Lubrizol

Ingredients for Household and I&I Applications

noveon® Consumer Specialties

Noveon® Consumer Specialties

Rheology Modifiers for Surface Care

June 2010

Formulate with Confidence™

Agenda

- Introduction
- Rheology for Hard Surface
- Benefits and Characteristics of Rheology Modifiers
- Review of Applications of Flow Control
- Summary

Lubrizol Rheology Modifiers for Surface Care

- **Improve vertical cling with shear-thinning rheology for:**
  - Minimized dripping on surface and spray nozzle
  - Increased contact time and cleaning effectiveness
  - Controlled misting in spray systems
- **Improve ingredient compatibility**
  - Suspension of insolubles
  - Emulsification
- **Provide stabilization**
- **Are highly efficient**
- **Applications: A wide range of products from gels to pump spray liquids**

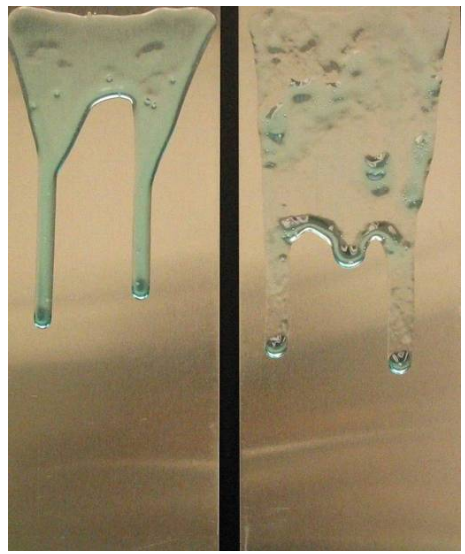
Flow control allows for consumer convenience

Impact of Flow in Cleaning of Vertical Surfaces

- Control dripping or running of product down the substrate to allow time for effective cleaning and wiping
- Lubrizol rheology modifiers:
  - Impart shear-thinning properties for ease of pumping a spray
  - Have minimal thixotropy so rapid polymer recovery allows for the sprayed material to adhere and be held on the substrate

Sprayability

Smooth Flow and Leveling



Thickened with Carbopol® EZ-4 polymer

Thickened with Xanthan Gum

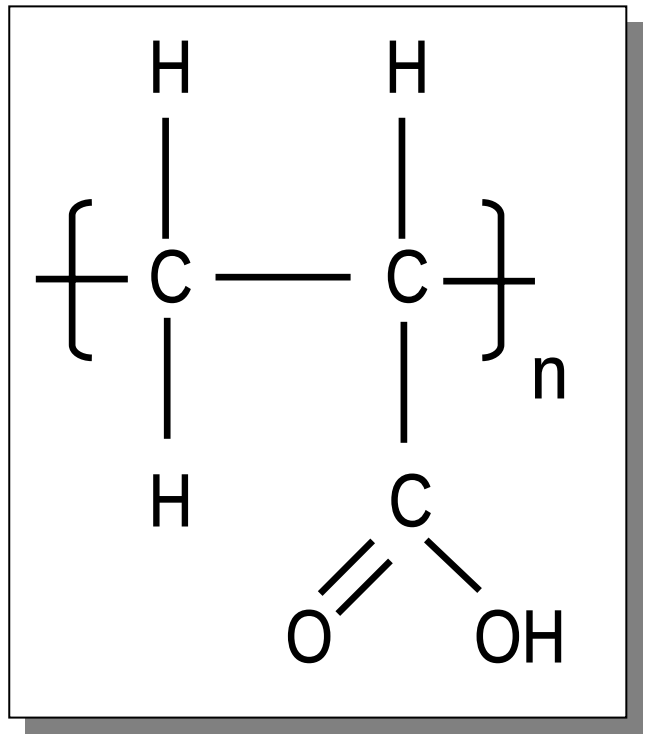
Flow control for pump sprays

Rheology Basics

- Carbopol® polymers exhibit both viscous and elastic flow properties
- Rheology characterization consists of various methods
- Dynamic rheology is a useful tool in characterizing both the viscous and elastic components of microgel forming polymers
- Characterization in the formulation is important to predict application performance

Powdered Carbopol® Polymers

- Rheology Modifiers
- Poly(acrylic acid) polymers
  - High molecular weight
  - Crosslinked



Particle Nature of Carbopol® Polymers

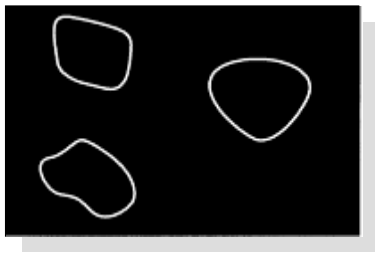
- “Agglomerate” Particle Size

  Average 2-7 microns

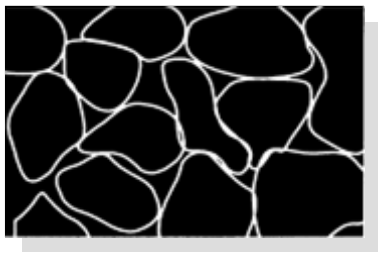
- "Primary" Particle Size
  - Smallest = 0.046 micron
  - Largest = 0.280 micron
  - Average = 0.200 micron

