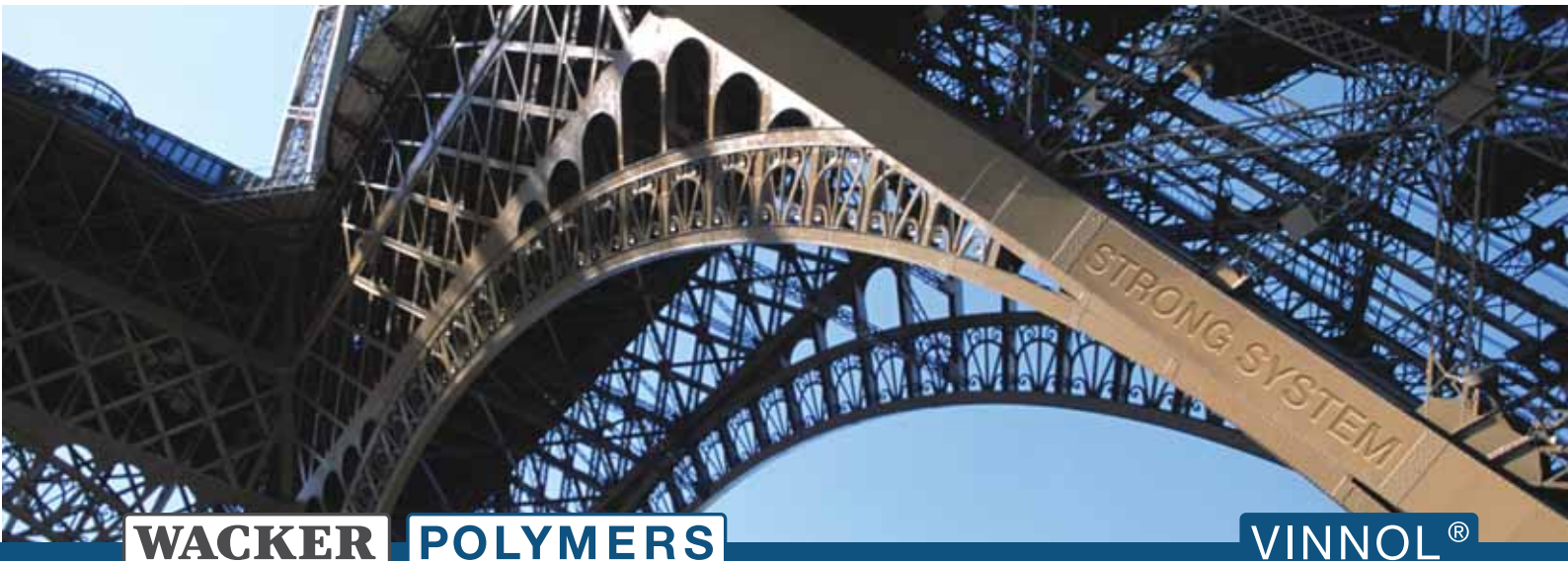


WACKER POLYMERS

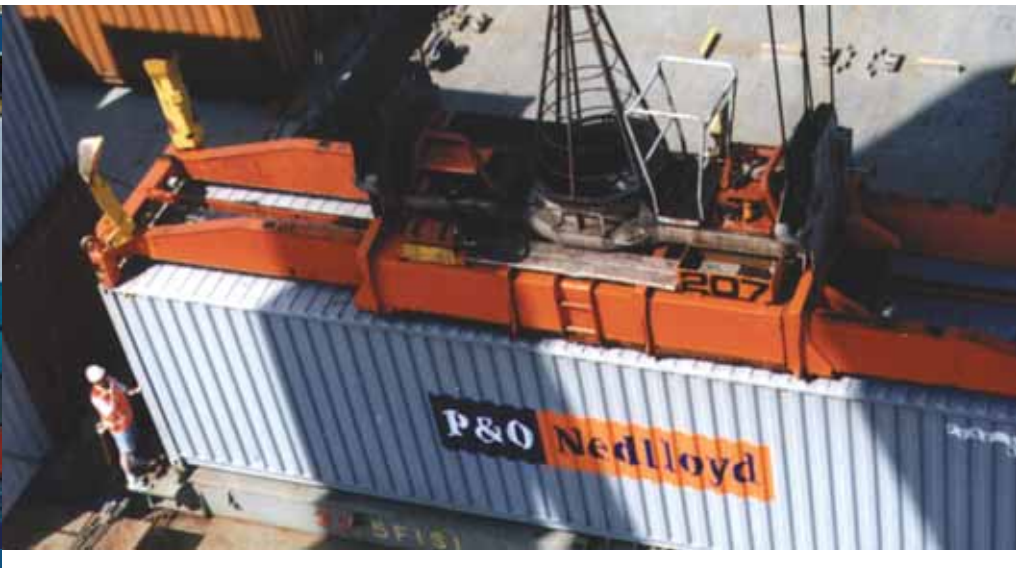
VINNOL®

VINNOL® SURFACE COATING RESINS VINYL CHLORIDE COPOLYMERS AND TERPOLYMERS

CREATING TOMORROW'S SOLUTIONS

Contents

VINNOL®-COATING RESINS – A STRONG SYSTEM



The brochure “VINNOL® SURFACE COATING RESINS – VINYL CHLORIDE CO- AND TERPOLYMERS“ describes the properties, application areas and advantages that VINNOL® offers for the formulation of

– Industrial coatings,
– Printing inks and
– Heat-sealable and heat-seal-resistant coatings for aluminum foil.

GENERAL PRODUCT INFORMATION

WACKER markets vinyl chloride copolymers and terpolymers under the trade name VINNOL® surface coating resins.

The product range currently contains
– VINNOL® surface coating resins without functional groups
– VINNOL® surface coating resins with carboxyl groups
– VINNOL® surface coating resins with hydroxyl groups.

VINNOL® surface coating resins are further classified as E and H grades in accordance with the polymerization process employed in their production, namely emulsion or suspension polymerization.

VINNOL® E resins are made by an emulsion polymerization process, and VINNOL® H resins by a suspension process. The excellent pigment wetting properties of VINNOL® E grades render them ideal for pigmented systems, whereas VINNOL® H grades are best used in transparent coatings.

VINNOL® resins without functional groups are copolymers of vinyl chloride and vinyl acetate of different molar compositions and degrees of polymerization.

VINNOL® resins containing carboxyl groups, the VINNOL® M grades, are terpolymers of vinyl chloride, vinyl acetate and dicarboxylic acids. The VINNOL® M grades also differ in their molar composition, and degree and method of polymerization.

VINNOL® resins containing hydroxyl groups, the VINNOL® E/A grades, are copolymers and terpolymers of vinyl chloride, hydroxy acrylate and, sometimes, dicarboxylic acid ester. They, too, differ in their compositions and degrees of polymerization.

The physical and chemical properties of the VINNOL® surface coating resins vary with the degree of polymerization and the molar distribution of the individual constituents in the polymer backbone.

Given otherwise constant polymer composition, as the molecular weight (K value) increases, the solution viscosity also increases. So, too, do the mechanical strength and softening range.

A rise in the polymer's vinyl acetate content greatly increases the flexibility of VINNOL® coatings. In direct contrast to the effect of increasing the molecular weight, increasing the vinyl acetate content lowers the solution viscosity and softening range. Vinyl chloride-vinyl acetate copolymers, with very high vinyl acetate content, such as the grades in our VINNOL® H 40 series, are frequently used to enhance the flexibility of coating systems that are subject to stretching and to reduce the heat-sealing temperature of heat-sealable coatings.

Products containing a dicarboxylic acid in addition to vinyl chloride and vinyl acetate exhibit excellent adhesion, particularly to metal substrates. Adhesion to mineral substrates is also enhanced.

Vinyl chloride copolymers containing hydroxyl groups are ideal for producing 2-pack resin coatings, such as baking enamels. The desired properties can be selected by choosing the reaction components carefully.

These cross-linking systems show increased thermomechanical resistance and, depending on the extent of cross-linking, improved surface hardness and abrasion resistance.

Suitable reaction components for vinyl chloride copolymers and terpolymers containing hydroxyl groups are mainly:
– Phenolic resins,
– Epoxy resins,
– Melamine resins and
– Isocyanate resins.

