Wanhua Waterborne Solutions for Adhesive

Wanhua Chemical
Emerging Technology Business Group
Apr., 2021

Product Categories & Applications

Adwel®

- PUD
- PA

Aquolin®

- WB Polyisocyanate

Vesmody®

- Rheology Modifier

Footwear

Sponge

Auto Interior

Paper

3D Lamination

PSA

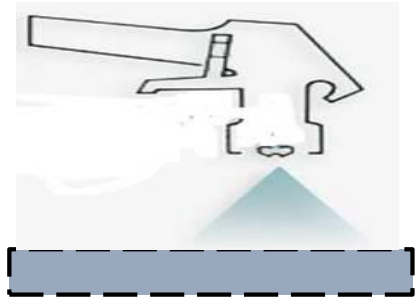
Waterborne Adhesive Solutions for

Footwear

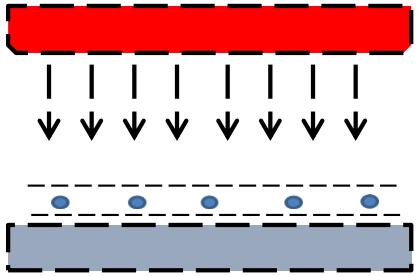
Product Line for Footwear Adhesive

Product	REACH	Type	Solids (%)	Viscosity (mPa·s)	pH	Features
Adwel® 1630C	Y	PUD	50±1	40-600	6.0-9.0	• Good reactivation • Long open time
Adwel® 1630B	Y	PUD	50±1	500-4000	6.0-9.0	• Excellent bonding strength • Excellent heat/water resistance
Adwel® 1645	Y	PUD	45±1	500-4000	6.0-9.0	• Outstanding brushability • Excellent bonding strength • Excellent heat/water resistance • High cost-effective
Adwel® 1631	Y	PUD	48±1	1000-6000	6.0-9.0	• 1K application • Suitable for brushing & spraying • Outstanding heat/water resistance

1/Reactivation Process for Footwear Manufacture

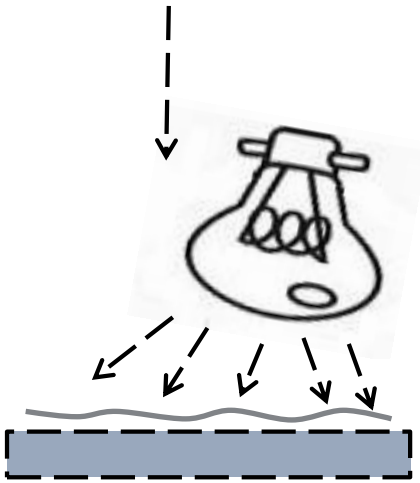


Spraying

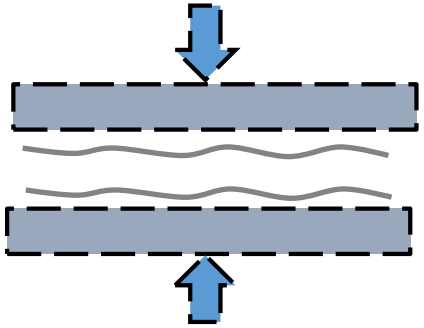


IR flash drying

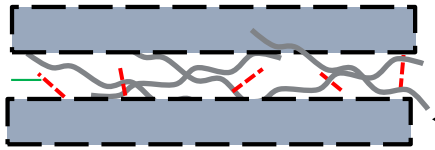
Transmission on the line



Reactivating the **dried film**
70˚C×10s



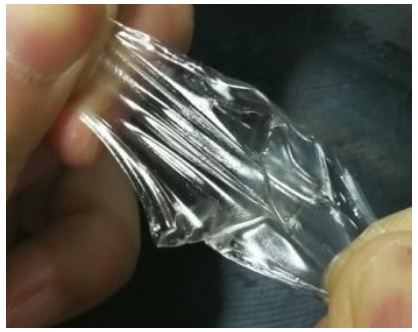
Attaching & pressing



Chilling

Adwel® 1630C - PUD for Good Reactivation

Reactivation Test

	Adwel® 1630C	Adwel® 1630B	Competitor
Dried film			
Reactivated @70˚C×5min			
Tack	**Excellent**	Weak	Excellent

Adwel® 1630C - PUD for Good Reactivation

Bonding Performance Comparison

- Substrates: Rubber/Leather

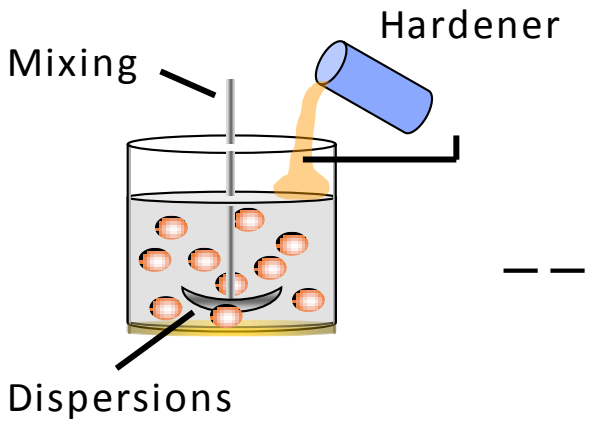
Items	Adwel® 1630C	Adwel® 1630B	Competitor
Green tack, N/mm (30s after bonding)	**1.9**	0.9	1.9
Initial peeling, N/mm (15min after bonding)	**4.1**	3.4	4.0
Final peeling, N/mm (12hours after bonding)	**5.5**	3.7	5.4
Heat resistance, cm (1KG load)			
50˚C×1h	**0**	0	0
60˚C×1h	**5**	0	5
70˚C×1h	**20mins peel off**	1	10mins peel off
80˚C×1h	**-**	5	-

