



Ammonia

Product performance for insulation of
ammonia piping





K-FLEX USA
INNOVATION IN INSULATION

ABOUT K-FLEX USA



Youngsville, NC Headquarters



K-FLEX USA IS A LEADING MANUFACTURER of closed cell flexible elastomeric foam insulation products for mechanical piping, air handling units and vessels.

Designed for ease of installation and reliable performance, K-FLEX products provide excellent thermal and acoustical performance, including inherent resistance to moisture intrusion.

K-FLEX USA prides itself on being responsive to the market, providing dependable service to customers throughout North America, bringing an innovative approach to product offerings, and having products that are 3rd party tested and certified.

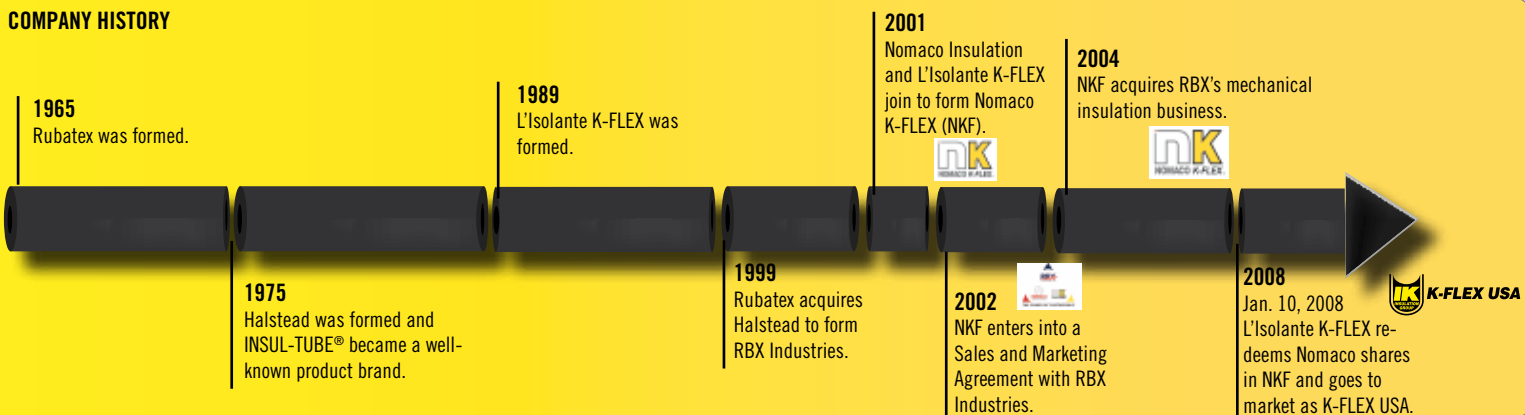
In April 2012, K-FLEX USA was awarded with ISO 9001:2008 certification by FM Approvals. The independent certification demonstrates the company's commitment to quality.

K-FLEX products have proven performance in the Plumbing, HVAC/R, Commercial/Industrial, Marine, Oil & Gas, Acoustic and OEM Markets.

As a member of the IK Insulation Group, K-Flex USA delivers state-of-the-art levels of technical knowledge and customer support to the global mechanical insulation market.



COMPANY HISTORY



K-FLEX USA BENEFITS

- Designed for lasting performance:
K-Value: 0.245 @ 75°F & Permeability: 0.03 perm-in
- Responsive to market
- Industry & Product expertise
- 3rd Party Certified Products
- Broad size range: 25/50-rated up to 2" thick
- Systems Approach
- Factory-applied PSA & Cladding
- Full line of accessories



GLOBAL PRESENCE

L'ISOLANTE K-FLEX:

- 11 production facilities worldwide
- Commercial distribution in 43 countries
- Headquartered in Italy