WACKER currently markets the following VINNOL® surface coating resins:

VINNOL® resins without functional groups:
– VINNOL® E 15/45
– VINNOL® E 20/45
– VINNOL® H 14/36
– VINNOL® H 15/42
– VINNOL® H 15/50
– VINNOL® H 11/59
– VINNOL® H 40/43
– VINNOL® H 40/50
– VINNOL® H 40/55
– VINNOL® H 40/60

VINNOL® resins with carboxyl groups:
– VINNOL® E 15/45 M
– VINNOL® H 15/45 M
– VINNOL® H 15/45 M special
– VINNOL® H 30/48 M

VINNOL® resins with hydroxyl groups:
– VINNOL® E 15/40 A
– VINNOL® E 15/48 A
– VINNOL® E 22/48 A

VINNOL® SURFACE COATING RESINS PRODUCT OVERVIEW

Grades	Vinyl chloride % by wt[2]	Vinyl acetate % by wt[2]	Other monomers % by wt[2]	Acid value mg KOH/g polymer[2]	Hydroxyl content % by wt[2]	Glass transition temperature T_g (DSC) °C[4]
without functional groups						
E 15/45	85.0 ± 1.0	15.0 ± 1.0	-	-	-	ca. 75
E 20/45	80.0 ± 1.0	20.0 ± 1.0	-	-	-	ca. 68
H 14/36	85.6 ± 1.0	14.4 ± 1.0	-	-	-	ca. 69
H 15/42	86.0 ± 1.0	14.0 ± 1.0	-	-	-	ca. 70
H 15/50	85.0 ± 1.0	15.0 ± 1.0	-	-	-	ca. 74
H 11/59	89.0 ± 1.0	11.0 ± 1.0	-	-	-	ca. 75
H 40/43	65.7 ± 1.0	34.3 ± 1.0	-	-	-	ca. 58
H 40/50	63.0 ± 1.0	37.0 ± 1.0	-	-	-	ca. 60
H 40/55	62.0 ± 1.0	38.0 ± 1.0	-	-	-	ca. 60
H 40/60	61.0 ± 1.0	39.0 ± 1.0	-	-	-	ca. 62
with carboxyl groups						
E 15/45 M	84.0 ± 1.0	15.0 ± 1.0	ca. 1.0	7.5 ± 1.5	-	ca. 73
H 15/45 M	84.0 ± 1.0	15.0 ± 1.0	ca. 1.0	7.0 ± 1.5	-	ca. 74
H 15/45 M special	84.0 ± 1.0	15.0 ± 1.0	ca. 0.5	4.5 ± 1.5	-	ca. 73
H 30/48 M	70.0 ± 1.0	29.0 ± 1.0	ca. 1.0	7.0 ± 1.5	-	ca. 65
with hydroxyl groups						
E 15/40 A	84.0 ± 1.0	-	ca. 16.0	-	1.8 ± 0.2	ca. 69
E 15/48 A	83.5 ± 1.0	-	ca. 16.5	-	1.8 ± 0.2	ca. 69
E 22/48 A	75.0 ± 1.0	-	ca. 25.0	-	1.8 ± 0.2	ca. 61

1) 20 % solution in methyl ethyl ketone, dissolved at 50 °C
2) WACKER method
3) Method: SEC (Size Exclusion Chromatography)
   Solvent: THF
   Standard: Polystyrene
4) The information contained is for guideline only.
   We make no warranty as to the accuracy of these data and they should not be interpreted as a specification.
5) DIN EN ISO 1628-2

K value[5]	Molecular weight average M_W (SEC)[3,4]	Viscosity[1] DIN 53015 [mPa·s]	Efflux time ISO 2431 4 mm cup[1,4]	Particle size mm[2]	Monomers in section A/B of EU Directive 2002/72/EG	FDA regulation § 175.300
45 ± 1	45–55 x 10^3	37 ± 5	ca. 36	< 2.5	yes/no	yes
45 ± 1	45–55 x 10^3	35 ± 5	ca. 32	< 2.5	yes/no	yes
35 ± 1	30–40 x 10^3	13 ± 3	ca. 20	< 1	yes/no	yes
42 ± 1	35–50 x 10^3	28 ± 5	ca. 26	< 1	yes/no	yes
50 ± 1	60–80 x 10^3	70 ± 10	ca. 66	< 1	yes/no	yes
59 ± 1	80–120 x 10^3	450 ± 100	-	< 1	yes/no	yes
42 ± 1	40–50 x 10^3	25 ± 5	ca. 26	< 1	yes/no	yes
50 ± 1	60–80 x 10^3	55 ± 10	ca. 45	< 1	yes/no	yes
55 ± 1	80–120 x 10^3	100 ± 20	ca. 80	< 1	yes/no	yes
60 ± 1	100–140 x 10^3	180 ± 30	ca. 145	< 1	yes/no	yes
45 ± 1	50–60 x 10^3	40 ± 5	ca. 34	< 2.5	yes/no	yes
48 ± 1	60–80 x 10^3	60 ± 10	ca. 50	< 1	yes/no	yes
48 ± 1	60–80 x 10^3	60 ± 10	ca. 50	< 1	yes/no	yes
48 ± 1	60–80 x 10^3	45 ± 10	ca. 45	< 1	yes/no	yes
39 ± 1	40–50 x 10^3	20 ± 5	ca. 22	< 2.5	yes/no	no
48 ± 1	60–80 x 10^3	60 ± 10	ca. 69	< 2.5	yes/no	no
48 ± 1	60–80 x 10^3	45 ± 7	ca. 46	< 2.5	yes/yes	no

APPLICATIONS
VINNOL® WITHOUT FUNCTIONAL GROUPS

Application	VINNOL® E 15/45	VINNOL® E 20/45	VINNOL® H 14/36	VINNOL® H 15/42	VINNOL® H 15/50
Adhesives					
Adhesive for PVC-P	○	○	○	○	●
Adhesive for PVC-U					○
Industrial coatings					
Artificial leather coatings	●	●	○	○	●
Coil coatings					
Corrosion-protection coatings					
Marine paints	○	○		○	
Metal coatings	○	○	○	○	○
Plastic coatings	○	○	○	○	○
Strippable coatings	●	●	●	●	●
Vinyl wallpaper top coats	●	●	●	●	●
Wood varnishes	○	○	○	○	○
Magnetic storage media					
Audio and video tape coatings					
Magnetic stripes					
Masonry paints					
Concrete paints	●	●	●	●	●
Floor paints	●	●	●	●	●
Road-marking paints			●	●	
Roof paints					
Packaging coatings					
Barrier coatings	●	●	●	●	●
Can coatings					
Heat-sealable coatings					●
Primers for metallization			○	○	
Protective coatings for metallized film					
Pigment preparations					
Chips/Liquid/Paste	●	●		●	●
Printing Inks					
Gravure printing	●	●	●	●	○
Ink-jet printing	●	●	●	●	
Screen printing	●	●			●
Transfer printing	●	●	○	○	○

● = Recommended ○ = Suitable

VINNOL® H 11/59	VINNOL® H 40/43	VINNOL® H 40/50	VINNOL® H 40/55	VINNOL® H 40/60
●	○	●	●	●
●				
○	○	●	●	●
	○	○	○	○
	○	○	○	○
	○	○	○	
	○	○	○	○
○	○	○	○	○
●	●	●	●	●
●	●	●	●	●
	●	●	●	○
	○	○	○	
	○	○	○	
○	●	●	●	○
○	●	●	●	○
	●	●	●	○
	●	●	●	○
●	●	●	●	●
	○	○	○	○
	●	●	●	●
	○	○	○	○
	○	○	○	○
	○	○		
	○			
●		○	●	●
○	●	●	●	●

APPLICATIONS
VINNOL® WITH FUNCTIONAL GROUPS

Application	VINNOL® E 15/45 M	VINNOL® H 15/45 M	VINNOL® H 15/45 M special
Adhesives			
Adhesive for metal	○	●	●
Two-Pack adhesive			
Industrial coatings			
Artificial leather coatings			
Coil coatings	●	●	●
Corrosion-protection coatings	●	●	●
Marine paints		●	●
Metal coatings	●	●	●
Plastic coatings	●	●	●
Baking enamels	●	●	●
Vinyl wallpaper top coats	○	○	○
Wood varnishes			
Magnetic storage media			
Audio and video tape coatings			
Magnetic stripes			
Masonry paints			
Concrete paints	●	●	●
Floor paints	●	●	●
Road-marking paints	●	●	●
Roof paints	●	●	●
Packaging coatings			
Barrier coatings	○	○	○
Can coatings	○	●	●
Heat-sealable coatings	●	●	●
Heat-seal-resistant coatings			
Primers for metallization	●	●	●
Protective coatings for metallized film	●	●	●
Pigment preparations			
Chips/Liquid/Paste			
Printing Inks			
Gravure printing	●	○	○
Ink-jet printing	○		
Screen printing	●	●	●
Transfer printing	●	●	●

● = Recommended ○ = Suitable

VINNOL® H 30/48 M	VINNOL® E 15/40 A	VINNOL® E 15/48 A	VINNOL® E 22/48 A
●		○	
	●	○	●
	●		●
●	●		●
●	●	●	●
●	●		●
●	●	●	●
●	●	○	●
●	●		●
○		●	
	●	●	●
		●	
	●	●	●
	●	●	●
		●	
●	○	●	○
●	○		○
●		●	
●			
○	○	●	○
●	○		○
●		●	○
	●	●	●
●	○		○
●	○	●	○
	●	○	●
		○	
○	●		●
		●	○
●	●	○	○
●	○	○	○

