

Stepan Polyesters for Polyurethane Adhesives



Founded in 1932 in Chicago, IL, USA, Stepan Company is a publicly traded manufacturer of specialty and intermediate chemicals. These products include commercial and industrial surfactants, nutritional oils, polyester polyols for rigid and flexible foam, coatings, adhesives, sealants, and polyurethane elastomers. Stepan's commitment to the global polyester polyol market has been complemented with recent acquisitions of manufacturing facilities in Europe and the United States bringing our global footprint for polyester polyols production to five sites.

STEPANPOL® aliphatic polyester polyols offer greater light stability and non-yellowing properties while providing durability, solvent resistance, and tear strength.

STEPANPOL® aromatic polyester polyols use several aromatic acids. Phthalic anhydride is also utilized to take advantage of ortho-ester linkages for enhanced hydrolytic stability. All of these polyesters offer diverse substrate adhesion while improving abrasion resistance and overall hardness.

STEPANPOL polyester polyols for polyurethane adhesives

Stepan is dedicated to being a global leader in esterification and the product line reflects this – Stepan remains strictly a raw material supplier providing polyester polyols for the polyurethane adhesive industry and offering polyester technical support. Stepan is a global company and as the Company grows and expands, customers can expect to purchase the same STEPANPOL grades regionally.

Stepan offers a broad range of aliphatic and aromatic products including many prepolymer grade products. The “P” in the name of certain products, such as STEPANPOL PC-105P-30, stands for prepolymer grade, meaning that these are neutralized particularly for use in making prepolymers. Stepan is committed to innovation in the polyurethane adhesive market with the continuous addition of new products and dedicated resources in each region.

Stepan specializes in polyesters for use in polyurethane reactive hot melts (PURHMs) as a technology and flexible packaging adhesives, providing a technical introduction and basic formulation guidance.



Polyester Polyols for Flexible Packaging

				TYPICAL CHEMICAL PROPERTIES*					
STEPANPOL® Products	Region	Performance Features	Backbone	Viscosity at 25°C (cP)	Average Molecular Weight	Hydroxyl Value (mgKOH/g)	Tg/Tm (°C) [◇]	Functionality	Regulatory [‡] Compliance
STEPANPOL BC-180	A E C	Contains bio-content material, imparts low viscosity, aromatic	Proprietary	3300	700	180	-36 Tg	2.25	FD FI B
STEPANPOL PC-1011-55	A E C	Solvent resistance, general purpose product	DEG-AA	1075 at 60°C	2040	55	-58 Tg	2	FD FI B
STEPANPOL PC-1011P-110	A E	Solvent resistance, general purpose product	DEG-AA	775 at 40°C	1020	110	ND	2	FD FI B
STEPANPOL PC-1011P-210	A E	Solvent resistance, general purpose product	DEG-AA	250 at 40°C	540	210	ND	2	FD FI B
STEPANPOL PC-2011-225	A E	Solvent resistance, general purpose product	DEG-AA	500	500	225	ND	2	FD FI B
STEPANPOL PC-107P-55	A E	Flexibility, elongation, and toughness	NPG-AA	2300 at 60°C	2040	55	36 Tm	2	FD FI B
STEPANPOL PC-107-110	A E	Flexibility, elongation, and toughness	NPG-AA	565 at 60°C	1020	110	ND	2	FD FI B
STEPANPOL PC-207-125	A E	Flexibility, elongation, and toughness	NPG-AA	6700	900	125	ND	2	FD FI B
STEPANPOL PC-5030-270	A E	Good pigment wetting and low viscosity, aromatic	Proprietary	1750	500	270	ND	2	B
STEPANPOL PC-5050P-60	A E	Balance of flexibility and toughness, aliphatic	Proprietary	1750 at 60°C	2300	60	ND	2.46	FD FI B
STEPANPOL PC-5060-165	A E	Low viscosity aromatic for bonding latitude, aromatic	Proprietary	5000	750	165	-29 Tg	2.21	B L
STEPANPOL PC-5070P-56	A E	Great adhesion to aluminum, high performance, aromatic	Proprietary	7000 at 75°C	2000	56	-27 Tg	2	FD FI B
STEPANPOL PD-195	A E	Aromatic for bonding, extends open time	DEG-PA	26000	600	200	-40 Tg	2	FD FI B X
STEPANPOL PDC-279	A E	Low viscosity aromatic for 2K bonding	Proprietary	1450	416	279	-37 Tg	2.1	FI B X
STEPANPOL PD-320	A E	Low viscosity aromatic for 1 and 2K applications	DEG-PA	2800	350	320	ND	2	FD FI B X
STEPANPOL PDP-70	A E C	"Imparts low viscosity, flexibility, aromatic, and ester/ether compatibility	Proprietary	1900	1600	70	ND	2	FI B

A=Americas E=Europe C=Asia

*Property values are typical and based on product concentration and/or mathematical and statistical calculations.

