets is less able to hold water, causing a difference in partial vapour pressure. In these conditions, moisture is continually drawn to the cold brackets, diffusing and condensing into the adjoining insulation material. If the condensation spreads through the insulation system thermal efficiency is lost and corrosion and consequential secondary damage will result (**see figure 2**).

Pipes in refrigeration and air-conditioning applications must therefore always be isolated from their mounting element with an adequate closed-cell insulation thickness, taking into account the line temperature, pipe size, ambient temperature and relative humidity conditions.

Figure 2: Consequences of not insulating pipe clamps on refrigeration pipes

USING NON-COMPATIBLE CLAMPS ON COLD INSTALLATIONS

PUR/PIR clamps are often used to mount pipes. However, tests on the reliability of bonds between elastomeric insulation materials and these clamp types shows that it is not always effective. In fact, the connection can be a weak point, allowing condensation to form and, in some cases, ice as shown on **Figure 3**.

Figure 3: After cold services equipment has been in operation for a while condensation and eventually ice will form

A reliable connection between the clamps and an elastomeric insulation material can only be achieved by encasing the PUR/PIR clamp with insulation.

INSULATED PIPE SUPPORTS AS SYSTEM COMPONENTS

Alternatively pipes and pipe brackets in cold applications can be thermally isolated from each other by installing pre-fabricated elastomeric insulation supports such as the Armafix range. Compatible and available for all Armaflex tubes and sheet types, this ensures that the key technical requirements for insulation of brackets on cold installations are covered with a low thermal conductivity and high μ-value material (resistance to water vapour transmission).

Integrated load-bearing segments prevent the insulation material being compressed and are themselves protected against moisture absorption with fully-glued vapour barriers. In addition outer metal shells serve to distribute the load. Easy to install Armafix supports are also available for air-conditioning ducts (traverses).

Figure 4: The Armafix pipe support is available with an environment-friendly, lightweight PET core

Figure 5: Installing Armafix pipe supports

NITRILE RUBBER THERMAL INSULATION MATERIALS FOR COLD AIR SUPPLY DUCTING

Ducts that transport cool air need a good thermal insulation solution in order for the required supply temperature to be maintained. By preventing heat gain transferring from warmer air outside the duct, the correct insulation material ensures a more efficient HVAC system operation, with less power required to maintain the cold air supply temperatures.

CONDENSATION

For cold air supply applications a key consideration is prevention of condensation on the outside of ducting in warmer ambient and high humidity conditions. Increases in relative humidity levels in particular have a dramatic effect on the thickness of insulation required, and failure to adequately insulate ventilation systems in these conditions can lead to expensive consequential damage and corrosion of ductwork. On the other hand, the correct choice of insulation material, with adequate space allowed for air flow around the ducting to prevent cold build up zones, will ensure the surface temperature of cold air ductwork is kept above the ambient temperature, preventing ductwork surfaces from falling below the dew point.

ELASTOMERIC INSULATION

Nitrile rubber sheet provides a number of advantages for cold air ducting, owing to the closed cell structure providing an in-built resistance to condensation and water vapour ingress, with no additional vapour barrier required. Mineral wool and phenolic alternatives are reliant on the integrity of an external foil vapour barrier to prevent moisture penetrating and wicking through the insulation. Any gaps or pin holes in the system can lead to moisture ingress and a loss of thermal performance. Closed cell products with a high resistance to water vapour transmission (mu factor) built up throughout the material thickness can provide a longer term thermal performance, with a low thermal conductivity (for example 0.033 W/[m • K] for AF/Armaflex Class 0 nitrile rubber). The black rubber material also has a higher surface emissivity value, helping to bring the outer temperature above the dew point, with reduced insulation thickness required compared to shiny / reflective finishes.

INSTALLATION CONSIDERATIONS

The flexible properties of elastomeric rolls and sheet also provide a good solution when it comes to installation. The sheets can be easily cut to size for rectangular panels, bends and supports and to exactly fit around the circumference of circular ducting. Sections are cut with an additional 5mm to allow for compression sealing and to accommodate expansion and contraction of the material once the system is operational. This method ensures no gaps are left and use of the appropriate adhesive on all longitudinal and circumferential joins provides a seamless vapour seal against condensation on cold air supply systems. Higher density duct supports sections are available with PET inserts to prevent compression at hangers and Armaflex tubes can be used to encapsulate and cover flanged joints to prevent thermal bridging.

Nitrile rubber is suitable for operating temperatures down to -50°C and have a Class 0 fire rating for use in commercial premises such as offices, hotels, schools, hospitals, supermarkets, shops and process applications.

For aesthetic considerations nitrile rubber sheets are available with an alu foil facing. For additional mechanical impact resistance and protection against damage from birds and vermin, sheets with a pre-applied PVC covering are also available. Sheets with the covering may be secured with compatible tapes and mastics for

weather proofing outdoors. On rectangular ducting, horizontal sheets should overlap insulation on the vertical panels to prevent moisture damage. On circular ducting a 50mm overlap on the covering should be sealed on the underside of the duct, facing downwards (water shed effect).

All sheets are available with a self-adhesive backing for fast fixing in place or can be glued in place using a suitable contact adhesive.

ACOUSTIC AND ANTI-MICROBIAL PROPERTIES

Nitirle rubber products such as Armaflex also provide significant sound absorption advantages. When used as an external acoustic lining, noise break-out from the duct wall can be significantly reduced. Isolating ducting from hanging brackets also reduces the transfer of sounds reverberating through the structure of the building.