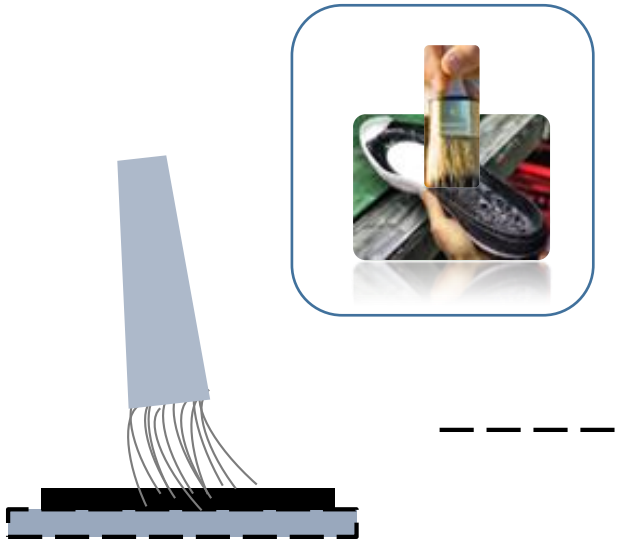
Basic Formula

No.	Component	%	Supplier
1	PUD resin	99.60	Wanhua
2	BYK 024	0.05	Defoamer/BYK
3	Tego® Wet KL 245	0.20	Wetting agent/ Tego
4	Vesmody® U604	0.15	Thickener/ WanHua
Total		100.00	

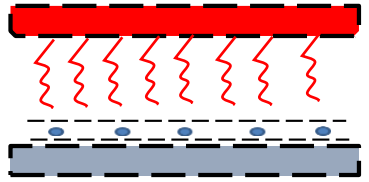
- Adwel® 1630C shows comparative bonding strength and heat resistance as competitor in 1K easily reactivated solution.

2/Traditional Process for Footwear Manufacture



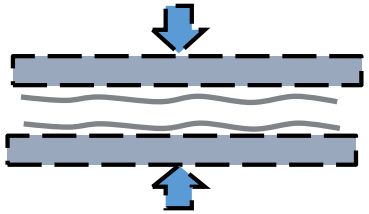


Brushing adhesive



Drying **wet film** in heat oven
70˚C×3~5mins

Transmission on the line



Attaching & pressing

Chilling

Adwel® 1630B/1645 - PUD for 2K Solution

Bonding Performance Comparison

- Substrates: Rubber/Rubber

Items	Adwel® 1630B	Adwel® 1645
Initial tack	A+++	A++
Brushability	Good	Excellent
Initial bonding strength (N/mm)	4.0	3.6
Green heat resistance, mm (80˚C×10min×500g load)	4.0	4.0
Final heat resistance, mm (80˚C×30min×1kg load)	0	0
Anti-hydrolysis, mm (70˚C×95%RH×8h×500g load)	0	0

Basic Formula

Component A

No.	Component	%	Supplier
1	PUD resin	99.60	WanHua
2	BYK 024	0.05	Defoamer/BYK
3	Tego® Wet KL 245	0.20	Wetting agent/ Tego
4	Vesmody® U604	0.15	Thickener/ WanHua
Total		100.00	

Component B

No.	Component	%	Supplier
1	Aquolin® 161	4.00	Hardener/ WanHua

Adwel® 1631 - PUD for 1K Solution

Bonding Performance Comparison

- Substrates: Rubber/Rubber

Items	Adwel® 1631 – 1K	Adwel® 1630B – 1K	Adwel® 1630B – 2K
Initial tack	**A++~A+++**	A+++	A+++
Brushability	**Excellent**	Good	Good
Initial bonding strength (N/mm)	**4.1**	4.1	4.0
Green heat resistance, mm (80˚C×10min×500g load)	**6.0**	4.0	4.0
Final heat resistance, cm (80˚C×30min×1kg load)	**3.0**	15.0	0
Anti-hydrolysis (70˚C×95%RH×500g load)	**3h**	0.5h	0mm/8h

Basic Formula

No.	Component	%	Supplier
1	PUD resin	99.60	WanHua
2	BYK 024	0.05	Defoamer/BYK
3	Tego® Wet KL 245	0.20	Wetting agent/ Tego
4	Vesmody® U604	0.15	Thickener/ WanHua
Total		100.00	

- Adwel® 1631 shows much better heat resistance and anti- hydrolysis than Adwel® 1630B in 1K solution.

