lyondellbasell
Advancing Possible

ADVANCING GEOMEMBRANES WITH

Catalloy and Masterbatch

Overview

The LyondellBasell *Catalloy* technology creates a PP/EPR (Ethylene Propylene Rubber) alloy directly in the polymerization reactors.

This results in a very fine and uniform rubber dispersion that allows for optimum:

- Impact/stiffness balance
- Thermal resistance
- Cold temperature impact
- Creep resistance
- Softness
- Toughness
- Tear resistance
- Puncture resistance
- Controlled shrinkage
- Good dimensional stability

Catalloy produced grades, like *Hifax* CA10A, are used in various waterproof membrane applications and can also be used as a HDPE/MDPE modifier owing to the following key properties:

- High flexibility
- Good puncture resistance
- Excellent tear and impact resistance
- Very good dimensional stability
- Good environmental stress cracking resistance (ESCR)
- Durability

Hifax CA10A contains a barefoot stabilization package and has to be considered as a building block for geomembrane formulations.

Typical formulations consist of at least:

- *Hifax* CA10A (base resin)
- Colorant Masterbatch
- Primary and Secondary Antioxidant Masterbatches
- UV-Stabilizer Masterbatches

The LyondellBasell Masterbatch portfolio offers *Polyblak* HI 7416 for *Hifax* CA10A for a long-lasting performance of the geomembrane. It is based on a combination of highly dispersed carbon black and a specific stabilizer package to meet the requirements of relevant standards such as GM18.

Masterbatch dosing levels are typically in the range 5 - 7% and tailor-made combinations can be considered.

Other Masterbatches for *Hifax* CA10A are available such as:

- Conductive grades
- Colors with high weather and chemical stability
- High reflectance colors
- Special additive packages

Note: Customers need to conduct their own tests and make their own determinations regarding the suitability of LyondellBasell resins for their specific end use applications.

Advanced Polymer Solutions for geomembranes

Advantages of *Hifax* CA10A for geomembranes:

Attributes

- Impact/Stiffness Balance
- Thermal Resistance
- Cold Temperature Impact
- Creep Resistance
- Softness
- Toughness
- Tear Resistance
- Puncture Resistance
- Controlled Shrinkage
- Good Dimensional Stability

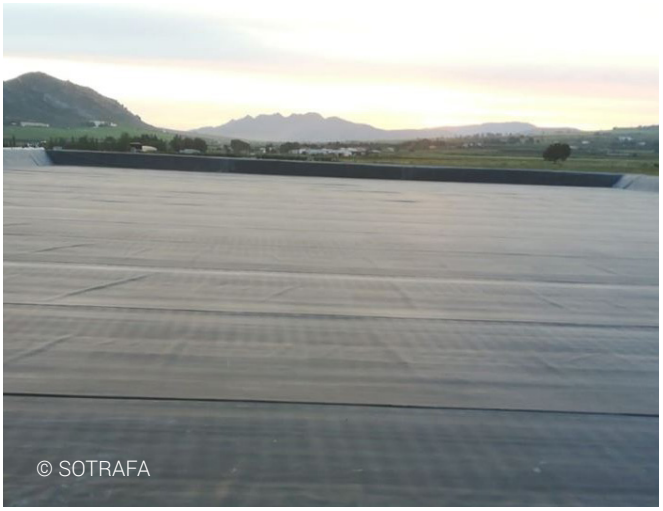
Hifax CA10A can be processed using all common technologies and has a wide seaming window allowing successful installation even under extreme weather conditions.

Advantages of *Polyblak* Masterbatches for *Hifax* CA10A based geomembranes:

Attributes

- Highly concentrated black and additive systems
- Designed to be added to a natural grade such as *Hifax* CA10A
- Excellent carbon black dispersion level results in better color economy and additive consistency
- Combined carbon black + stabilization package simplifies operations and avoids dosing mistakes
- Addition rates are in general 5 - 7 %

Note: It is the owner's responsibility to determine and test for material suitability for each application. Tests should be performed to simulate application specific conditions prior to material selection.



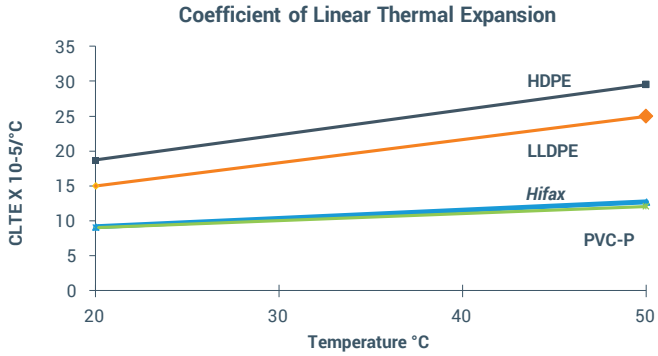
Physical properties: *Hifax* CA10A as modifier for PE based membranes