AF/Armaflex Class O also comes with Microban anti-microbial protection built-in, offering enhanced resistance against bacteria and mould growth. This makes AF/Armaflex Class O suitable for use in offices, schools and hospitals.

Application guidance and a calculation tool to work out the correct thickness of insulation required for cold air ducting can be found online at www.armacell.co.uk.

PROTECT AGAINST LEGIONELLA WHEN INSTALLING PIPEWORK

Heating and plumbing pipework, air-conditioners, swimming pools and whirlpools are well-known sources of legionella infection. The bacteria multiplies where the water temperatures are between 20-45°C and nutrients are available. As buildings have become more energy efficient it has meant that cold water pipes have the potential to warm above 20°C and in these situations legionella is a risk, especially when combined with extended periods of stagnation, both of which result in optimal conditions for bacteria growth. Traditionally' flushing systems have been used to beat legionella, although this is water intensive, wasteful and relies on personnel carrying out the task on a regular basis.

The risk of legionella rises in summer because during the holiday period water stagnates in the pipes and buildings are becoming superheated due to improved energy efficiency and greater air tightness causing water temperatures to rise, making HVAC and plumbing systems an ideal breeding ground for this hazardous bacteria. Elderly people are usually worst at risk of legionella or those who have pre-existing conditions, such as diabetes, lung or heart disease or have problems with immunosuppression. That makes it a particular concern in residential homes as well as hospitals and schools.

Legionella is contracted by inhaling airborne water droplets and these droplets can be created by most hot and cold water outlets, atomisers, showers and wet air conditioning plant. On average there are around 15,000 cases each year, a concerning statistic for anyone involved in building design and management.

INSULATE COLD PIPES

As water conservation becomes more important, the industry is looking for environmentally friendlier methods of reducing the risk of legionella, other than flushing systems. One of the most important preventative measures for reducing the risk of this disease is to insulate both hot and cold water pipes using suitable materials. That is because poorly chosen insulation can lead to the HVAC system operating in optimum conditions for the bacteria, which usually means the 'cold' water temperatures regularly rising to above 20°C, although poorly insulated hot water pipework could also create the same conditions if temperatures fall below 45°C.

There are a number of steps that heating engineers can take to maintain water temperatures at a level that don't support bacteria growth, apart from ensuring that the water circulates continuously.

In terms of pipework layout too, there are some simple steps that can be taken, such as ensuring that pipes for cold drinking water don't follow the same routes or run adjacent to space heating or hot water pipes. Cold water pipes should also be protected against heat gain by ensuring sufficient clearance or preferably by insulating properly. Similar requirements apply for hot water pipes to protect them against heat loss.

If hot and cold pipes are laid in one duct or wall cavity, or wherever water is not circulated regularly, we recommend using what is known as 100% insulation. That is where the insulation thickness roughly corresponds to the pipework outer diameter. For example, if the pipe is 22mm diameter, insulation thickness used would also be 22mm.
On hot water pipes this not only prevents legionella, but also protects the pipes against unnecessary energy losses. On cold water pipes the insulation provides

protection against freezing in cold weather as well as providing protection against unwanted temperature rises.

Suitable insulation materials also prevent condensation. The best material for this is closed-cell insulation which has a high resistance to water vapour diffusion, making it ideal for use on cold drinking water pipes. In practice, accidental damage to insulation has shown that open-cell insulation materials, whether specified with or without a vapour barrier, do not sufficiently prevent moisture ingress as a result of diffusion.

This means that there is a danger of water vapour in the air penetrating open cell insulation, condensing and saturating the insulation material. As the material becomes damp, the thermal conductivity increases and insulation properties deteriorate, causing greater energy losses, and a greater risk of hot water pipes creating conditions for legionella bacteria. Furthermore, corrosion and

other expensive consequential damage can occur. Plus, by preventing moisture ingress and providing no ready food source, closed cell insulation discourages the growth of microbes. AF/Armaflex Class 0 has additional anti-microbial protection built in, giving active protection against microbial growth.