Waterborne Adhesive Solutions for

Auto Interior

Waterborne Adhesive Used in Auto Interior

Door Panel

- Vacuum forming or manual assembling
- PUD

Roof

- Molding process
- PUD & VAE

Seat

- Manual assembling
- CRD

Instrument Panel

- Vacuum forming
- PUD

Carpet

- Laminating process
- VAE

Product Line for Auto Interior Adhesive

Product	REACH	Type	Solids, %	Viscosity, mPa·s	pH	Features
Adwel® 1665	Y	PUD	50±1	500-2000	6.0-9.0	• Good tack • Fast thermal activation • Fast crystallization
Adwel® 1630C	Y	PUD	50±1	40-600	6.0-9.0	• Good reactivation • Long open time
Adwel® 1675	Y	PUD	40±1	10-1000	6.0-9.0	• Fast crystallization • Good bonding property
Adwel® 1631	Y	PUD	48±1	1000-6000	6.0-9.0	• 1K application • Excellent heat resistance

Bonding performance comparison

- Substrates: ABS/PVC leather

Product	Tack kg	1min bonding N/mm	8min bonding N/mm	Final bonding N/mm	Initial heat resistance min	Final heat resistance min
Adwel® 1665	**4.1**	**1.0**	**2.3**	**4.2**	**≈8**	**≈22**
Competitor-1	4.0	0.9	2.2	4.4	≈9	≈25

- **Initial bonding:**
  1min or 8min after bonding, 200mm/min, 2.5cm width strips.
- **Final bonding:**
  72h after bonding, 200mm/min, 2.5cm width strips.
- **Initial heat resistance:**
  10min after bonding, 80˚C×200g, 2.5cm width, 180˚ hanging, record time of total open.
- **Final heat resistance:**
  72h after bonding, 80˚C ×200g, 2.5cm width, 90˚ hanging, record time of total open.

- **Summary**

  Adwel® 1665 shows comparative bonding behavior as competitor-1 in 2K adhesive solution.

Bonding performance comparison

- Substrates: ABS/PVC leather

Product	Tack kg	1min bonding N/mm	8min bonding N/mm	Final bonding N/mm	Initial heat resistance min	Final heat resistance cm
Adwel® 1630C	**3.2**	**0.9**	**2.0**	**4.2**	**22**	**5.5**
Competitor-2	3.0	0.9	1.9	4.0	25	4.5

- **Initial bonding:**
  1min or 8min after bonding, 200mm/min, 2.5cm width strips.
- **Final bonding:**
  72h after bonding, 200mm/min, 2.5cm width strips.
- **Initial heat resistance:**
  10min after bonding, 80˚C×200g, 2.5cm width, 180˚ hanging, measure opening length after 30mins or record time of total open.
- **Final heat resistance:**
  72h after bonding, 80˚C ×200g ×4h, 2.5cm width, 90˚ hanging, measure the opening length.

- **Summary**

  Adwel® 1630C has better tack and other properties are similar to competitor-2 in 2K adhesive solution.

Bonding performance comparison

- Substrates: ABS/PVC leather

Product	Tack kg	1min bonding N/mm	8min bonding N/mm	Final bonding N/mm	Initial heat resistance cm	Final heat resistance cm
Adwel® 1675	**2.2**	**0.9**	**2.0**	**4.8**	**3.8**	**2.0**
Competitor-3	2.1	0.7	1.8	4.6	6.5	2.5

- **Initial bonding:**
  1min or 8min after bonding, 200mm/min, 2.5cm width strips.
- **Final bonding:**
  72h after bonding, 200mm/min, 2.5cm width strips.
- **Initial heat resistance:**
  10min after bonding, 80˚C×200g, 2.5cm width, 180˚ hanging, measure opening length after 30mins or record time of total open.
- **Final heat resistance:**
  72h after bonding, 80˚C ×200g ×4h, 2.5cm width, 90˚ hanging, measure the opening length.

- **Summary**

Adwel® 1675 shows better initial heat resistance, and other properties are similar to competitor-3 in 2K adhesive solution.

2K Solution for Auto Interior Door

Recommended formula

Component A

No.	Component	Dosage/g	Supplier/Function
1	Adwel® 1675 or Adwel® 1630C	50	Wanhua/PUD resin
2	Adwel® 1665	50	Wanhua/PUD resin
2	BYK 024	0.05	Defoamer/BYK
3	Tego® Wet KL 245	0.20	Wetting agent/Tego
4	Vesmody® U604	0.50	Thickener/Wanhua

Component B

No.	Component	Dosage/g	Supplier/Function
1	Aquolin® 166	5	Wanhua/Hardener

Bonding samples preparation

- ABS board and PVC leather cleaned by alcohol. 2K adhesive spraying on ABS board, 80-100g/m^2.
- Room temperature (25˚C) drying for 30min and both substrates were heated in oven 70˚C×2min.
- Pressure at 0.1MPa for 30s.

