



INCHEM®
INVESTMENT IN CHEMICALS

INCHEMREZ™ PKHW-34

Waterborne Phenoxo Resin For Thermoset Coatings

Technical Data Bulletin PS001

InChemRez™ PKHW-34 is a water borne phenoxo resin intended for coatings applications. When crosslinked with phenolics and melamine resins **PKHW-34** provides excellent coatings properties on steel and aluminum including high gloss, impact strength and resistance to acids and bases. **PKHW-34** is also formulated to 2.15 pounds/gallon (max.) on VOC's. The polymer in **PKHW-34** is FDA compliant (21CFR175.300).

TYPICAL PROPERTIES

Solids, wt. %	34.0
Viscosity, @ 25°C	1100 cP
Weight per Gallon	8.80 pounds
pH	7.2
Particle size, average	0.09 micron
VOC's	2.00 pounds/gallon
Appearance	opaque white with bluish cast
Co-solvents	butanol, propylene glycol propyl ether
Neutralizing amine	dimethyl ethanolamine

Features & Benefits

- contains non-HAP listed co-solvents
- low crosslinker demand
- good shelf stability

PKHW-34 Specifications

Solids (wt. %)	33.0 - 35.0
Viscosity (cP @ 25°C, #4 at 50 rpm)	800 - 1600
pH	6.8 - 7.8
Propylene glycol n-propyl ether (wt. %)	5 - 7
n-Butanol (wt. %)	2 - 4
N,N-Dimethyl ethanolamine (wt. %)	1 - 3
Appearance	milky white emulsion with blue cast

Other Properties (typical)

Weight per gallon	8.7 - 8.9 pounds
Flash point (PMCC)	141°F
Freeze point	- 4°C (25°F)
Particle size range	0.04 - 0.20 µm
mean, s.d.	0.09 µm, 0.025 µm
Heat stability (7 days at 140°F)	pass
Freeze/thaw stability (3 cycles)	pass
Shear stability (Waring blender, 5 minutes)	pass
VOC's	1.81 -2.15 lb/gal 217 - 258 gm/liter
Solids (volume %)	29.6
Functionality	hydroxyl/carboxyl
Acid number (on solids)	50 ± 3
Water (wt. %)	54 ± 1

Refer to MSDS for all toxicity and handling information.

Product Description

PKHW-34 is an anionically-stabilized aqueous colloidal dispersion of a solid grade phenoxy resin. The dispersion is a non-Newtonian fluid at room temperature; it exhibits very, very slight thixotropic behavior at low shear rates. **PKHW-34** is provided at a pH sufficient to ensure excellent shelf stability, however, at pH levels below 6.5 the disperse phase will become unstable and some coagulum will likely form. This coagulum will not easily re-disperse at higher pH's.