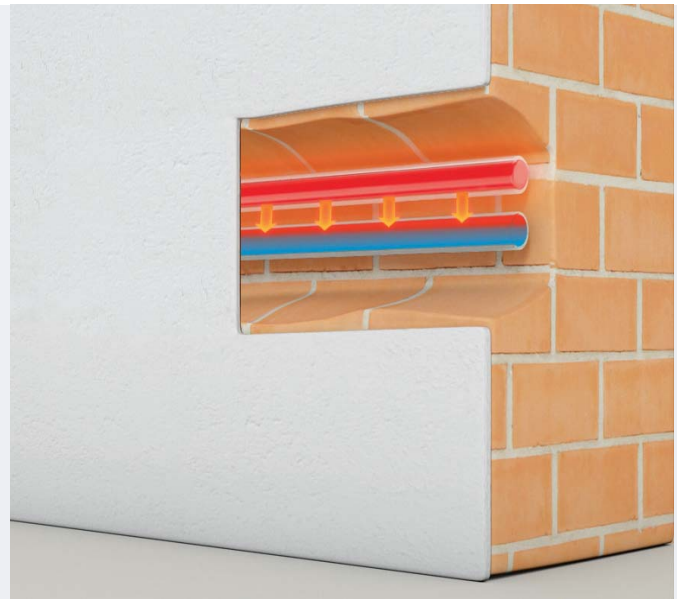
A CLOSED CASE

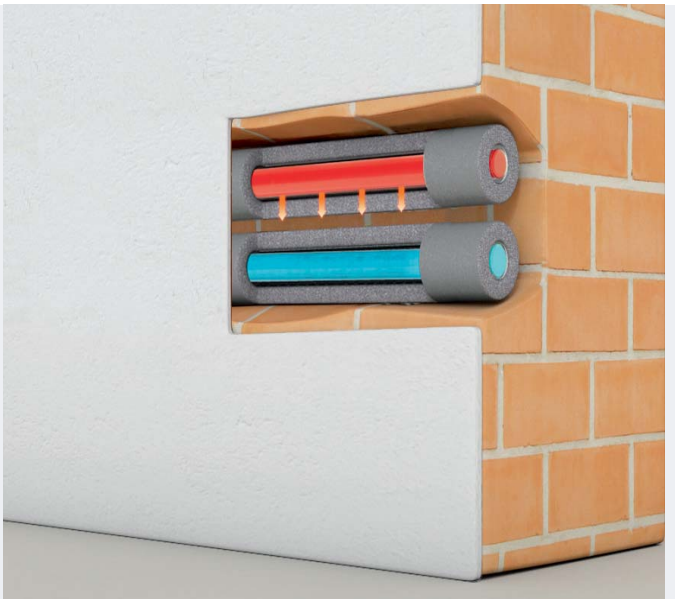
Closed-cell insulation, due to its excellent technical properties, prevents unacceptable increases or decreases in water temperature. The closed-cell material structure of the insulation also prevents energy losses, moisture ingress and the subsequent corrosion of heating and plumbing pipework, plus acts in an antimicrobial manner. Legionella is a constant threat in well insulated buildings and a common source of this bacteria comes from air-conditioners, showers, drinking water, swimming pools and whirlpools.

However, the root cause of the infection is commonly errors made in the choice of insulation. One of the most important preventative measures to avoid this potentially fatal disease is to insulate hot and cold water pipes with closed-cell insulation. It can rightly be seen, therefore, that the plumber's job is defender of public health, a role that is often overlooked by those not in the trade.

CHECKLIST

- The temperature of hot drinking water pipes should not fall below 55°C
- The temperature of cold drinking water pipes should not exceed 25°C
- Hot and cold water pipes should be laid a sufficient distance apart to prevent temperature transfer
- When installing pipework, ensure that there is enough space for insulation
- Only closed-cell insulation materials should be used on cold water pipes to prevent condensation and energy loss
- The insulation thickness on cold pipes should be roughly equal to the pipe outer diameter





CONDENSATION CONTROL – THE NEED FOR LOW-TEMPERATURE INSULATION

Correctly specified insulation can prevent condensation in refrigerated systems whilst resulting in energy and CO2 savings. A better understanding of how condensation forms and advances in both insulation performance and methods of calculating the thicknesses required make it easier to address this issue.

Whereas hot installations (heating and hot-water pipes) are mainly insulated to save energy, cold systems (such as the chilled-water pipes of air-conditioning systems or the suction lines of commercial freezers) need protection against condensation. On refrigeration systems, where the line temperature is lower than the ambient temperature, water vapour can condense on the cold surface causing condensation.

Eventually, this condensation on buildings and equipment can result in considerable costs. Apart from the expense of repairing the damage, there may be maintenance costs resulting from continually wet ceilings, spoilt goods or disruption to production processes. Moreover, as the insulation effect of a material deteriorates greatly when it becomes damp, energy losses may rise dramatically. Presence of moisture also leads to corrosion of the equipment.

Condensation control must therefore be the primary aim of any low-temperature insulation.

WHY CONDENSATION OCCURS

Condensation occurs simply because there is only so much water vapour that air can absorb. At 100% saturation, commonly known as the 'dew point', the air is saturated and it is at this stage that moisture is released in the form of droplets on cold surfaces, which rapidly become wet.

At a given temperature and with a given relative humidity, the air contains a defined amount of water vapour. If air is cooled down, it will reach this 100% saturation at a certain temperature. If the air is then cooled further, some of the water can no longer be held in the form of invisible water vapour and so begins to form liquid droplets. Warm air is able to absorb more water vapour than cold air and so cooling the air past the dew point will result in the formation of moisture on cold pipes and equipment. In the example below, cooling the air from +22°C to its dew point at 18.4°C, results in condensation (**Figure 1**).

Where the line temperature is lower than the ambient temperature, water vapour can condense on the cold surface causing condensation. Here, incorrectly specified insulation performs well at first, but after a certain operating time condensation or, as in this case, ice forms

Figure 1: Air cannot absorb an infinite amount of water vapour

The respective water vapour content of air at a given temperature can be taken directly from published tables, which are available on request. This data shows to what extent air of a certain relative humidity can cool without 100% saturation being exceeded and thus condensation forming. Normally air only contains a certain percentage of the maximum possible moisture. It is expressed as relative humidity and can be defined in two ways:

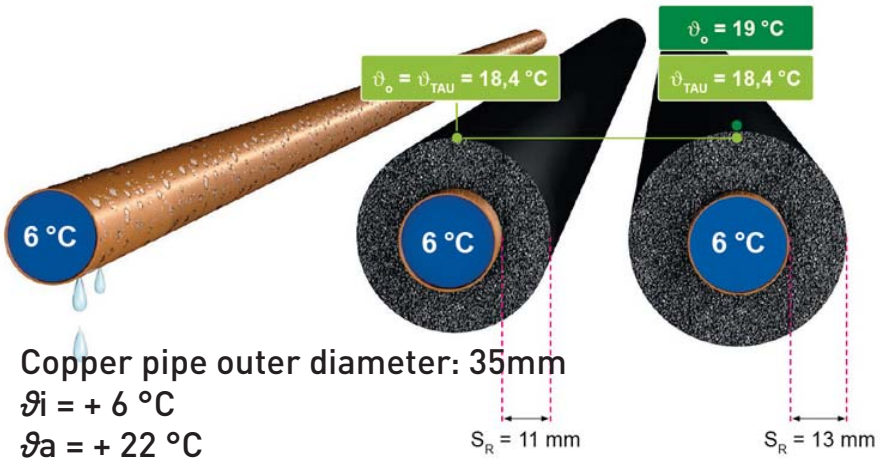
1. As one hundred times the value of the ratio of the existing moisture content to the maximum possible moisture content.