INSULATION SELECTION

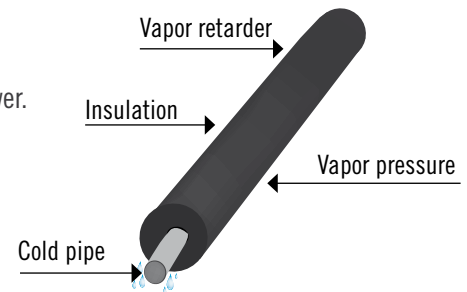
Critical Factors to Consider

- **Proper Material Selection, Thickness, Installation & Maintenance =**
 - Energy Savings
 - Eliminate Refrigerant (i.e. Ammonia) Leakage
 - Condensation Control
 - Moisture Intrusion & Ice Formation Prevention
 - Improved Equipment Performance
 - Minimize Corrosion
 - Mold / Mildew Resistance
 - Personnel Safety
 - Process Control
 - Meets Fire Codes
- **Cost efficiency**
 - Cost to remove a failed system = 3-5 times initial cost of installation + additional costs of downtime & mold removal.



Application Considerations

- Extreme below-ambient conditions (-50°F to 40°F process) --> vapor drive.
 - High level of moisture vapor pressure in ambient air trying to get to air surrounding the insulated pipe surface where moisture vapor pressure is much lower.
- Unidirectional --> steadily drives against insulation.
- Magnified when the system operates continuously in cold mode and in high humidity conditions.



Causes of Insulation Failure

Next to the issue of open seams, moisture vapor intrusion is the single-most destructive factor to insulation, with studies showing that **for every 1% moisture gain, the insulation efficiency drops 7%**. This gain takes place as moisture-laden air migrates through the insulation system to the pipe surface and forms moisture on the pipe. The closed cell structure of the insulation is critical as moisture inevitably accumulates in permeable insulation even with a concentrated vapor retarder jacket. The presence of job site abuse and improper installation means there is additional risk involved with permeable insulation products, which rely on jacketing to serve as a vapor retarder. Wet insulation and mold growth on the outer surface of the system (pictured right) are indicators that the insulation has failed.





INSULATION OPTIONS

The purpose of these technical notes is to offer designers and those working in the field a thorough overview of insulation materials commonly used for the purpose

of insulating ammonia systems. For an understanding of the analysis carried out, we will refer both to the most commonly used materials for ammonia applications

(table 1) and to the key properties of the different insulation options in table 2.

Table 1

A	K-FLEX CLOSED CELL ELASTOMERIC FOAM
B	CELLULAR GLASS
C	POLYSTYRENE
D	POLYISOCYANURATE (PIR)

Table 2

TECHNICAL PROPERTIES

	K-FLEX Closed Cell Elastomeric	Cellular Glass	Polystyrene	Polyisocyanurate (PIR)
Thermal k (75°F mean)	0.245	0.31	0.24	0.19
Water Vapor Permeability without jacketing (perm-in)	<0.01	0.001	1.5	4.0
Service Temperature (°F)	-297°F to +220°F	-450°F to +800°F	-65°F to +165°F	-297°F to +300°F
Density (pcf)	3 - 4	8.0	0.7 - 3.0	2.0
Closed Cell Structure	Yes	Yes	Yes	90%
Flexible	Yes	No (Fragile)	No	No
ASTM E84 25/50 flame rating (2")	Yes	Yes	No	No
Self-seal closure option	Yes	No	No	No
Thermoplastic (Highly combustible, may melt, drip or carry a progressive flame)	No	No	Yes	Yes