SOLUBILITY OF VINNOL®
IN VARIOUS SOLVENTS

Alcohols	E 15/45	E 20/45	E 15/40 A	E 15/48 A	E 22/48 A	E 15/45 M	H 11/59	H 14/36
Methanol	○	○	○	○	○	○	○	○
Ethanol	○	○	○	○	○	○	○	○
n-Propanol	○	○	○	○	○	○	○	○
i-Propanol	○	○	○	○	○	○	○	○
n-Octanol	○	○	○	○	○	○	○	○
i-Butanol	○	○	○	○	○	○	○	○
Benzyl alcohol	◐	◐	◐	◐	◐	◐	◐	◐
Diacetone alcohol	●	●	●	●	●	●	◐	◐
Ethylene glycol	○	○	○	○	○	○	○	○
Diethylene glycol	○	○	○	○	○	○	○	○
Glycerol	○	○	○	○	○	○	○	○
Ketones								
Acetone	●	●	●	●	●	●	●	●
Methyl ethyl ketone	●	●	●	●	●	●	●	●
Methyl isobutyl ketone	●	●	●	●	●	●	●	●
Diisobutyl ketone	●	●	●	●	●	◐	◐	●
Cyclohexanone	●	●	●	●	●	●	●	●
Isophorone	●	●	●	●	●	●	●	●
Ethers								
Diethyl ether	○	○	○	○	○	○	○	○
Dioxane	●	●	●	●	●	●	●	●
Tetrahydrofuran	●	●	●	●	●	●	●	●
Glykol ethers								
2-Methoxyethanol	●	●	●	●	●	●	○	◐
2-Ethoxyethanol	◐	◐	●	●	●	◐	○	○
2-Butoxyethanol	○	○	◐	○	○	○	○	○
3-Methoxy-butanol-1	○	○	○	○	○	○	○	○
1-Methoxy-propanol-2	○	○	○	○	○	○	○	○
Aromatic hydrocarbons								
Toluene	○	○	○	○	○	○	○	○
Xylene	○	○	○	○	○	○	○	○
Tetralin	○	○	○	○	○	○	○	◐
Solvent naphtha	○	○	○	○	○	○	○	○

● soluble ○ insoluble ◐ partially soluble

20 % solids; H11/59: 10 % solids

Alcohols	H 15/42	H 15/50	H 15/45 M	H 15/45 M special	H 30/48 M	H 40/43	H 40/50	H 40/55	H 40/60
Methanol	○	○	○	○	○	○	○	○	○
Ethanol	○	○	○	○	○	○	○	○	○
n-Propanol	○	○	○	○	○	○	○	○	○
i-Propanol	○	○	○	○	○	○	○	○	○
n-Octanol	○	○	○	○	○	○	○	○	○
i-Butanol	○	○	○	○	○	○	○	○	○
Benzyl alcohol	◐	◐	◐	◐	●	●	●	●	●
Diacetone alcohol	◐	◐	◐	◐	●	●	●	●	●
Ethylene glycol	○	○	○	○	○	○	○	○	○
Diethylene glycol	○	○	○	○	○	○	○	○	○
Glycerol	○	○	○	○	○	○	○	○	○
Ketones									
Acetone	●	●	●	●	●	●	●	●	●
Methyl ethyl ketone	●	●	●	●	●	●	●	●	●
Methyl isobutyl ketone	●	●	●	●	●	●	●	●	●
Diisobutyl ketone	●	◐	◐	◐	●	●	●	●	●
Cyclohexanone	●	●	●	●	●	●	●	●	●
Isophorone	●	●	●	●	●	●	●	●	●
Ethers									
Diethyl ether	○	○	○	○	○	○	○	○	○
Dioxane	●	●	●	●	●	●	●	●	●
Tetrahydrofuran	●	●	●	●	●	●	●	●	●
Glykol ethers									
2-Methoxyethanol	◐	◐	◐	◐	●	●	●	●	●
2-Ethoxyethanol	○	◐	○	○	●	●	●	●	●
2-Butoxyethanol	○	○	○	○	○	○	○	○	○
3-Methoxy-butanol-1	○	○	○	○	○	○	○	○	○
1-Methoxy-propanol-2	○	○	○	○	○	○	○	○	○
Aromatic hydrocarbons									
Toluene	○	○	○	○	○	●	◐	○	○
Xylene	○	○	○	○	○	○	○	○	○
Tetralin	◐	◐	○	○	○	○	○	○	○
Solvent naphtha	○	○	○	○	○	○	○	○	○

● soluble ○ insoluble ◐ partially soluble

20 % solids

SOLUBILITY OF VINNOL®
IN VARIOUS SOLVENTS

Aliphatic hydrocarbons	E 15/45	E 20/45	E 15/40 A	E 15/48 A	E 22/48 A	E 15/45 M	H 11/59	H 14/36
n-Hexane	○	○	○	○	○	○	○	○
Cyclohexane	○	○	○	○	○	○	○	○
Petroleum spirit 100/140	○	○	○	○	○	○	○	○
White spirit 180/210	○	○	○	○	○	○	○	○
Decalin	○	○	○	○	○	○	○	○
Ester								
Methyl acetate	●	●	●	●	●	●	●	●
Ethyl acetate	●	●	●	●	●	●	●	●
Propyl acetate	●	●	●	●	●	●	●	●
Isopropyl acetate	●	●	●	●	●	●	◐	●
Butyl acetate	●	●	●	●	●	●	●	●
Isobutyl acetate	●	●	●	●	●	●	◐	●
Amyl acetate	●	●	●	●	●	●	◐	●
2-Methoxyethyl acetate	●	●	●	●	●	●	◐	●
Methoxypropyl acetate	●	●	●	●	●	●	◐	●
Methoxybutyl acetate	●	●	●	●	●	●	◐	●
Butyl hydroxyethanoate	●	●	●	●	●	●	◐	●
Chlorinated hydrocarbons								
Methylene chloride	●	●	●	●	●	●	●	●
Ethylene chloride	●	●	●	●	●	●	●	●
Propylene chloride	●	●	●	●	●	●	●	●
Chloroform	●	●	●	●	●	●	●	●
Tetrachloromethane	○	○	○	○	○	○	○	○
Trichloroethylene	●	●	○	○	○	○	○	●
Tetrachloroethylene	○	○	○	○	○	○	○	○
Others								
Dimethyl acetamide	●	●	●	●	●	●	●	●
Dimethyl formamide	●	●	●	●	●	●	●	●
N-Methyl-2-pyrrolidone	●	●	●	●	●	●	●	●
Dimethyl sulfoxide	●	●	●	●	●	●	●	●
Acetic acid	○	○	○	○	○	○	○	○
Propylene oxide	●	●	●	●	●	●	●	●
Pyridin	●	●	●	●	●	●	●	●

● soluble ○ insoluble ◐ partially soluble

20 % solids; H11/59: 10 % solids

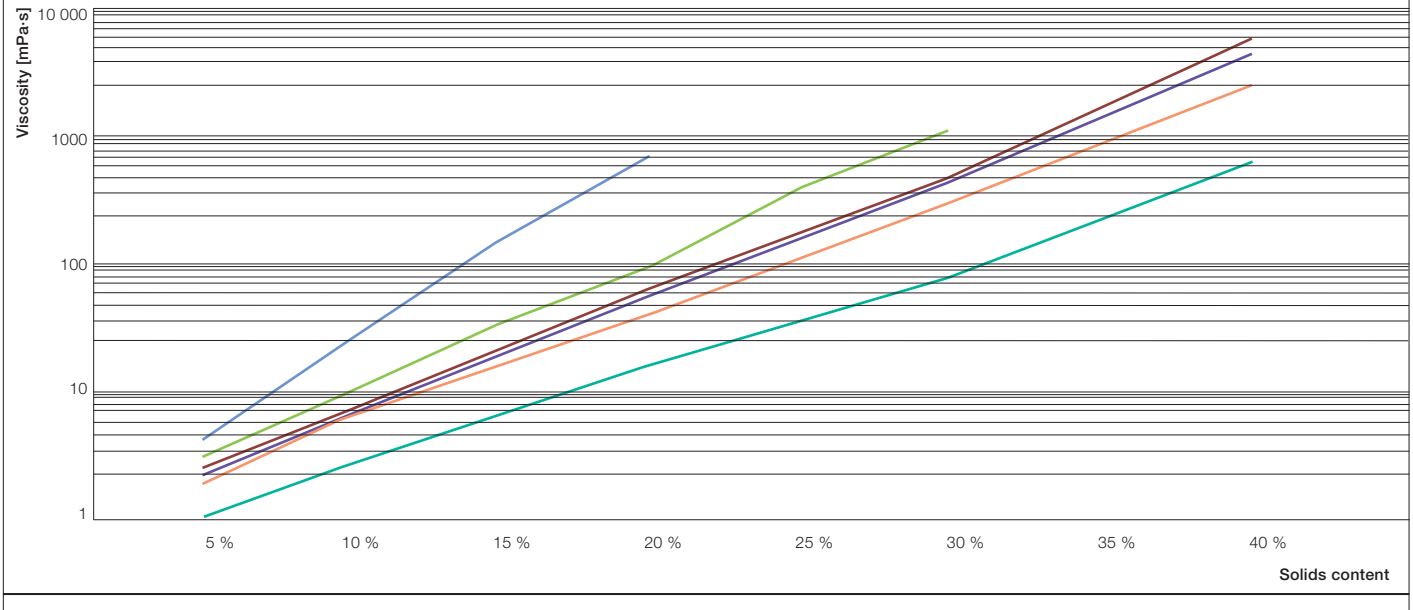
Aliphatic hydrocarbons	H 15/42	H 15/50	H 15/45 M	H 15/45 M special	H 30/48 M	H 40/43	H 40/50	H 40/55	H 40/60
n-Hexane	○	○	○	○	○	○	○	○	○
Cyclohexane	○	○	○	○	○	○	○	○	○
Petroleum spirit 100/140	○	○	○	○	○	○	○	○	○
White spirit 180/210	○	○	○	○	○	○	○	○	○
Decalin	○	○	○	○	○	○	○	○	○
Ester									
Methyl acetate	●	●	●	●	●	●	●	●	●
Ethyl acetate	●	●	●	●	●	●	●	●	●
Propyl acetate	●	●	●	●	●	●	●	●	●
Isopropyl acetate	●	●	●	●	●	●	●	●	●
Butyl acetate	●	●	◐	◐	●	●	●	●	●
Isobutyl acetate	●	●	◐	◐	●	●	●	●	●
Amyl acetate	●	●	◐	◐	●	●	●	●	●
2-Methoxyethyl acetate	●	●	●	●	●	●	●	●	●
Methoxypropyl acetate	●	◐	◐	◐	●	●	●	●	●
Methoxybutyl acetate	●	●	●	●	●	●	●	●	●
Butyl hydroxyethanoate	●	◐	◐	◐	●	●	●	●	●
Chlorinated hydrocarbons									
Methylene chloride	●	●	●	●	●	●	●	●	●
Ethylene chloride	●	●	●	●	●	●	●	●	●
Propylene chloride	●	●	●	●	●	●	●	●	●
Chloroform	●	●	●	●	●	●	●	●	●
Tetrachloromethane	○	○	○	○	○	○	○	○	○
Trichloroethylene	○	○	○	○	●	●	●	●	●
Tetrachloroethylene	○	○	○	○	○	○	○	○	○
Others									
Dimethyl acetamide	●	●	●	●	●	●	●	●	●
Dimethyl formamide	●	●	●	●	●	●	●	●	●
N-Methyl-2-pyrrolidone	●	●	●	●	●	●	●	●	●
Dimethyl sulfoxide	●	●	●	●	●	●	●	●	●
Acetic acid	○	○	○	○	○	○	○	○	○
Propylene oxide	●	●	●	●	●	●	●	●	●
Pyridin	●	●	●	●	●	●	●	●	●