2. As one hundred times the value of the ratio of the water vapour partial pressure and the saturation pressure.

MAINTAINING TEMPERATURE ABOVE DEW POINT TO AVOID CONDENSATION

Applying this physical law to refrigeration applications means that the insulation thickness must be designed so that the temperature is never allowed to fall lower than the dew point anywhere on the surface of the insulation material. In **Figure 2**, the insulation thickness must be at least 11 mm in order to prevent condensation forming (ambient temperature 22° C, line temperature 6° C, relative humidity 80%, pipe outer diameter 35 mm). In practice, it is seldom possible to obtain a product with exactly the insulation thickness calculated. Therefore, the next largest insulation thickness is usually selected.

In order to prevent condensation, the surface temperature on the insulation must be as high as or higher than the dew point temperature under defined ambient conditions. Only correctly dimensioned insulation thicknesses can provide optimal protection against condensation.



To calculate the insulation thickness needed to ensure that the surface temperature is at least as high as the dew point, not only the line temperature but also the ambient conditions – ambient temperature and relative humidity – must be known or defined as expected maximum values as part of the planning process. In addition, it is necessary to determine the thermal conductivity of the insulation material, the object (pipe, duct and equipment) to be insulated and the heat transfer coefficient of the surface of the insulation.

Although these variables should be calculated by the insulation specialist or installer, it is crucial to know how the individual factors influence the dimensioning of the insulation and its future serviceability.

Copper pipe outer diameter: 35mm
ϑi = + 6 °C
ϑa = + 22 °C
ϕ = 80 %
Dew point =18.4 °C

Figure 2: The temperature must not fall below the dew point

THE INFLUENCING FACTORS THE AMBIENT CONDITIONS

In order to determine the minimum thicknesses for low-temperature insulation, assumptions must be made about typical ambient conditions. The maximum values listed in Table 1 were given by insulators, specifiers and plant operators and reflect the conditions typically used when dimensioning low-temperature insulation.

Table 1: Typical ambient conditions for low-temperature insulation		
Building	**maximum ambient temperature [°C]**	**maximum relative humidity [%]**
Plant rooms	32	75
Pipe shafts/ pipe ducts - 'dry'	24	65
- 'damp'	22	85
Cellar corridors	22	85
Ceiling cavities (suspended ceilings)	24	65
Rooms in offices, schools and hospitals	28	70
Underground car parks - badly ventilated	22	85
- ventilated	26	89
Food manufacturing	20	90

A common mistake is to underestimate the impact of the relative humidity on the insulation thickness needed to prevent condensation. For example, in some areas a 10 per cent increase in humidity can mean that the insulation needs to be twice as thick.

THE THERMAL CONDUCTIVITY OF THE INSULATION MATERIAL

The thermal conductivity values of materials typically used for technical insulation range from 0.030 to 0.060 W/(m•K). One parameter which influences the thermal conductivity is the mean temperature. In the case of elastomeric insulation materials such as AF/Armaflex Class 0, the thermal conductivity increases as the temperature rises. This has a decisive influence on the insulation thickness, because the lower the thermal conductivity, the thinner the insulation thickness. Reputable suppliers of insulation materials only declare the thermal conductivity of their materials in combination with the mean temperature.

THE HEAT TRANSFER COEFFICIENT

Heat transfer coefficient depends on the type of flowing medium, the flow speed, the character of the wall surface (rough or smooth, shiny or dark) and further parameters. The heat transfer coefficient usually consists of heat transfer through convection and heat transfer through radiation.

CONVECTION

Convection makes a substantial contribution towards improving the heat transfer coefficient. The faster the ambient air flows, the more heat is transported. Therefore, in practice and when designing plant, it is essential to ensure that pipes and ducts have sufficient clearance to each other, walls and other installations. If this isn't done it will prove difficult to install insulation material correctly and there is also the danger of a build-up zone being created. In such areas, the air circulation (convection) needed for a sufficiently high surface temperature is prevented. In these build-up zones, the heat transfer coefficient is lower (Figure 3). As a result, the risk of condensation forming increases significantly.

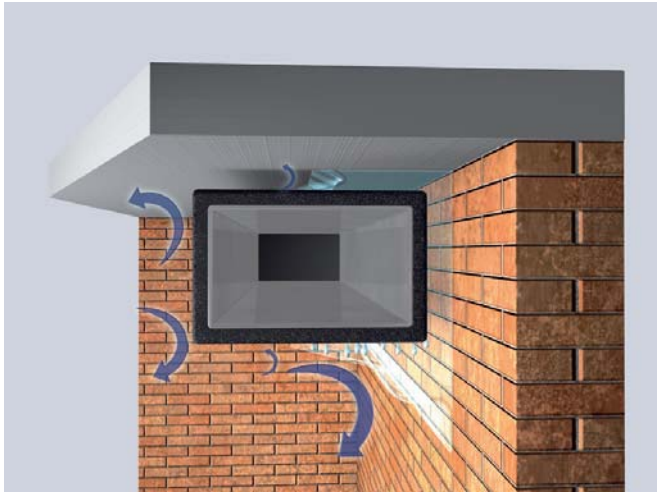


Figure 3: Build-up zones prevent convective heat transfer

Therefore, clearance of 25mm between the insulated pipes and from the pipes to the wall or ceiling is required. In the case of vessels and other equipment, the distance can be increased up to 100mm. Further details for the clearances can be found in the relevant standards.