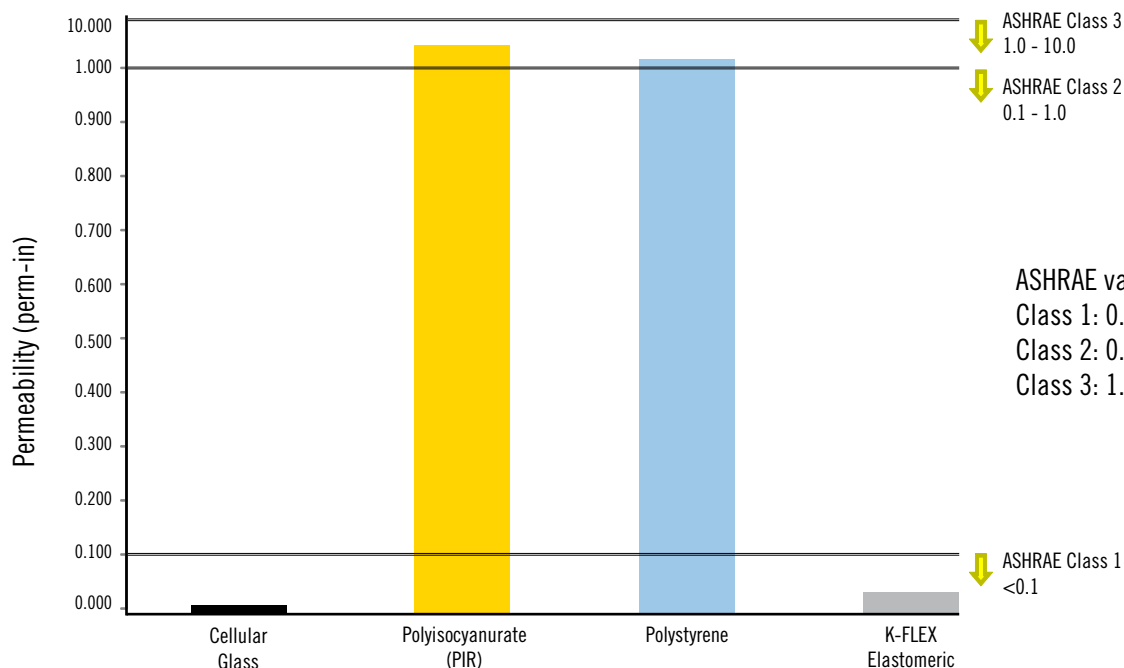
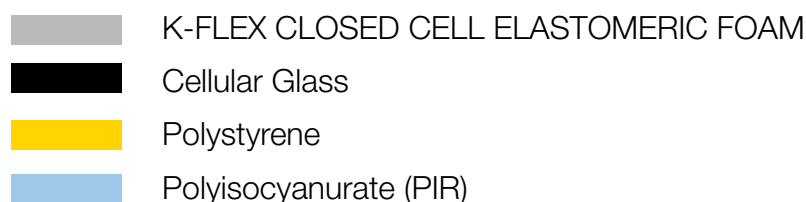
WATER VAPOR PERMEABILITY

As indicated by the detrimental effects of water vapor intrusion, the water vapor permeability of an insulation material is a critical component of its performance. If the insulation material is vapor permeable, as indicated by a high permeability value, moisture can move through the insulation

to reach areas where the temperature is low enough to form condensation, even if the surface temperature of the insulation is high enough to prevent surface condensation. An insulation material with low permeability would prevent this situation from occurring. The

chart below shows the permeability values for commonly used insulation materials in ammonia applications. As the chart indicates, elastomeric and cellular glass are the only two unjacketed materials that are classified as Class 1 vapor retarders as defined by ASHRAE.

Permeability Comparison



ASHRAE vapor retarder classes
 Class 1: 0.1 perm or less
 Class 2: 0.1 – 1.0 perm or less
 Class 3: 1.0 – 10 perm or less

	Permeability (perm-in)
Cellular Glass*	0.001
Polyisocyanurate (PIR)*	4.0
Polystyrene*	1.5
K-FLEX Elastomeric	<0.01

* Taken from manufacturer's published data.



WATER VAPOR PERMEABILITY

A further analysis of the importance of an insulation material's permeability is illustrated below.

K-FLEX insulation's closed cell structure and low permeability inherently resists moisture, providing distributed resistance against moisture vapor intrusion without the need of a jacket.