Product Name/Test	Description	Durometer	MFR	Flexural Modulus	Tensile Strength @ Break	Elongation @ Break	Brittleness Temperature	Vicat Softening Temp (A50 (50 °C/h 10 N))
Unit		Shore A	g/10 min	MPa	MPa	%	°C	°C
Test Method		ASTM D2240	ISO 133 (230 °C, 2.16 kg)	ISO 178	ISO 527	ISO 527	ASTM D746	ISO 306
Hifax CA 10 A		89	0.6	80	20	>800	<-70°C	56

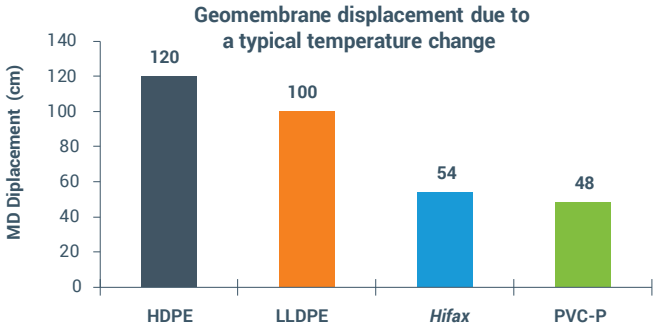
Technical data *Hifax* CA10A

Dimensional stability - Coefficient of Linear Thermal Expansion (CLTE)

A low CLTE allows to design and install liners with large total surface area without the need of controlling the effect of temperature changes (day-night, summer/winter) on dimensions. It also decreases the risk of creasing due to dilatation, and stress due to thermal contraction/expansion. PVC has the lowest CLTE, but it loses plasticizers with time. *Hifax* CA10A has almost the same thermal expansion behavior as PVC, and the lowest CLTE among the polyolefins used in geomembranes (approximately half of HDPE).



Tested per ASTM D696 - Test performed on typical samples provided by our customers



Displacement per 100 meter length of geomembrane when exposed to a 50°C temperature change (20°C - 70°C) as calculated from CLTE given in previous graph

Flexibility in cold environments

Hifax CA10A shows superior flexibility at temperatures below 0°C, and it is the material of choice in cold environments.

Hifax CA10A deforms like PVC-P rather than absorbing energy like HDPE.

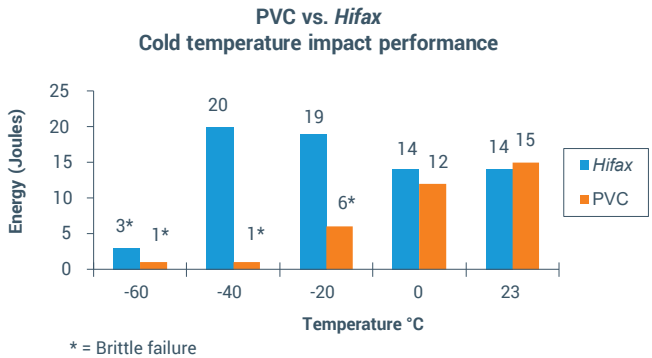
At low temperatures, PVC-P looses its deformation capacity.

Due to its low ductile/brittle transition temperature *Hifax* CA10A maintains its flexibility even at low temperatures. It can be installed in cold regions and in zones located at high geographic altitudes due to its stability at steeper slopes during installation.

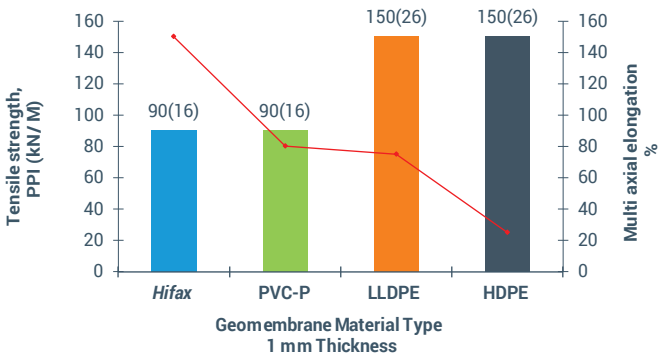
Multi-axial elongation performance

Geomembranes produced from *Hifax* CA10A exhibit high extensibility, giving it high conformance characteristics. *Hifax* CA10A does not show any yielding or necking. It deforms more than 200% (up to 450%) without rupture even in the welded area.

Membranes fail with a "star" shaped rupture, that demonstrates even stress distribution.