THERMAL RADIATION

Thermal radiation is a type of heat transfer and occurs through electromagnetic waves. The transfer of energy through radiation is not restricted to one transfer medium. For example, unlike thermal conduction or convection (heat flow), thermal radiation can spread in a vacuum. In the case of thermal radiation, the mechanism of heat transfer consists of two sub-processes:

- Emission: on the surface of a body with a high temperature, heat is transformed into radiation energy.
- Absorption: the radiation which strikes the surface of a body with a lower temperature is transformed into heat.

Dark-coloured bodies emit more radiation energy than light-coloured ones; on the other hand, dark-coloured bodies absorb more thermal energy than light-coloured ones.

The measure for the emissive power of a material is the emission coefficient. The measure for the absorptive power is the absorption coefficient (a). The emissive power of a body of a certain colour is as great as its absorptive power. A vessel which is completely black has the greatest absorptive or emissive power. Table 2 shows the emission and absorption coefficients of some surfaces of insulation systems. As the table shows, it is largely the nature of the surface of the insulation material or its jacket – apart from the influence of other radiating bodies – which determines the contribution of radiation α to the heat transfer coefficient. A synthetic-rubber-based insulation material absorbs much more thermal energy than, for example, an aluminium foil. This has an extremely positive effect on the insulation thickness required to prevent condensation, so the higher the absorptive power, the lower the insulation thickness.

TABLE 2: EMISSIVITY (E) OF VARIOUS SURFACES

Material and surface condition	ε = a
Aluminium foil, shiny	0.05
Aluminium, oxidized	0.13
Steel, galvanized, shiny	0.26
Steel, galvanized, dusty	0.44
Stainless austenitic steel	0.15
Alu-zinc, smoothly polished	0.16
Arma-Chek Silver	0.83
Paint-coated sheet metal	0.90
Plastic covering	0.90
Flexible elastomeric foam	0.93
Arma-Chek R	0.93
Arma-Chek D	0.94

DETERMINING INSULATION THICKNESSES

A crucial factor when calculating the insulation thickness needed to prevent condensation is whether a flat surface or cylindrical object (pipe) is to be insulated. In the case of cylindrical objects, not only the ambient conditions, but the logarithmic ratio of the diameter of the insulated pipe to that of the un-insulated pipe must be included in the calculation. The consequence is that thinner insulation thicknesses are sufficient to achieve the same effect on pipes. In other words, thinner insulation is needed on pipes to obtain the same surface temperature as on flat surfaces.

To avoid having to carry out this complicated calculation, the ArmWin program can be used. Apart from the minimum insulation thickness required for condensation control, the program can be used to carry out all the typical calculations both in the refrigeration and air-conditioning sector and in the heating and plumbing sector.

We have completely updated our calculation program and now offer ArmWin as a user-friendly aid in on and offline mode and as an app. This allows technical calculations to be carried out much more easily and quickly, with the input required reduced to a minimum. New features include the possibility of entering individual data on the

project in question and storing calculations as a pdf. ArmWin app also provides various interactive functions: calculations can be mailed directly, the program is linked to product information on our website and key terms are explained in a glossary.

Figure 4: The ArmWin calculation software provided by Armacell

SUMMARY

Preventing condensation on the surface of pipework and equipment is a vital requirement in all refrigeration systems where the line temperature is lower than the ambient temperature.

To achieve this, low-temperature insulation must be correctly specified and be able to perform over the long term, even under critical conditions. A key element of this is ensuring that the correct insulation thickness has been used. Another crucial factor is the quality of both the material and the workmanship, since this can have a dramatic effect on performance.

Particularly in cold applications, it is worth having insulation work assessed, specified and installed by a specialist. Specifiers and installers often introduce an element of vulnerability into the system if they accept inferior quality, low-temperature insulation. Using unsuitable materials or specifying and installing inadequate insulation thicknesses will result in the refrigeration system being vulnerable to condensation.

Minimum insulation thicknesses, which prevent condensation, are usually not optimally designed for reducing energy losses. As the results of a study carried out by Armacell show, much higher energy - and CO2 - savings are possible if greater insulation thicknesses are specified. Greater levels of insulation, which means insulation thicknesses exceeding those required for condensation control, require slightly higher investments, however the pay back can be substantial if the savings are projected over the life of the system.

A COMPARISON OF INSULATION MATERIALS FOR LOW TEMPERATURE APPLICATIONS

The most important task of low-temperature insulation is to prevent condensation, since with every volume percentage increase in moisture content the thermal conductivity and insulation effect deteriorates. A reliable insulation system must therefore protect against water ingress and keep diffusion processes to a minimum.

The most important requirements for insulation materials for low-temperature applications are expressed by the following assessment criteria:

- low thermal conductivity [λ] in combination with
- high resistance to water vapour transmission [μ],
- fire behaviour which complies with the standards and
- ease of installation.

Insulation materials based on polyethylene (PEF) would be perfect based on their thermal conductivity and resistance to water vapour transmission, but in reality thermoplastics are extremely difficult to glue and to achieve a reliable bond on parts near valves etc.