● soluble ○ insoluble ◐ partially soluble

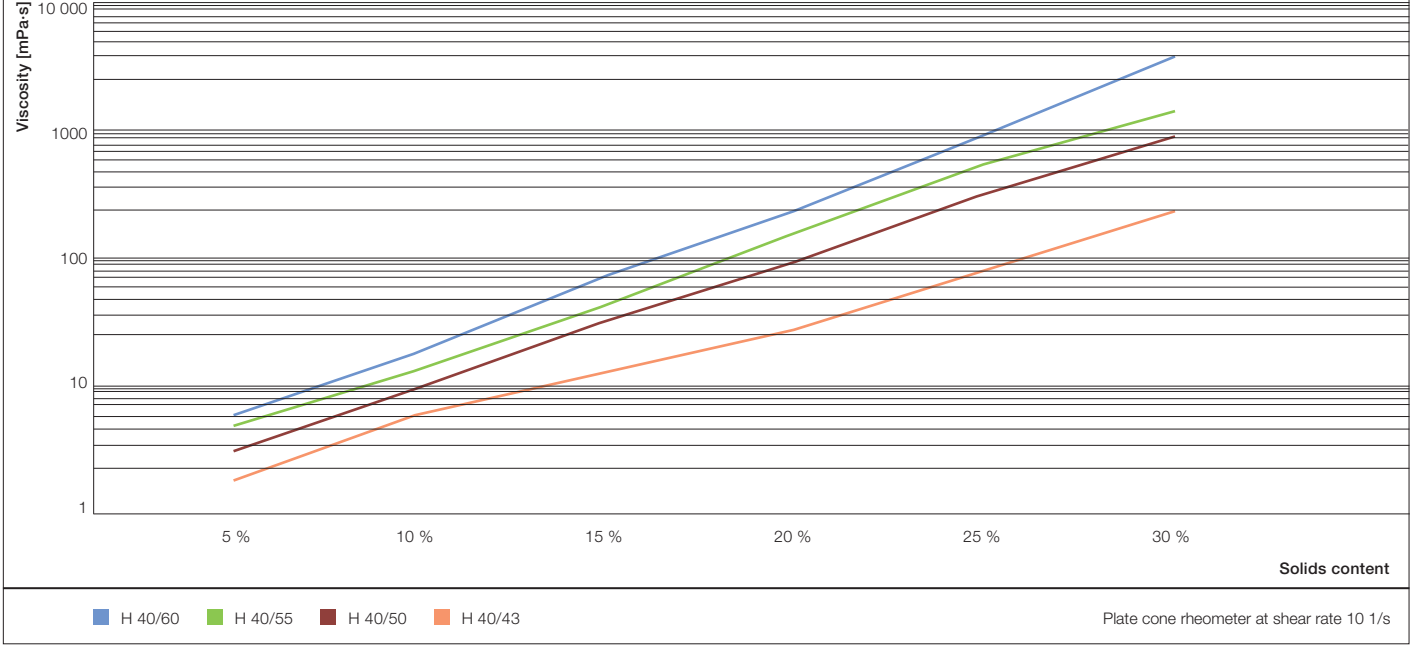
20 % solids

VISCOSITY OF VINNOL® SURFACE COATING RESINS SOLUTIONS BASED ON % SOLIDS

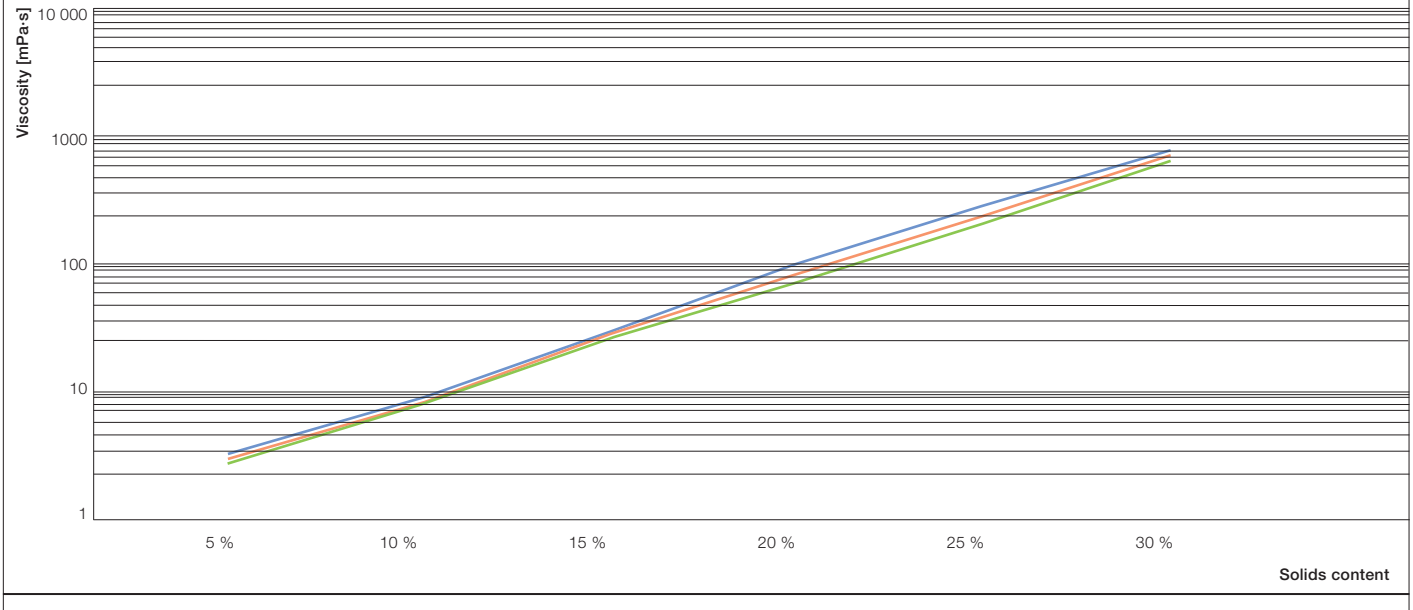
VINNOL® without functional groups solutions in methyl ethyl ketone



