

vercet ™

COATINGS

CREATING PERFORMANCE THROUGH CHEMISTRY

Building upon decades spent advancing materials chemistry innovation, NatureWorks offers solutions based on lactides and lactide intermediates that help innovators within the coatings, adhesives, sealants, and elastomers (C.A.S.E.), toner and surfactant industries realize:



Significant, measurable product performance benefits

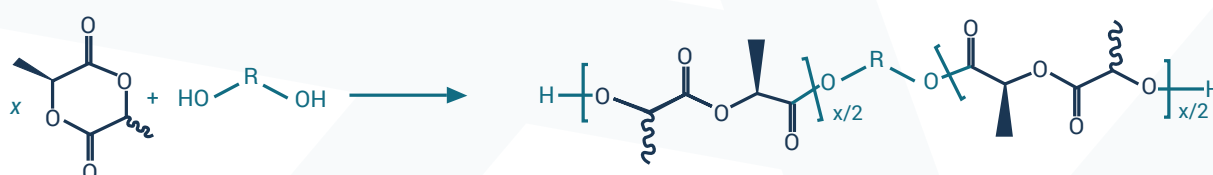


Move through the R&D process more efficiently and with minimal risk



Decrease systems costs via an optimized supply chain

VERSATILE VERCET LACTIDE CHEMISTRY

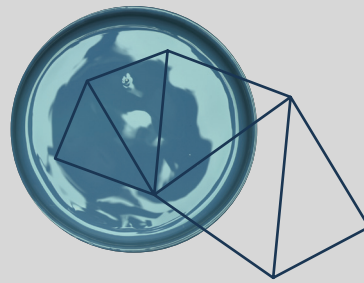


LACTIDE

- Reacts readily with alcohols, amines, glycols
- 100% solids
- No water loss
- Sustainably sourced

LACTIDE POLYOLS

- Tg ranges ~ 0-60°C
- Hydroxyl values 12-112 mg-KOH/g
- Secondary hydroxyl functionality
- Readily reacts with isocyanates
- Readily soluble in esters and ketones
- Renewably-sourced biobased polyols and resins



We achieve this by coupling tunable Vercet™ lactide-based chemistries with the knowledge of scientists and engineers who understand how to dial in the full capabilities of this versatile product line.

POLYOLS + RESINS

CUSTOM SOLUTIONS FOR COATINGS

Using Vercet polyester polyols for polyurethanes enables unique properties including excellent grease and oil resistance for coating applications.

VERCET COATINGS	
SUBSTRATES	MARKETS
Wood Metal Cements Ceramics	Furniture Flooring Architecture Decorative Nonwovens / hygiene Electronics Packaging- rigid & flexible
PERFORMANCE BENEFITS	
Excellent oil, grease, and solvent resistance High hardness polyurethanes Controlled functionality	Controlled viscosity (hydroxyl values 12-112 mg-KOH/g) Low haze Solvent-borne & hot melt coatings

VERCET POLYOLS FOR URETHANE COATINGS

Vercet polyols show compatibility with a variety of polyols such as 2000 molecular weight adipate-based polyols.

Vercet Grade	<i>f</i>	Tg (°C)	Viscosity @100°C (Pa*s)	OHV ¹ [mg-KOH/g]	Performance Features
P1025X	1	15	1.3	25	Chain stopper
P2025X	2	40	11.3	25	High modulus & hardness. Oil & grease resistance.
P2056X	2	25	2.1	56	
P20112X	2	5	<1.0	112	
P2225X	2	35	13	25	High modulus & hardness. Oil & grease resistance. Improves flexibility & toughness.
P2256X	2	21	2	56	
P22112X	2	-1	<1.0	112	
P3025X	3	40	19.1	25	Crosslinker