Photomicrograph 20,000X

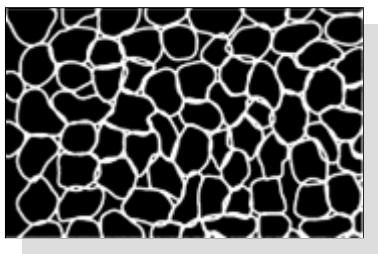
Microgel Thickening Mechanism Model



→ Dilute:
Particles are swollen to equilibrium (c < c*)



→ Transition Regime:
Particles are swollen to equilibrium (c = c*)

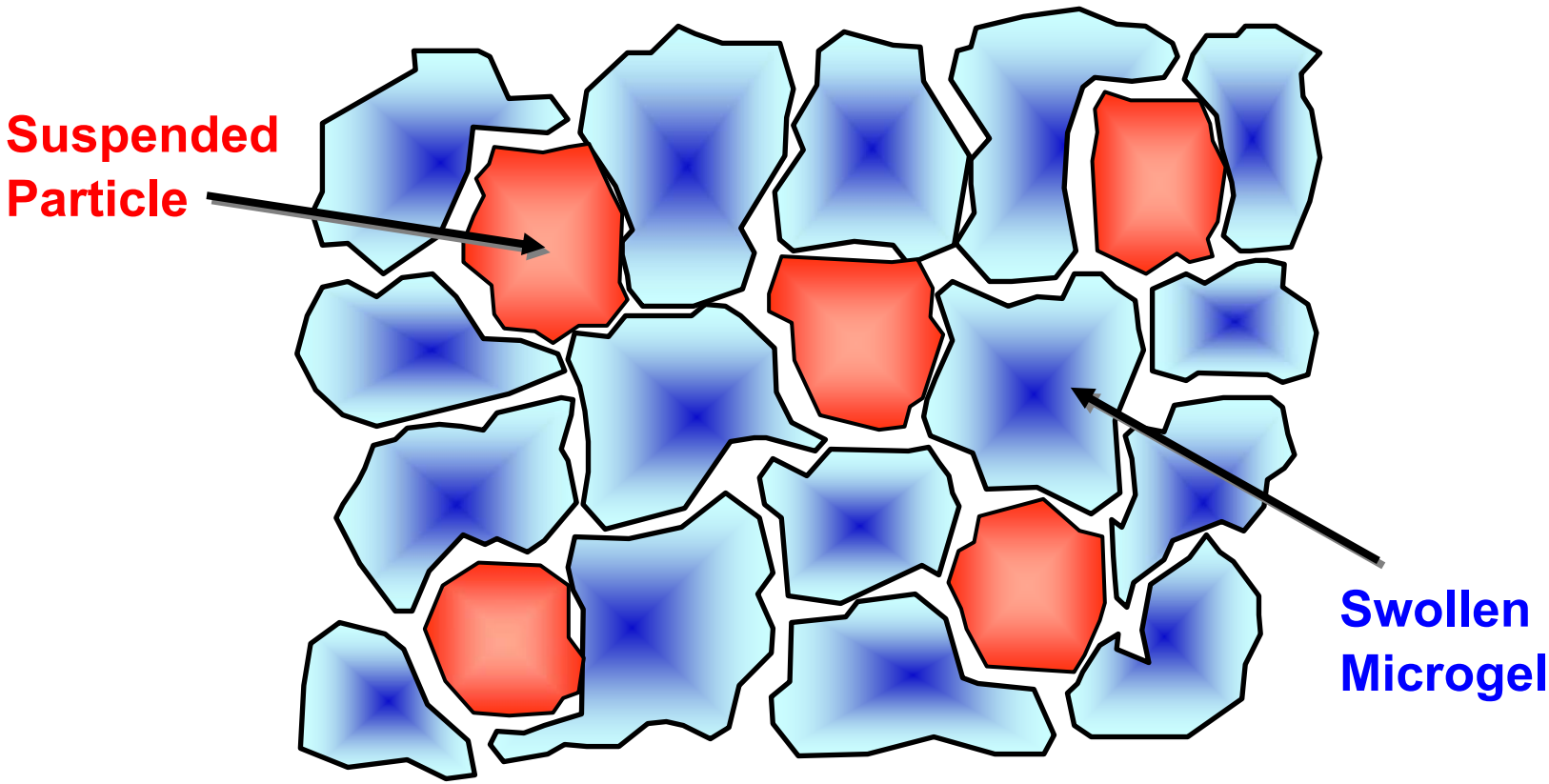


→ Concentrated:
Particles are swollen to less than equilibrium (c > c*)