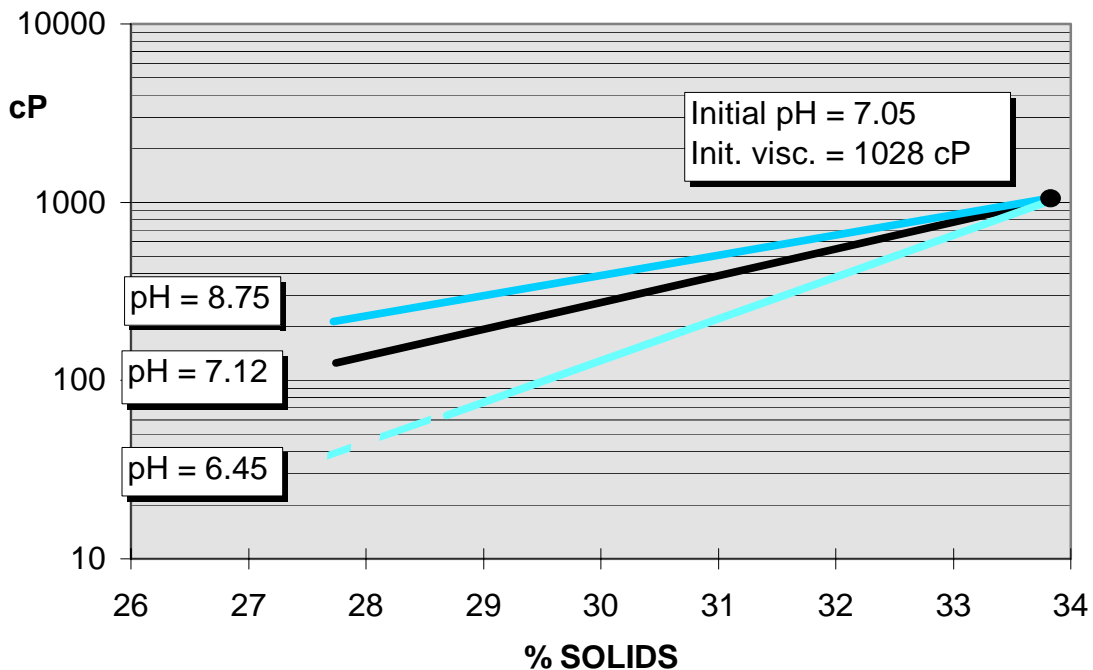
PKHW-34 provides both hydroxyl groups and carboxyl groups for subsequent crosslinking at elevated temperatures in thin coatings on metals or plastics. At room temperature **PKHW-34** will crosslink with polyfunctional aziridines, and at low bake conditions the neat dispersion will develop some minimal film properties including water resistance, acid/base resistance, and select solvent resistance. All thermoset coatings of **PKHW-34** display excellent

flexibility and reverse impact resistance based on the inherent tensile and adhesive strength properties of the base phenoxy polymer.

Rheological Properties

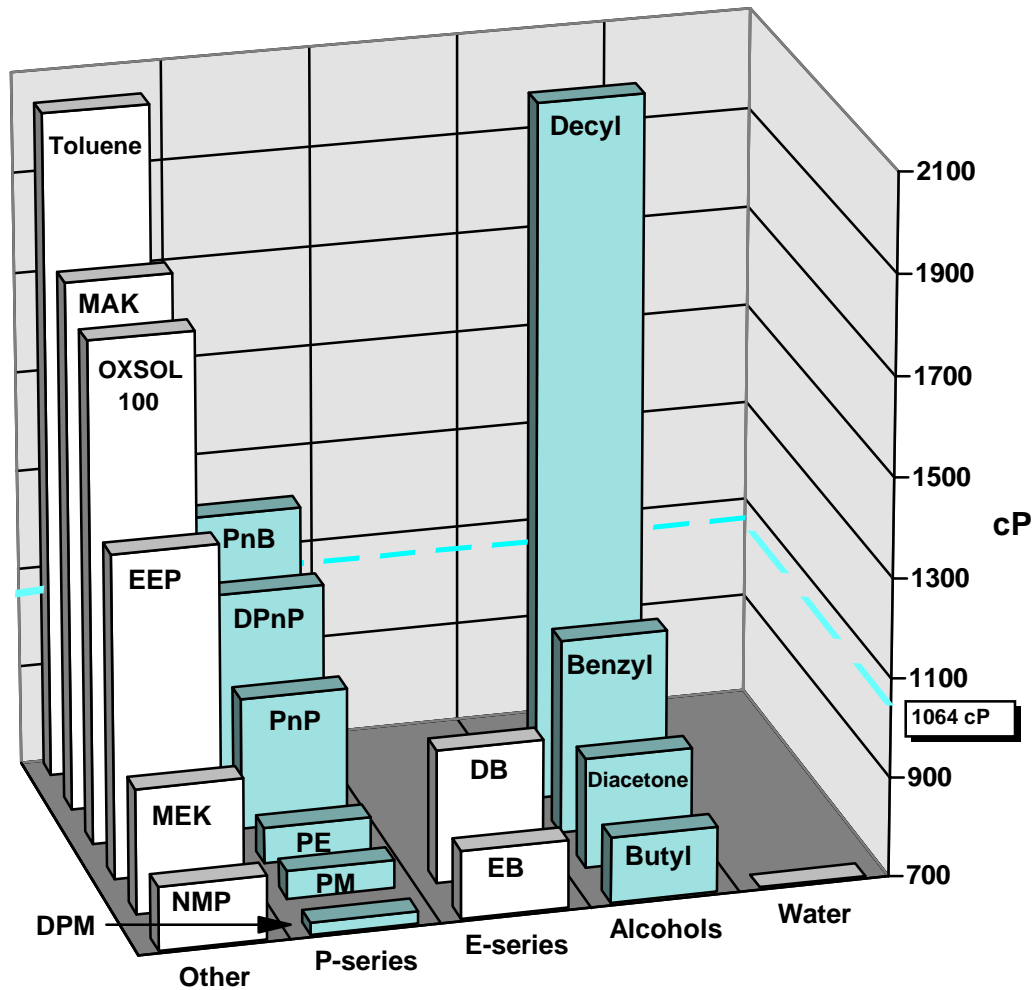
The viscosity/solids relationship for **PKHW-34** on reduction of solids with water is pH dependent as shown in Figure 1. **PKHW-34** is incrementally reduced with d.i. water, a 3% aqueous solution of DMEA (pH = 11.2), and a 2% acetic acid aqueous solution (pH = 2.7) down to 28% solids. Brookfield viscosity is determined at 25°C with #4 spindle at 50 rpm. At below 29% solids some coagulum forms when the pH approaches 6.5 or less.