VINNOL® without functional groups solutions in methyl ethyl ketone



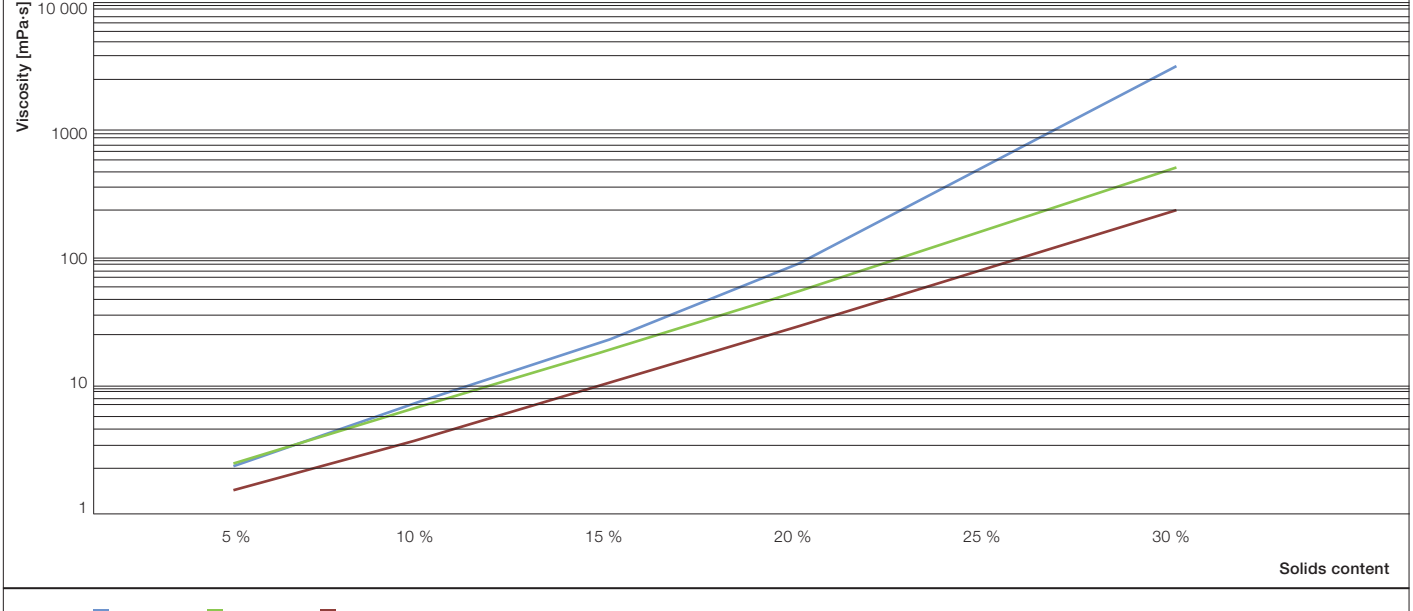
VINNOL® with carboxyl groups solutions in methyl ethyl ketone



H 15/45 M, H 15/45 M special H 30/48 M E 15/45 M

Plate cone rheometer at shear rate 10 1/s

VINNOL® with hydroxyl groups solutions in methyl ethyl ketone



E 15/48 A E 22/48 A E 15/40 A

Plate cone rheometer at shear rate 10 1/s

COMPATIBILITY OF VINNOL® WITH OTHER BINDERS AND PLASTICIZERS

Binders	Chemical Characterization*	VINNOL®				
		H 40/43 H 40/50 H 40/55 H 40/60	E 15/45 E 20/45 H 11/59 H 14/36 H 15/42 H 15/50	E 15/45 M H 15/45 M H 15/45 M special H 30/48 M	E 15/40 A E 15/48 A	E 22/48 A
Amino-formaldehyde resins						
Maprenal® MF 590/55IBX	melamine-formaldehyde resin, isobutylated	○	○	○	●	●
Maprenal® MF 800/72IB	hexamethoxymethylmelamine resin, solvent-free	○	○	○	●	●
CYMEL® 300	melamine-formaldehyde resin, alkylated	○	○	○	●	●
Epoxy resins						
EPIKOTE®/EPON® 828	medium viscosity liquid bisphenol A/epichlorohydrin epoxy resin	●	●	●	●	●
EPIKOTE®/EPON® 834	high viscosity liquid bisphenol A/epichlorohydrin epoxy resin	●	●	●	●	●
EPIKOTE®/EPON® 1001	solid bisphenol A/epichlorohydrin epoxy resin	●	●	●	●	●
Acryl resins						
DEGALAN® P 24	polyacrylate resin based on n-butylmethacrylat and methylmethacrylate	●	●	●	●	●
DEGALAN® PM 555	organic dispersion of copolymers based on methacrylacidester and olefines	●	●	●	●	●
DEGALAN® LP AL 23	polyacrylate resin based on n-butylmethacrylat and methylmethacrylate	●	●	●	●	●
DEGALAN® MB 319	polyacrylate resin based on methylmethacrylat and ethylacrylate	●	●	●	●	●
DEGALAN® M 345	polyacrylate resin based on methylmethacrylate	●	●	●	●	●
PARALOID® A 11	polyacrylate resin based on methylmethacrylate	●	●	●	●	●
PARALOID® B 82	polyacrylate resin based on methylmethacrylate	●	●	●	●	●
NeoCryl® B 805	polyacrylate resin based on methylmethacrylate	●	●	●	●	●
NeoCryl® B 842	polyacrylate resin based on butylmethacrylate	●	●	●	●	●
Macrynal® SM 510	hydroxy functional polyacrylate resin	●	●	●	●	●

● soluble ○ insoluble ◐ partially soluble

* according to manufacturer/supplier

The information contained in this leaflet is for guideline only. It should also be pointed out that information on compatibility cannot be applied to systems which contain other components.
We make no warranty as to the accuracy of these data.

Maprenal® and Macrynal® are products of CYTEC Surface Specialties.
CYMEL® is a product of Cytec Industries Inc.
EPIKOTE® and EPON® are products of Resolution Performance Products.
DEGALAN® is a product of Evonik/Degussa.
PARALOID® is a product of Rohm & Haas.
NeoCryl® is a product of DSM.

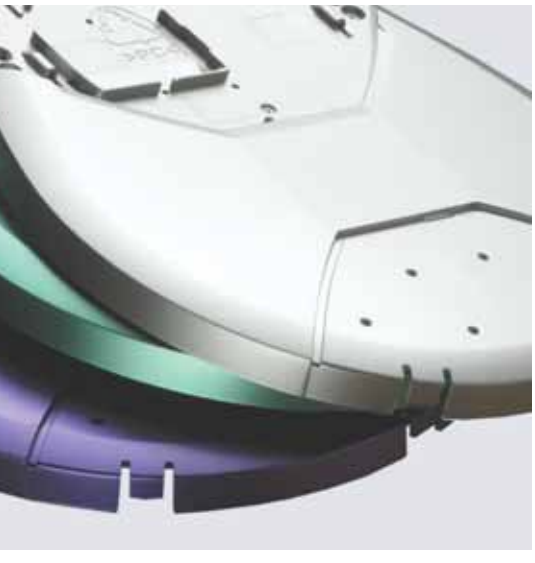
Binders	Chemical Characterization*	VINNOL®				
		H 40/43 H 40/50 H 40/55 H 40/60	E 15/45 E 20/45 H 11/59 H 14/36 H 15/42 H 15/50	E 15/45 M H 15/45 M H 15/45 M special H 30/48 M	E 15/40 A E 15/48 A	E 22/48 A
Polyester resin						
Adhesion Resin LTH	styrene-free unsaturated polyester resin	●	●	●	●	●
Adhesion Resin LTW	styrene-free unsaturated polyester resin	●	●	●	●	●
Urea resin						
Plastopal® ATB	urea-formaldehyde resin, butylated	○	○	○	●	●
Maleic resin						
ALRESAT® KM 140	maleic acid modified colophony resin	○	○	○	○	○
ERKAMAR 2100	maleic acid modified colophony resin	○	○	○	●	●
Polyisocyanate						
Desmodur® N	aliphatic polyisocyanate	◐	○	○	●	●
Desmodur® L	aromatic polyisocyanate	◐	○	○	●	●
Cellulose derivates						
Walsroder Nitrocellulose E 510	ester soluble grade (app. 12 % nitrogen)	●	○	○	○	◐
CAB 551-02	cellulose acetate butyrate	○	○	○	○	○
Phenol resin						
Phenodur® PR 285	unplasticizec phenolic resin	○	◐	◐	●	●
Alkyd resin						
short oil alkyd resin, based on synthetic fatty acid		○	○	○	●	●
middle oil alkyd resin, based on linseed oil		○	○	○	●	●

VINNOL® grades are compatible with a large number of plasticizers, such as:

– Phthalates
– Adipates
– Sebacates
– Citrates
– Phosphates
– Epoxides
– Chlorinated paraffins

Adhesion Resin LTH and Adhesion Resin LTW are products of Evonik/Degussa.
Plastopal® is a product of BASF.
ALRESAT® is a product of AKZO Nobel.
ERKAMAR is a product of KRAEMER.
Desmodur® is a product of Bayer AG.
Walsroder Nitrocellulose is a product of Wolff Cellulosics.
CAB 551-02 is a product of Eastman Chemical Company.
Phenodur® is a product of CYTEC Surface Specialties.

VINNOL® SURFACE COATING RESINS FOR INDUSTRIAL COATINGS



This section describes in detail the uses of VINNOL® surface coating resins as binders for the formulation of industrial coatings and corrosion protection paints.