◇ ND is noted for Tg/Tm (°C) when no thermal transition was detected.

‡ F= FDA compliance for 175.300 (D) or 175.105 (I), B= European compliance for EU 10/2011, X= Chinese compliance for GB 9685, L= Insufficient information to determine FDA status.



Polyester Polyols for 1K Liquid Moisture Cure

STEPANPOL® Products	Region	Performance Features	TYPICAL CHEMICAL PROPERTIES*						
			Backbone	Viscosity at 60°C (cP)	Average Molecular Weight	Hydroxyl Value (mgKOH/g)	Tg/Tm (°C) [‡]	Viscosity 25°C (cP) 10% Prepolymer**	Viscosity 25°C (cP) 15% Prepolymer**
STEPANPOL PC-1011-55	A E C	Solvent resistance, general purpose product	DEG-AA	1075	2040	55	-58 Tg	49150	13700
STEPANPOL PC-1011P-110	A E	Solvent resistance, general purpose product	DEG-AA	775 at 40°C	1020	110	ND	38300	5540
STEPANPOL PC-1017P-55	A E	Tensile and tear strength, solvent and oxidation resistance	EG/PG-AA	1200	2040	55	69 Tm	26400	7280
STEPANPOL PC-201P-110	A E	Good adhesion to a variety of substrates	EG-AA	400	1020	110	42 Tm	43900	1420
STEPANPOL PC-102P-110	A E	Tensile and tear strength, solvent resistance, flexibility	BDO-AA	320	1020	110	43 Tm	52000	6210
STEPANPOL PC-202P-110	A E	Tensile and tear strength, solvent resistance, flexibility	BDO-AA	320	1020	110	43 Tm	52000	6210
STEPANPOL PC-1040P-55	A E C	Balance of tensile and tear strength and flexibility	EG/BDO-AA	1300	2040	55	17 Tm	29500	6050
STEPANPOL PC-1040P-110	A E	Balance of tensile and tear strength and flexibility	EG/BDO-AA	700	1020	110	11 Tm	49200	10950
STEPANPOL PC-105P-110	A E	Improve flexibility, tear strength, and cold crack resistance	HDO-AA	295	1020	110	46 Tm	Solid	955
STEPANPOL PC-107-110	A E	Improve durability, UV stable	NPG-AA	565	1020	110	ND	15700	875
STEPANPOL PDP-70	A E C	Imparts low viscosity, flexibility, aromatic, and ester/ether compatibility	Proprietary	1900 at 25°C	1600	70	ND	61600	7250

A=Americas E=Europe C=Asia **Prepolymers were made by reaction of polyol component with 4, 4'-diphenylmethane diisocyanate (MDI) to targeted % NCO by weight.

Polyester Polyols for Polyurethane Reactive Hot Melts (PURHMs)

Polyol for CASE

Nominal OHV

STEPANPOL® PC-101P-55

Series indicating monomer backbone

1: Contains Tin Catalyst

2: Contains Titanium Catalyst

P: Prepolymer grade

Indicates monomer backbone

STEPANPOL® PD-56

Nominal OHV

Series	Backbone	Series	Backbone
101	EG/AA	1035	HD/AzA/IPA
102	BD/AA	1040	BD/EG/AA
105	HD/AA	5000	Proprietary
107	NPG/AA	PD	DEG/PA
1011	DEG/AA	PN	NPG/PA
1015	HD/NPG/AA	PH	HD/PA
1017	EG/PG/AA	PHN	HD/NPG/PA
1021	BD/IPA/AA	BC	Biocontent
1028	HD/PA	PS	Polyester