c = Concentration of Carbopol® Polymer
c* = Critical overlap concentration

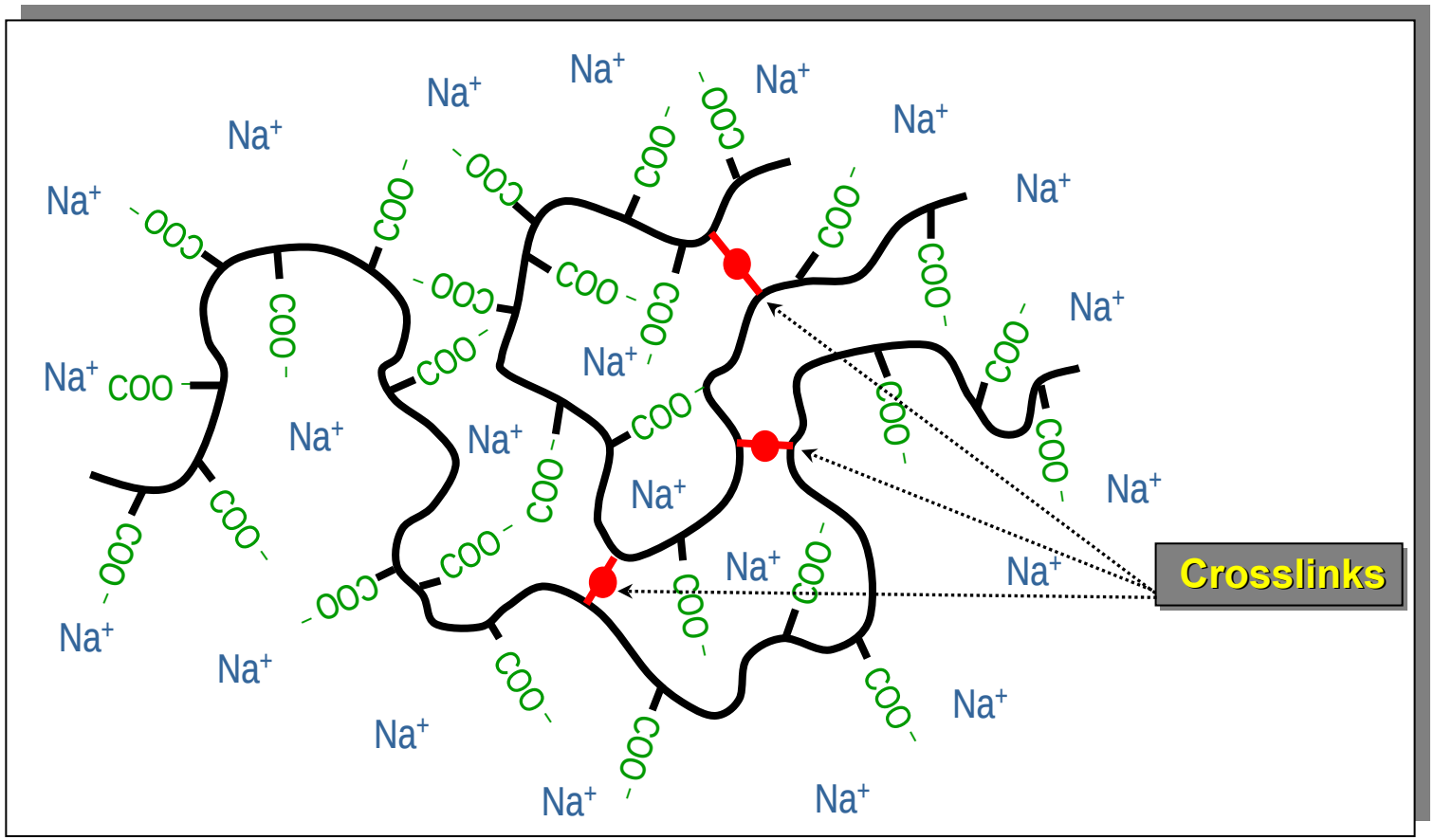
Carbopol® polymers swell when neutralized to ~1000x their initial volume

Suspension of Particles in a Gel of Carbopol® Polymer



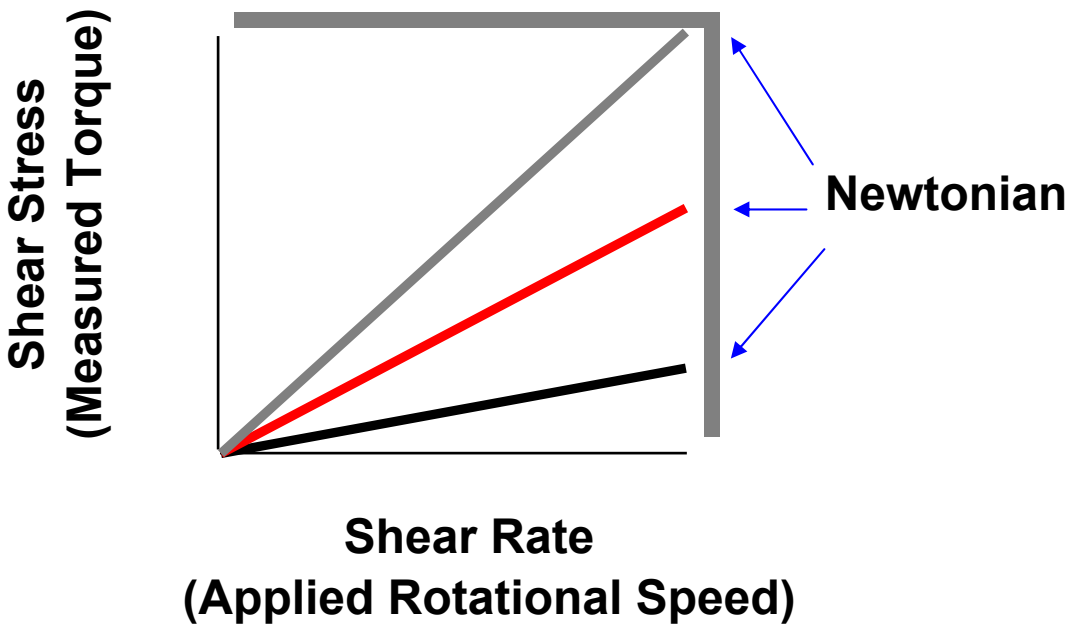
Carbopol® polymers provide 3-D gel matrix