Figure 1. PERCENT SOLIDS REDUCTION OF PKHW-34 SOLIDS
EFFECT OF pH ON VISCOSITY AT 25°C



The relative increase in viscosity for the 3% DMEA (aqueous) curve in Figure 1 above may be attributed to some particle swelling by migration of the organic amine (into the disperse phase). The addition of solvents to **PKHW-34** cause varying degrees of such swelling dependent on the partitioning between the disperse phase and the mobile (aqueous) phase. Figure 2 shows the effect on viscosity (Brookfield RVT, #4 spindle at 50rpm at 25°C) for 10phr of diluent (on solids) in **PKHW-34**. In effect the solids were reduced from 33.89% to 32.78%. Equilibrium viscosities were determined after seven days at room temperature. The control sample (reduced with d.i. water only) dropped to 700 cP from 1064 cP. Conversely, the addition of 10phr toluene swelled the apparent viscosity to 2040 cP.

Figure 2. EFFECT OF SOLVENT ADDITION ON PKHW-34 VISCOSITY
 10 phr on Solids (see legend on page 11 for solvent sources)



On reduction to 28% solids with additional water the mixtures illustrated in Figure 2 above showed a similar relationship in #4 Ford cup viscosities. For water only the viscosity was 26 seconds; with 10phr DPnP: 33 sec., with 10phr toluene: 49 seconds.

Thickening

Additional thickening of **PKHW-34** can be effected by the controlled addition of select acrylic colloidal dispersions. The addition of 10% *JONCRYL*[®] 646 (S.C. Johnson Polymer) on a solids basis to **PKHW-34** (reduced to 23% solids) and adjusted to a pH of 7.09 gave a #4 Ford viscosity of 22 seconds compared to 15 seconds for the unadjusted control. In general those colloids that display significant viscosity increases when adjusted to pH's greater than 7.5 may be useful as thickeners for **PKHW-34**. Cellulosic thickeners are not recommended.