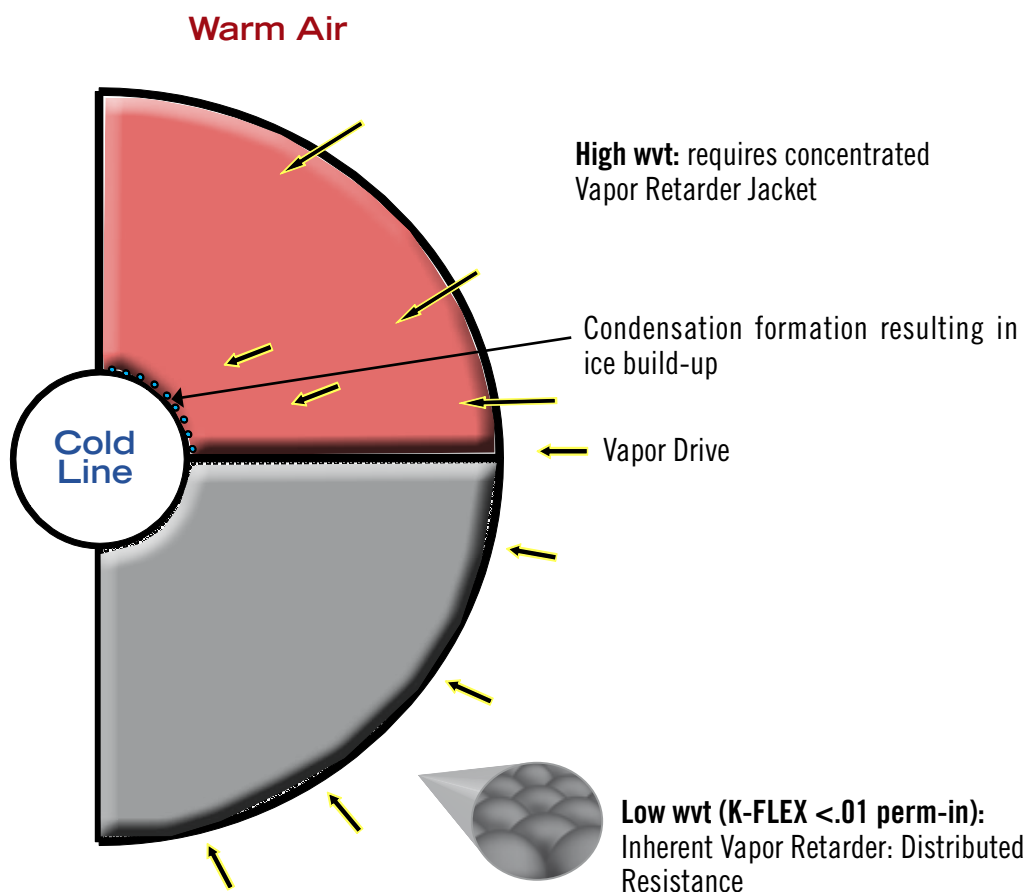
Additionally, elastomeric closed cell insulation materials have an established history of successful use as an insulation material for cryogenic applications (see Project Experience on page 11).

In contrast, closed cell materials with a high permeability (i.e. polystyrene and polyisocyanurate) are not inherently resistant to moisture and rely on a

concentrated moisture vapor barrier (jacket) for protection against moisture intrusion.

If the barrier is damaged (even a pinhole) or the edges are not properly sealed, they are susceptible to moisture intrusion and subsequent energy loss or mold growth. Once moisture penetrates, it can wick and involve large areas in the mold growth and energy loss process.

Performance Comparison



MOISTURE GAIN & THERMAL k

Thermal k performance over time with moisture gain (10 years)