1. OHV-Hydroxyl Value as determined by ASTM E1899

MEASURABLE PERFORMANCE

POLYURETHANES FORMULATED WITH VERCET POLYOLS

Polyurethane with Polyol	Vercet P2025X	Control (Based on AA-HDO) ⁸
Wt% - Polyol / MDI ⁶ / 1,2 PDO ⁷	85.3/12.5/0.8	86.6/11.6/0.8
Polyol OHV ¹ [mg-KOH/g]	30	29
Gel Time [sec] 120°C	158	60
Hardness ² [Shore A / D]	84/71	70/33
Tg/Tm ³	Tg 51-55°C	Tm peak 55°C
Resiliency ⁴	17	23
Water Pickup ⁵	0.9%	0.6%

1. OHV – Hydroxyl Value as determined by ASTM E1899

2. Hardness as determined by ASTM 2240, 4 weeks

3. DSC mid-point, 20°C/min, 2nd heat

4. Resiliency as determined by ASTM D2632

5. Immersion testing, 8 days at 25°C

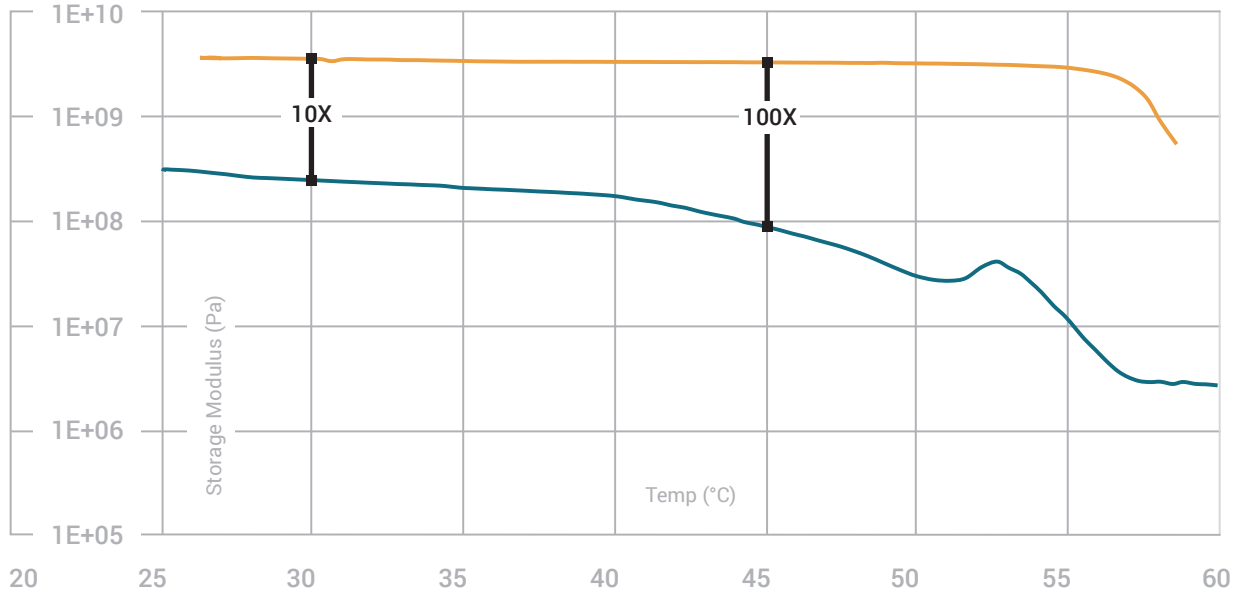
6. 4,4' - Methylene diphenyl diisocyanate