Resin Compatibility

PKHW-34 can be used to modify other waterborne resins however compatibility will be dependent on level, resin type, and nature of stabilization. Table 1 shows the compatibility of **PKHW-34** with select waterborne or water reducible resins at 20, 50, and 100 phr (solids basis). For resins requiring additional coalescent a mixture of glycol ethers was used. For resins requiring pre-neutralization a stoichiometric amount of DMEA was used to disperse the polymer before mixing with **PKHW-34**. Compatibility was judged on the stability of the formulation and on the appearance & adhesion (1 mil on CRS, polished) of clear films after 7 days drying at room temperature. For those systems failing to adhere to steel, adhesion could be improved (to 5B rating) by baking for 30 minutes at 65°C.

TABLE 1
Compatibility of PKHW-34 with Commercial Waterbase Resins

PKHW-34 LEVEL:	20 phr		50 phr		100 phr	
	App.	Adh. 1	App.	Adh.	App.	Adh.
POLYURETHANES						
<i>DAOTAN VTW 1237</i> (Solutia)	C	5B	C	4B	C	5B
<i>DAOTAN VTW 1265</i> (Solutia)	mC	5B	mC	4B	mC	5B
<i>SANCURE 847</i> (B.F. Goodrich)	C	4B	C	0B	C	0B
ACRYLICS						
<i>JONCRYL 537</i> (S.C. Johnson)	C	5B	mC	0B	mC	0B
<i>JONCRYL 540</i> (S.C. Johnson)	C	5B	C	0B	C	5B
<i>SCX 1532</i> (S.C. Johnson)	mC	5B	I	0B	I	0B
<i>NEOCRYL A-633</i> (NeoResins)	mC	5B	I	5B	C	0B
<i>NEOCRYL A-639</i> (NeoResins)	I	5B	I	5B	I	2B
<i>NEOCRYL A-640</i> (NeoResins)	mC	5B	I	5B	I	5B
EPOXY ESTERS						
<i>REZIMAC WR 73-7331</i> (Eastman)	mC	5B	I	4B	mC	0B
<i>EPOTUF 91-263</i> (Reichhold)	C	5B	C	5B	C	3B
ALKYDS						
<i>DURAMAC WR 207-3070</i> (Eastman)	mC	5B	I	5B	I	4B
<i>DURAMAC WR 74-7451</i> (Eastman)	mC	5B	I	5B	I	0B
SPECIAL PURPOSE RESINS						
<i>ECO-CRYL 9790</i> (Resolution)	C		C		C	
<i>MAINCOTE AE-58</i> (Rohm and Haas)	C		mC		mC	
<i>ANQUAMINE 401</i> (Air Products)	mC		mC		C	
<i>EPI-REZ 3540 WY 55</i> (Resolution)	C		C		C	

C = compatible, clear I = incompatible, hazy mC = moderately compatible, slight haze ¹ ASTM D-3359, method B

For the special purpose resins shown above in Table 1 the coatings adhesion test was not conducted. These resins are almost always used in conjunction with other resins in 2-part formulations. **PKHW-34** is not recommended for modifications of waterborne epoxies (liquid & solid grades). Gelation of such mixtures will occur depending on the epoxy type and concentration.

Foam Control

PKHW-34 is susceptible to some foaming under high or prolonged agitation especially during solids reduction with water or other diluents. The foam will usually subside in several hours, however the addition of antifoam/defoamers should minimize foam duration. *DEE FO XHD-47J*, *DEE FO 806-102*, *DEE FO 2020E/50*, and *DEE FO XJH-123* (Ultra Additives Inc.) are recommended at 0.1% (active) on **PKHW-34**. A silicone-based additive, *PS 887* (Wacker Silicones Corp.), is also useful at the 0.1% level.

Thermoset Properties

PKHW-34 is designed to function as a thermosetting polyol (with appropriate crosslinkers) based on the high functionality (>30) of secondary hydroxyls on the phenoxy polymer backbone. Crosslinker levels are recommended at less than 15 phr, typically well below the stoichiometric amount. At high bake conditions some minimal film properties will develop for **PKHW-34** in the absence of crosslinkers as shown in Table 2. For high imino-content methylated melamine crosslinkers, 20 to 30 phr levels are useful in low bake conditions (< 120°C).

