Stepan®

Alkoxylates

Collaborative Chemistry.
Creative Solutions.

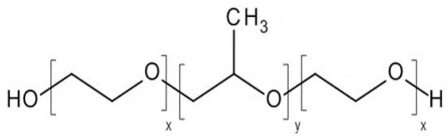
Stepan Company EO/PO Block Copolymers

Stepan EO/PO Block Copolymers

Block copolymers provide a broad range of physical properties that make them versatile, low-foam nonionic surfactants made from ethylene oxide and propylene oxide.

MAKON® L-Series: Liquid EO/PO Block Copolymers
MAKON P-Series: Paste EO/PO Block Copolymers
MAKON R-Series: Liquid Reverse EO/PO Block Copolymers

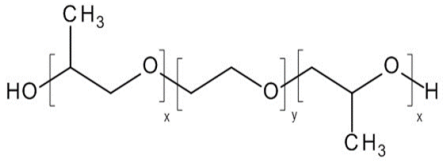
MAKON L-Series & P-Series



EO | PO | EO

The MAKON L-Series and P-Series EO/PO Block Copolymers are both made by addition of hydrophilic ethylene oxide (EO) to both ends of a polypropylene glycol (PPG) hydrophobe.

MAKON R-Series



PO | EO | PO

The MAKON R-Series Reverse EO/PO Block Copolymers are made by addition of hydrophobic propylene oxide (PO) to both ends of a polyethylene glycol (PEG) hydrophile.

Typical Properties

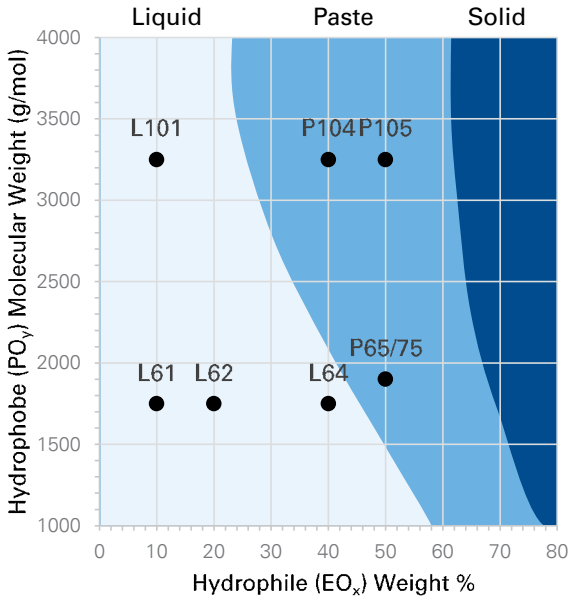
Stepan Tradename	INCI Name	Form at 25°C	HLB	Average Molecular Weight, g/mol	Cloud Point at 1 wt% aqueous, °C	Pour Point, °C	Viscosity at 38°C, cps
MAKON L61	Poloxamer 181	Liquid	3	2,000	24	-32	162
MAKON L62	Poloxamer 182	Liquid	7	2,500	32	-41	268
MAKON L64	Poloxamer 184	Liquid	15	2,900	58	18	312
MAKON L101	Poloxamer 331	Liquid	1	3,800	15	-36	392
MAKON P65/75	N/A	Paste	17	3,800	82	27	222[2]
MAKON P104	Poloxamer 334	Paste	13	5,900	82	32	448[2]
MAKON P105	Poloxamer 335	Paste	15	6,500	63[1]	36	626[2]
MAKON 17R2	Meroxapol 172	Liquid	6	2,150	35	-39	224
MAKON 17R4	Meroxapol 174	Liquid	12	2,650	46	10	333

MAKON L-Series and R-Series products contain <100 ppm ash catalyst
For unfiltered grades of the MAKON L-Series, please contact your Stepan Sales Representative