Bonding performance comparison

Product	Tack kg	1min bonding N/mm	8min bonding N/mm	Final bonding N/mm	Initial heat resistance	Final heat resistance	Heat aging 90˚C*500h N/mm
1675/1665	**3.1**	**1.0**	**2.3**	**4.6**	**24min**	**3.5h**	**3.7**
1630C/1665	**3.6**	**0.9**	**2.0**	**4.4**	**15.5min**	**2.7h**	**3.7**
Competitor	3.1	1.0	2.2	4.5	13min	2.5h	3.4

Summary

1) Tack: 1630C/1665 > 1675/1665 = Competitor

2) Final heat resistance: 1675/1665 > 1630C/1665 > Competitor

3) No obvious difference was observed for other properties between these three samples

Adwel® 1631 - PUD for 1K Solution

Basic physical property

Product	Appearance	Solid content	Particle size nm	Viscosity* cps	Minimum activation temperature ℃	MFFT ℃
Adwel® 1631	Milky white	48±1%	150-175	1000-6000	60-65	≈5

* Brookfield DV2T, 25˚C, 63#30RPM, cps

Advantages of 1K

- No 2nd component mixing
- No pot life limitation
- Good process ability
- Excellent heat resistance
- Good bonding performance

Bonding performance comparison

Product	Tack *Kg*	1min bonding *N/mm*	8min bonding *N/mm*	Final bonding *N/mm*	Initial heat resistance *mm*	Final heat resistance *mm*	Heat aging 90℃×500h *N/mm*
Adwel® 1631-1K	**3.0**	**1.9**	**3.6**	**4.2**	**10**	**50**	**3.8**
Competitor-2K	3.1	1.0	2.2	4.5	13min	2.5h	3.4

- **Initial bonding:**
  1min or 8min after bonding, 200mm/min, 2.5cm width strips.
- **Final bonding:**
  72h after bonding, 200mm/min, 2.5cm width strips.
- **Initial heat resistance:**
  10min after bonding, 80˚C×200g, 2.5cm width, 180˚ hanging, measure opening length after 30mins or record time of total open.
- **Final heat resistance:**
  72h after bonding, 80˚C ×200g ×4h, 2.5cm width, 90˚ hanging, measure the opening length.

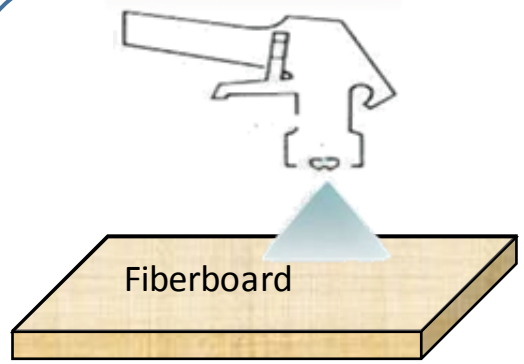
Summary

Adwel® 1631 in 1K solution shows excellent heat resistance compared with 2K competitor.

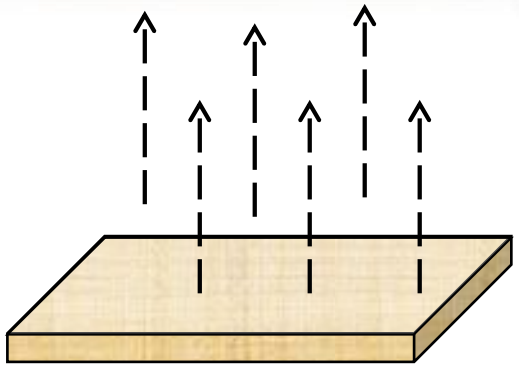
Waterborne Adhesive Solutions for

3D Lamination

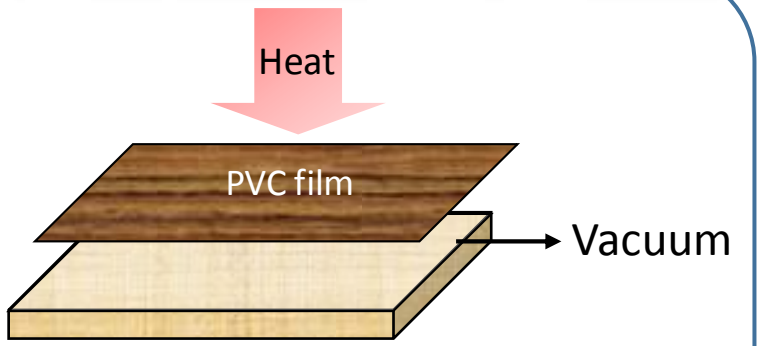
3D Lamination: Manufacture Process



Spraying



Drying



Laminating

Product Line for 3D Lamination

Product	REACH	Type	Solids, %	Viscosity, mPa·s	pH	Features
Adwel® 1630C	Y	PUD	50±1	40-600	6.0-9.0	• Good reactivation • Long open time
Adwel® 1675	Y	PUD	40±1	10-1000	6.0-9.0	• Fast crystallization • Good bonding properties
Adwel® 1665	Y	PUD	50±1	500-2000	6.0-9.0	• Good tack • Fast thermal activation • Fast crystallization
Adwel® 1631	Y	PUD	48±1	1000-6000	6.0-9.0	• 1K application • Excellent heat resistance

Performance comparison

- Substrates: MDF/PVC film

Items	Formula-1K	Formula-2K
Solids content, %	**50±1**	**50±1**
Viscosity, mPa·s	**800-1000**	**800-1000**
Spraying	**Good**	**Good**
Minimum activation temperature ˚C	**50-60**	**50-60**
Bonding strength	**Good**	**Excellent**
Heat resistance, ˚C	**60-70**	**80-90**

Basic Formula

Component A

No.	Component	Type	wt.%	Supplier
1	**Adwel® 1630C**	**PUD Resin**	**40**	**WanHua**
2	**Adwel® 1675**	**PUD Resin**	**20**	**WanHua**
3	DA-102	EVA Resin	40	Dairen
4	BYK-028	Defoamer	0.05	BYK
5	Tego® Wet KL 245	Wetting Agent	0.2-0.4	Tego
6	Vesmody® U902	Rheology Modifier	0.05	WanHua