TABLE 2
Clear Unmodified Coatings of PKHW-34 on CRS

Film Properties:	<u>Bake Schedule</u>		
	<u>20 min. @ 165°C</u>	<u>20 min. @ 175°C</u>	<u>30 min. @ 175°C</u>
dry film thickness:	0.90 - 1.05 mil	0.85 - 0.95 mil	0.95 - 1.05 mil
Sward hardness:	66	61	61
adhesion:	5B	5B	5B
MEK double rubs:	< 20	< 20	35
reverse impact:	< 20 in-lb	< 100 in-lb	> 160 in-lb

Clear thermosetting coatings formulations of **PKHW-34** with a standard phenolic resin and a methylated melamine resin are shown below in Table 3. Crosslinker content was 8 phr (solids basis). Coatings were applied at 3 mils wet and allowed to flash five minutes at 22°C before baking at 175°C for 30 minutes. The formulations were uncatalyzed.

TABLE 3
Clear Thermoset Coatings of PKHW-34
Formulations & Film Properties

Component:	<u>Formulation</u>	
	<u>Phenolic Crosslinked</u>	<u>Melamine Crosslinked</u>
InChemRez™PKHW-34	150g	150g
GPRI™ 7550	5.9	-----
CYMEL® 370	-----	4.7
butyl CARBITOL®	5.9	4.7
d.i. water	36.1	38.5
% solids:	28	28
# 4 Ford cup:	26 seconds	22 seconds
Film Properties:		
substrate:	Steel, iron phosphated	steel, iron phosphated
appearance:	Glossy, transparent	glossy, transparent
dry film thickness:	0.70 - 0.80 mil	0.55 - 0.75 mil
crosshatch adhesion:	100% pass	100% pass
MEK double rubs:	> 200; sl. dulling	> 200; v. sl. dulling
reverse impact:	> 160 in-lb	> 160 in-lb
Sward hardness:	68	63
Chemical spot tests:		
(30 minute)		
10% HCl	no effect	no effect
20% nitric acid	no effect	no effect
25% NaOH	no effect	no effect
glacial acetic acid	slight effect	no effect
dimethyl ethanolamine	slight effect	no effect
MEK	slight dulling	very slight dulling
toluene	no effect	no effect
isopropanol	no effect	no effect
PM acetate	slight effect	no effect
NMP	Blushed, medium blisters	blushed, small blisters

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 CARBITOL is a registered trademark of Dow CYMEL is a registered trademark of Cytec Industries, Inc.

A clear thermosetting coatings formulation of **PKHW-34** with a blocked isocyanate crosslinker is shown in Table 4 (page 8). Crosslinker level was 8 phr (solids basis); catalysis (dibutyltin dilaurate) was 0.1% on solids. At 165°C, sufficient crosslinking was present to develop significant film properties on cold rolled steel (polished).

TABLE 4
Clear Coatings of PKHW-34 Crosslinked with Blocked Isocyanate

Component:	<u>Formulation (parts by wt.)</u>		
InChemRez™ PKHW-34	150.0		
BAYHYDUR BL116 (Bayer) premixed with d.i. water	6.1 5.9		
DBTDL (1% in NMP) d.i. water	5.5 15.6		
	<u>Bake Schedule</u>		
Film Properties:	<u>45 min. @ 140°C</u>	<u>30 min. @ 150°C</u>	<u>20 min. @ 165°C</u>
dry film thickness:	0.80 - 0.95 mil	0.60 - 0.85 mil	0.70 mil
Sward hardness:	72	71	73
adhesion:	5B	5B	5B
MEK double rubs:	33	35	40
reverse impact:	< 20 in-lb	< 40 in-lb	> 160 in-lb

Gloss white thermosetting enamels of **PKHW-34** formulated with 0, 8, 15, and 25 phr of *CYMEL 303* are shown in Table 5. Coatings (3.0 mils wet) were cast onto smooth finish steel panels and baked 20 minutes at 175°C. A balance of coatings properties were obtained between 8 and 15 phr *CYMEL 303* level (solids basis).