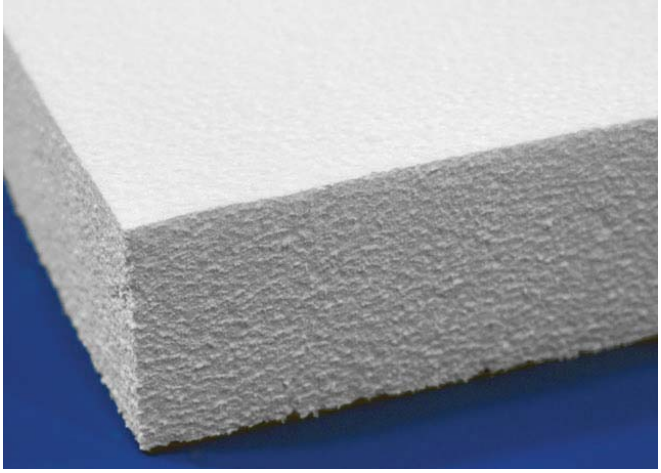
The insulation materials assessed in the following, therefore, are those on the basis of polystyrene (PS), polyurethane (PUR/PIR), phenolic resin (PF), cellular glass (CG) and elastomeric foam (FEF).

EXPANDED POLYSTYRENE FOAM (EPS)

Expanded rigid polystyrene is a predominantly closed-cell insulation material where the proportion of air-filled pores is up to 98%. The raw density of EPS rigid foam is usually between 10 and 35 kg/m³ and has a great influence on most of the characteristics of the foam.

The most important property of EPS rigid foam is its low thermal conductivity which depends on the raw density. The minimum thermal conductivity is recorded when the raw density is between 30 and 50 kg/m³ and ranges from 0.034 to 0.037 W/(m•K) when the mean temperature is 0°C. For a given raw density, the thermal conductivity of the foam is linear with the temperature. The moisture content has a significant impact on the thermal conductivity of the foam: thermal conductivity increases by 3 - 4% for every volume % increase in moisture.

The resistance to water vapour transmission (μ-value) of EPS rigid foam is low. In the case of raw densities ranging from 15 to 30 kg/m³, the μ-value is only 20 to 100. This means that moisture can penetrate the insulation material if there is an appropriate difference in vapour pressure. Therefore, if used as low-temperature insulation, EPS rigid foam must always be equipped with a vapour barrier made of metal foil – usually aluminium foil. In order to protect this foil vapour barrier an additional metal sheet is usually installed, making the installation process considerably more complex. EPS rigid foam is flammable and equipped with flame retardant. When exposed to a flame the foam melts away from the flame without being ignited. If the contact with the external flame is interrupted, the material does not continue to burn of its own accord. At 100°C, rigid polystyrene foams begin to soften and shrink. If heating continues, they melt. EPS can be used at temperatures ranging from +80 °C to -180°C.



EXTRUDED POLYSTYRENE FOAM (XPS)

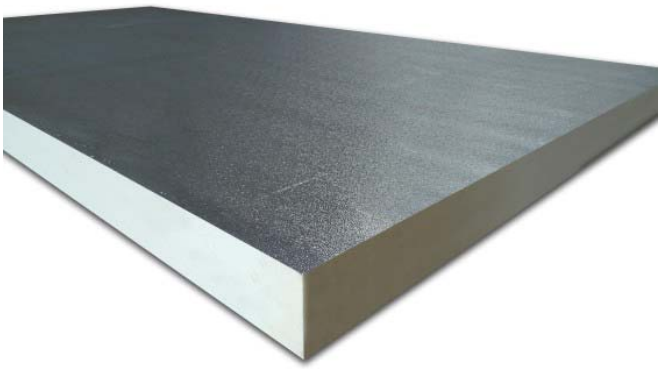
One important difference between the technical properties of extruded and expanded polystyrene foam is to be found in the higher compressive strength of XPS. Furthermore, the material has a slightly higher resistance to water vapour transmission than EPS rigid foam. Depending on the raw density, the μ-value lies between 80 and 200. This means that a separate vapour barrier is also absolutely necessary for this polystyrene insulation material.

RIGID PUR/PIR FOAM

Insulation materials made of rigid PUR foam are predominantly closed-cell, rigid foams. They are to > 90% closed-cell. The raw density of rigid polyurethane foam lies between 30 kg/m³ and 60 kg/m³ depending on the area of application. However, materials with considerably higher raw densities are available for special applications. As the raw density increases, so too does the amount of structural substance. As a result, the proportion of heat conductance via the structural substance increases. However, the rise in thermal conductivity is not proportional to the increase in raw density. Therefore, the thermal conductivity of products in the raw density range used in the construction sector only rises slightly. Of all traditional insulation materials, rigid PUR/PIR foam has the lowest thermal conductivity. At a mean temperature of 0°C it lies between 0.025 W/(m•K) and 0.033 W/(m•K).

Rigid PUR/PIR foams are not hygroscopic and so do not absorb moisture from the ambient air. However, like rigid polystyrene foam, rigid PUR/PIR foam has only a low resistance to water vapour transmission with μ-values of between 40 and 200. In the long-term, this leads to an increase in water ingress if the material is used as low-temperature insulation because of differences in water vapour partial pressure. It is, therefore, not possible to use these materials on refrigeration lines without a vapour barrier.

