



Barrier casings for pre-insulated pipe systems



kuraray

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.

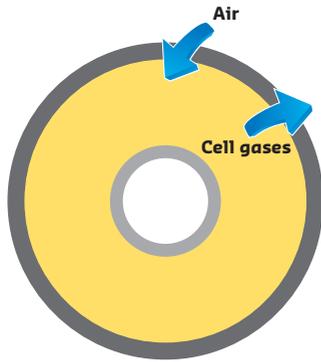
2

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.

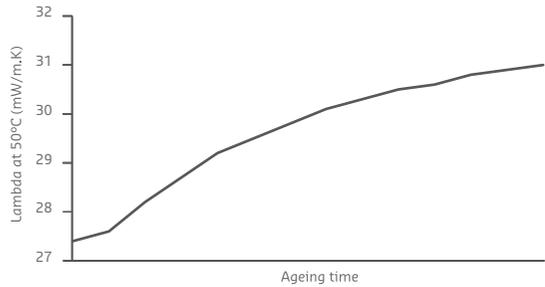
Oxygen permeation can lead to oxidative degradation of the PUR-foam insulation. This reduces the adhesion between the PUR-foam and inner pipe, weakening the structure and compromising the mechanical integrity of the pipe system.

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.



- High-density polyethylene (HDPE) outer casing
- Polyurethane foam insulation
- Service pipe



The insulation efficiency of PUR foam decreases as air ingress in and cell gasses permeate out of the pipe structure, increasing thermal conductivity.

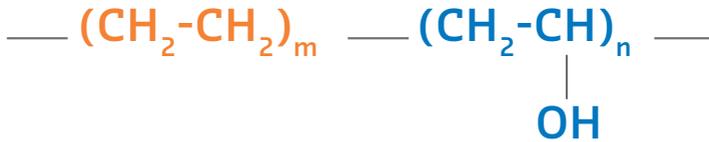
Degradation of the PUR-foam insulation due to oxygen ingress can compromise the mechanical integrity of the pipe structure.

EVAL™ resins

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

Ethylene and Vinyl Alcohol



Properties of EVAL™ EVOH

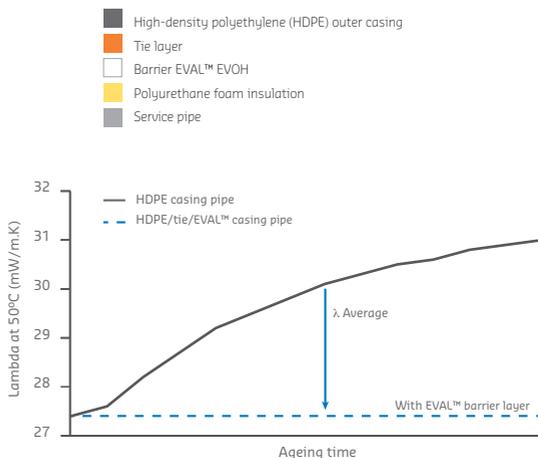
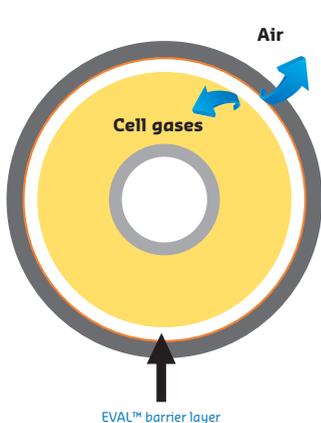
- Superior gas barrier against O₂, N₂, CO₂. 1mm EVAL™ = 9 meters of HDPE.
- Extremely effective against permeation of air and typical blowing agents.
- Direct adhesion to PUR without corona treatment (necessary for PE).
- Easy installation, compatible with butt welding and electro-fusion welding.
- Easy 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.



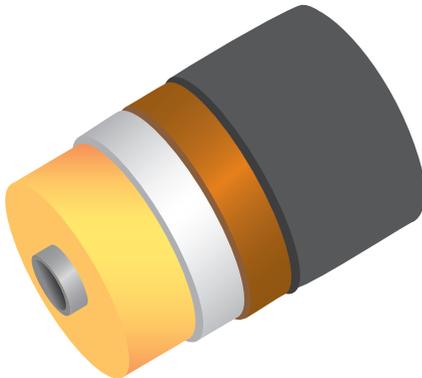
With EVAL™ the insulation efficiency of the PUR foam is maintained, avoiding an increase in thermal conductivity.

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™)



- High-density polyethylene (HDPE) outer casing
- Tie layer
- Barrier EVAL™ EVOH
- Polyurethane foam insulation
- Service pipe

6

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

Material	Test conditions	Gas transmission rates (GTR) (cm ³ .mm/m ² .day.atm)		
		N ₂	O ₂	CO ₂
EVAL™ FP101B ⁽¹⁾	25°C, 0% RH	0.00034	0.0054	0.016
EVAL™ FP101B ⁽¹⁾	20°C, 65% RH	-	0.0080	-
EVAL™ EP105B ⁽¹⁾	25°C, 0% RH	0.00260	0.0250	0.140
EVAL™ EP105B ⁽¹⁾	20°C, 65% RH	-	0.0300	-
HDPE ⁽²⁾	22°C	22	70	247

⁽¹⁾ ISO 14663-2

⁽²⁾ Extending the Service Life of Pre-Insulated Pipes - Analyses of Diffusion Rates Through PE and Impact on Ageing. Euroheat&Power, Vol 11/2009, 48-53.