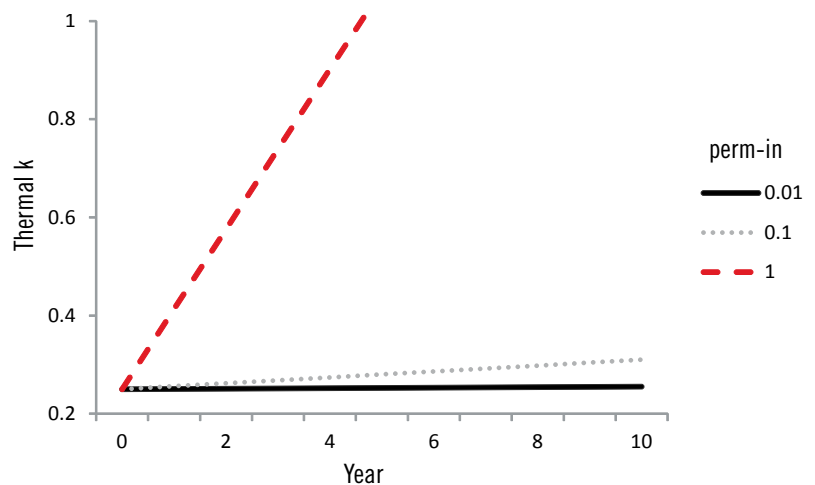
The effect of moisture gain on thermal k after 10 years is shown below. The data leads to the conclusion that *on most below-ambient systems, if the*

permeability of the insulation is less than 0.10 perm-in, there will be minimal long-term effects on the k-value.

Conditions: Ambient 90°F • Pipe 40°F • Relative Humidity 85% • Pipe Size 4" • Insulation Thickness 2" • wvt drive exists 50% of the year

Permeability (perm-in)	.01	.10	1.00
k-value (start)	.250	.250	.250
k-value (10 years)	.255	.310	1.88

	k-value (75°F mean)	Permeability (perm-in) unjacketed
K-FLEX Elastomeric	0.245	<0.01
Cellular Glass	0.31	0.001
Polystyrene	0.24	1.5
Polyisocyanurate (PIR)	0.19	4.0

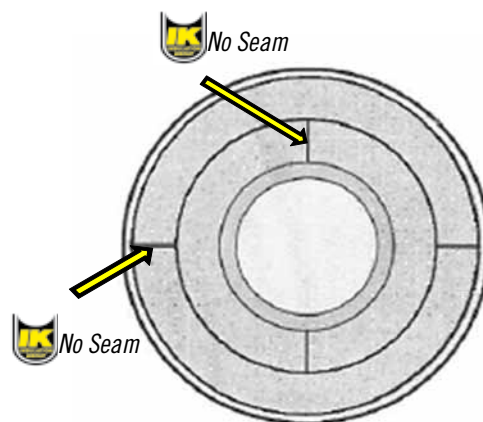


Effect of seams on risk of moisture intrusion

Seams in an insulation system often have a much higher wvt than the insulation itself. This can have a significant impact on the moisture absorbed by the system.

Also, insulations that rely on a concentrated vapor barrier often get damaged, resulting in a much higher wvt than reported in the literature. Many insulation material types, such as cellular glass or polystyrene which are fabricated in two halves, require double the number of seams as K-FLEX, thus increasing the risk for moisture intrusion.

Further, K-FLEX is also available in 6' lengths (compared to 3' or 4' lengths), significantly reducing the number of butt joints that need to be sealed in a system.



Material Type	Seams
Competitive	4
K-FLEX	2



K-FLEX USA: PERFORMANCE ADVANTAGES

Analysis of main features

- Low perm without jacketing (<0.01 perm-in, Class 1 vapor retarder).
- Lasting performance against damaging moisture intrusion.
- Excellent thermal k (0.245).
- CUI resistance: moisture migration prevention, especially important with iron pipe.
- Does not fracture from pipe vibration or expansion/contraction cycles.
- Low VOC emission, CFC- and HCFC-free.
- High mold & mildew resistance.
- Meets Fire Safety Codes (25/50-rated up to 2" wall).
- Single material can be used on lines that cycle hot to cold due to wide temperature range (vs. i.e. polystyrene temperature limitations).
- **IIAR Handbook:** "The insulation itself should be a low thermal conductivity material with low water vapor permeability and it should provide moisture resistance."