Neutralized Carbopol® Polymer



Carbopol® polymers thicken through space filling and hydrogen bonding

Newtonian Flow Properties



$$\text{Viscosity} = \frac{\text{shear stress}}{\text{shear rate}}$$

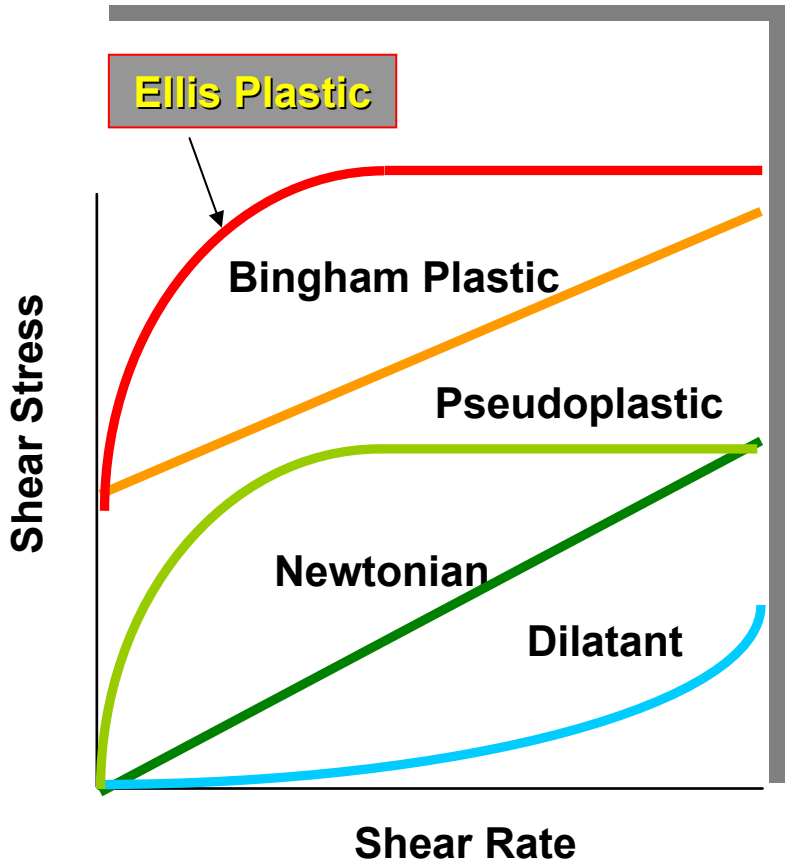
Viscosity units:

MilliPascal seconds (mPa·s)

(or) Centipoise (cP)

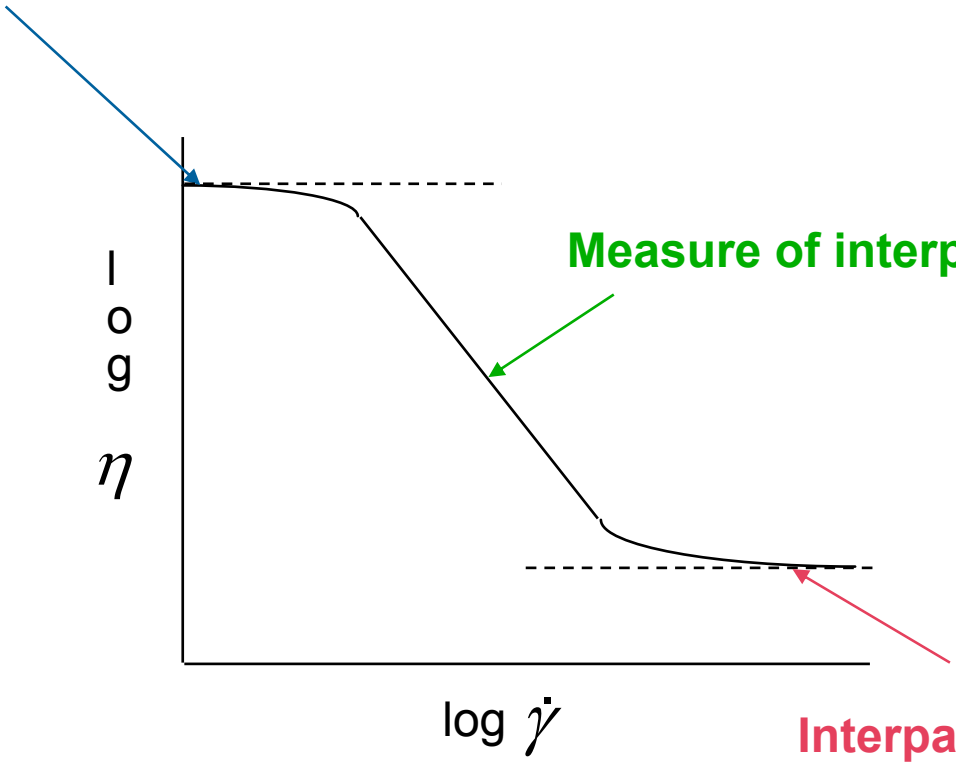
Rheology of Non-Newtonian Fluids

- Non-Newtonian fluids display different types of shear stress behavior with shear rate
- Formulations containing Carbopol® polymer exhibit **Ellis Plastic** behavior - such systems have yield value and are shear-thinning



