Barrier casings for pre-insulated pipe systems
EVAL™ EVOH extends the performance of pre-insulated pipe systems

Kuraray Co., Ltd. is the world leader in EVOH (ethylene vinyl-alcohol copolymer) production and development. An EVAL™ layer thickness of only a few microns helps keep the structure of pre-insulated pipes intact, extending service life and maintaining efficient energy use.

Many pre-insulated pipes use rigid polyurethane foam and a HDPE casing. Over time the insulation efficiency of the pipe structure decreases, caused by the permeation of air (oxygen, nitrogen) into the foam cells and the diffusion of cell gases (blowing agent, carbon dioxide) outside the foam cells.

Oxygen permeation can lead to oxidative degradation of the PUR-foam insulation. This reduces the adhesion between the PUR-foam and inner pipe, weakening the structure and compromising the mechanical integrity of the pipe system.

Since permeated air also has a higher thermal conductivity than the cell gases, the thermal conductivity properties of the pre-insulated pipe will increase over time. The result is a decrease in insulation efficiency, resulting in higher energy losses in the pre-insulated pipe system.

Pipeline networks often require long service times (district energy systems have a lifetime of minimum 30 years, often a lifetime of 50 years or more), so it is important to ensure that the insulation efficiency and thus the energy efficiency of the system itself does not decrease as a function of time.
The insulation efficiency of PUR foam decreases as air ingress in and cell gases permeate out of the pipe structure, increasing thermal conductivity.

Degradation of the PUR-foam insulation due to oxygen ingress can compromise the mechanical integrity of the pipe structure.
EVAL™ is the registered trademark for EVOH resins manufactured and marketed by Kuraray since 1972. EVAL™ resin is a random copolymer of ethylene and vinyl alcohol (EVOH). It is a crystalline polymer which has a molecular structure represented by the following formula:

Molecular structure of EVAL™ resins

\[
\text{Ethylene and Vinyl Alcohol} \\
(\text{CH}_2-\text{CH}_2)_m (\text{CH}_2-\text{CH})_n \text{OH}
\]

Properties of EVAL™ EVOH

- Superior gas barrier against O\(_2\), N\(_2\), CO\(_2\). 1mm EVAL™ = 9 meters of HDPE.
- Extremely effective against permeation of air and typical blowing agents.
- Direct adhesion to PUR without corona treatment (necessary for PE).
- Easy installation, compatible with butt welding and electro-fusion welding.
- Easy and economical to produce on conventional coextrusion equipment.
Solutions with EVAL™ EVOH

A barrier layer of EVAL™ EVOH will maintain the energy efficiency of your system. The insulation layer will remain intact longer, maintaining structural integrity and extending performance and service life.

Add an EVAL™ layer to your casings.
- Prevent oxidation of the PUR foam.
- Maintain the insulation properties of the PUR foam.
- Avoid increase of thermal conductivity within the pipe.

With EVAL™ the insulation efficiency of the PUR foam is maintained, avoiding an increase in thermal conductivity.

Oxygen ingress that can degrade the PUR-foam insulation is sharply reduced.

“1 mm of EVAL™ provides about the same gas barrier properties as a 9 metre thickness of HDPE”.
Incorporating an EVAL™ barrier layer into a pre-insulated pipe

A pre-insulated pipe with a 3-layer outer casing pipe (HDPE/tie/EVAL™)

Advantage: The EVAL™ barrier layer directly adheres to the polyurethane foam. Unlike PE, no corona treatment is required for EVAL™.
Product benefits of EVAL™ barrier casings

Maintain the insulation efficiency and extend the service life of pipe systems.

An EVAL™ barrier layer prevents the permeation of air (oxygen & nitrogen) inside the polyurethane foam and the permeation of cell gases outside the foam:

- EVAL™ has an excellent barrier to oxygen, nitrogen, carbon dioxide and blowing agents e.g. cyclopentane.

**Gas transmission rates of EVAL™ resins versus HDPE**

<table>
<thead>
<tr>
<th>Material</th>
<th>Test conditions</th>
<th>Gas transmission rates (GTR) (cm³.mm/m².day.atm)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>N₂</td>
</tr>
<tr>
<td>EVAL™ FP101B (1)</td>
<td>25°C, 0% RH 20°C, 65% RH</td>
<td>0.00034</td>
</tr>
<tr>
<td>EVAL™ EP105B (1)</td>
<td>25°C, 0% RH 20°C, 65% RH</td>
<td>0.00260</td>
</tr>
<tr>
<td>HDPE (2)</td>
<td>22°C</td>
<td>22</td>
</tr>
</tbody>
</table>

(1) ISO 14663-2
EVAL™ grade choice and processing applications for barrier casings

**EVAL™ resins for barrier casings**

<table>
<thead>
<tr>
<th>Type</th>
<th>Density(^{(1)}) (g/cm(^3))</th>
<th>MFR(^{(2)}) (g/10 min)</th>
<th>Melting temperature (^{(°C)})</th>
<th>Oxygen gas transmission rate (OTR)(^{(3)}) (cm(^3).20µm/m(^2).day.atm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>EVAL™ FP101B</td>
<td>1.19</td>
<td>1.6</td>
<td>183</td>
<td>0.4</td>
</tr>
<tr>
<td>EVAL™ FP104B</td>
<td>1.19</td>
<td>4.5</td>
<td>183</td>
<td>0.4</td>
</tr>
<tr>
<td>EVAL™ EP105B</td>
<td>1.14</td>
<td>5.5</td>
<td>165</td>
<td>1.5</td>
</tr>
</tbody>
</table>

