Renewable UV Curable Resins for Wood Finishes

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More environmentally friendly and "greener" approaches to wood finishing are being driven by stringent regulations and consumer demand. This focus has resulted in a wide variety of new and improving technologies being developed to meet performance requirements while complying with environmental regulations. The use of waterborne (WB) UV chemistry is growing in the wood finishing market because of these environmental regulations. New developments in biobased oil containing WB polyurethane dispersions have yielded unique alternatives to the traditional polyurethane dispersions. The project scope of this work has been to focus on the development of biobased resins for waterborne UV polyurethane dispersions for wood coatings. These resins show comparable performance against traditional commercial products in markets such as KCMA (Kitchen Cabinet Manufacturers Association). They offer eco-friendly alternatives with excellent chemical resistance, excellent application properties and overall exceptional performance at lower VOC levels. In this study, a castor-oil based PUD is evaluated as both a 1k and 2k system and is compared to a newly developed biobased waterborne UV resin. The table below summarizes the physical properties of the resins evaluated.

	% Solids (wt)	pH	Viscosity (cps)
BIO UV	33-35	7.0-8.0	20-200
PUD 1	29-31	7.5-8.5	20-100

Procedure

A study has been conducted to compare the properties of the BIO UV resin with a traditional castor-oil based resin as 1k and 2k systems. These coatings were tested according to Kitchen Cabinet Manufacturer's Association (KCMA), American Woodworking Standards (AWS) and individual office furniture manufacturer's specifications.

Panel Preparation

For 1k and 2k

Spray 3 to 4 wet mils on an 18 x 18-inch stained maple panel; air dry for 10 minutes; force dry for 20 minutes at 50 C. Cool the panels for 15 minutes then sand with 320 grit sandpaper. Repeat procedures for second coat. Allow the panel to dry at ambient temperature for seven days unless otherwise indicated in test methods.

For edge, coat and allow all sides of a 4"X4" solid oak panel to dry at ambient temperatures. Sand and repeat. Air dry for 7 days before testing.

Water based UV

Spray approximately 3 wet mils of coating over 18X18 stained birch plywood panel; air dry for 10 minutes; force dry for 10 minutes at 50C. Cure with mercury bulb at 800 mJ/cm^2. Sand with 3M Superfine Sanding Sponge. Apply a second coat at approximately 3 wet mils. Air dry for 10 minutes then force dry for 10 minutes at 50C. Cure with mercury bulb at 800 mJ/cm^2. Wait 7 days before testing unless otherwise indicated in test method.

For edge soak, coat and cure all sides of a 4”X4” solid oak panel. Sand and repeat. Cure with mercury bulb at 800 mJ/cm^2. Airdry for 7 days before testing.

Formulations

	PUD 1	BIO UV
PUD 1	**84.34**	**0**
BIO UV	**0**	**95.73**
Defoamer	**0.35**	**0.20**
Surfactant	**0.42**	**0.39**
Water	**7.56**	**0**
Cosolvent 1	**2.33**	**0**
Coslvent 2	**4.65**	**0**
Rheology Modifier	**0.35**	**0.70**
Matting Agent	**0**	**2.00**
Photoinitator	**0**	**.98**
Solids (wt)	**28.5**	**34.5**
Solids (vol)	**25.6**	**31.4**
VOC (g/l)	**200**	**38**
Gloss (60°)	**89.4**	**90.1**