<i>K-FLEX® Elastomeric Insulation</i>		
PROPERTY	RATING	CRITERIA
Operating Temperature Range (°F)	-297°F to +220°F	
Permeability	<0.01 perm-in	ASTM E 96
Water Absorption % (volume change)	0	ASTM C 209
Thermal k (75 °F mean)	0.245 (Btu-in/h-ft ² -°F)	ASTM C 177 & C 518
Fire Rating	25/50 up to 2" thick Pass	ASTM E 84 NFPA 90 A / 90 B
Density	3 - 5 lb/ft ³	ASTM D 1667
Mold Resistance	Pass	UL 181
Energy Rating	Complies	ASHRAE 90.1 & 189.1



K-FLEX® Elastomeric Sheet



K-FLEX® Elastomeric Tube

K-FLEX USA: INSTALLATION ADVANTAGES

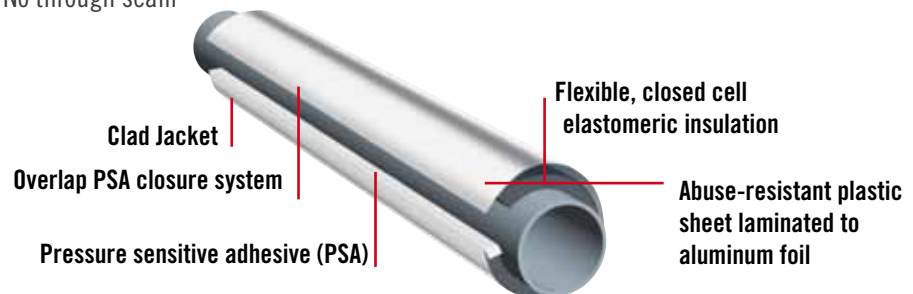
Analysis of main features

- Flexible: non-breakable, easily conforms to curvatures.
- Lightweight: easy handling.
- Low maintenance & easy to clean.
- Less prone to damage from shipping, installation errors & job site abuse.
- Safe to handle: Non-abrasive, No protective clothing required.
- Faster installation: reduced steps on-site
 - No metal bands or on-site application of complex vapor retarder jackets
 - Non-dusting = reduced time spent vacuuming & screening work areas
 - No fabrication from bun form to tubing or sheet necessary



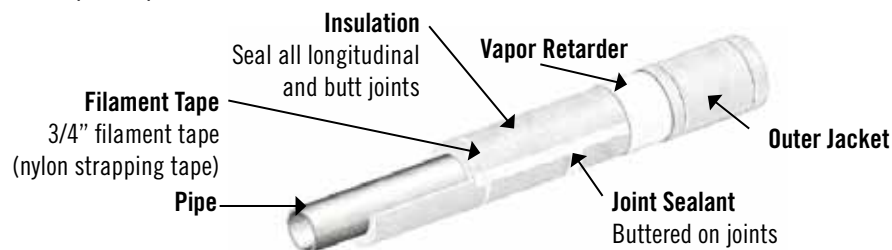
K-Flex: 2" and below

- Single Layer – K-FLEX Clad®: 1-Step / No through seam



Competitive: 2" and below

- Single Layer – Competitive: Multiple Steps



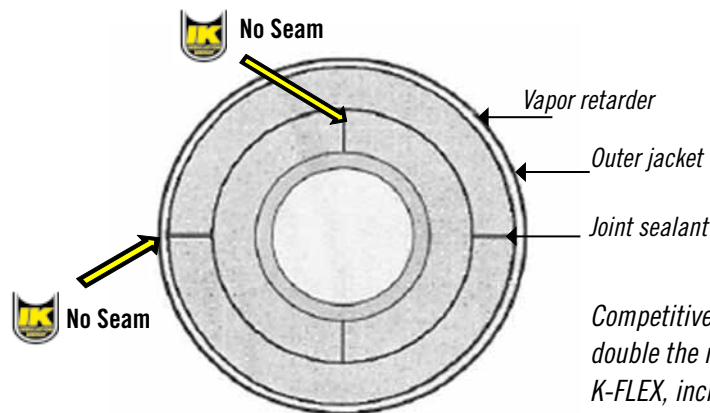


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K-FLEX USA: INSTALLATION ADVANTAGES

Multiple layers: 2" and above

- Multiple Layers – Competitor and K-FLEX USA



Competitive materials require double the number of seams as K-FLEX, increasing the risk for moisture intrusion.