Rheology Basics: Viscosity

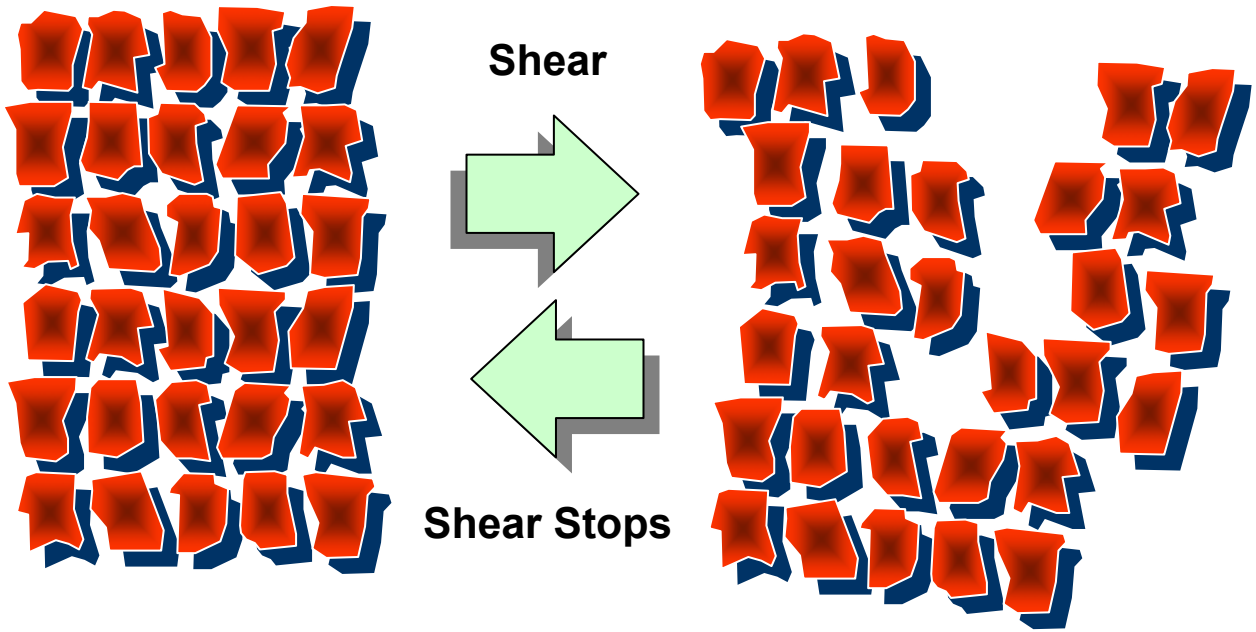
First Newtonian Plateau is fixed by the volume fraction



Measure of interparticle attractive forces

Interparticle attractive forces are overcome. Second Newtonian Plateau

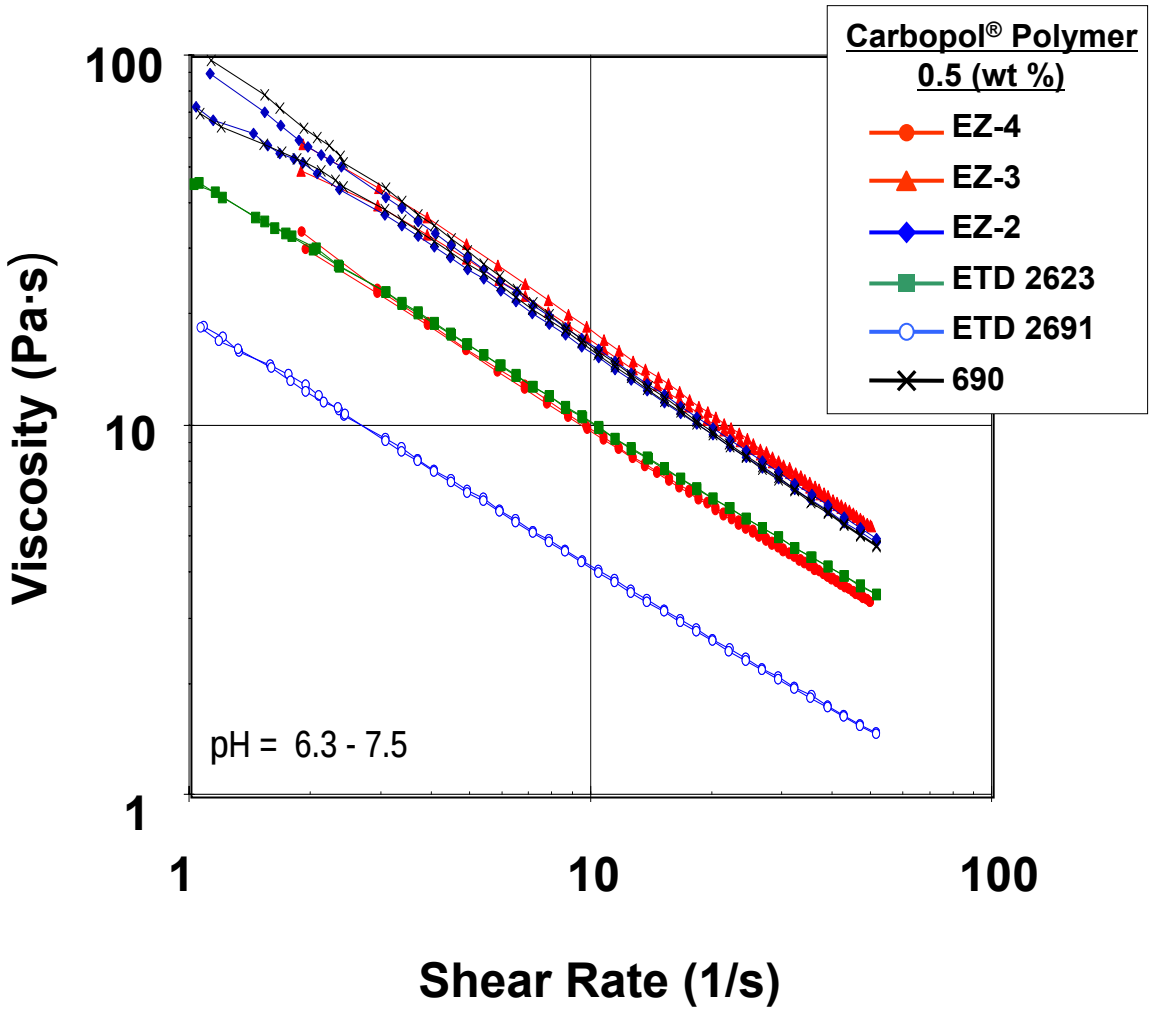
Shear-Thinning Nature of Gels Thickened with Lubrizol Rheology Modifiers