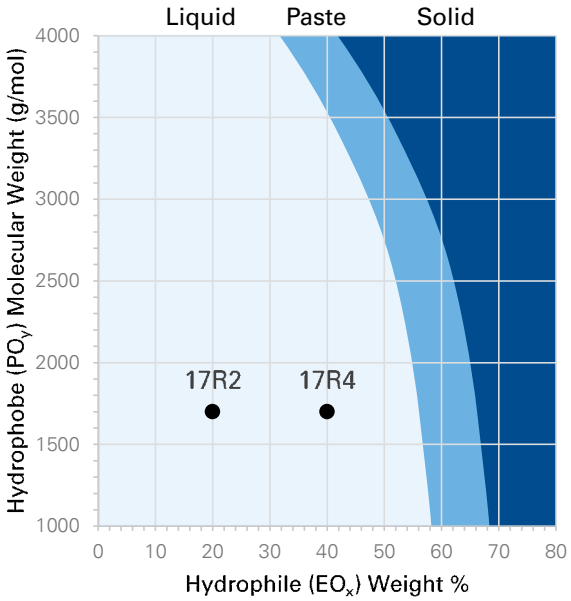
[1] 1 wt% in 10 wt% NaCl (sodium chloride)
[2] At 60°C

Molecular Structure Guide

MAKON L-Series & P-Series



MAKON R-Series



MAKON L-Series & P-Series Naming Structure: The naming and molecular structure for EO/PO block copolymers use the following rules: The first digit (the first two digits in a three digit number) multiplied by 300 indicates the approximate molecular weight of the hydrophobe (PO content). The last digit multiplied by ten gives the percentage of hydrophile (EO content) in the molecule. For example, MAKON L64 indicates a hydrophobe molecular weight of approximately 1,800 g/mol and a hydrophile molecular weight of 40% of the molecular mass.

MAKON R-Series Naming Structure: The naming and molecular structure for reverse EO/PO block copolymers use the following rules: The first two digits multiplied by 100 indicate the approximate molecular weight of the hydrophobe. The last digit multiplied by ten gives the percentage of hydrophile in the molecule. For example, MAKON 17R2 indicates a hydrophobe molecular weight of approximately 1,700 g/mol and a hydrophile molecular weight of 20% of the molecular mass.

Solubility

Stepan Tradename	Distilled Water	Ethanol (95%)	Isopropanol	Methanol	Ethylene Glycol	Propylene Glycol	Toulene	Kerosene	Mineral Oil (light)	Xylene	Perchloroethylene
MAKON L61	Insoluble	>10	>10	>10	Insoluble	>10	>10	>10	Insoluble	>10	>10
MAKON L62	>10	>10	>10	>10	Insoluble	>10	>10	Insoluble	Insoluble	>10	>10
MAKON L64	>10	>10	>10	>10	Insoluble	>10	>10	Insoluble	Insoluble	>10	>10
MAKON L101	Insoluble	>10	>10	>10	Insoluble	Insoluble	>10	Insoluble	Insoluble	>10	>10
MAKON P65/75	>10	>10	>10	>10	Insoluble	>10	>10	Insoluble	Insoluble	>10	>10
MAKON P104	>10	>10	>10	>10	Insoluble	<10	>10	Insoluble	Insoluble	>10	>10
MAKON P105	<10	>10	<10	>10	Insoluble	<10	>10	Insoluble	Insoluble	<10	<10
MAKON 17R2	<10	>10	>10	>10	Insoluble	<10	>10	<10	Insoluble	>10	>10
MAKON 17R4	>10	>10	>10	>10	Insoluble	>10	>10	Insoluble	<10	>10	>10

Solutions evaluated at 22°C
<10 indicates the surfactant forms a clear solution at less than 10 wt% in solvent
>10 indicates the surfactant forms a clear solution at greater than 10 wt% in solvent
Insoluble indicates the surfactant does not form a clear solution at 1 wt%