* = Brittle failure



Geomembranes - application examples

Geomembranes for irrigation ponds

Geomembranes for landfill capping

Chemical resistance *Hifax* CA10A

Many polymers swell when exposed to concentrated organic chemicals. Based on laboratory data (ISO 175) *Hifax* CA10A would not be suggested for secondary containment of most hydrocarbons. For this reason, flexible polypropylene is not suggested for containment of:

- Hazardous wastes with high concentrations of petroleum products.
- Aromatic hydrocarbons
- Chlorinated organic hydrocarbons

It is important to note the degree of attack on any material is influenced by a number of variable factors, including concentration of the chemical, stress, temperature, aeration, velocity of flow, duration of exposure, possible chemical reaction with other compounds being held in the same impoundment, size of the test sample, etc. Therefore, this information is only offered as a guide. It is suggested that a sample of the specified geomembrane be tested under actual or simulated service conditions

Table 1: Chemical resistance of *Hifax* CA10A to various classes of chemicals

Chemical Classes	Chemical Resistance
Acids Inorganic e.g., hydrochloric acid, nitric acid, dilute sulfuric acid	good resistance
Bases Organic e.g., amines	good resistance
Bases Inorganic e.g., sodium hydroxide, calcium hydroxide, ammonium hydroxide	good resistance
Alcohols e.g., methanol, n-propanol, ethylene glycol	good resistance
Heavy Metals e.g., mercury, lead, cadmium	good resistance
Salts e.g., sodium chloride, potassium bromide, cupric sulfate, calcium carbonate	good resistance
Acids Organic e.g., acetic acid, stearic acid	marginal resistance
Volatile/Semivolatile Organics e.g., ketones, aldehydes, esters, amides, ether, other oxygenated solvents	marginal resistance
Oil and Grease	marginal resistance
Strong oxidizers, e.g. potassium permanganate, potassium dichromate, chlorine, bleach, chlorine dioxide, perchloric acid, peroxides	marginal resistance
Aliphatic Halogenated Hydrocarbons e.g., trichloroethylene, methylene chloride, chloroform, other chlorinated solvents	poor
Aromatic Halogenated Hydrocarbons e.g., dichlorobenzene, other chlorinated solvents	poor
Aliphatic Hydrocarbons e.g., butane, pentane, hexane, light petroleum ethers	poor
Aromatic Hydrocarbons e.g., benzene, toluene, xylene	poor

In Table 1, an indication of the chemical resistance of *Hifax* CA10A to classes of chemicals is given. Samples of the specified item should be tested in all cases.

LyondellBasell (NYSE: LYB) is one of the largest plastics, chemicals and refining companies in the world. Driven by its employees around the globe, LyondellBasell produces materials and products that are key to advancing solutions to modern challenges like enhancing food safety through lightweight and flexible packaging, protecting the purity of water supplies through stronger and more versatile pipes, improving the safety, comfort and fuel efficiency of many of the cars and trucks on the road, and ensuring the safe and effective functionality in electronics and appliances. LyondellBasell sells products into more than 100 countries and is the world's largest producer of polymer compounds and the largest licensor of polyolefin technologies. More information about LyondellBasell can be found at www.LyondellBasell.com.

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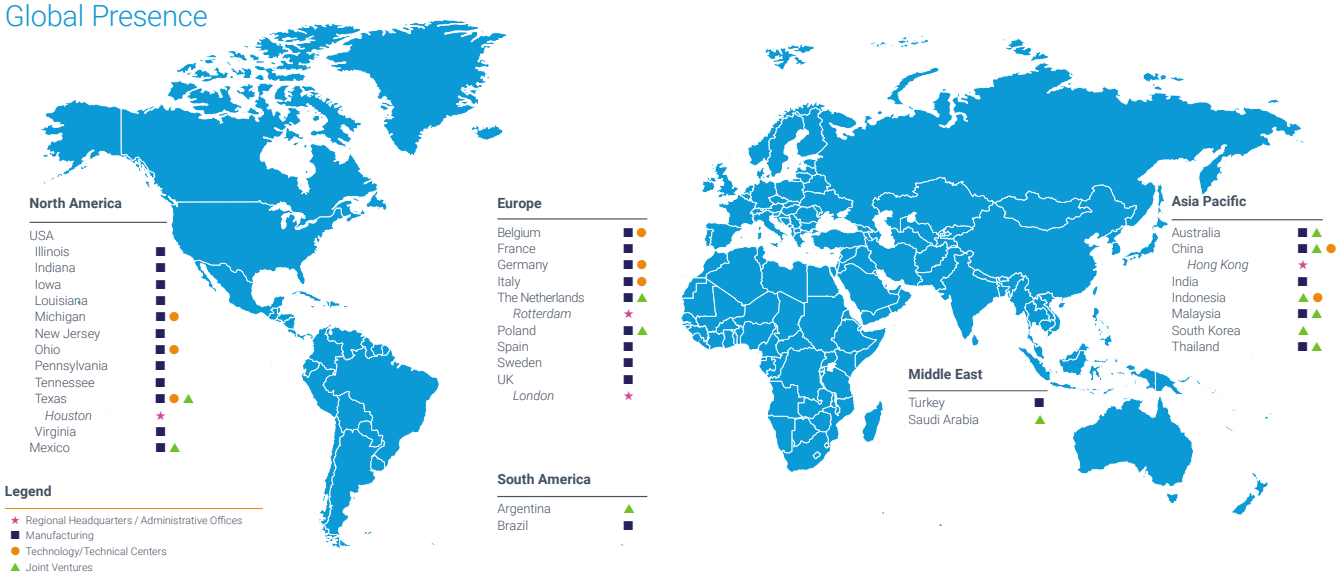

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