- After shear stops, the original high viscosity is recovered quickly
- Systems are viscoelastic
- Product can be a gel in the bottle, but will easily spray though a pump spray

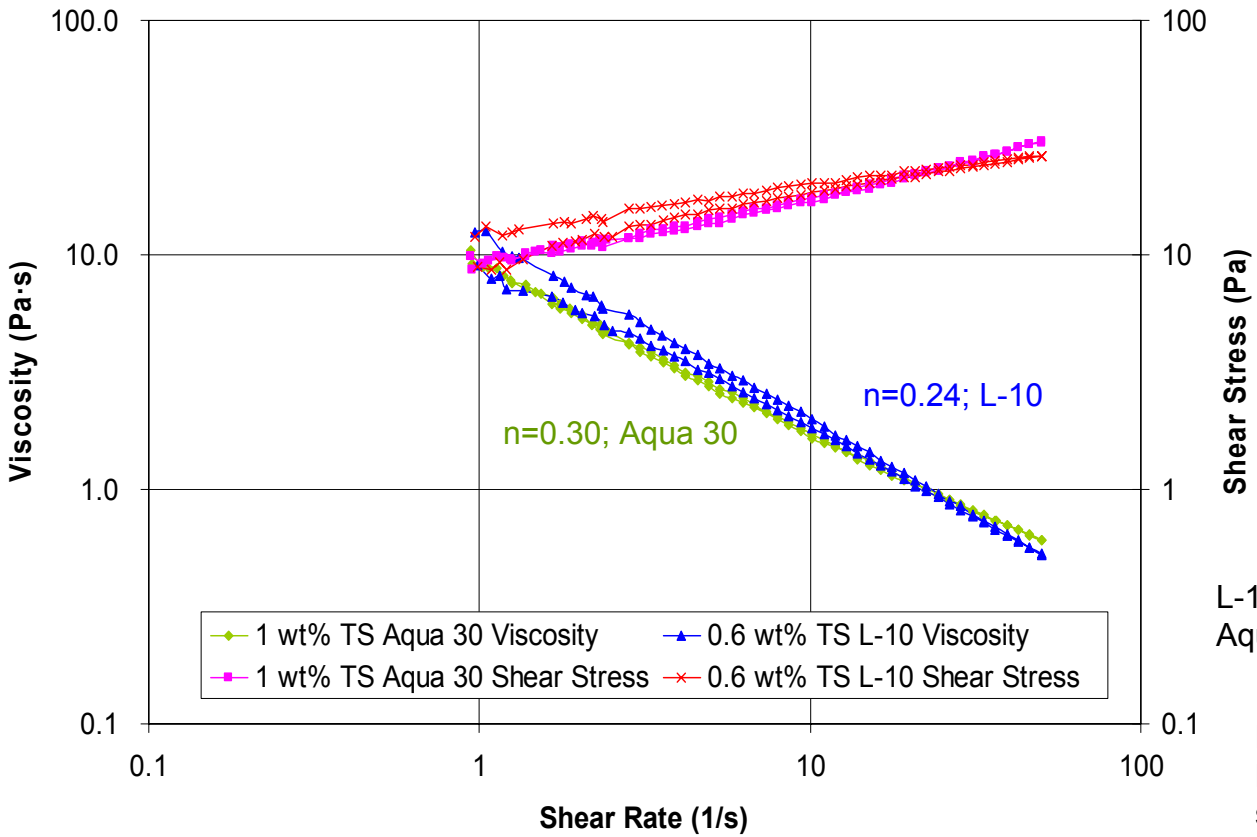
Shear-Thinning Nature of Gels of Carbopol® Polymers

- **High apparent viscosity at rest**
  - "Stays put"
- **Low viscosity under stress**
  - Easy pumping, spraying, and spreading