Data

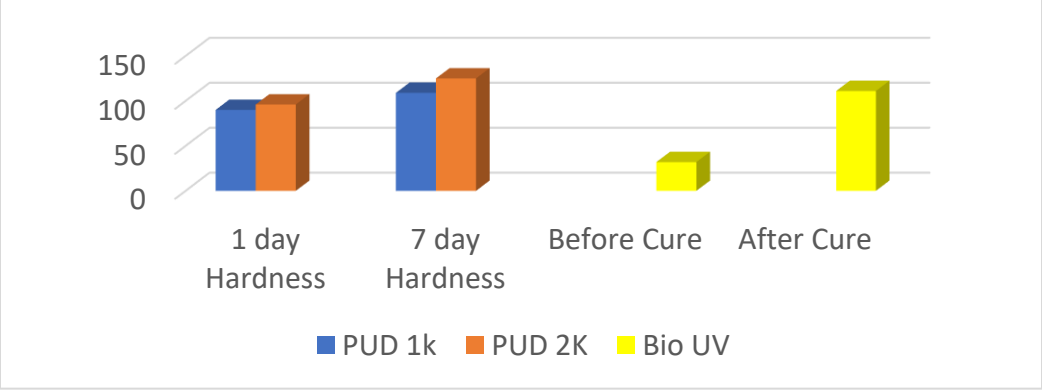
Koenig Pendulum Hardness:

1k and 2K

Make a 150-micron drawdown on a glass panel. Air dry and measure Koenig Pendulum hardness in seconds at 1 day and 7 days after cure.