7. 1,2 - Propanediol

8. 1,6 - Hexanediol adipate

POLYURETHANE PERFORMANCE

HIGHER MODULUS CREATES HIGHER STRENGTH OVER EXTENDED TEMPERATURE RANGE

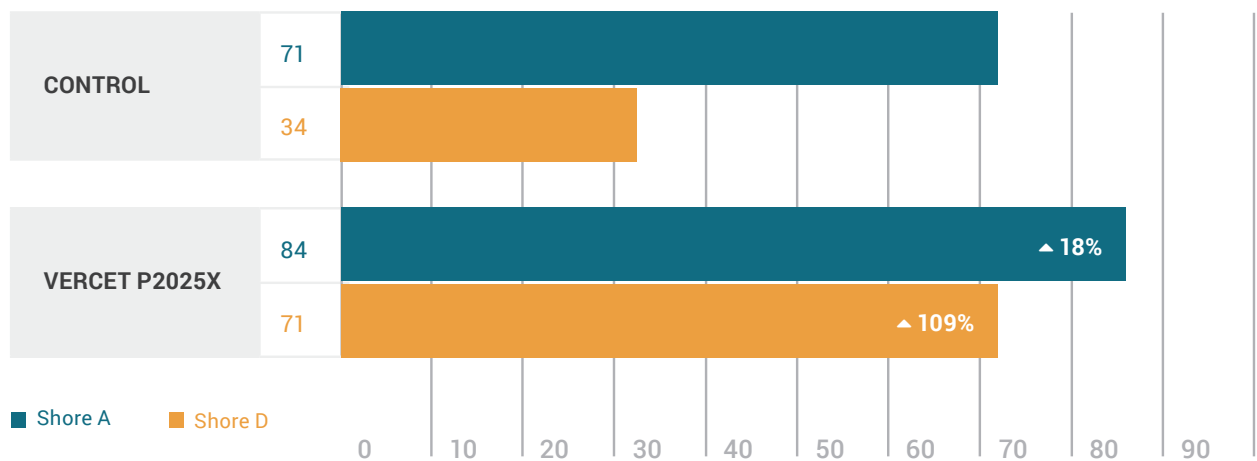


	Tg (°C, DSC)	Tg (°C, DMA)	E' (MPa, 30°C)	E' (MPa, 35°C)	E' (MPa, 45°C)	E' (MPa, 50°C)
CONTROL TPU	41-44 Tm (onset)		24	21	8.8	3.0
VERCET P2025X	49-52	56	347	331	321	315

ASTM Method D790. 3 point bend fixture heated 3°C per minute.

POLYURETHANE PERFORMANCE

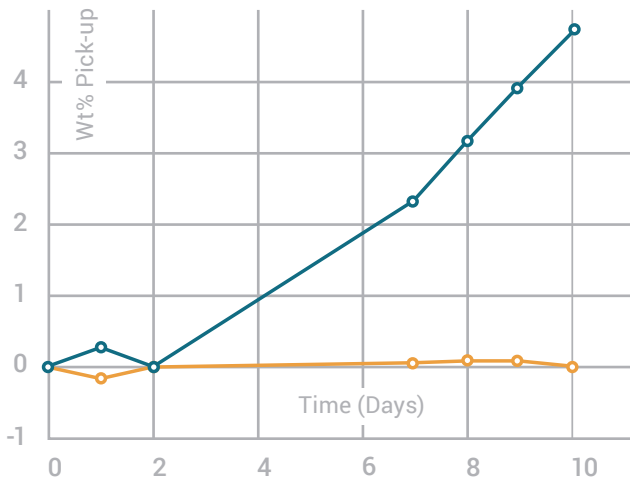
EXCELLENT HARDNESS AT LOW MDI CONTENT USES LESS ISOCYANATE



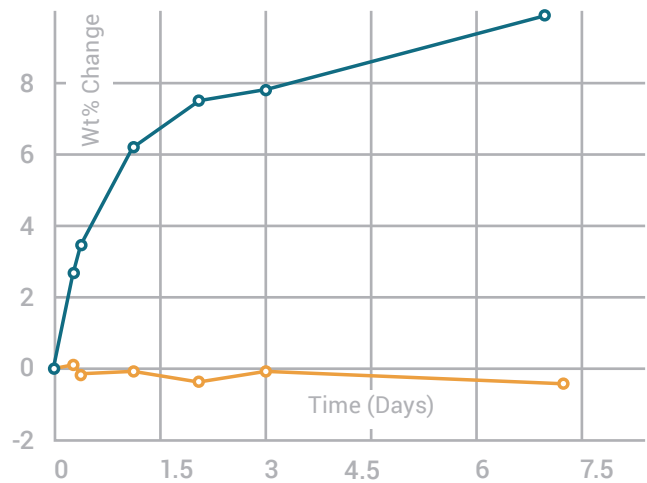
ASTM Method 2240. Measured after 4 weeks.