Component B

No.	Component	%	Supplier
1	Aquolin® 166	5.00	Hardener/ WanHua

1K Solution for 3D Lamination

Performance comparison

- Substrates: MDF/PVC film

Items	1630C/1675 formula-2K	1631 formula-1K
Solids content, %	50±1	52±1
Viscosity, mPa·s	800-1000	1000-1500
Spraying	Good	Good
Minimum activation temperature ˚C	50-60	50-60
Bonding strength	Excellent	Good
Heat resistance, ˚C	80-90	80-90

Advantages of 1K

- No 2nd component mixing
- No pot life limitation
- Good process ability
- Excellent heat resistance
- Good bonding performance

Basic Formula

No.	Component	Type	wt.%	Supplier
1	Adwel® 1631	PUD Resin	50	WanHua
2	DA-102	EVA Resin	50	Dairen
3	BYK-028	Defoamer	0.05	BYK
4	Tego® Wet KL 245	Wetting Agent	0.2-0.4	Tego

Waterborne Adhesive Solutions for

Sponge

Product Line for Sponge Adhesive

Product	REACH	Type	Solids (%)	Viscosity (mPa·s)	pH	Tg (˚C)	Process	Features
Adwel® 1356	Y	PA	65±1	<3000	3.0-7.0	-25	Rolling	• High solid content • Good bonding strength • High cost-effective
Adwel® 1336	Y	PA	48±1	<1000	2.1-7.0	-15	1C spraying	• Good wet tack • Long open time • Resettable within 3mins • High cost-effective
Adwel® 1336C	Y	PA	55±1	<1000	3.0-6.0	-40	1C spraying	• Good wet tack • Effectively improve initial adhesion • High cost-effective
Adwel® 1336S	Y	PA	48±1	<1000	3.0-7.0	-26	2C spray-mix	• Good wet tack • Long open time • Good compatibility with CRD • High cost-effective

Adwel® 1356 – PA for Rolling Application

- High solid content product for foam bonding application, especially suitable for mattress industry
- Recommended for rolling process
- Bonding effect can be effectively improved if there are heating equipment before laminating process

Adwel® 1336/1336C – PA for 1C Spraying Adhesive

Advantage of 1C solution

- Easy to spraying
- No need special spraying equipment
- High cost-effective

Adwel® 1336 + Adwel® 1336C

- Good initial adhesion at low temperature (15˚C)
- Meet requirements of both double-side and single-side spraying
- Different mixing ratios can cope with different surrounding temperature demands

Recommended Formula

No.	Component	Type	wt.%	Supplier
1	Adwel® 1336	PA Resin	70	WanHua
2	Adwel® 1336C	PUD Resin	30	WanHua

Adwel® 1336S – PA for 2C spraying-mix adhesive

Advantage of 2C solution

- Better wet tack and initial bonding performance
- More flexible formula

Suggested process

- Spraying two components together by double-nozzle equipment
- 1st spraying adhesive → 2nd spraying coagulant

Adwel® 1336S

Recommended coagulant: 2-3% $ZnSO_4$

- Better initial adhesion
- Meet requirements of both double-side and single-side spraying
- Good cohesive property, and can be stably combined with CRD to further enhance cohesive property

Comparison of Different Solutions

Product	Initial adhesion	Cohesion	Open time/min	Heat resistance 80℃*3h
Adwel® 1336+1336C (7:3) – 1C	★★★	★★★	> 20	√
Adwel® 1336S – 2C	★★★★	★★★	> 20	√
Adwel® 1336S+CRD (7:3) – 2C	★★★★★	★★★★	> 20	√
CR benchmark – 2C	★★★★	★★★★★	> 20	√

Summary

1. Adwel 1336/1336C for 1C spraying adhesive is suitable for foam bonding with low stress requirements.
2. Adwel 1336S for 2C spraying-mix adhesive can improve cohesion by combing with CRD to meet foam bonding with different stress requirements.

Waterborne Adhesive Solutions for

Paper

Product Line for Paper Adhesive and Coating

Product	REACH	Type	Solids (%)	Viscosity (mPa·s)	Tg (˚C)	pH	Features
Adwel® 1318S	Y	PA	45±1	10-1000	15-20	3.0-7.0	• For lamination of substrates such as paper, PP, PE, PET, foil, etc. • Good water and oil resistance
Wantipro® 0624	Y	PA	46±1	500-3000	25-30	7.0-9.0	• Coating for substrates such as Paper, PP, PE, PET, Foil and high barrier packaging material • Good water and oil resistance

Waterborne Adhesive Solutions for

PSA

Product line for PSA Application

Product	REACH	Commercial	Solids (%)	Viscosity（mPa·S）	Tg (˚C)	Features	Application			
							Label	Tape	Protective film	Flooring
Adwel® 1367	Y	Y	62±1	100-1500	-47	• High solid, low viscosity • Excellent loop tack • Excellent anti-aging property	★	★	☆	★
Adwel® 1370	Y	Y	55±1	100-500	-40	• Good loop tack • Good peel strength • High cost-effective	★	★	★	☆
Adwel® 1369^{T}	Y	N	62±1	100-1500	-40	• High solid, low viscosity • Excellent tack and re-tack • Excellent peel strength	★	★	☆	★

★ Main recommended application

☆ Recommended application

Recommended Formula

Material	Type	Wt.%	Supplier
Adwel®1367	PA	100	Wanhua
780G	Rosin resin	25	Laote Chemical
WE3485	Wetting agent	0.5-1.0	BASF
FoamStar 2410	Defoamer	0.5-2.0	BASF
Vesmody®U604	thickener	0.01-0.1	Wanhua

* The tack and viscosity can be adjusted according different process and demands.