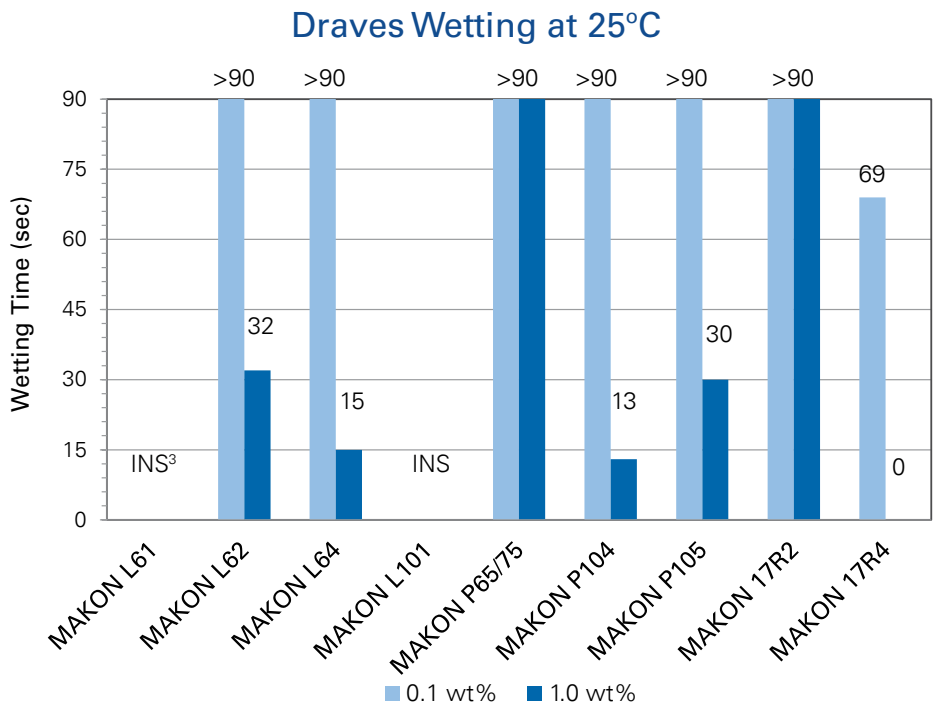
Application Selection Guide

Due to the wide range of physical properties, EO/PO block copolymers can be utilized for many different industries and applications. Some of the industries they can be utilized for include paints & coatings, household & industrial cleaning, agricultural chemicals, metalworking fluids, textiles, pulp & paper and personal care.

Applications	MAKON L61	MAKON L62	MAKON L64	MAKON L101	MAKON P65/75	MAKON P104	MAKON P105	MAKON 17R2	MAKON 17R4
Adhesives	X	X							
Agrochemical	X	X	X		X	X	X		
Clean-in-Place	X	X		X				X	X
Detergent		X	X						
Foam Control	X			X				X	X
Food Processing	X			X				X	X
Iodophor			X		X	X	X		
Machine Dishwash	X	X						X	X
Metalworking Fluids	X			X				X	X
Paints & Coatings	X	X	X	X				X	X
Personal Care	X	X	X	X					
Pulp & Paper	X	X		X				X	X
Rinse Aid	X	X						X	X
Sanitizing Solutions	X	X	X	X				X	X
Textiles	X			X				X	X
Water Treatment	X	X	X					X	X
Wetting Agent	X			X		X			X

Wetting

Draves Wetting describes a surfactant's ability to penetrate and wet cotton. Based on the data shown below, MAKON L64, MAKON P104 and MAKON 17R4 show good wetting and penetrating properties. MAKON L61 and MAKON L101 are both insoluble in water at 25°C.



[3] INS = Insoluble

Draves Wetting Method:
ASTM D2188-10, 5-g skein, 3-g hook, 0.1 wt% nonionic, deionized water, 25°C

Surface Tension and Interfacial Tension

Surface Tension (ST): Surface tension is a measure of the amount of energy (work) required to expand surface area between air and water. Lowering the surface tension of water improves its capability to wet surfaces and solubilize liquids or disperse solids. Surfactant performance such as detergency is often correlated with lower surface or interfacial tension.