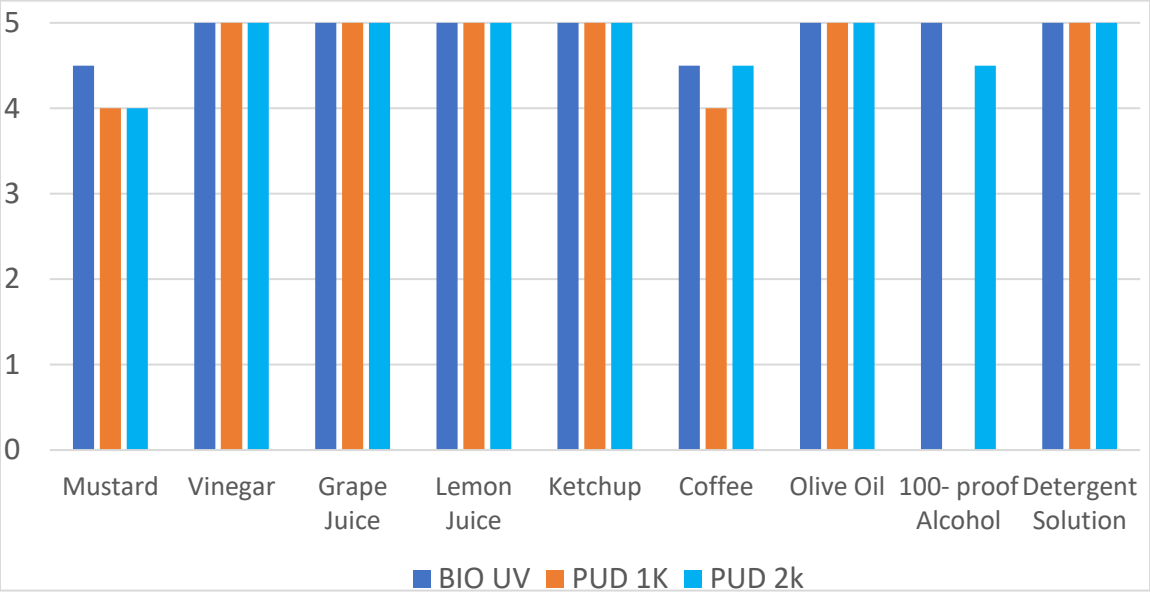
Bio UV

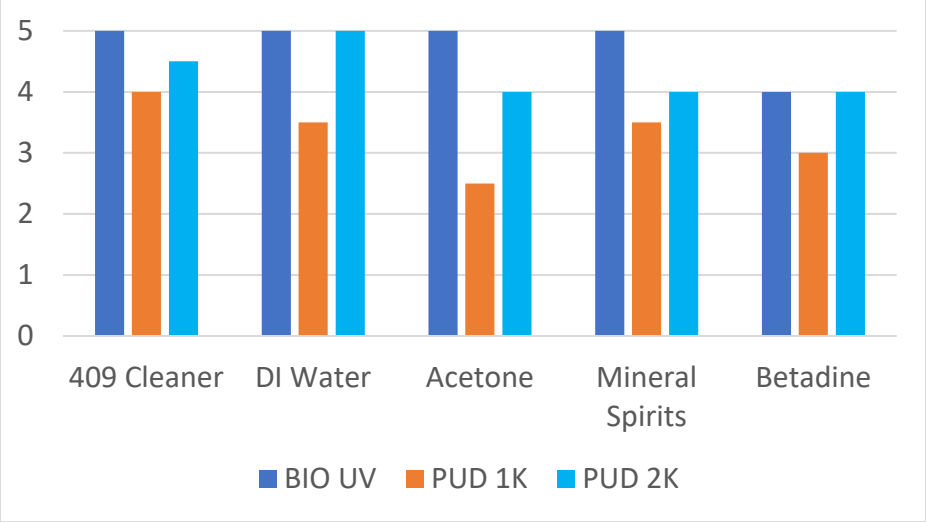
Make a 150-micron drawdown on a glass panel. Airdry for 10 minutes. Force dry at 50C for 10 minutes. Cure with mercury bulb at 800 mJ/cm^2. Measure Koenig Pendulum Hardness seconds before UV cure and 1 day and 7 days after cure.

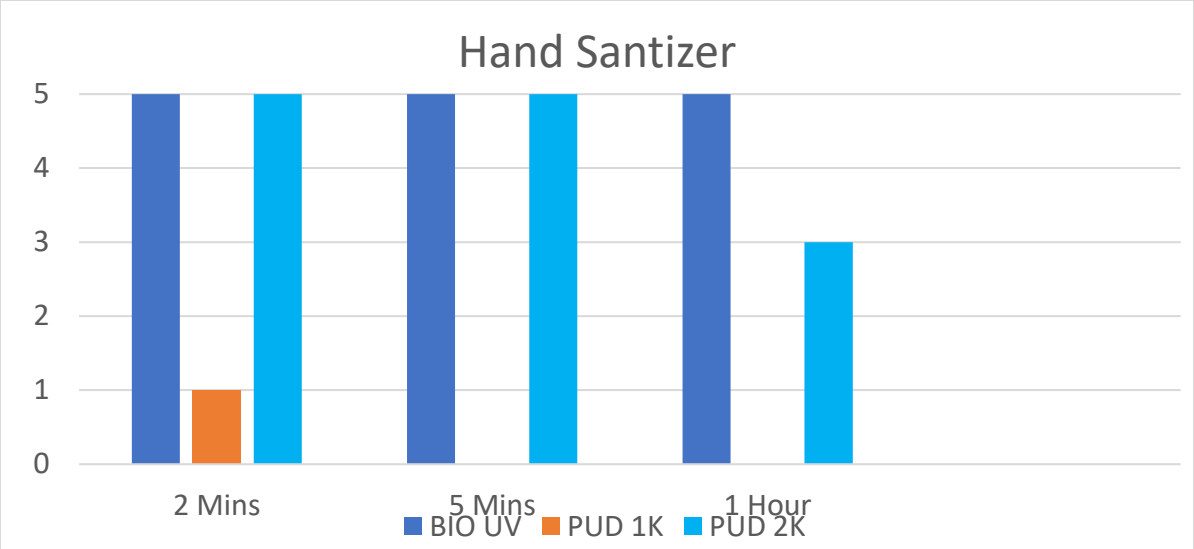


Chemical/Stain Resistance:

Place a 7/8-inch diameter filter paper on the test panel and saturate with the chemical/stain. Cover with watch glass. Wait recommended time according to the specification. Remove chemical/stain and wash the surface of the panel with water. Rate each chemical/stain on a scale of 0 to 5 with 0 being complete destruction of the film and 5 being no effect on the film.