Like all foam plastics, rigid polyurethane foam is an organic material and therefore flammable. In the event of a fire the duroplastic insulation material does not melt and does not form burning droplets. Depending on the raw density, PUR/PIR insulation materials can be used for the temperature range of +90 °C to -30 °C. Special products can also be used at temperatures as high as +200 °C or, in low-temperature applications, as low as -180 °C.



CELLULAR GLASS (CG)

Cellular glass was developed in the 1930s by the St. Gobain group and has since been sold under the brand-name Foamglas®. The material is manufactured in blocks from which shells, sheets and shaped parts are milled. Cellular glass has a completely closed-cell structure. The raw density is between 100 kg/m³ and 160 kg/m³ depending on the type. Of all the insulation materials compared here, cellular glass has the highest thermal conductivity. It lies between 0.037 and 0.042 W/(m•K) at 0 °C mean temperature. Cellular glass is not hygroscopic and does not absorb moisture from its surroundings. Furthermore, cellular glass is practically vapour-tight and so vapour transmission processes can be prevented permanently. Being an inorganic material, cellular glass is non-combustible. Because it is brittle, cellular glass cannot bear spot loads and must lie flat on the object which is to be insulated. Cellular glass is usually bonded with a flammable cold bitumen adhesive. When the material is cut to size, small amounts of hydrogen sulphide are released causing a foul smell. The application temperature range for this product lies between +430 °C and -260 °C.

RIGID PHENOLIC FOAM (PF)

Rigid PF foam is produced from phenolic resins by adding a blowing agent and an accelerator with or without applying external heat. It is primarily manufactured in a continuous process in the form of bands, occasionally also in blocks.

Rigid phenolic foam is a hard, predominantly closed-cell foam with a raw density of ≥ 70 kg/m³. It is supplied as sheet material and in the form of half-shells which are glued together with a non-combustible silicate adhesive. The insulation material has good thermal insulation properties. At a mean temperature of 0°C, the thermal conductivity is between 0.030 and 0.035 W/(m•K).

Like rigid polystyrene and polyurethane foam, rigid phenolic foam has a low resistance to water vapour transmission. The product is covered with tough, 200 µm thick coarse grain aluminium – four times thicker than usual vapour barriers – and then a vapour-tight seal is made using aluminium adhesive tape.

As it is an organic insulation material, it is usually flammable. However, by adding inorganic fillers it is has also been possible to provide materials which achieve a non-combustible building material class. These special products can be used on industrial installations with an operating temperature ranging from +120 °C to -50 °C.

ELASTOMERIC FOAM (FEF)

The first elastomeric insulation material was developed by the American company Armstrong in 1954. Since then it has been sold under the brand name Armaflex. The term elastomeric foam is mainly used to describe insulation materials on the basis of synthetic rubber. The basic component used nowadays is synthetic rubber made of NBR (nitrile butadiene rubber) and EPDM (ethylene propylene diene monomer). NBR is of greater importance because on the whole it has better technical values.

Like cellular glass, insulation materials on the basis of synthetic rubber have a completely closed-cell material structure. The material is not hygroscopic. The resistance to water vapour transmission is between μ = 2000 and 10,000, depending on the type of rubber. However, it is usually considerably higher and in individual cases values of up to μ = 20,000 are achieved. The vapour barrier is not concentrated on a thin foil, but is built up through the whole thickness of the insulation material itself. There is no need for a separate vapour barrier. These insulation materials are, therefore, particularly suitable for insulating refrigeration lines. Excellent results are achieved by using a flexible, closed-cell insulation material with a high resistance to water vapour transmission throughout.

Furthermore, elastomeric foams have very good thermal insulation properties. At a mean temperature of 0°C, the thermal conductivity lies between 0.033 and 0.040 W/(m•K) depending on the type of rubber. Unlike the aforementioned insulation materials, this material can be produced in many different thicknesses, affording opportunities to save space. Like all organic insulation materials, elastomeric foams are combustible. Due to the three-dimensional structure of their molecules they do not drip in practical fire conditions; so it is possible to rule out the possibility of fire spreading by these means. Moreover, the material is self-extinguishing and does not propagate fire horizontally or vertically. There is also no possibility of the material self-combusting. One special point, which should be mentioned in this context, is that pipes insulated with synthetic rubber can, under certain circumstances, be passed through fire resistant structural elements without impairing their fire resistance classification.

Elastomeric insulation materials stand out not only because they have good technical values but also because they are particularly user-friendly – they are flexible, dust and fibre free, and can be bonded reliably.

Insulation materials on the basis of synthetic rubber can be used at temperatures ranging from +110 °C to -50 °C and under certain installation conditions at temperatures as low as -200 °C. Insulation materials on the basis of EPDM are suitable for long-term use on machinery with operating temperatures of +150 °C.

NEW CE MARKING REQUIREMENTS FOR TECHNICAL INSULATION PRODUCTS

CE marking became mandatory requirement in the UK for technical insulation products manufactured and sold in the EU from 1st July 2013. From this date, under the Construction Products Regulation 2011 (CPR), it will become obligatory for manufacturers to apply CE marking to any of their products which are covered by a harmonised European standard (hEN) or European Technical Assessment (ETA). The CPR harmonises the methods of assessment and test, the means of declaration of product performance and the system of conformity assessment of construction products. Such required values must be expressed in a consistent manner (technical language) as used in the harmonised technical specifications. The recently agreed harmonised standard for technical insulation products includes a new European fire classification which includes an assessment for smoke development and the burning droplets associated with insulation materials in the event of fire. It is estimated that 95% of casualties die as a consequence of smoke inhalation rather than as a direct result of the fire hazard itself, so a low smoke density is vitally important to allow trapped people, and the emergency services, safe access to escape routes.