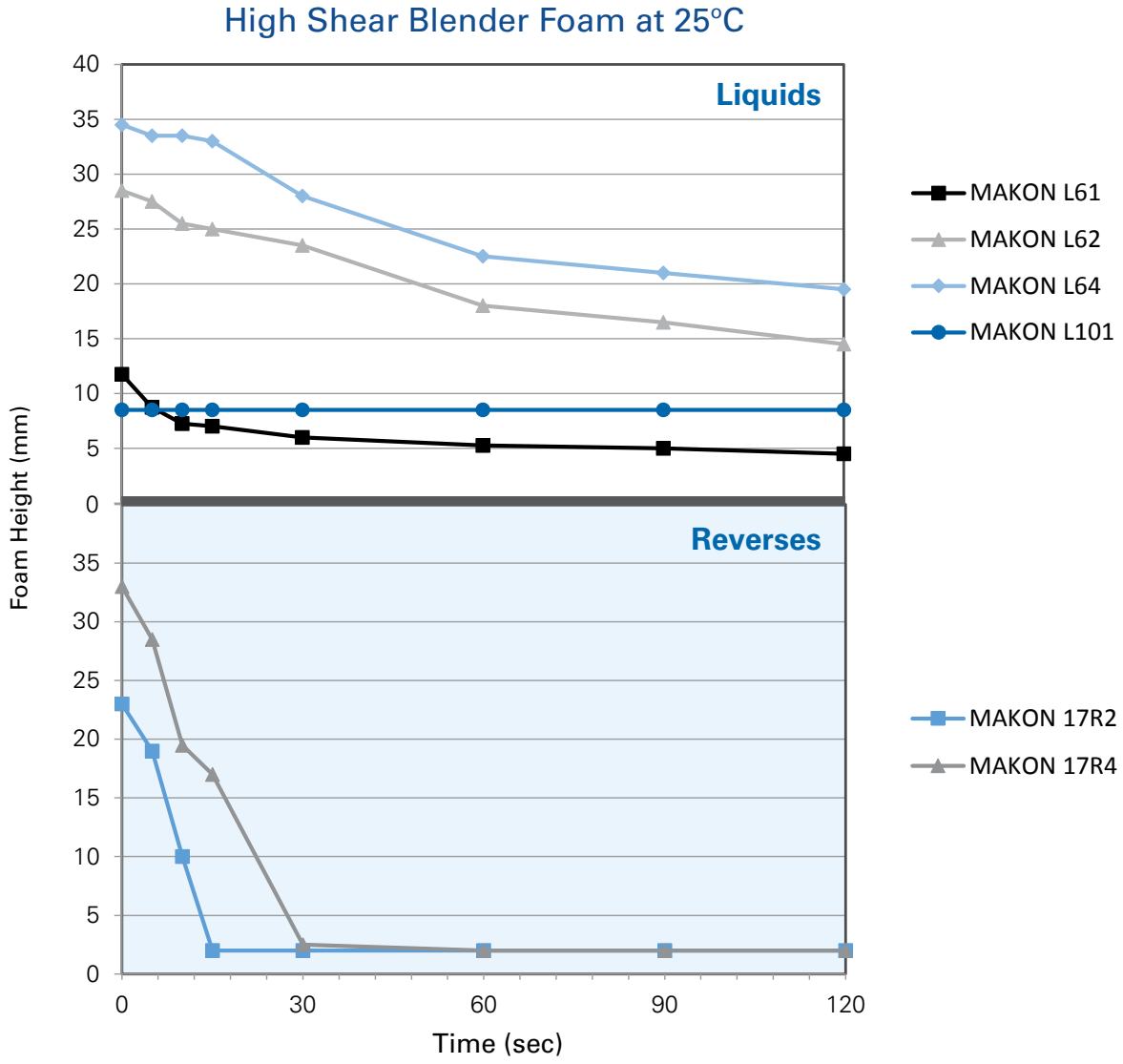
Interfacial Tension (IFT): Interfacial tension is a measure of the work required to expand the interfacial area between two immiscible liquids, such as water and mineral oil. Lower IFT values correlate to better wetting and increased detergency, solubilization, or emulsification.