HOT OIL SWELL SHOWS EXCELLENT OIL RESISTANCE

WT% CANOLA OIL PICK-UP 68°C



WT% IRM 903 OIL PICK-UP 68°C

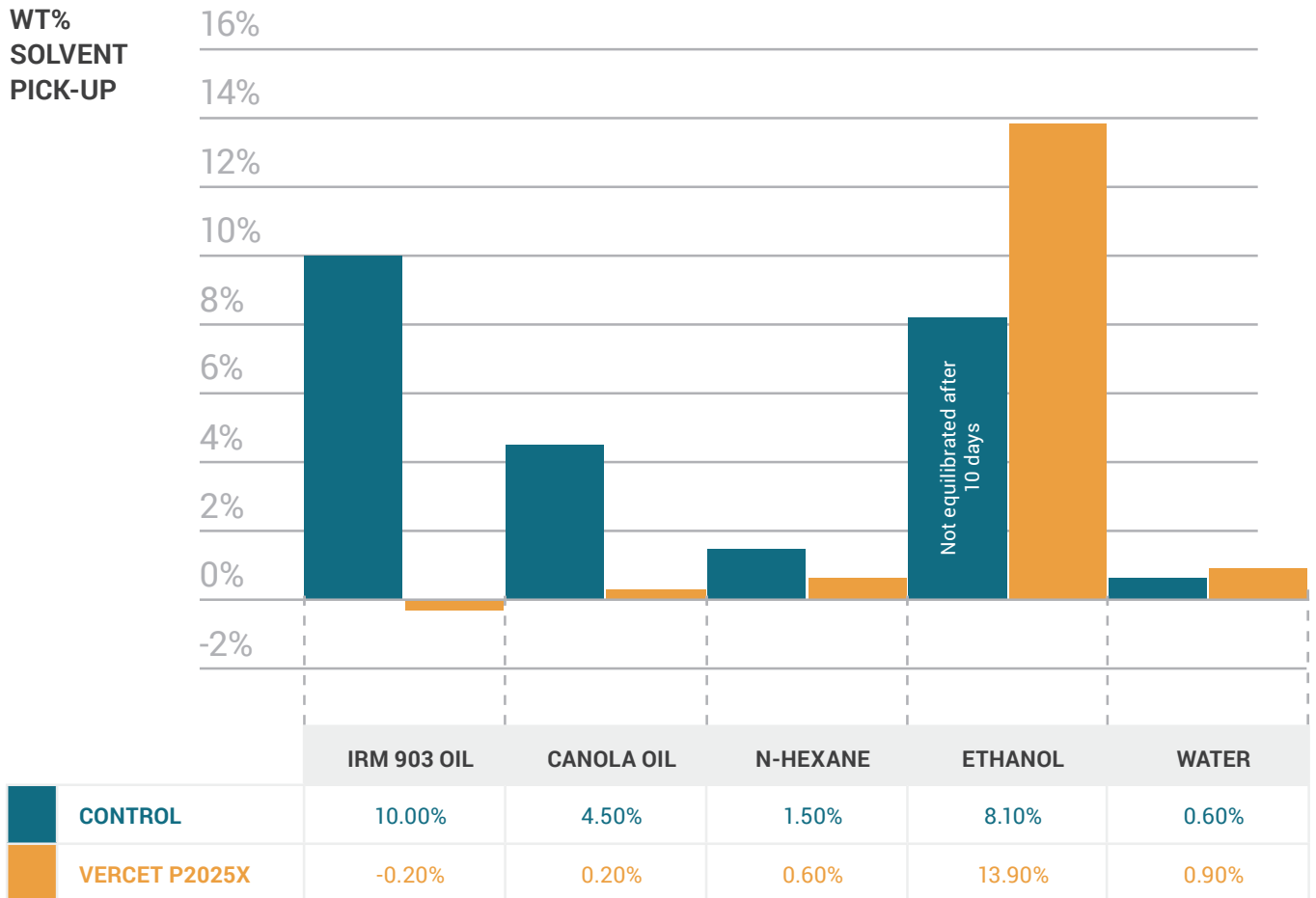


Vercet P2025X Control

MEASURABLE PERFORMANCE

VERCET-BASED POLYURETHANE SOLVENT RESISTANCE: 10 DAY SWELL VALUES