EVAL™ grade choice and processing applications for barrier casings

EVAL™ resins for barrier casings

Type	Density ⁽¹⁾ (g/cm ³)	MFR ⁽²⁾ (g/10 min)	Melting temperature (°C)	Oxygen gas transmission rate (OTR) ⁽³⁾ (cm ³ .20µm/m ² .day.atm)
EVAL™ FP101B	1.19	1.6	183	0.4
EVAL™ FP104B	1.19	4.5	183	0.4
EVAL™ EP105B	1.14	5.5	165	1.5

⁽¹⁾ 20°C (ISO 1183)

⁽²⁾ 190 °C , 2160 g (ISO 1333)

⁽³⁾ 20°C, 65% RH (ISO 14663-2 annex C), 20µm

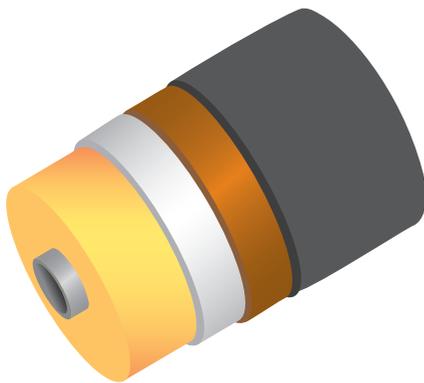
8

Typical extrusion temperature conditions for EVAL™ resins

Extrusion profile			EVAL™ FP101B EVAL™ FP104B	EVAL™ EP105B
Barrel temperature	C ₁	°C	180	170
	C ₂	°C	200	190
	C ₃	°C	205	195
	C ₄	°C	215	205
	C ₅	°C	220	210
Adapter temperature	AD ₁	°C	215	195
	AD ₂	°C	215	195
Die temperature		°C	215	195

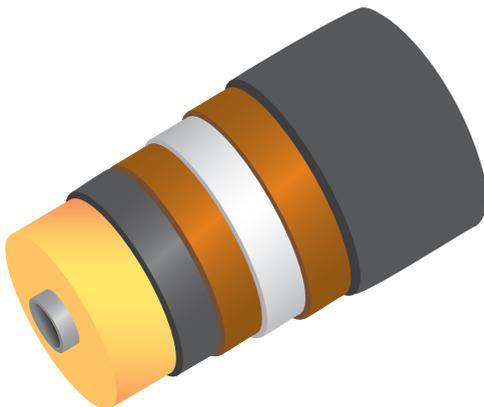
Example of 3 and 5-layer barrier casings

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



- High-density polyethylene (HDPE) outer casing
- Tie layer
- Barrier EVAL™ EVOH
- Polyurethane foam insulation
- Service pipe

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



- Polyethylene (PE) outer casing
- Tie layer
- Barrier EVAL™ EVOH
- Polyurethane foam insulation
- Service pipe

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.

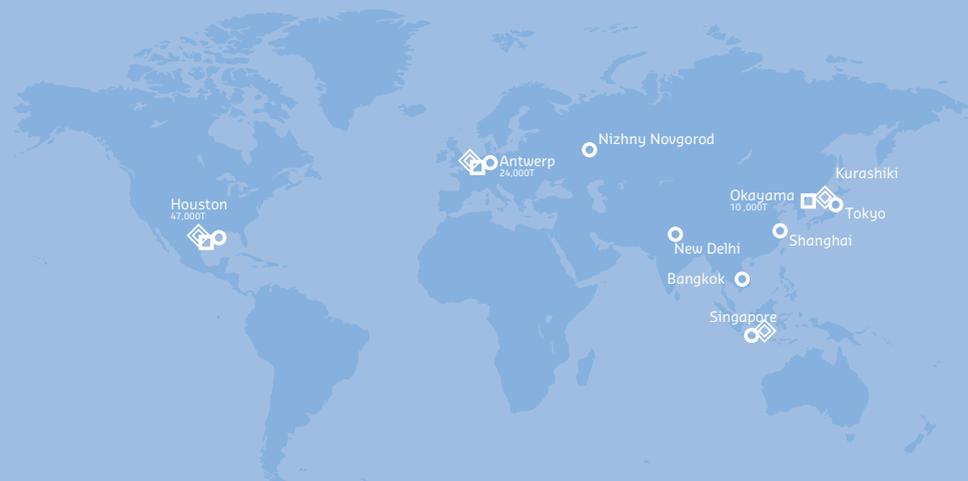
Building better barriers

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

NOTICE

The information, specifications, procedures, methods and recommendations herein are presented in good faith, are believed to be accurate and reliable, but may well be incomplete and/or not applicable to all conditions or situations that may exist or occur. No representation, guarantee or warranty is made as to the completeness of said information, specifications, procedures, methods and recommendations or that the application or use of any of the same will avoid hazards, accidents, losses, damages or injury of any kind to persons or property or that the same will not infringe patents of others or give desired results. Readers are cautioned to satisfy themselves as to the suitability of said information, specifications, procedures, methods and recommendations for the purpose intended prior to use.



Your contacts for EVAL™ barrier casings for pre-insulated pipe systems

Asia-Pacific

Kazuhiro Kurosaki

Tel: +81 (3) 6701 1490

kazuhiro_kurosaki@kuraray.co.jp

China

Yuan Song

Tel: +86 21 611 98 111 – 2201

en_sou@kuraray.co.jp

Américas

Emilio Morales

Tel: +1 (832) 729 3251

emilio.morales@kuraray.com

Europe, Africa, Middle East

Cynthia Teniers

Tel: +32 3 250 9721

cynthia.teniers@kuraray.com

EVAL™ resins are produced worldwide under unified Kuraray product and quality specifications. PIP1410.1504.0 Copyright Kuraray Co., Ltd.

kuraray