As a leading manufacturer of insulation materials for mechanical services in commercial and public buildings, Armacell are pleased to reveal that their Armaflex Ultima product range is the first flexible insulation material to achieve a fire class B_L-s1, d0 (in tube form, or B–s2, d0 in sheet form) rating within the harmonised technical insulation materials classification. This new product exhibits 10 times less smoke development compared to a standard elastomeric product, as well as exhibiting zero tolerance toward the development of burning droplets or particles in fire conditions. The blue coloured elastomeric Armaflex Ultima foam incorporates the innovative Armaprene® Technology and has been patented in the USA, with patent pending in Europe.

The European product standards for insulation materials for building equipment and industrial installations were passed by the national standards organisations in the CEN (Comité Européen de Normalisation) in 2009 and published in the official journal of the European Union in June 2010. From 1st July 2013 in the UK it is only permitted to sell technical insulation products in the EU countries which comply with the European product standards (and thus with the Construction Products Directive and Construction Products Regulation) and bear the CE mark. With Armaflex products, Armacell has been providing CE – certified flexible insulation materials since the beginning of 2012, and was the first manufacturer to do so.

The superior fire behaviour of Armaflex Ultima is also clearly demonstrated in a video that can be viewed on the company's website www.armacell.com/ArmaflexUltima. A technical article giving further information on the New European fire classifications and incorporating relevant product performance values can be viewed on the Armacell UK website at www.armacell.com/uk/cemarking. A CPD presentation on CE marking and the new European fire standards for technical insulation materials is available, please email info.uk@armacell.com for details.

ENERGY SAVING OPPORTUNITIES SCHEME

Energy saving begins at home but if carbon emissions are to be cut and climate change is to be averted then it can't stay there. Large commercial and industrial organisations account for a majority of energy use in the UK and identifying the potential savings for these companies can be tough.

This is why the UK government has instituted the Energy Saving Opportunities Scheme (ESOS) that targets big organisations and requires them, by law, to evaluate their energy use and find ways to reduce it. In many cases companies complying with their ESOS obligations will be poised to discover that insulating pipework is one of the simplest and most cost effective energy saving measures available to them.

ENERGY AUDITS

At the heart of ESOS is the need to conduct an energy audit. This looks at all of the current areas of energy use and provides senior management with the overview they need to assess how further investments could yield major energy savings – resulting in a 'win-win' scenario for the company and for the environment.

In many large organisations, particularly those with an industrial or manufacturing side, energy loss from pipework is likely to feature heavily in the audit. When this is the case an organisation will want to look at this whole area in more detail.

TipCheck, a thorough pipe insulation auditing scheme run by the EIIF, is the best next step for any organisation that conducts an energy audit and finds that they could save energy by improving the levels of insulation on their pipework. Only accredited assessors can carry out a TipCheck with the EIIF keeping a Europe-wide register of assessors.

ESOS assured with EN ISO 50001

EN ISO 50001 is a standard for energy management systems that includes a requirement for carrying out ongoing audits and evaluation of the energy use within a company. Because of this there is an incredible synergy between EN ISO 50001 and ESOS and the UK government recognises EN ISO 50001 certification as an alternative route to ESOS compliance.

Since EN ISO 50001 is part of the same 'family' of standards as EN ISO 9001 and EN ISO 14001 many organisations already following the disciplines of continual improvement needed to comply, making EN ISO 50001 a logical and easy extension. This means that certification against EN ISO 50001 is likely to be the best option for demonstrating ESOS compliance many companies in the UK.

Product Selector

			Heating & Plumbing pipework	HVAC & commercial pipework
	**AF/Armaflex®** Class 0	Nitrile rubber tube, sheet & coils range for cold water & HVAC-R applications	Seal with Armaflex 520 adhesive	Seal with Armaflex 520 adhesive
	**Tubolit®**	Polyethylene pipe insulation for domestic applications	Close seams with Tubolit clips	
	**AF/Armaflex®** Class 0 Self Seal	Nitrile rubber tube insulation with self-seal closing for easy application	Seal butt joins with 520 adh.	Seal butt joins with 520 adh.
	**Armaflex®** TuffCoat	PVC outer covering for protection against mechanical impact and bird attack		Seal joins with 520 adhesive
	**HT/Armaflex®**	EPDM rubber for high temperature process applications (up to 150°C)	For outdoor condensate pipes	
	**Arma-Chek®** Silver	High surface emissivity silver PVC covering for protection in outdoor areas		Seal butt joins with 520 adh.
	**Armaflex®** DuoSolar	Pre-insulated twin corrugated steel pipes for connecting solar hot water systems		

Refrigeration pipework	Outdoor pipework	Pre-fabricated fittings for bends / elbows	Solar thermal hot water applications	Ground source heat pump pipework	Self-Seal closing
Seal with Armaflex 520 adhesive	Armafinish 99 paint required				
		Tubolit Quick 90° elbows			
	Armafinish 99 paint required				Seal butt joins with 520 adh.
Tuffcoat mastic, tape & 520 adh.	Tuffcoat mastic, tape & 520 adh.			Seal with Armaflex 520 adhesive	
	Covering for bird attack required?		Covering for bird attack required?		
Tape & 520 adhesive to seal	Tape & 520 adhesive to seal	Bends and t-pieces available			Seal butt joins with 520 adh.
			DuoSolar fitting sets available		

armacell®

MAKING A **DIFFERENCE**
AROUND THE **WORLD.**

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