WT% SOLVENT PICK-UP



Wt% data collected 68°C

VERCET POLYOLS IN SOLVENTBORNE URETHANE COATINGS

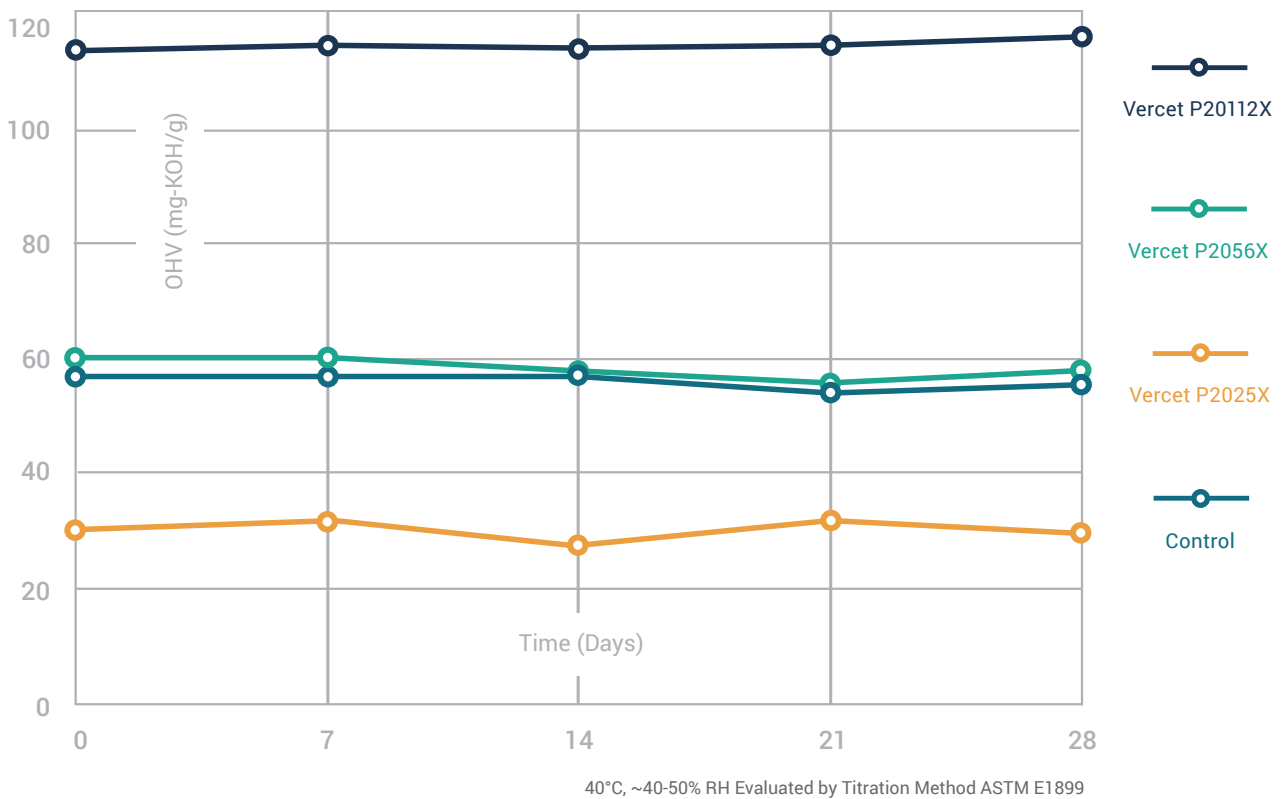
Excellent gloss, adhesion and hardness in urethane coatings.