Mechanical property

Test conditions: 23±2˚C, 50±5% RH; Standard aging: 65±2˚C, 80±5% RH, 24h; 19g/m², transfer to copperplate paper

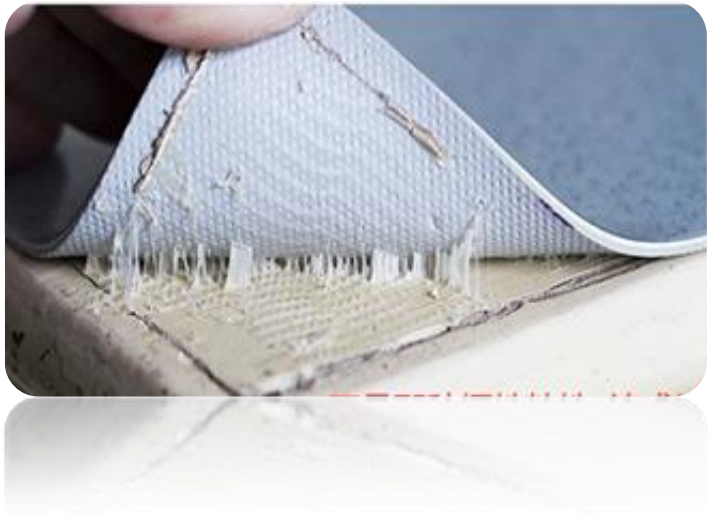
Products	Loop tack (N/inch²)			
	Before aging SS	Before aging HDPE	After aging SS	After aging HDPE
Adwel® 1367	9.8	7.9	5.1	3.9
formula	14.7	12.8	7.2	5.4

Products	90° Peel strength (SS,N/inch)		Holding tack (SS,1*1inch² *1KG,h)	
	Before aging	After aging	Before aging	After aging
Adwel® 1367	6.4	4.1	>100	55
formula	7.2	5.9	17	>100

* The test results may be different according to different substrates and conditions

Tack performance comparison

- **Substrate:** PE film, wooden boards
- **Coating amount:** 35g /m^2
- **Initial tack:** After coating on PE film for 30min, rolling it onto the wooden board, record the 180˚peel strength (N/inch).
- **Re-tack:** After initial tack test, rolling again, after staying 30min, record the 180˚ peel strength (N/inch).

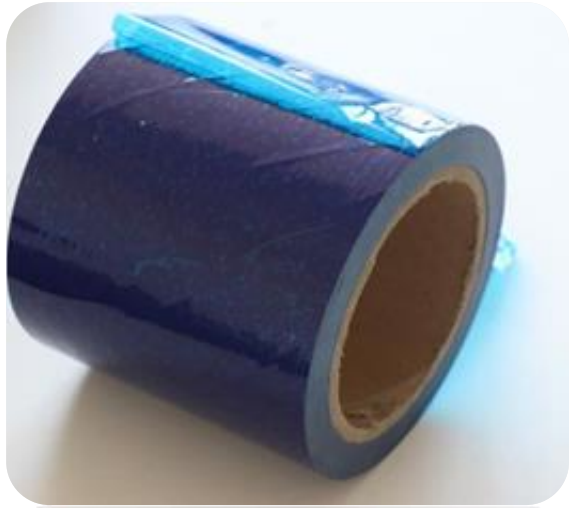


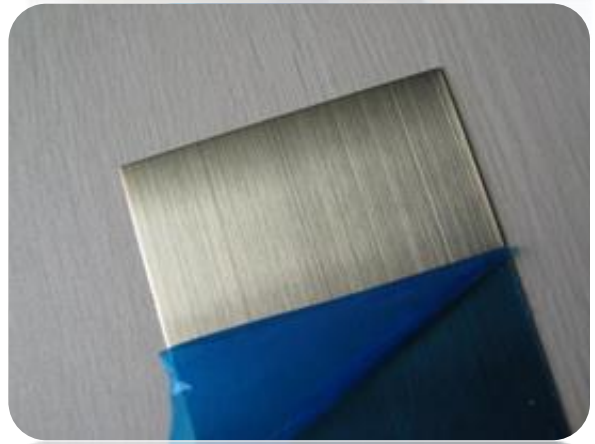
Items	Adwel 1369^T	Adwel 1367	Competitor
Initial tack	**20.2**	**10.1**	16.7
Re-tack	**10.3**	**5.6**	8.1

03/Innovative Solution for protective film - Adwel® 1370

Recommended Formula

Material	Type	Wt.%	Supplier
Adwel® 1370	PA	100.0	Wanhua
DI Water	/	3.7	/
WE3485	Wetting agent	0.20	BASF
2410	Defoamer	0.10	BASF
BYK 024	Defoamer	0.10	BYK
HD-100A	Aziridine crosslinker	0.03-0.25	/