STEPANPOL® Products	Region	Performance Features
STEPANPOL PC-105-10	A E	Broad adhesion profile, extends open time, crystalline
STEPANPOL PC-205P-17	A E	Good bonding profile, crystalline
STEPANPOL PC-205P-20	A E	Good bonding profile, crystalline
STEPANPOL PC-105P-22	A E	Good bonding profile, crystalline
STEPANPOL PC-105P-30	A E	Workhorse, good bonding profile, crystalline
STEPANPOL PC-205P-30	A E C	Workhorse, good bonding profile, crystalline
STEPANPOL PC-105P-42	A E	Good bonding profile, crystalline
STEPANPOL PC-205P-56	A E	Good bonding profile, crystalline
STEPANPOL PC-2072P-30	A E	Specialty, good bonding profile, crystalline
STEPANPOL PC-5000P-30	A E C	Excellent bonding profile, amorphous, aromatic, flexibility
STEPANPOL PC-5010P-35	A E	Broad adhesion profile, flexibility, aromatic, extends open time while maintaining green strength
STEPANPOL PC-5120P-20	E	Good bonding profile, increase flexibility, amorphous, aromatic
STEPANPOL PH-56	A E C	Broad adhesion profile, extends set time, prepolymer grade
STEPANPOL PD-56	A E C	Broad adhesion profile, shortens set time, prepolymer grade
STEPANPOL PDP-70	A E C	Imparts low viscosity, flexibility, aromatic, and ester/ether compatibility
STEPANPOL PHN-56	A E C	Improves green strength, prepolymer grade
STEPANPOL PN-110	A E C	Improves green strength, prepolymer grade

A=Americas E=Europe C=Asia

*Property values are typical and based on product concentration and/or mathematical
[‡] ND is noted for Tg/Tm (°C) when no thermal transition was detected.

Thermoplastic to Thermoset - The Basics of PURHMs

Polyurethane Reactive Hot Melts, or PURHMs, are one component (1K) urethane reactive adhesives. These isocyanate-functional prepolymers are usually melted and applied around 120°C. Polyols in the PURHMs that are solid at room temperature refreeze upon cooling to develop initial bonds. Moisture curing then converts the adhesives from thermoplastic to thermoset polymers of even higher bond strength. As a technology, PURHMs provide variable open times to tailor assembly requirements with good green and ultimate bond strengths. Below is a representation of how these are made and work.

Crystalline aliphatic polyesters, typically hexanediol adipates or hexanediol dodecadioic acid polyols, are used as the workhorse polyols to put the “melt” in “hot-melts”. These provide great strength, chemical and solvent resistance, a broad adhesion profile, and sufficiently low viscosity at working temperatures. Aromatic polyesters are used to modify product adhesion and setting.

Polyol + Excess Isocyanate → Prepolymer of ~2% excess Isocyanate

Prepolymer + heat to 120°C to melt and apply; acts as thermoplastic tacky adhesive