The addition of compatible co-resins into **PKHW-34** formulations is illustrated in Table 6. The waterborne (or water reducible) resins were incorporated at 20 phr (solids basis) on **PKHW-34**. Crosslinker level (*CYMEL 303*) was 15 phr on total resin solids. *JONCRYL® 540* is a hydroxyl functional acrylic dispersion. *EPOTUF® 91-263* is a water reducible epoxy ester. *DURAMAC™ WR 74-7451* is a water reducible alkyd. Coatings (3.0 mils wet) were cast onto smooth finish steel panels and baked for the standard 20 minutes at 175°C. While impact resistance and crosshatch adhesion were slightly diminished versus the control (**PKHW-34** unmodified) the presence of the co-resins did not appear to affect chemical resistance.

The addition of strong acid catalysts (p-toluene sulfonic acid) to **PKHW-34** formulations (with alkylated melamines and the like) should be made cautiously. Neat strong acid catalysts will de-stabilize the base resin; always use amine blocked acid catalysts to preserve package stability. The addition of p-TSA (DMEA blocked) to *CYMEL 303* crosslinked formulations of **PKHW-34** (as in Tables 5 and 6) will permit lower temperature baking parameters (150°C, 30 minutes) to get similar film properties.

JONCRYL is a registered trademark of S.C. Johnson & Son, Inc.
EPOTUF is a registered trademark of Reichhold Chemicals, Inc.
DURAMAC is a trademark of Eastman.

TABLE 5
Gloss White Thermosetting Enamels: PKHW-34 with Methylated Melamine

Formulations:	CYMEL 303 LEVEL			
	0 phr	8 phr	15 phr	25 phr
Grind:				
InChemRez™ PKHW-34	225.0g	225.0g	225.0g	225.0g
Ti-Pure R-900 (DuPont)	280.5	280.5	280.5	280.5
EEP (Union Carbide)	75.0	75.0	75.0	75.0
DEE-FO XKF-1B (Ultra)	6.0	6.0	6.0	6.0
d.i. water	60.0	60.0	60.0	60.0
Letdown:				
InChemRez PKHW-34	1104.1g	1104.1g	1104.1g	1104.1g
Premix and add:				
EEP	45.0g	45.0g	45.0g	45.0g
CYMEL 303 (Cytec)	-----	36.6	69.0	114.5
BYK 307 (Byk Chemie)	1.8	1.8	1.8	1.8
Reduce with:				
d.i. water	308.3g	356.8g	415.0g	498.4g
% solids (wt.):	35	35	35	35
WPG (pounds):	9.57	9.55	9.52	9.52
VOC's (lb/gal):	2.71	2.73	2.70	2.68
#4 Ford cup (seconds):	30	27	24	21
Film Properties:				
dry film thickness, mils:	0.75 - 0.90	0.80 - 0.95	0.95 - 1.00	0.75 - 0.95
gloss, at 60°/20°:	101.3/93.2	102.5/91.0	101.6/89.0	100.8/87.0
Sward hardness:	53	49	49	55
pencil hardness:	5H	5H	5H	5H
crosshatch adhesion:	5B	5B	5B	4B
MEK double rubs:	32	> 200	> 200	> 200
reverse impact (in-lb):	> 160	> 160	> 160	fail at 120
Chemical spot tests:				
10% HCl	no effect	no effect	no effect	no effect
10% acetic acid	no effect	no effect	no effect	no effect
20% nitric acid	no effect	no effect	no effect	no effect
25% NaOH	no effect	no effect	no effect	no effect
toluene	sl. Blush	v. sl. blush	no effect	no effect
PM acetate	sl. Blush	no effect	no effect	no effect
DMEA	Softened	v. sl. blush	no effect	no effect
NMP	Softened	sl. blush	sl. blush	v. sl. blush