03/Innovative Solution for protective film - Adwel® 1370

Test conditions: 23±2˚C, 50±5% RH

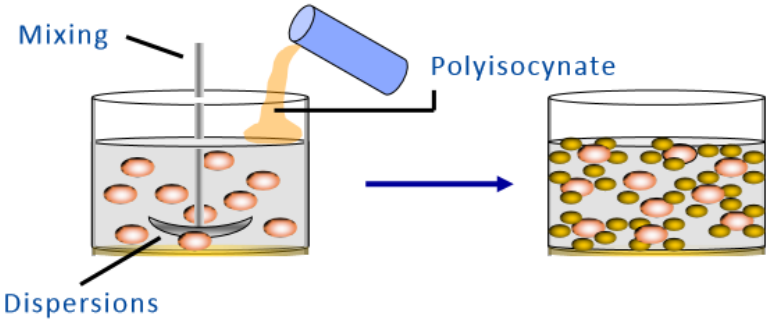
Sample	Loop tack ($N/inch^2$)	180°peel strength (N/inch)	70°C*95%RH*24h Adhesive Residue
1.0‰ crosslinker	6.5	3.9	No
1.5‰ crosslinker	5.6	3.6	No
2.0‰ crosslinker	5.2	3.2	No
2.5‰ crosslinker	4.7	1.8	No

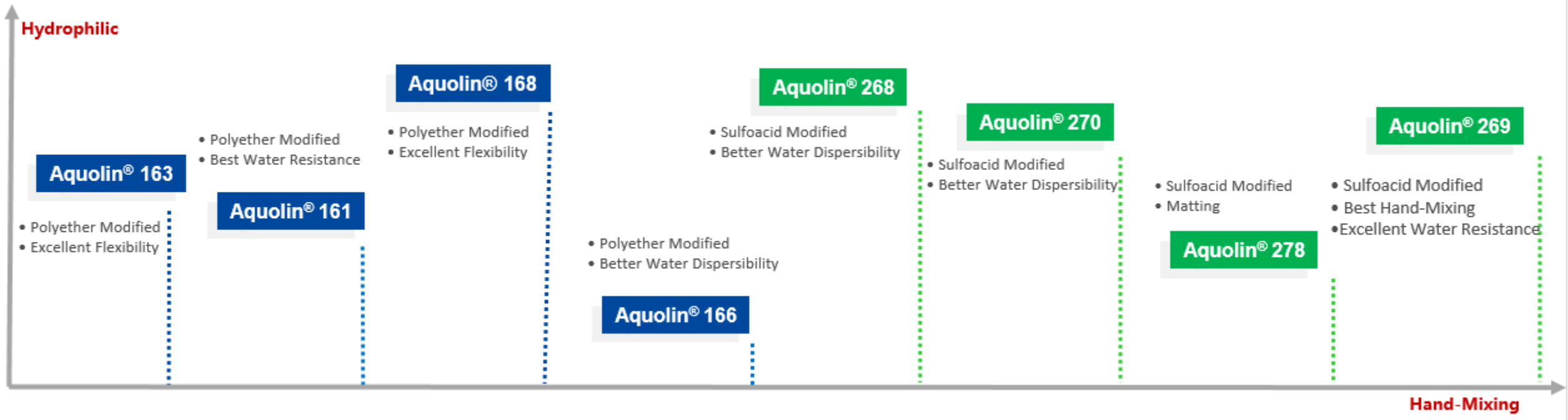
- The loop tack and peel strength can be adjusted as needed .

Water-dispersible Polyisocyanate Hardeners

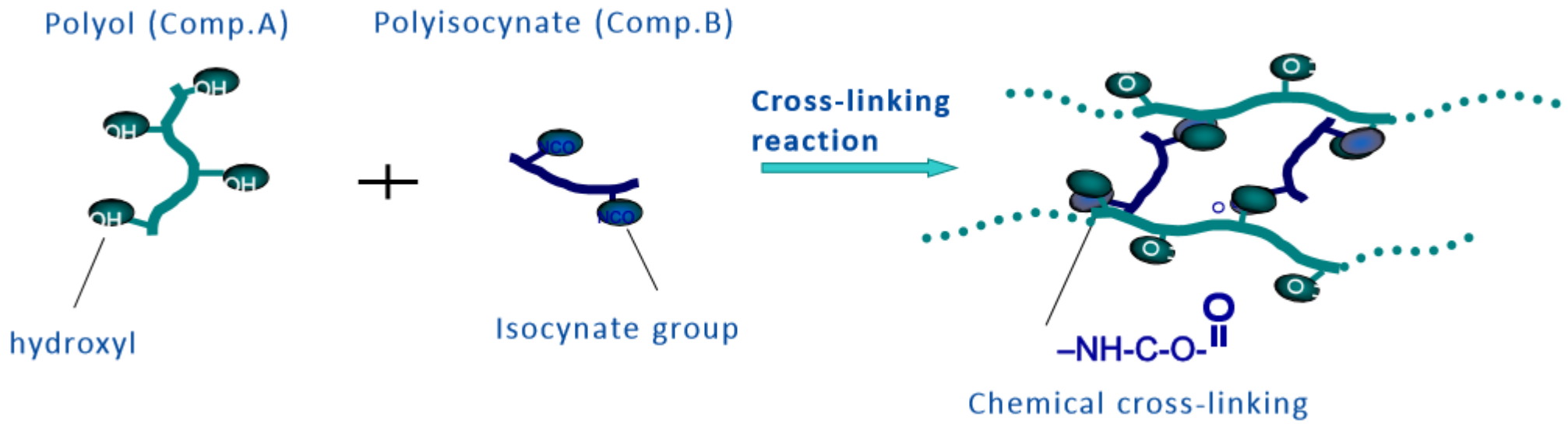
Water-dispersible Polyisocyanate Hardeners