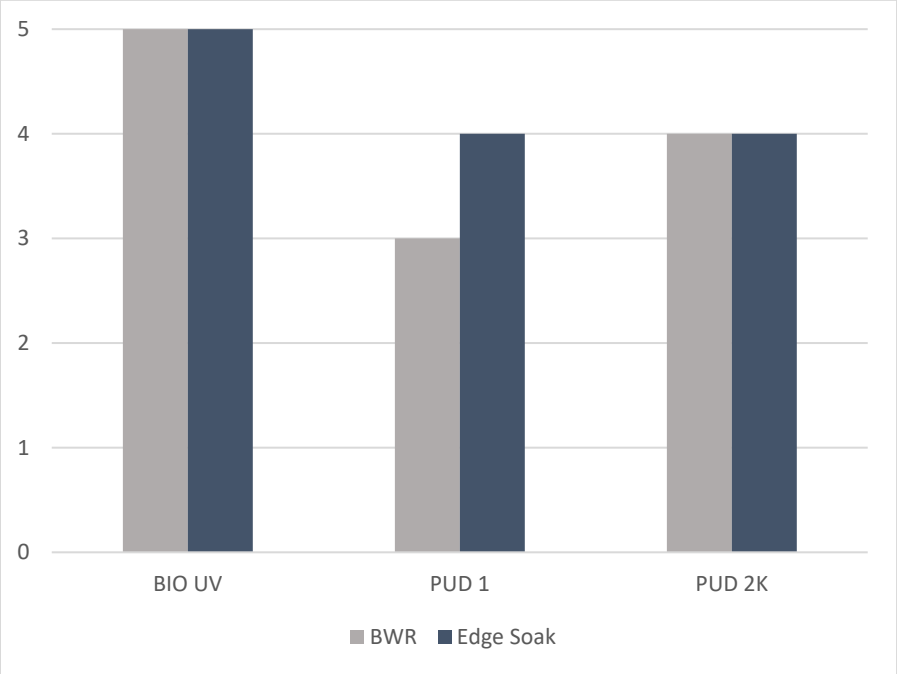






Boiling Water Resistance:

Apply 10 ml boiling water to the test panel. Place a ceramic coffee cup full of boiling water on top of the 10 ml of water. Wait 1 hour. Remove the cup and wipe with paper towel. Wait 24 hours. Evaluate for whitening, blushing and blistering.



Scrape Adhesion:

Cut a 4X4 inch piece from each test panel. Test adhesion with a BYK Balanced Beam Scrape Adhesion and Mar Tester with 5 Kg of weight using the loop stylus. Rate on a pass/ fail scale

BIO UV	PUD 1K	PUD 2K
pass	pass	pass

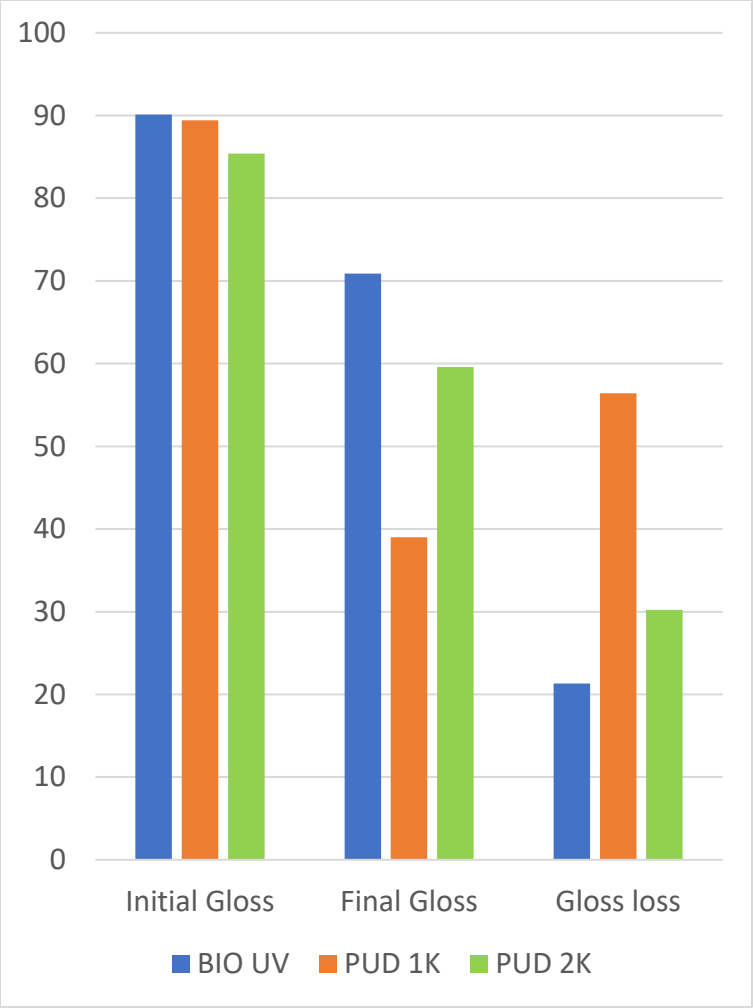
Ball Point Pen Indentation:

Cut a 4X4 inch piece from each test panel. Test for ball point pen indentation with a BYK Balanced Beam Scrape Adhesion and Mar Tester with 500 grams of weight using the small pen #5785. Wait 1 hour before evaluating the panel. Any indentation that can be seen from 24 inches is considered a failure.

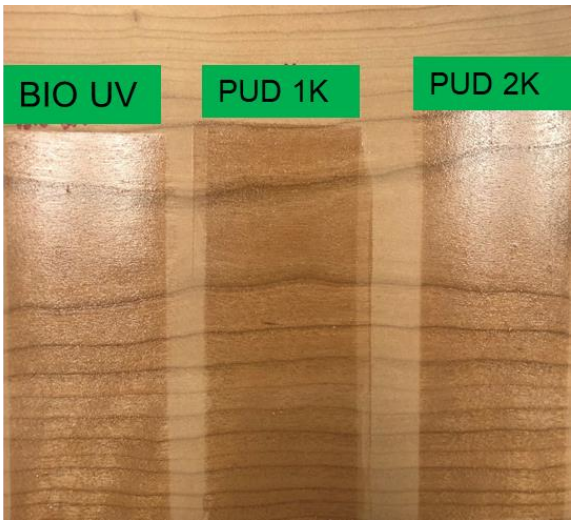
BIO UV	PUD 1K	PUD 2K
pass	pass	pass

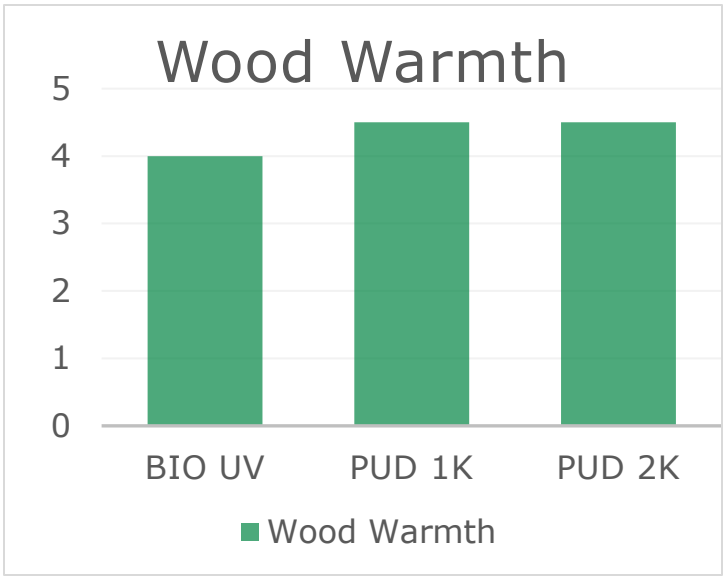
Scratch Resistance

The coatings are scratched with a green Scotch Brite scrub pad with a 200-gram weight applied (10 double rubs). The gloss is measured before and after the rubs and the % gloss lost is reported. The lower the number, the higher the performance.