Industrial coatings is a collective term that embraces, in addition to corrosion protection, paints and coatings for the following areas of application:
– Automotive refinishes
– Automotive finishes
– Coil coatings
– Packaging coatings (flexible, rigid)
– Wood varnishes
– Artificial leather coatings
– Plastic coatings
– Powder coatings
– Marine paints
– Other industrial coatings

Vinyl chloride copolymers generally offer:
– High toughness and permanent flexibility
– High abrasion resistance
– High water and chemical resistance
– Flame retardance
– Good solubility and ease of processing

as well as wide formulation latitude, yielding
– Physiologically safe,
– Odorless and tasteless films.

They are therefore the preferred binders for formulating industrial coatings.

VINNOL® surface coating resins without functional groups

VINNOL® surface coating resins without functional groups adhere outstandingly to porous and absorbent substrates, such as paper and wood, but they only bond well to metal substrates if modified with VINNOL® resins containing carboxyl groups (VINNOL® M grades). VINNOL® surface coating resins without functional groups are therefore used mainly in connection with monomeric or polymeric plasticizers to formulate permanently elastic strippable coatings that can withstand high mechanical loads. The extent of adhesion can be regulated via the amount of added VINNOL® M.

The low-molecular grades, VINNOL® H 14/36 and H 15/42, facilitate the production of high-solids, easy-to-apply, high-build coatings for a host of different application areas.

Good adhesion to PVC and PVC-containing substrates permits use in coatings for artificial leather and plastic tarpaulins.

The vinyl acetate content of the VINNOL® H 40 range is 30–40 % and so these products may not only serve in the application areas mentioned above. They can also be used to produce permanently elastic coatings for flexible substrates subject to high stress. In combination with other VINNOL® surface coating resins or VC copolymers, they also function as internal plasticizers.

The VINNOL H 40 range may also be combined with ester-soluble NC coatings for increasing chemical resistance and elasticity of such coatings.

VINNOL® surface coating resins with carboxyl groups (VINNOL® M grades)

VINNOL® surface coating resins with carboxyl groups (vinyl chloride/vinyl acetate/dicarboxylic acid-based terpolymers) adhere outstandingly to ferrous and non-ferrous metals. This property and the possibility of combining the VINNOL® M grades with VINNOL® surface coating resins without functional groups and low K-value facilitate the formulation of high-build industrial coatings for metals. The coatings' flexibility can be varied through judicious blending with VINNOL® H 40 resins.

Further application areas are primers for hot-dip-galvanized substrates, underwater paints, sterilization-resistant organosols and coil coatings.

The adhesion of epoxy-based coatings to untreated metals is markedly enhanced by blending with VINNOL® resins containing carboxyl groups.

The good chemical stability of VINNOL® M grades as well as their freedom from taste and odor permits the production of sterilization-resistant interior can coatings.

VINNOL® M grades frequently serve in the production of primers for PVC plastisols, as well.

VINNOL® surface coating resins with hydroxyl groups (VINNOL® E/A grades)

By virtue of their hydroxyl groups and their good polymer compatibility, VINNOL® E/A grades may be combined with alkyd, epoxy, urea, ketone, melamine, phenolic, acrylic and isocyanate resins.

The widest polymer compatibility of any VINNOL® E/A grade with other resins is shown by VINNOL® E 22/48 A. This product also displays very high aromatic tolerance in solvent mixtures. Ester-soluble alkyd resins may be modified with VINNOL® E/A grades to enhance chemical resistance, permanent elasticity and the water resistance of the coating.

Even high-build coatings with a high urea resin content can be rendered much less prone to cracking through blending with VINNOL® E/A grades.

VINNOL® resins containing hydroxyl groups may be used both alone and in combination with other polyol components in two-pack PUR coatings. In the latter case, they function as reactive thickeners, i.e., VINNOL® E/A grades may be used to control the consistency. They crosslink with the curing agent component during drying. In addition, the VINNOL® surface coating resins accelerate initial physical drying of the coating.

The good pigment wetting of the VINNOL® E/A grades facilitates the formulation of highly-filled coatings having especially good adhesion to polyvinyl butyral primers, which serve primarily as the intermediate layer in multilayer coatings. Such coating systems are mainly used in shipbuilding.

APPLICATION AREAS OF VINNOL® SURFACE COATING RESINS IN THE INDUSTRIAL COATING SECTOR

Application area	Additional information
Can coatings	VINNOL® M grades have good chemical stability and are odorless and neutral in taste, enabling the production of sterilization-resistant interior can coatings.
Coil coatings	VINNOL® resins containing carboxyl groups are suitable for this application area on account of their good metal adhesion, but are less widespread than PVC organosols and plastisols.
Corrosion-protection coatings	VINNOL® resins containing carboxyl groups, with their excellent metal adhesion, combined with high resistance to acids, alkalis and salt solutions, good pigment wetting and low water absorption, are ideal for formulating primers and corrosion-protection paints.
Film coatings	See plastics coatings
Marine paints	VINNOL® resins containing carboxyl groups, with their excellent metal adhesion, combined with high resistance to acids, alkalis and salt solutions, good pigment wetting and low water absorption, are ideal for formulating primers and corrosion-protection paints. The good pigment wetting of the VINNOL® E/A grades allows the formulation of highly-filled coatings with especially good adhesion to primers based on polyvinyl butyrals, which serve above all as the intermediate coating in multilayer coatings. One application area limited not only to ship building is the manufacturing of primers for hot-dip-galvanized substrates and for underwater paints.
Nitrocellulose coatings	VINNOL® H 40 resins are also suitable for blending with ester-soluble NC coatings for increasing their chemical resistance and elasticity.

Application area	Additional information
Plastic coatings	VINNOL® surface coating resins adhere well to PVC, PET and other plastics, in some cases in conjunction with other resins, and are used for formulating coatings for artificial leather and plastic tarpaulins. VINNOL® H 40 resins can be used to produce permanent-elastic coatings for flexible substrates subject to high stress.
Primers	VINNOL® M grades are suitable for producing adhesive primers for PVC-P (e.g. for crown caps)
Baking enamels	The hydroxyl groups of the VINNOL® E/A grades and their good polymer compatibility facilitate blending with alkyd, epoxy, urea, ketone, melamine, phenol, polyacrylic and polyisocyanate resins. The widest polymer compatibility of all VINNOL® E/A grades with other blending resins is shown by VINNOL® E 22/48 A.
Strippable coatings	VINNOL® surface coating resins without functional groups serve mainly in conjunction with monomeric or polymeric plasticizers for formulating permanently-elastic strippable coatings that can withstand high loads. The extent of adhesion may be regulated by adding VINNOL® M.
Tarpaulin coatings	See plastics coatings
Wire enamels	See baking enamels

VINNOL® SURFACE COATING RESINS FOR PRINTING INKS

This section details the uses of VINNOL® surface coating resins as binders for the formulation of printing inks.

Vinyl chloride copolymers generally offer:
– High toughness and permanent flexibility,
– High abrasion resistance,
– High water and chemical resistance,
– Flame retardance,
– Good solubility and ease of processing

as well as wide formulation latitude, yielding films that are
– Physiologically safe,
– Odorless and tasteless.

They are therefore the main binders for formulating:
– Screen-printing inks,
– Gravure inks,
– Inkjet inks,
– Transfer printing inks, as well as
– Overprint varnishes.

It is not usual to employ VINNOL® surface coating resins for formulating flexographic printing inks, as the solvents (ketones and esters) cause the printing plates to soften or swell.

Flexographic and gravure printing are the dominant processes employed for printing flexible packaging primarily used in the food industry, and to a lesser extent in the pharmaceutical and chemical industries.

Printing inks in the food industry must basically meet the following requirements:
– Suitability for food packaging
– Adhesion to the substrate
– Stability to the packaging contents
– Light fastness
– Gloss
– Hiding power
– Sealability or non-sealability

Printing inks on food packaging must not have any odor or taste and must also satisfy the corresponding foodstuffs legislation, e.g., FDA rules. Printing inks meeting these demands may be formulated with VINNOL® surface coating resins. Additional information is available upon request.

VINNOL® surface coating resins are therefore used as binders for formulating modern printing inks in the packaging sector.

FORMULATION OF INKS BASED ON VINNOL® SURFACE COATING RESINS

Printing inks based on VINNOL® surface coating resins are ideal for printing on PVC substrates, such as floor coverings, wall coverings, electric cable insulation, truck tarpaulins and artificial leather.

The low-molecular VINNOL® surface coating resins
– VINNOL® H 14/36
– VINNOL® H 15/42
– VINNOL® H 40/43
– VINNOL® E 15/40 A

are used on their own or in blends with other resins to formulate:
– Gravure printing inks
– Inkjet printing inks
– Overprint varnishes

The higher-molecular VINNOL® surface coating resins
– VINNOL® H 11/59
– VINNOL® H 40/50, H 40/55, H 40/60
– VINNOL® E 15/48 A and E 22/48 A

are used to produce screen-printing inks that are mainly intended for printing truck tarpaulins and plastic sheeting.