Type	Advantage	Disadvantage
Sulfoacid modified	Good appearance and dispersity	Cost/rapid reactivity
Polyether modified	High cost-effect/mild reactivity/good water resistance	Normal clarity and dispersity





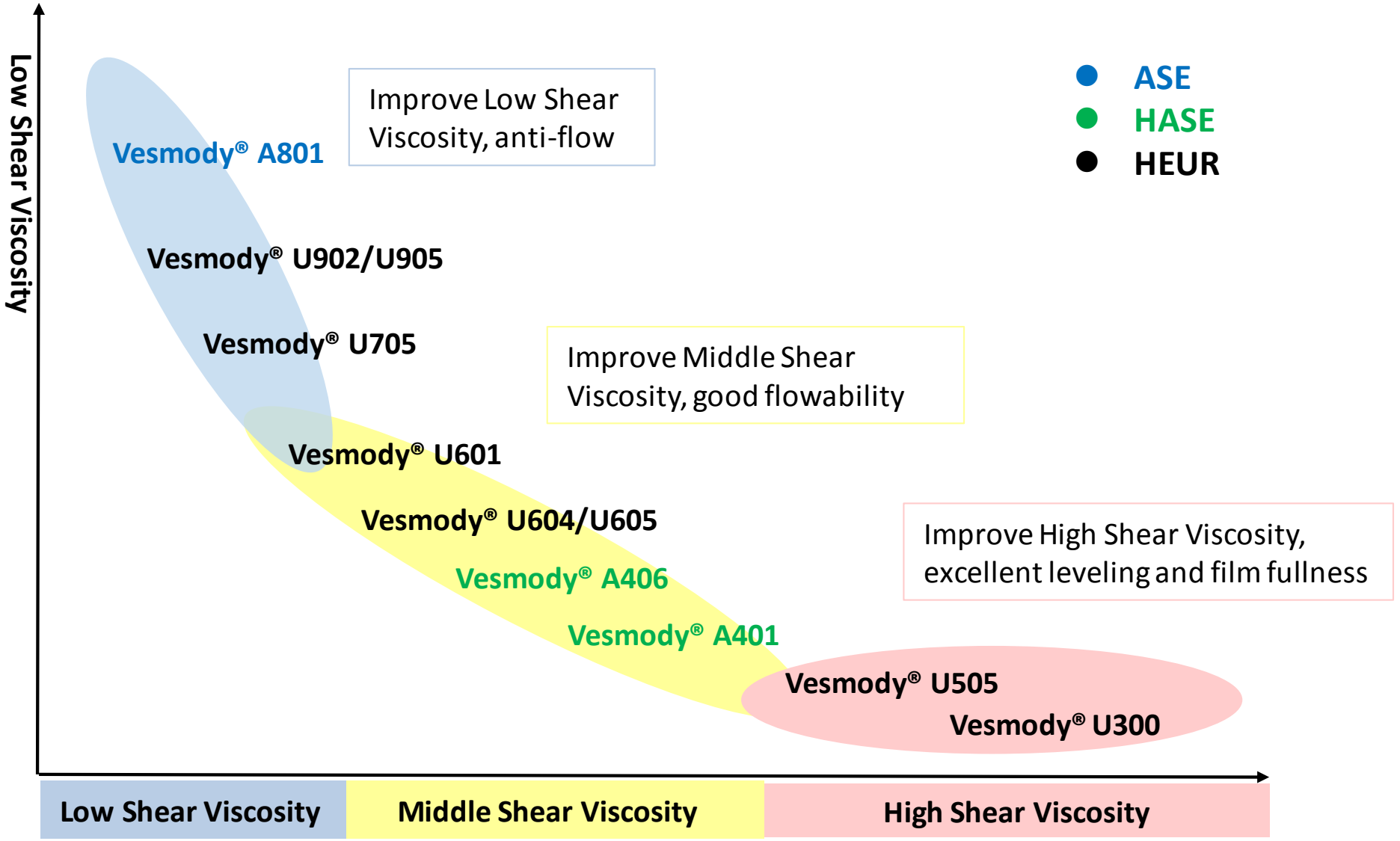
Polyether Modified Hardener for Adhesive Applications



Product	REACH	Solids (%)	Viscosity (mPa·s)	NCO	Features
Aquolin® 166	Y	100	700-1700	21.5-22.5	• Low viscosity, good water dispersibility, providing excellent heat/hydrolysis resistance
Aquolin® 161	Y	100	1500-3500	18.2-19.2	• Providing excellent heat/hydrolysis resistance

Rheology Modifier

Overview of Rheology Modifier



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