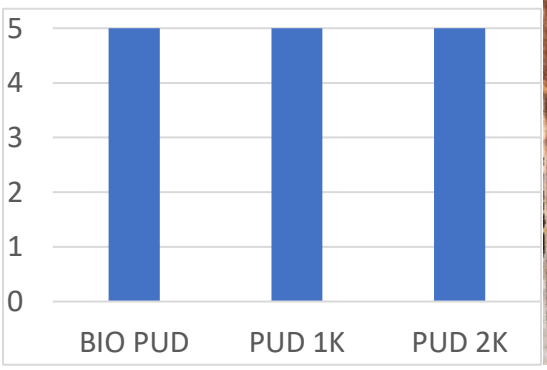

100
90
80
70
60
50
40
30
20
10
0
Initial Gloss
Final Gloss
Gloss loss
BIO UV
PUD 1K
PUD 2K

Wood Warmth

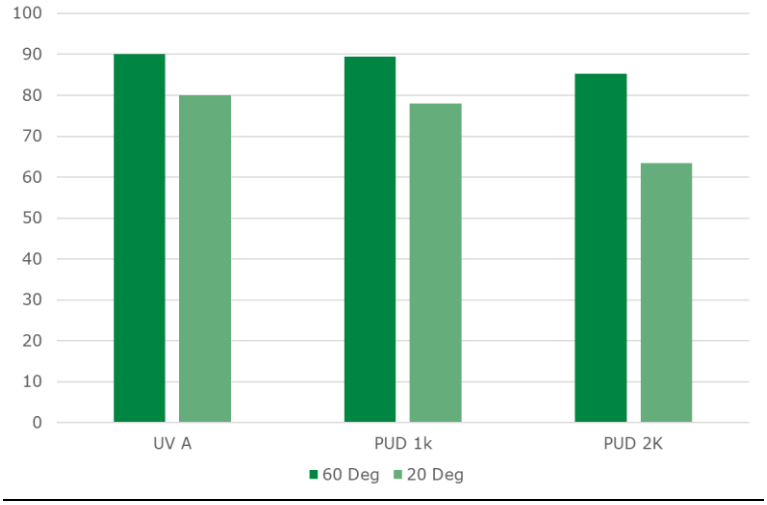




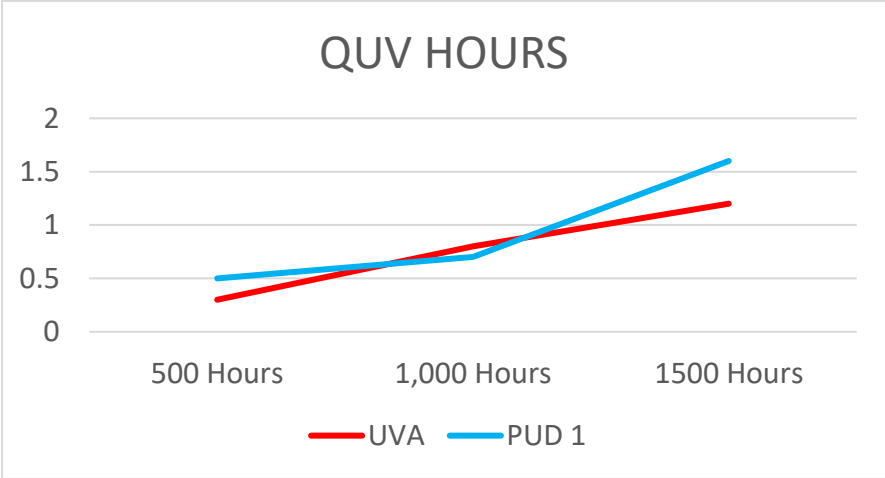
Clarity over stain



Gloss



QUV Data



Discussion

The WB biobased UV coating in this study performed very well in all tests as specified by KCMA, AWS and furniture manufacturer standards. The WB renewable UV resin performance better than a traditional 1k castor-based PUD by giving better chemical resistance and developing hardness/ block

resistance initially. The WB renewable UV resin had comparable properties to 2K castor-based PUD. The VOC of the WB renewable resin is significantly less than that of the traditional based castor oil.