VINNOL® E grades are produced by emulsion polymerization and are therefore particularly suitable for formulating pigmented systems for pigment concentrates and for milling pigments that are hard to disperse. VINNOL® E products are also highly recommended where high gloss and short milling times are required.

Printing inks based on VINNOL® surface coating resins may be pigmented by
– Milling the pigments in the binder solution (varnish) and
– Blending with pigment preparations.

When pigment preparations are used, particular care must be taken to ensure that the base resin of the pigment preparation is compatible with VINNOL® surface coating resins and is soluble in the same solvent or solvent mixture.

Among the best solvents for VINNOL® surface coating resins are ketones and esters. Detailed information on solubility is contained in the solubility tables for VINNOL® surface coating resins on pages 12–15.

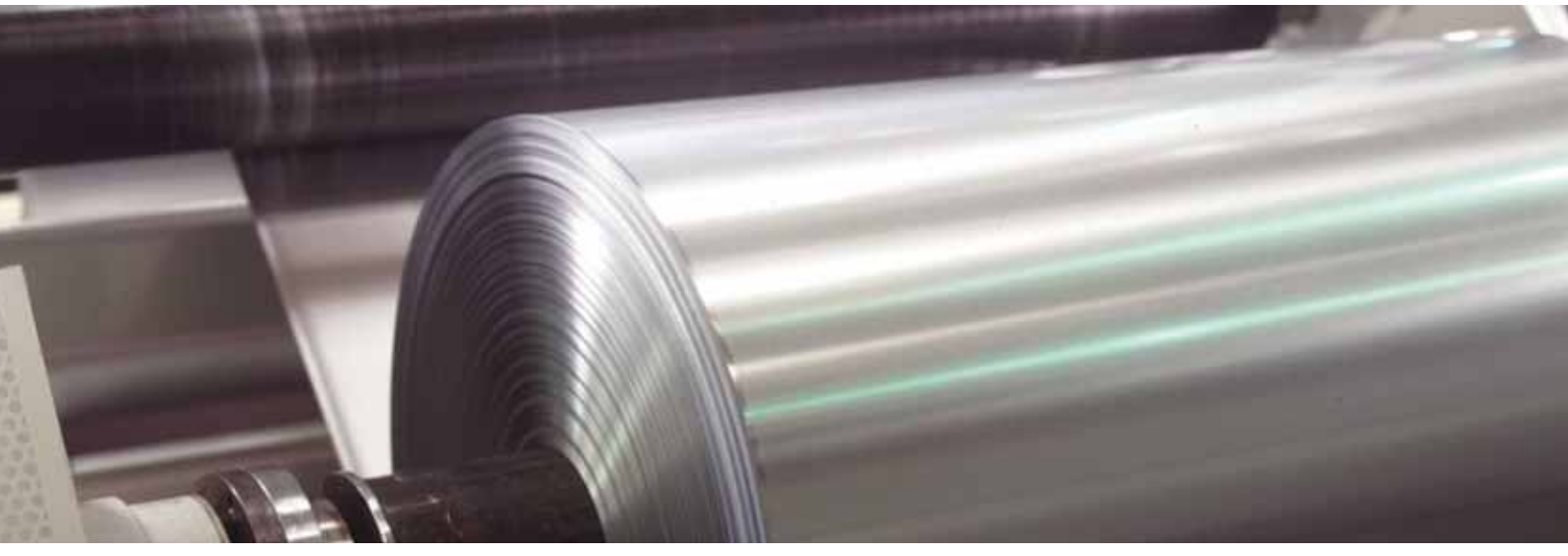
VINNOL® surface coating resins without functional groups

VINNOL® surface coating resins without functional groups adhere outstandingly to porous and absorbent substrates, and particularly to PVC. VINNOL® E 15/45 and E 20/45 are excellent binders for formulating screen-printing, inkjet and gravure inks as well as overprint varnishes. VINNOL® E 15/45-based and E 20/45-based overprint varnishes serve primarily to increase the water, oil, alcohol and abrasion resistance of printed images on absorbent substrates, such as paper and cardboard.

The VINNOL® surface coating resins in the H 40 range, whose vinyl acetate content is between 30 and 40 %, may be combined with ester-based NC coatings. This combination is utilized in top coats to improve the gloss and the chemical resistance, to increase the solids content and to vary the blocking and sealing point over a wide range.

The VINNOL® H 40 range may also be combined with the VINNOL® M range (VINNOL® resins containing carboxyl groups) to formulate high-solids screen-printing inks for metal substrates.

They can also be combined with ketone resins, PVC, chlorinated PVC, acrylics, epoxy and polyester resins, and can therefore be regarded as co-binders with a broad spectrum of applications.



VINNOL® surface coating resins with carboxyl groups (VINNOL® M grades)
VINNOL® surface coating resins with carboxyl groups (vinyl chloride/vinyl acetate/dicarboxylic acid-based terpolymers) adhere outstandingly to ferrous and non-ferrous metals. This property and the possibility of blending the VINNOL® M grades with VINNOL® surface coating resins without functional groups and low K value allows the formulation of screen-printing and gravure inks for metals.

The adhesion of such inks to untreated metals can be greatly improved by blending VINNOL® M grades with epoxies.

VINNOL® surface coating resins with hydroxyl groups (VINNOL® E/A grades)
The good pigment wetting of the VINNOL® E/A grades, which arises from their hydroxyl groups, allows them to be blended with polyisocyanates to formulate highly-pigmented screen and gravure printing coatings for OPP, PE and PETP film.

Furthermore, the good polymer compatibility of the VINNOL® E/A grades permits blending with alkyd, epoxy, urea, ketone, melamine, phenolic, acrylic and isocyanate resins. This again demonstrates that these VINNOL® surface coating resins are blending resins with a broad range of applications.

The widest polymer compatibility of any VINNOL® E/A grade with other resins is shown by VINNOL® E 22/48 A. This product also displays very high aromatic tolerance in solvent mixtures.

VINNOL®-BASED HEAT-SEALABLE COATINGS FOR ALUMINUM FOIL

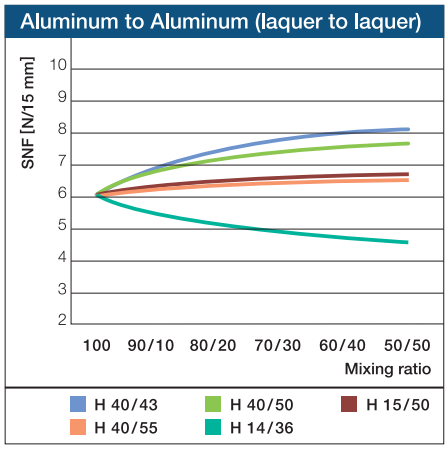
By virtue of its special properties, namely,
– outstanding adhesion to aluminum,
– high chemical resistance,
– thermo-activability from approx. 140 °C and above, and the
– possibility of reducing the sealing temperature by adding plasticizers or VINNOL® H 40 grades according to requirements, the VINNOL® M range (VINNOL® resins containing carboxyl groups), is an ideal binder for heat-sealable coatings for aluminum foil in the packaging sector.

Heat-sealing of aluminum foil to NC-coated papers is primarily carried out with heat-sealable coatings based on the VINNOL® E/A grades (hydroxy VINNOL® resins).

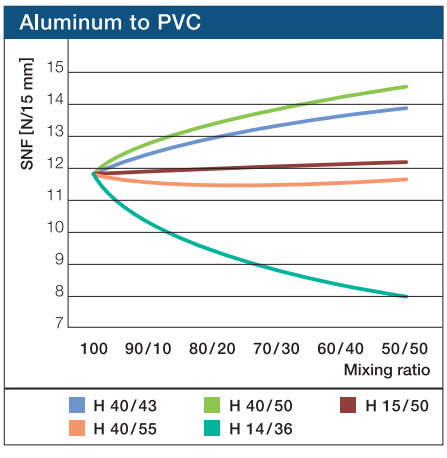
Key application areas for VINNOL®-based aluminum compounds are the heat-sealable coatings shown in the following table:

Heat-sealable laminates	One-coat system	Two-coat system	
		Primer	Sealing coat
Alu – Alu	VINNOL® H 15/45 M	VINNOL® H 15/45 M	VINNOL® H 40/50 VINNOL® H 40/55
Alu – NC-coated paper	Blend of VINNOL® H 15/45 M VINNOL® H 40/50 in a ratio of 1/1	VINNOL® H 15/45 M	VINNOL® H 40/43 VINNOL® H 40/50 VINNOL® E 22/48 A
Alu – PET	VINNOL® H 15/45 M	-	-
Alu – PP and OPP		VINNOL® H 15/45 M	DEGALAN® PM 555
Alu – PS	Blend of VINNOL® H 15/45 M / polyacrylate* in a ratio of 1/4 to 1/1	VINNOL® H 15/45 M	Blend of VINNOL® resins / polyacrylate* in a ratio of 1/9 or pure polyacrylate*
Alu – PVC	VINNOL® H 15/45 M VINNOL® H 15/45 M + VINNOL® H 40/43 or VINNOL® H 15/45 M + VINNOL® H 15/50 in a ratio of 1/1	VINNOL® H 15/45 M	VINNOL® H 15/50 VINNOL® H 40/50 VINNOL® H 40/55
Alu – PVDC	VINNOL® H 15/45 M / polyacrylate* in a ratio of 1/1	-	-

* DEGALAN® P 24, DEGALAN® PM 555, DEGALAN® LP AL 23, PARALOID® B 82, NeoCryl® B-842



Seal bond strength of VINNOL® H 15/45 M mixtures (20 % in methyl ethyl ketone) sealing temperature: 180 °C pressure: 3 atm; time: 0,5 sec



Seal bond strength of VINNOL® H 15/45 M mixtures (20 % in methyl ethyl ketone) sealing temperature: 180 °C pressure: 3 atm; time: 0,5 sec

Aluminum – aluminum laminates

Processed cheese is mainly packaged by sealing aluminum foil to itself at temperatures of less than 100 °C.