Mucilage Rheograms

Novethix™ L-10 Polymer and Carbopol® Aqua 30 Polymer



$$\eta = K\,\dot{\gamma}^{n-1}$$

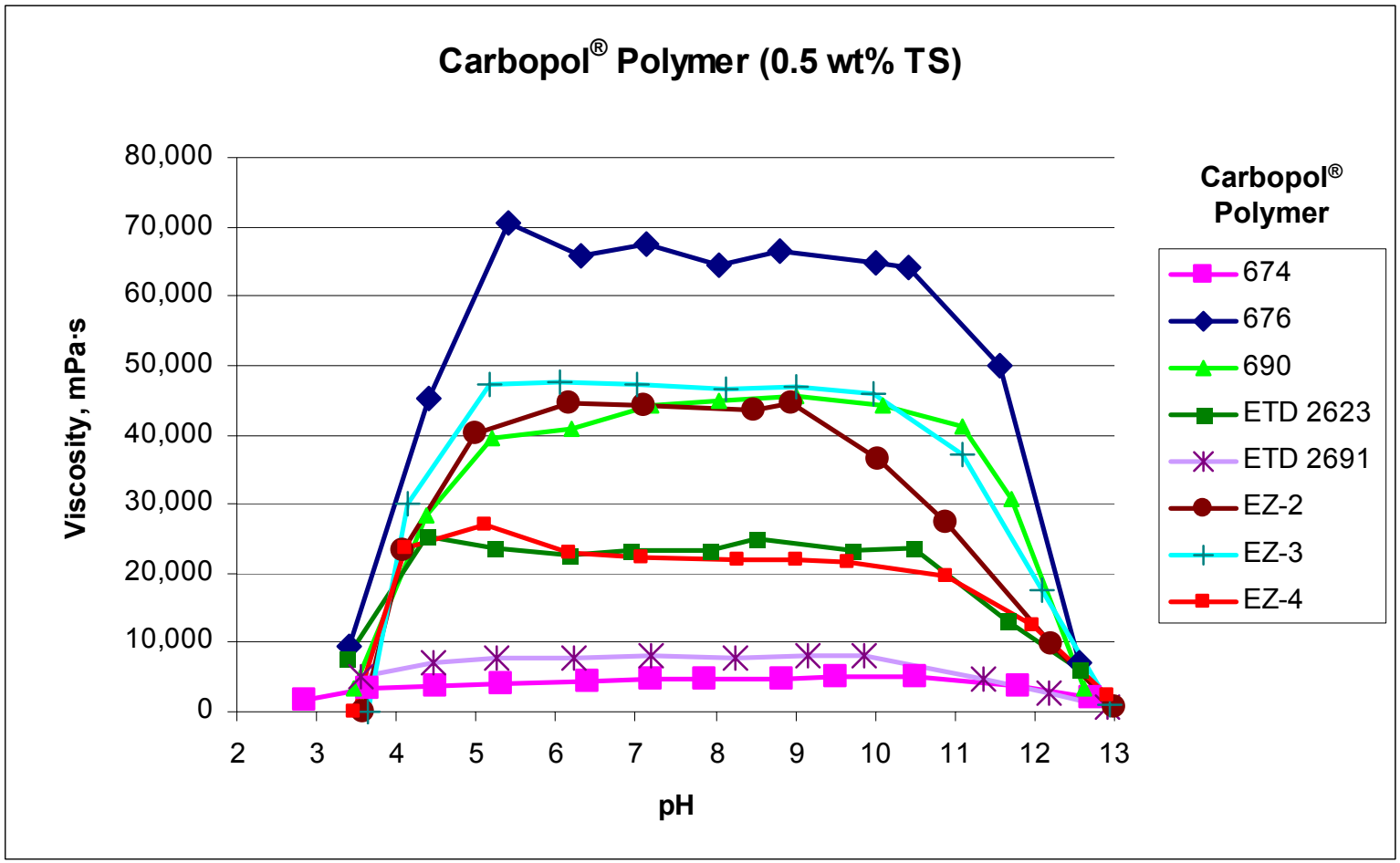
* n = power law index

L-10 = Novethix™ L-10 Polymer
Aqua 30 = Carbopol® Aqua 30Polymer

Neutralizer: NaOH
Brookfield RVT viscometer, 20 rpm, spindle #4, 23° C

Novethix™ L-10 polymer has excellent shear-thinning performance providing good pourability

Performance of Carbopol® Polymers vs. pH



Carbopol® polymers give a variety of performances, especially at alkaline pH

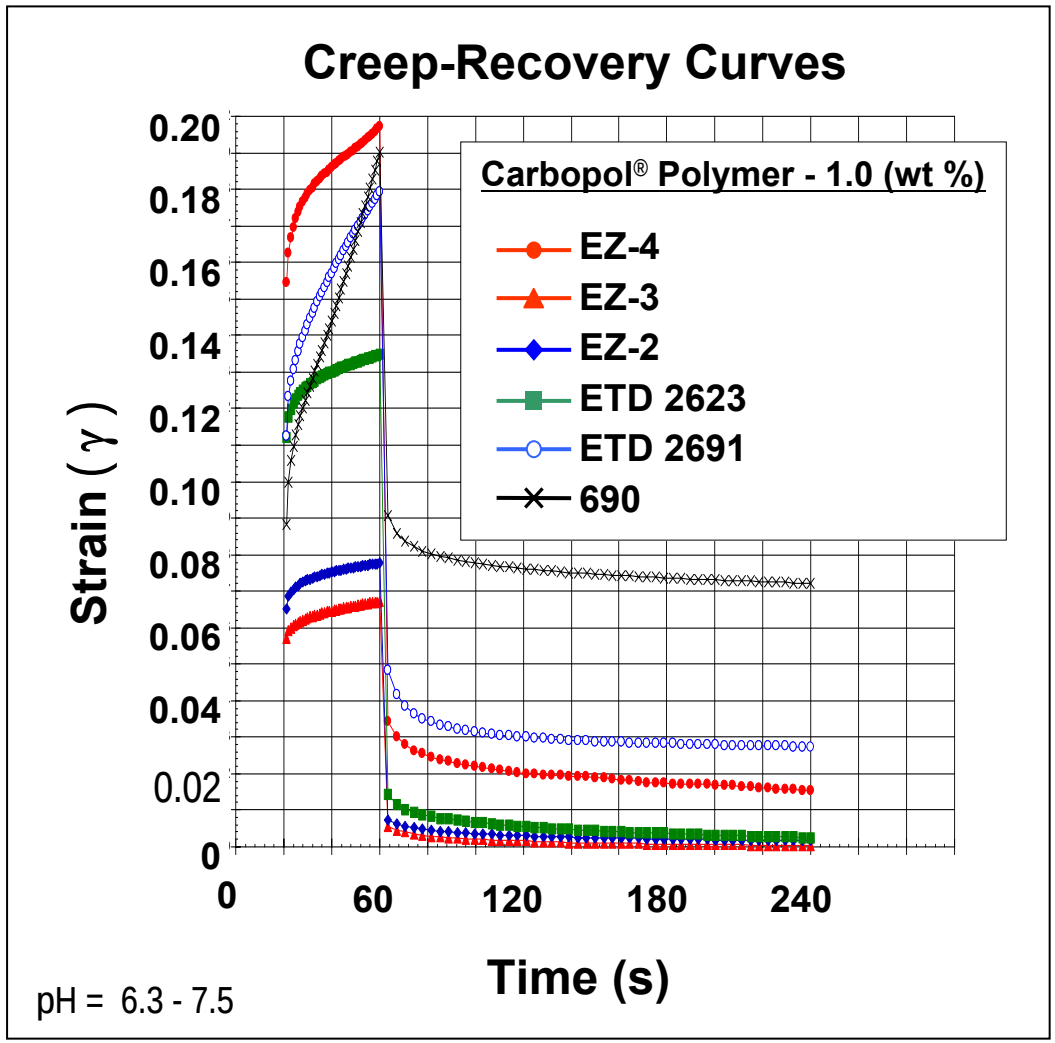
Rigidity of Microgels - Carbopol® Polymers