\(^{(1)}\) 20°C (ISO 1183)  \(^{(2)}\) 190 °C, 2160 g (ISO 1333)  \(^{(3)}\) 20°C, 65% RH (ISO 14663-2 annex C), 20µm

**Typical extrusion temperature conditions for EVAL™ resins**

<table>
<thead>
<tr>
<th>Extrusion profile</th>
<th>EVAL™ FP101B</th>
<th>EVAL™ EP105B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Barrel temperature</td>
<td>C(_1) °C</td>
<td>180</td>
</tr>
<tr>
<td></td>
<td>C(_2) °C</td>
<td>200</td>
</tr>
<tr>
<td></td>
<td>C(_3) °C</td>
<td>205</td>
</tr>
<tr>
<td></td>
<td>C(_4) °C</td>
<td>215</td>
</tr>
<tr>
<td></td>
<td>C(_5) °C</td>
<td>220</td>
</tr>
<tr>
<td>Adapter temperature</td>
<td>AD(_1) °C</td>
<td>215</td>
</tr>
<tr>
<td></td>
<td>AD(_2) °C</td>
<td>215</td>
</tr>
<tr>
<td>Die temperature</td>
<td>°C</td>
<td>215</td>
</tr>
</tbody>
</table>
Example of 3 and 5-layer barrier casings

A pre-insulated pipe with a 3-layer outer casing pipe (HDPE/tie/EVAL™)

A pre-insulated pipe with a 5-layer casing (HDPE/tie/EVAL™/tie/HDPE)
Environmental benefits of EVAL™ resins

As the impact we create on our environment becomes an ever greater concern, the world continues to look for solutions that are truly sustainable. EVAL™ resins can help, providing valuable function to pipe applications even while reducing impact on the environment throughout the entire life-cycle of the product.

A one millimetre thickness of EVAL™ EVOH has about the same gas barrier properties as nine metres of HDPE. With such high performance, EVAL™ layers of only a few microns can add real function to multilayer structures. Barrier performance previously only available from metal or glass can thus be added to lightweight structures based on other recyclable and energy recoverable plastics.

**Better efficiency, longer life**

EVAL™’s barrier properties help improve the performance of heating and cooling systems, prolonging the effectiveness of insulation and avoiding corrosion. The result is systems that last longer, waste less and use energy more efficiently.

**Reduced emissions**

When used in barrier structures for construction, agricultural and automotive fuel system applications, EVAL™ helps create lightweight structures that protect the environment from gas, fuel or chemical emissions.

**Recyclable and recoverable**

EVAL™ EVOH is recyclable, and is commonly used as part of a regrind structural layer in rigid packaging and automotive applications. It can also be used for post-consumer recycling, and will not disrupt polyolefin or PET recycling streams.

EVAL™ has excellent and safe energy recovery properties, often reducing the amount of extra fuel necessary for energy generation from the thermal disposal of sorted waste. Under perfect combustion, the few microns of EVAL™ in the structure emit only small amounts of CO₂ and water vapour.

In addition to ISO 9001:2000, EVAL Europe nv is compliant with ISO 14001:2004 and ISO/TS16946 standards.
Introducing Kuraray and EVAL™

Kuraray Co., Ltd. was established in 1926 in Kurashiki, Japan, for the industrial manufacture of chemical fibres. As the world’s largest producer of vinyl acetate monomer (VAM) derivatives, Kuraray has long been a leader in high gas barrier technology and development. Today the Kuraray Group consists of about 70 companies, employing nearly 7,000 people worldwide.

Kuraray has been manufacturing and marketing ethylene vinyl-alcohol copolymers (EVOH) under the name EVAL™ since 1972, and remains the world leader in EVOH production and market development.

EVAL™ is one of Kuraray’s core businesses and is produced worldwide in Japan, the USA and Europe. The sales and technical development of EVAL™ is supported by specialised local teams in each region.

Building better barriers
EVAL™ adds superior barrier functionality to multilayer plastic structures. Since 1 mm of EVAL™ provides about the same gas barrier properties as a 10 metre thickness of LDPE, even very thin EVAL™ layers provide excellent results. EVAL™ is widely used as a functional gas and flavour/aroma barrier in food, medical, pharmaceutical and cosmetic packaging, and as a gas and solvent barrier in industrial, construction, agricultural and automotive fuel system applications.
EVAL™ the world’s leading EVOH

Asia-Pacific
Kuraray Co., Ltd. (Okayama, Japan)
Capacity: 10,000 tons/year
The world’s first EVOH production facility

Americas
EVAL Company of America (Pasadena, Texas, USA)
Capacity: 47,000 tons/year
The world’s largest EVOH production facility

Europe
EVAL Europe nv (Antwerp, Belgium)
Capacity: 24,000 tons/year
Europe’s first and largest EVOH production facility

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