In view of the aggressiveness of the cheese ingredients, it is advisable to employ a two-layer system consisting of VINNOL® H 15/45 M and a heat-sealable coating based on VINNOL® H 40/50 or VINNOL® H 40/43. External plasticizers may be needed in order that sealing may be carried out at 75 to 90 °C, with the precise temperature depending on the processed cheese. These plasticizers are usually citric acid esters.

Aluminum – polyvinyl chloride (PVC) laminates

One-layer coatings based on VINNOL® H 15/45 M are used for sealing aluminum to PVC. In two-layer coatings, the primer also consists of VINNOL® H 15/45 M, with VINNOL® H 15/50 being used for the heat-sealable coating.

If the heat-sealing temperature has to be reduced, the following options exist:
– Use of monomeric plasticizers,
– Use of polymeric plasticizers,
– Use of VINNOL® H 40/50 or H 40/43 as a blending resin or as the sole binder in the heat-sealable coating of a two-layer system.

Additions of up to 50 % of the general VINNOL® grades to VINNOL® H 15/45 M have no negative influence on sealing strength, or when serving as the sole binder in the sealing layer of a two-layer system.

Aluminum – polypropylene (PP, OPP) laminates

Where aluminum is sealed to polypropylene, this is most often done with a two-layer system consisting of primer VINNOL® H 15/45 M, and heat-sealable coating DEGALAN® PM 555.

Matching the sealing properties is somewhat more difficult in a one-coat system based on Morprime® than in the two-layer system mentioned above.

Morprime® is a product of Rohm & Haas.

Aluminum – polystyrene (PS)

An acrylic resin must be added to VINNOL® H 15/45 M to enhance its adhesion to polystyrene.

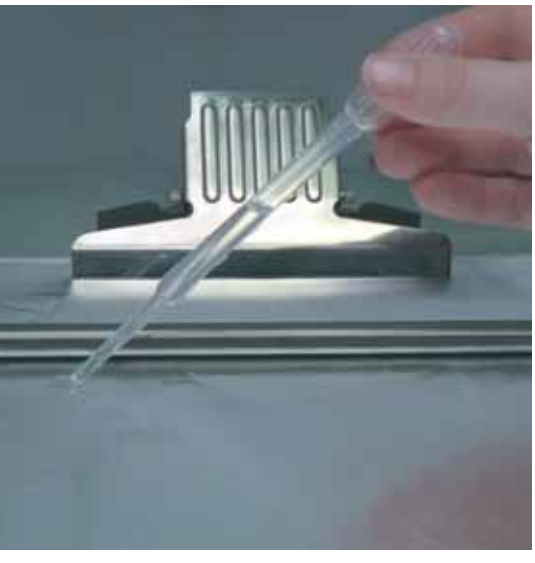
One-layer systems consist of, e. g., 20 % VINNOL® H 15/45 M and 80 % acrylic resin. However, combinations of up to 1/1 are in used, the exact proportion depending on the substrate.

In two-layer systems, a prime coat based on VINNOL® H 15/45 M is applied, followed by a heat-sealable coat of the above-mentioned combination or just pure acrylic resin.

Suitable polyacrylic resins include DEGALAN® P 24, DEGALAN® PM 555, DEGALAN® LP AL 23, PARALOID® or ACRYLOID® B 82 and NeoCryl® B-842.

ACRYLOID® is a product of Rohm & Haas.

FORMULATION TIPS



For optimum heat-sealed laminates, observe the following rules of thumb:

Solvents

In the application areas mentioned above, VINNOL® H 15/45 M is usually applied as a 20 % solution in methyl ethyl ketone (MEK) or 1/1 mixtures of methyl ethyl ketone/ethyl acetate. Ethyl acetate alone or acetone may also serve as solvent. However, these solvents have slightly less solvent power than methyl ethyl ketone and yield solutions that are more viscous.

Slightly higher temperatures accelerate the dissolving process (often, the heat of rapid stirring is enough to warm the solution) and allows the polymer to develop its full potential.

The use of highly volatile solvents is fundamentally advisable to minimize solvent retention and therefore odor and taste impairment of the contents as well as to prevent any impairment of seal strength.

Modification of the heat-sealing temperature

The heat-sealing temperature of heat-sealable aluminum foil based on VINNOL® surface coating resins may be raised and lowered to suit the contents or the desired sealing conditions.

The heat-sealing temperature may be lowered as follows:

– Use of monomeric plasticizers

In this case, the relevant legal recommendations and legislation, which may vary from country to country, must be observed. A suitable monomeric plasticizer is a citric acid ester.

– Use of polymeric plasticizers

Resamin® HF 480 (a carbamide resin) or Palamol® 632 (a polyester) may be used.

– Use of VINNOL® surface coating resins in the VINNOL® H 40 range as a blending resin or as sole binder in the heat-sealable coating of two-layer systems.

VINNOL® H 40 surface coating resins have higher thermoplasticity and a lower glass transition temperature than VINNOL® H 15/45 M and VINNOL® H 15/50 on account of their high vinyl acetate content and can therefore be heat-sealed at temperatures from approx. 120 °C. This cuts down on plasticizer consumption and may even eliminate plasticizer altogether. Additions of up to 50 % to VINNOL® H 15/45 M have no negative effects on seal strength. VINNOL® H 40/50 and VINNOL® H 40/43 are ideal for this area of application. Compared to VINNOL® H 15/45 M, VINNOL® H 30/48 M can generally be sealed at lower temperatures, since there is a higher proportion of vinyl acetate in the polymer backbone.

The seal-bond-strength can be lowered to a specific value by combination with VINNOL® H 14/36 or addition of minimal quantities of ester-soluble NC. Caution must be exercised if NC is used, however, since the decrease in sealing properties can be very abrupt.

Further information regarding individual products (technical data sheets, material safety data sheets) is available at:

Tel. +49 8677 83-7979
Fax. +49 8677 83-8181
info.polymers@wacker.com
www.wacker.com

Resamin® is a product of CYTEC Surface Specialties.
Palamol® is a product of BASF.

EXPERTISE AND SERVICE NETWORK ON FIVE CONTINENTS

WACKER is one of the world's leading and most research-intensive chemical companies. In 2009, its sales totaled €3.7 billion. Products range from silicones, binders and polymeric additives for diverse industrial sectors to bioengineered pharmaceutical actives and hyperpure silicon for semiconductor and solar applications. As a technology leader focusing on sustainability, WACKER promotes products and ideas that offer high value-added potential to ensure that current and future generations enjoy a better quality of life based on energy efficiency and protection of the climate and environment.

Spanning the globe via five business divisions, 26 production sites and over 100 subsidiaries and sales offices, we have established a presence in all key economic regions and growth markets. With a workforce some 15,600 strong, WACKER sees itself as a reliable innovation partner that develops trailblazing solutions for, and in collaboration with, its customers. WACKER also helps them boost their own success. Our technical centers employ local specialists, who assist customers worldwide in the development of products tailored to regional demands, supporting them during every stage of their complex production processes, if required.

WACKER e-solutions are online services provided via our customer portal and as integrated process solutions. Our customers and business partners thus benefit from comprehensive information and reliable service to enable projects and orders to be handled fast, reliably and highly efficiently.
Visit us anywhere, anytime around the world at: **www.wacker.com**

All figures are for 2009.

• Sales and production sites, plus 20 technical centers, ensure our local service presence worldwide.

The data presented in this brochure are in accordance with the present state of our knowledge, but do not absolve the user from carefully checking all supplies immediately upon receipt. We reserve the right to alter product constants within the scope of technical progress or new developments. The information given in this brochure should be checked by preliminary trials because of conditions during processing over which we have no control, especially where other companies' raw materials are also being used. The information provided by us does not absolve the user from the obligation of investigating the possibility of infringement of third parties' rights and, if necessary, clarifying the position. Recommendations for use do not constitute a warranty, either express or implied, of the fitness or suitability of the product for a particular purpose.

5568e/12.10 supersedes 5568e/12.09

WACKER POLYMERS

Wacker Chemie AG
Hanns-Seidel-Platz 4
81737 München, Germany
Tel. +49 89 6279-0
Fax +49 89 6279-1770
info.polymers@wacker.com

www.wacker.com/vinnol