Stepan Tradename	Surface Tension, dynes/cm (wt%)			Interfacial Tension with Light Mineral Oil, dynes/cm (wt%)		
	0.1%	0.01%	0.001%	0.1%	0.01%	0.001%
MAKON L61	Insoluble	43.7	46.9	Insoluble	17.0	24.1
MAKON L62	42.3	44.6	48.6	13.9	24.1	27.7
MAKON L64	41.5	44.4	48.0	13.9	17.4	20.4
MAKON L101	Insoluble	34.8	39.2	Insoluble	4.5	25.1
MAKON P65/75	41.8	45.0	47.9	15.6	21.7	23.8
MAKON P104	35.7	38.9	42.9	4.3	12.6	31.9
MAKON P105	35.7	38.5	42.9	5.6	9.3	12.8
MAKON 17R2	43.0	45.8	48.8	15.1	19.1	23.3
MAKON 17R4	45.2	48.1	51.1	17.5	21.6	24.3

High Shear Foam Behavior

MAKON EO/PO Block and Reverse Block Copolymers exhibit low foaming characteristics. Traditionally, the Ross-Miles Method (ASTM D1173-53, 2001) has been used to show the foam profile of surfactants. However, it is hard to differentiate the products with this method due to their low levels of foam from a lack of shear. The Blender Foam Method shows the foam behavior under high shear conditions and is able to differentiate product performance.

The charts shown below describe the foaming characteristics of aqueous solutions at 0.1% active concentration at a temperature of 25°C in a Waring blender. The MAKON L-Series and R-Series exhibit the best low-foam properties. In general, the initial foam generation (flash foam) of block copolymers increases as the molecule has increasing amounts of EO. Additionally, as a block copolymer increases hydrophobe molecular weight (PO), while EO remains constant, foam stability increases. Low foaming is dependent upon surfactant cloud point and application-use temperature. When deciding on a formulation component, it is recommended that a formulator use a block copolymer whose cloud point is below the intended use temperature.



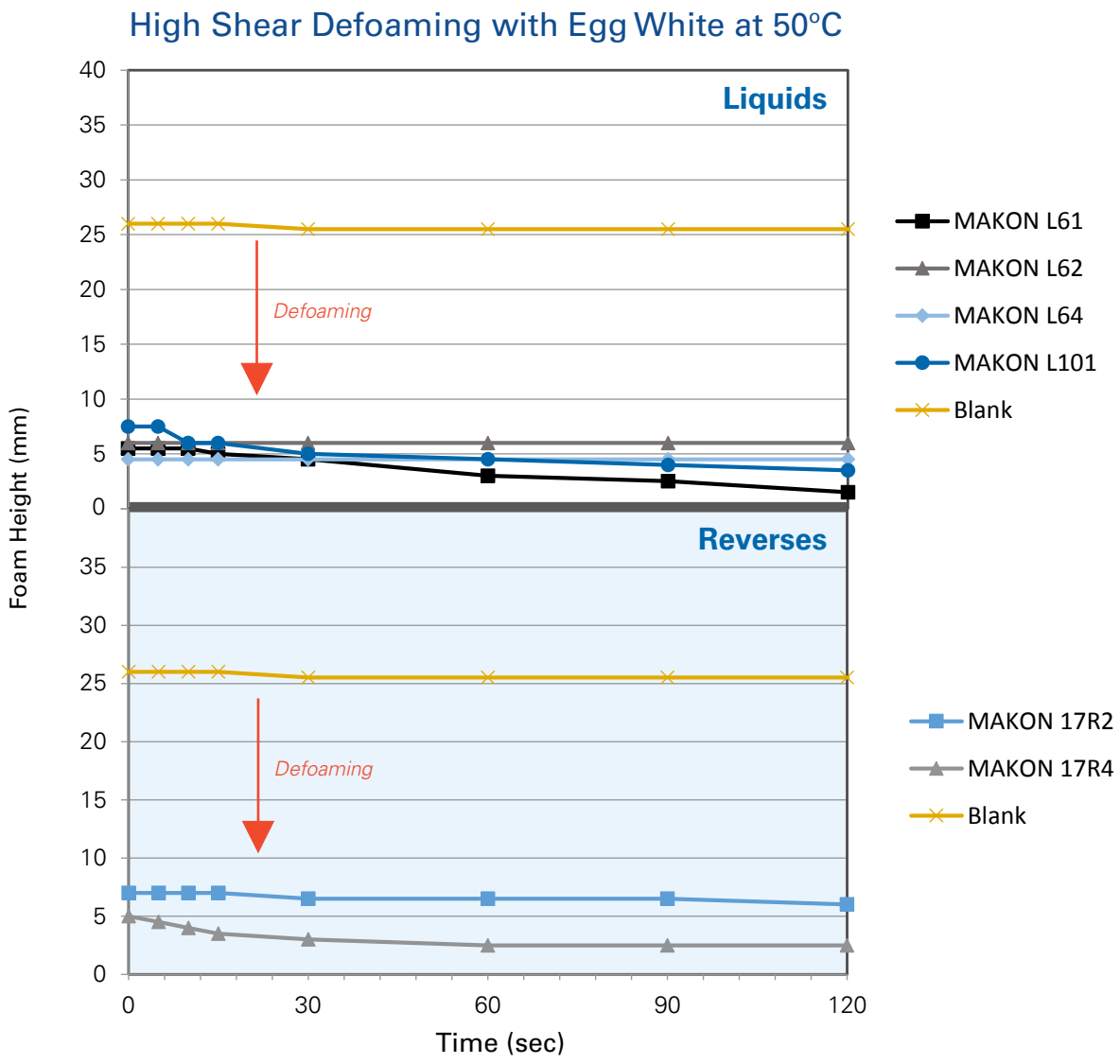
Under the conditions described, MAKON L61, MAKON L101, MAKON 17R2 and MAKON 17R4 exhibit the best low-foaming properties.