TABLE 6
Gloss White Thermosetting Enamels: PKHW-34 with Waterborne Co-resins

Formulations:	Co-Resin Type			
	Control	JONCRYL 540	EPOTUF 91-263	DURAMAC WR 74-7451
Grind:				
InChemRez™ PKHW-34	225.0g	225.0g	225.0g	225.0g
Ti-Pure R-900 (DuPont)	280.5	280.5	280.5	280.5
EEP (Dow)	75.0	75.0	75.0	75.0
DEE-FO XKF-1B (Ultra)	6.0	6.0	6.0	6.0
d.i. water	60.0	60.0	60.0	60.0
Letdown:				
InChemRez PKHW-34	1104.1g	1018.3g	1018.3g	1018.3g
JONCRYL 540	-----	191.3	-----	-----
Premix and add:				
DMEA	-----	-----	7.8	6.6
EPOTUF 91-263	-----	-----	122.3	-----
DURAMAC WR 74-7451	-----	-----	-----	120.5
EEP	45.0g	45.0g	43.2g	46.2g
CYMEL 303 (Cytec)	69.0	77.4	77.4	77.4
BYK 307 (Byk Chemie)	1.8	1.8	1.8	1.8
Reduce with:				
d.i. water	415.0g	480.4g	543.3g	543.3g
% solids (wt.):	35	35	35	35
phr co-resin (on PKHW-34)	0	20	20	20
phr CYMEL 303 (on resin)	15	15	15	15
Film Properties:				
dry film thickness, mils:	0.95 - 1.00	0.85 - 0.95	0.85 - 0.95	0.80 - 1.00
gloss, at 60°/20°:	101.6/89.0	102.0/86.4	93.8/66.1	101.3/88.9
Sward hardness:	49	44	52	51
pencil hardness:	5H	5H	5H	5H
crosshatch adhesion:	5B	4B	4B	5B
MEK double rubs:	>200	> 200	> 200	> 200
Reverse impact (in-lb):	> 160	fail at 150	fail at 150	fail at 120
Chemical spot tests:				
10% HCl	no effect	no effect	no effect	no effect
10% acetic acid	no effect	no effect	no effect	no effect
20% nitric acid	no effect	no effect	no effect	no effect
25% NaOH	no effect	no effect	no effect	no effect
toluene	no effect	no effect	no effect	no effect
PM acetate	no effect	no effect	no effect	no effect
DMEA	no effect	v. sl. blush	v. sl. blush	no effect
NMP	sl. Blush	sl. blush	blushed	v. sl. blush

Notes

Additional Remarks: InChem Corp. makes no express or implied warranties with regard to this product in its performance or fitness for use alone or in combination with other resins or products. The statements in this brochure are for guideline purposes only and all users should test this product for suitability in their specific applications.

Legend: (for Figure 2)

EB is DOWANOL EB (ethylene glycol butyl ether)
DB is DOWANOL DB (diethylene glycol butyl ether)
DPM is DOWANOL DPM (dipropylene glycol methyl ether)
PM is DOWANOL PM (propylene glycol methyl ether)
PnP is DOWANOL PnP (propylene glycol n-propyl ether)
DPnP is DOWANOL DPnP (dipropylene glycol n-propyl ether)
PnB is DOWANOL PnB (propylene glycol butyl ether)
(DOWANOL is a trademark of The Dow Chemical Company)

PE is ARCOSOLV[®]PE (propylene glycol ethyl ether)
(ARCOSOLV is a registered trademark of Arco Chemical Company)

EEP is UCAR[®]ESTER EEP (ethyl 3-ethoxypropionate)
(UCAR is a registered trademark of the Dow Chemical Co.)

OXSOL 100 is OXSOL[®]100 (parachlorobenzotrifluoride)
(OXSOL is a registered trademark of Occidental Chemical Corporation)

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