Sample	60° Gloss	Cross-hatch Adhesion	Konig Hardness	Pencil Hardness	Weight % Solvent Swell Canola Oil @ 68°C
Vercet P2025X	95	5B (<5% removed)	73	2B	0.05
PU Control	40	1B (35-65% removed)	45	<8B	5.0
Uncoated Metal	83	NA	220	NA	NA

- Solvent borne TPU coated on metal Q panels
- Ethyl acetate ~20% solids, bar coated DFT ~30 um thick
- RT dried, no crosslinking reagent

VERCET POLYOL THERMAL STABILITY

No significant change to hydroxyl value after thermal aging.



VERCET RESINS FOR COATINGS

Vercet offers high polarity, amorphous PLA resins, customizable to a range of viscosities, as well as glass transition temperatures less than 20°C. Vercet resins are highly soluble with common solvents, enabling formulation flexibility. These bio-based resins offer good adhesion to metal and other polar substrates, high gloss, and greatly improve solvent/oil resistance.

Physical Properties ¹	Vercet Resin Grades ²					Method
	C1000X	C1010	C1020X ³	C1030X ³	C1050	
Specific Gravity	1.21-1.24					ASTM D792
Tg-Range (°C)	48-56	54-57	48-56	48-56	54-57	
Melt Flow Index (g/10min)	80 @ 150°C	10 @ 180°C	450 @ 150°C	600 @ 150°C	10 @ 210°C	ASTM D1238
Brookfield Viscosity Pa* sec	120°C		350-370	20-40	NM	NW Internal Brookfield Method (#27 spindle)
	150°C	140-160	30-40		NM	
	180°C	20-40			NM	
	200°C		310-340		NM	
Solution Viscosity ⁵						
15% solids	16	284	7	2	>680 ^{6,7}	NW Internal Method ISO 4 Cup Measured at ~21°C
30% solids	136	NM	54	19	NM	
Approx. solubility in ethyl acetate (wt%)	+++	++	+++	+++	++	+++ - >50 wt% ++ - 25-50 wt% + - 5-25 wt%
Approx. solubility in butyl acetate (wt%)	+	+	+	+	+	
Approx. solubility in acetone (wt%)	++	++	++	++	++	
Approx. solubility in MEK (wt%)	+++	+	+++	+++	++	
Approx. solubility in toluene (wt%)	+++	+	+++	+++	++	
Coating Properties on Metal (DFT=>25um, not cross linked)						
	C1000X	C1010	C1020X ³	C1030X ³	C1050	
X-Hatch Adhesion	0B (>65% removed)	4B (<5% removed)	2B (15-35% removed)	2B (15-35% removed)	5B (0% removed)	ASTM D3359
Pendulum Hardness (s)	162	218	241	236	98	ASTM D4366
Pencil Hardness	4B	2B/3B	HB/3B	3B	HB	ASTM D3363
Gloss 20°	59	25	65	73	6	ASTM D523
Gloss 60°	91	73	89	95	20	