Cooling: thermoplastic product refreezes to form an initial fixture/bond

After cooling: Prepolymer + H₂O → Urethane crosslinked adhesive

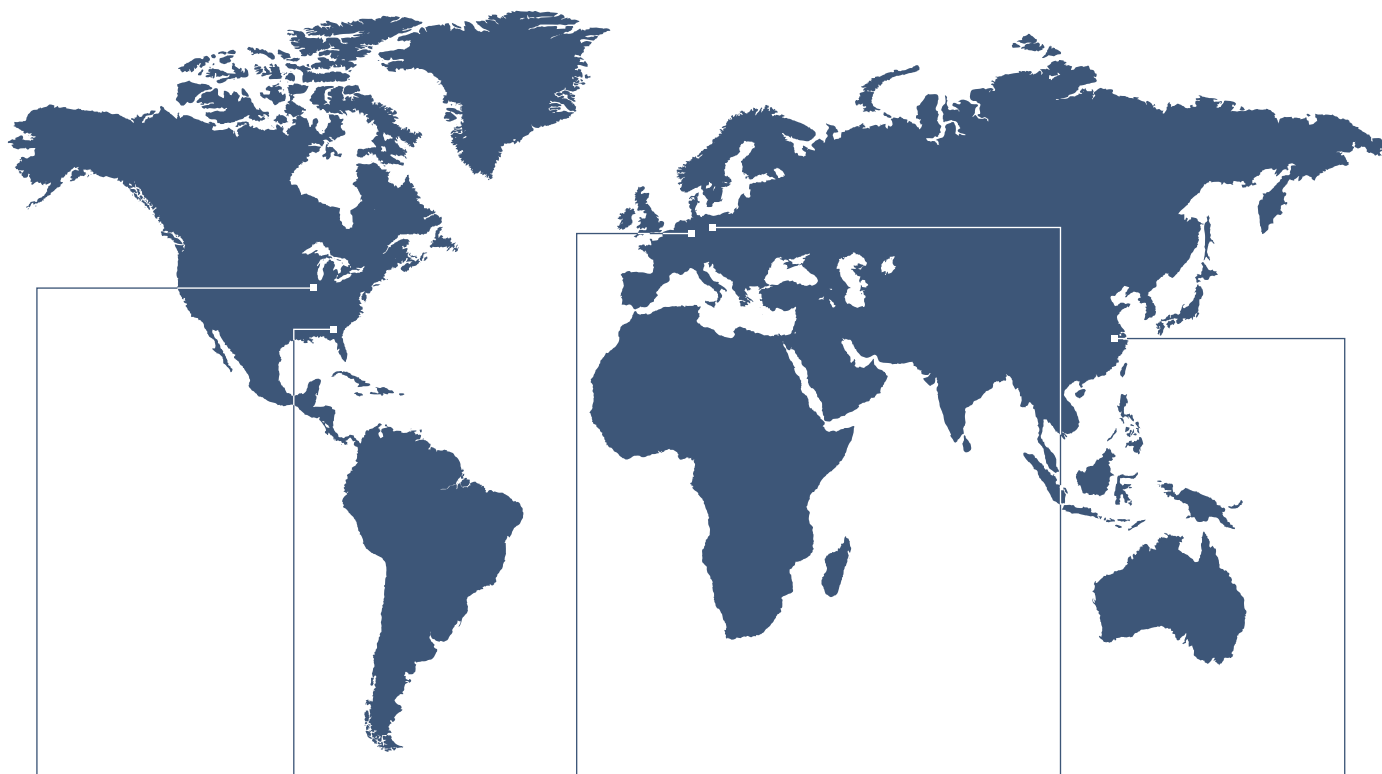
TYPICAL CHEMICAL PROPERTIES*

Backbone	Viscosity at 80°C (cP)	Average Molecular Weight	Hydroxyl Value (mgKOH/g)	Tg/Tm (°C) [‡]	Melt Viscosity at 120°C (cP)	Melt Viscosity at 130°C (cP)	Polyol or blend	Open time, s [†]	Set time, s [†]	Tensile strength, psi ^{***}	Elongation at break, % ^{***}
HDO-AA	4500 at 60°C	11,220	10	62 Tm	59370	45860	polyol				
HDO-AA	5400	8670	17	62 Tm	17240	17020	polyol				
HDO-AA	5400	5600	20	62 Tm	17240	17020	polyol				
HDO-AA	5400	5090	22	62 Tm	17240	17020	polyol				
HDO-AA	3500	3740	30	56 Tm	9990	7890	polyol	18	10	3684	960
HDO-AA	3500	3740	30	56 Tm	16575	13200	polyol	15	15	3668	979
HDO-AA	2650 at 60°C	2670	42	56 Tm	14720	12660	polyol				
HDO-AA	2800	2000	56	54 Tm	19520	15410	polyol				
HDO-DDDA	2800	3740	30	71 Tm	17200	14520	polyol	<5	2	2846	<5
Proprietary	10500	3740	30	-24 Tg	12280	9460	blend 25% in 205P-30	35	21	3175	1146
Proprietary	26000	3200	35	-36 Tg	16000	13050	blend 25% in 205P-30	45	15	3315	1215
Proprietary	6500 at 75°C	5600	20	ND	7350	5810	blend 25% in 205P-30	45	21	1096	11
HDO-PA	2885	2000	56	-15 Tg	12650	9840	blend 25% in 205P-30	30	45	1367	44
DEG-PA	4150	2000	56	-1 Tg	15910	13800	blend 25% in 205P-30	50	9	1550	9
Proprietary	1900 at 25°C	1600	70	ND	6480	5310	blend 25% in 205P-30	95	22	1468	552
HDO/NPG-PA	21700	2000	56	-7 Tg	608130	460700	blend 25% in 205P-30	100	55	1453	175
NPG-PA	15000	1020	110	26 Tg	28770	21120	blend 25% in 205P-30	90	72	1555	15

cal and statistical calculations.

[†] Tests completed on the reaction products of the polyol blend with 4,4'-diphenylmethane diisocyanate (MDI) to 2% NCO by weight.

^{***}The same prepolymers were first cured at 25°C and 50% relative humidity for at least 72 hours before testing.



Millsdale, IL, USA

- Production Plant
- Pilot Reactors



Columbus, GA, USA

- Production Plant, liquid and powder products



Wesseling, Germany

- Production Plant



Brzeg Dolny, Poland

- R&D Center
- Production Plant



Nanjing, China JV

- R&D Center
- Production Plant
- Esterification Pilot Reactor
- Propoxylation Pilot Reactor

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