Blender Method:
Equipment: Waring Food & Beverage blender with 40-oz cloverleaf carafe
Test solution: 0.1 wt% surfactant in deionized water
Procedure: Incubate test solution and blender carafe at 25°C, blend 200 mL on high speed for 30 seconds, allow foam to settle, use video camera to record foam during blending and for 5 minutes after, measure foam height in mm

Defoaming

In addition to having low-foam profiles, some of the MAKON EO/PO Block and Reverse Block Copolymers exhibit defoaming characteristics. The Defoaming Method shows the foam behavior under high shear conditions with food soil (egg white) and alkalinity at elevated temperatures. This is relevant to Clean-in-Place (CIP) and machine dishwash applications.

The charts shown below describe the defoaming characteristics of block copolymers added at 0.02% active concentration to aqueous solutions with 3% alkalinity and 1% egg white at a temperature of 50°C in a Waring blender. The blank represents the foam level generated from the alkaline egg white solution with no surfactant added. The MAKON L-Series and R-Series exhibit the best defoaming properties. Defoaming is dependent upon surfactant cloud point and application-use temperature. When deciding on a defoamer, it is recommended that a formulator use a block copolymer whose cloud point is below the intended use temperature.



Under the conditions described, MAKON L61, MAKON L101, MAKON 17R2 and MAKON 17R4 exhibit the best defoaming properties.

Defoaming Blender Method:
Equipment: Waring Food & Beverage blender with 40-oz cloverleaf carafe
Test solution: 0.02 wt% surfactant, 3 wt% NaOH (sodium hydroxide), and 1 wt% fresh egg white in deionized water
Blank test solution: 3 wt% NaOH, 1 wt% fresh egg white in deionized water, no surfactant added
Procedure: Incubate test solution and blender carafe at 50°C, blend 200 mL on high speed for 30 seconds, allow foam to settle, use video camera to record foam during blending and for 5 minutes after, measure foam height in mm

Visit www.stepan.com/alkoxylates for Stepan's full product portfolio.

For further information, contact North America Technical Service at techserv@stepan.com or (800) 745-7837.

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