1. Typical properties; not to be construed as specifications.

2. "X" suffix denotes experimental grade resin

3. Pellets of C1030X and C1020X may cold flow due to its low viscosity and could require additional handling.

4. "NM" not measured at conditions shown

5. Ethyl acetate, cSt

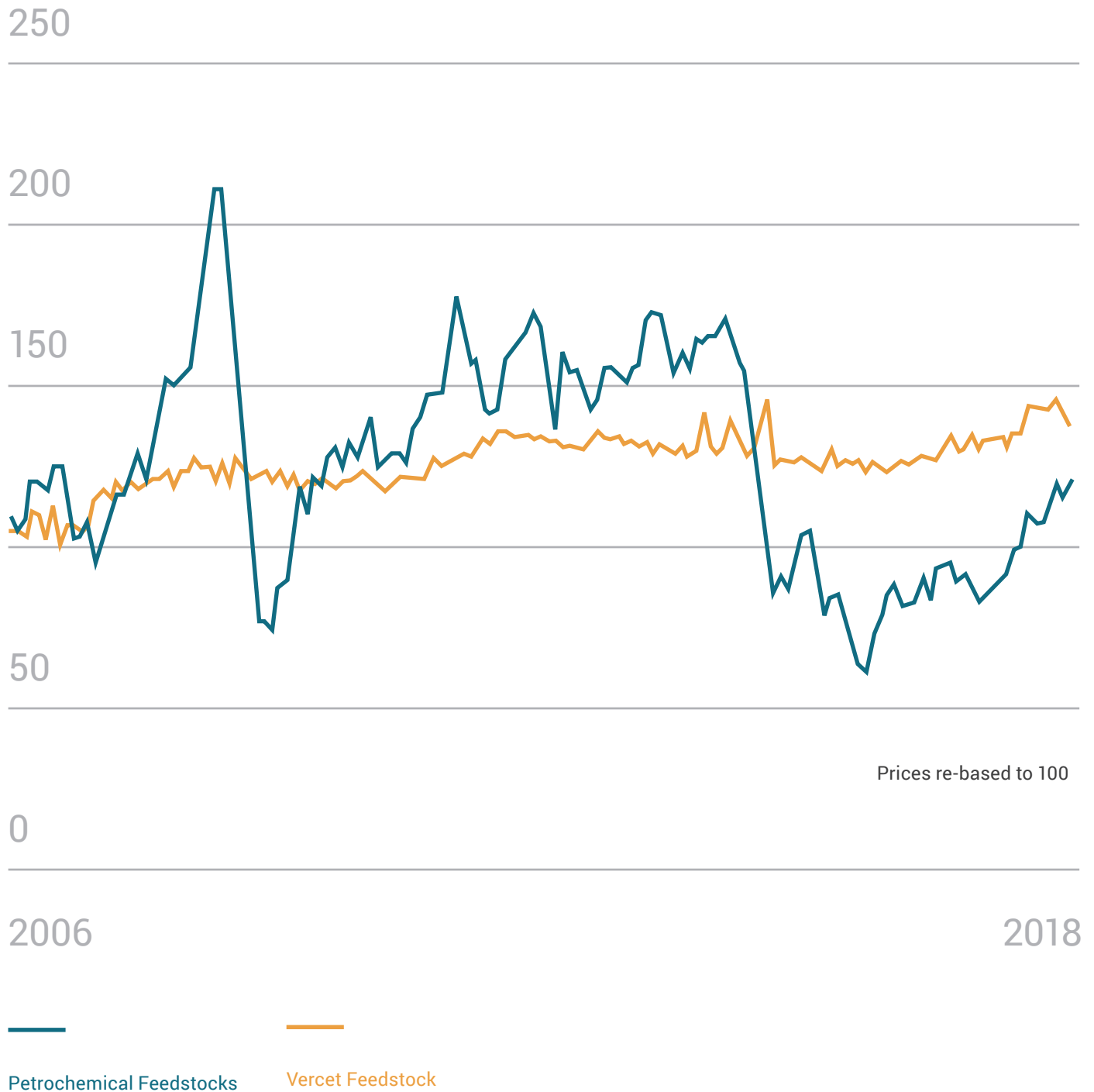
6. ISO 6 DIN Cup

7. Maximum viscosity range for ISO Viscosity Cup 6

BENIGN BY DESIGN

REDUCING VOLATILITY IN PRICING THROUGH ALTERNATIVE FEEDSTOCKS

Renewably-sourced Vercet lactide-based products bring sensible, elegant, and cost-effective solutions based squarely on the principles of green chemistry to supply chains that, until now, were coupled with traditional fossil-petroleum solutions and their inherent price volatility.





HOW CAN WE HELP YOU?

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To learn more about Vercet custom solutions, please contact a member of our Performance Chemicals team.

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