K-FLEX USA: SERVICE ADVANTAGES

- Responsive to market, world leader.
- Product & Industry expertise:
 - NIA Certified Insulation Appraisers on staff.
 - ISOCALC: calculator used to determine thickness to prevent surface condensation.
- 3rd Party Certified Products.
- Broad size range – tubes & sheets.
- Systems Approach:
 - Factory-applied solutions.
 - Full line of accessories.

COSTS: MATERIAL & LABOR

	Material Cost (\$)	Labor Cost (\$)	Total Installed Cost (\$)
1.5" Elastomeric	Baseline	Baseline	Baseline
1.5" Cellular Glass w/ ASJ	5% more	30% more	20% more

*Material, Labor and Total Installed Cost (\$) values obtained from 2011 RS Means Mechanical Cost Data. Cost data not available for polystyrene or polyisocyanurate. Elastomeric material, labor, and total installed costs for 1.5" based on extrapolation from known RS Means costs for 1" elastomeric / cellular glass. Detailed analysis available upon request.



"Subject to the conditions of Approval as a Pipe Insulation when installed as shown in the current edition of the FMRC Approval Guide."

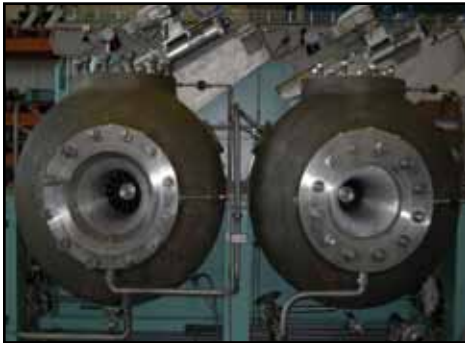


COLD SERVICE PROJECT EXPERIENCE

K-FLEX insulation has been specified for and installed on pipes, equipment and vessels for a range of cold service applications, ranging from HVAC to supermarket refrigeration to demanding industrial process refrigeration systems. A brief listing of projects is below:

- Wal-Mart (CO₂), Nationwide USA
- Seneca Foods (Ammonia), Rochester, Minnesota
- Shell LNG Carriers, Korea
- NIAC Urea-Ammonia Plant, Iran
- SIAD Group Nitrogen-Oxygen Plant, Italy
- Sonatrach Arzew LNG Terminal, Algeria

Cryostar: BOG Compressor



Cryostar: LNG Liquefaction Unit

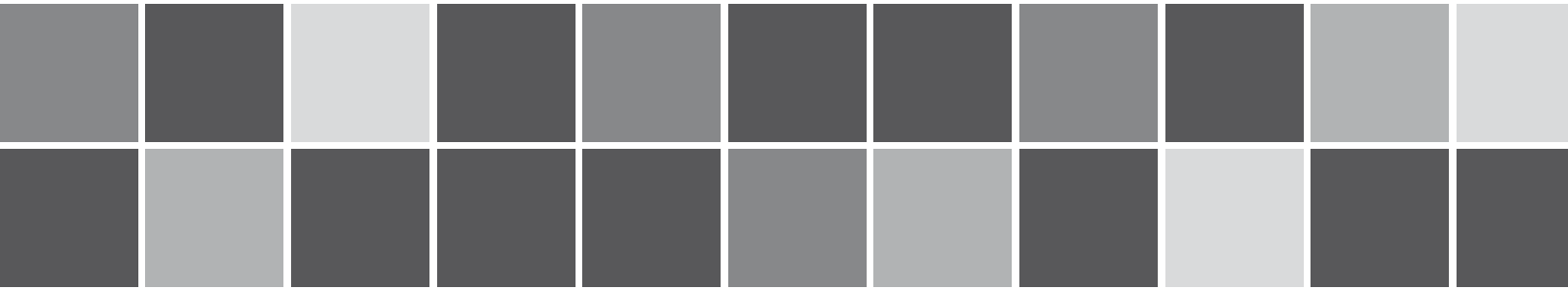


GDF Suez, FRANCE: Montoir LNG Terminal





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KFAP-0002-0314