METHOD:

Creep test using computerized rheometer

Strain (γ) as a function of Time: the area under curve

Carbopol® Polymer	Shear Stress (Pa)
EZ-4	60
EZ-3	50
EZ-2	15
ETD 2623	50
ETD 2691	5
690	25



Lubrizol

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noveon®
Consumer Specialties

Surface Care Applications

Formulate with Confidence™

Lubrizol Products For Surface Care Applications

		Standard Hard Surface Cleaners	Scouring Hard Surface Cleaners	Chlorine Bleach Hard Surface Cleaners	Chlorine Bleach Toilet Bowl Cleaners	Oven Cleaners	Window and Glass Cleaners	Polishes
Traditional Carbopol® Polymers	674	•	•	•	•	•	•	
	676	•	•	•	•	•		
	690	•	•	•	•	•		
Easy to Disperse Carbopol® Polymers	ETD 2623	•	•			•	•	
	ETD 2691	•	•			•	•	
Self-Wetting Carbopol® Polymers	EZ-2							•
	EZ-3	•	•			•		•
	EZ-4	•	•			•	•	•
Liquid Novethix™ L-10 Polymer	L-10	•				•	•	
Liquid Carbopol® Polymer	Aqua 30	•	•				•	
Pemulen™ Polymers	1621							•
	1622							•
Novemer™ EC-1 Polymer	EC-1							•

Hard Surface "Sanitizing" Cleaners

Properties provided by products of Noveon® Consumer Specialties

Hard surface "sanitizing cleaners are not intended to handle heavy dirt and grease, but to provide some "sanitizing" cleaning of a surface. Generally, these products are expected to clean without rinsing and result in a streak-free shine with anti-bacterial performance.

- **Suitable rheology for spray applications**
- **Reduced misting for improved product application and consumer safety**
- **Increased contact time on vertical surfaces**
- **Classifications**
  - Anti-bacterial
  - Sanitizing
  - Disinfecting

Alcohol Sanitizing Gel for Surfaces

H-HS-0021 LA

Carbopol® EZ-2 polymer imparts vertical cling and increased contact time for this sanitizer formulation. In addition, the rheology modifier provides appropriate flow properties for either spray or squeeze bottle packaging. These features increase the performance of the formulation and provide convenience to the consumer.

	Chemical Name *Trade Name*	Weight %	Function
1.	Deionized Water	29.55	Diluent
2.	**Crosslinked Acrylic Acid Homopolymer** ***Carbopol® EZ-2 Polymer***	***0.35***	***Rheology Modifier***
3.	Ethanol	70.00	Sanitizer
4.	2-amino-1-propanol, *AMP-Ultra™*	0.10	Neutralizing Agent

Product Properties:

Appearance	Clear
Viscosity** (mPa·s)	7,500-9,000
pH	7.0-8.0

***Brookfield RVT @ 20 rpm 25° C, #5 spindle*

Hard Surface Cleaner with Triclosan

H-HS-0026A

Carbopol® EZ-4 polymer provides excellent flow modification in this surface cleaner. The polymer will control the spray mist and provides vertical cling, maximizing the surface contact for improved performance.

	Chemical Name *Trade Name*	Weight %	Function
1.	Deionized Water	62.85	Diluent
2.	**Crosslinked Acrylic Acid Copolymer** ***Carbopol® EZ-4 Polymer***	**0.15**	**Rheology Modifier**
3.	Ethanol	30.00	Drying agent
4.	Triclosan	0.30	Anti-Bacterial Agent
5.	$C_{12\text{-}15}$ Alcohol Ethoxylate 5 EO, *Tomadol® 25-5*	3.00	Nonionic Surfactant
6.	Triethanolamine (99%)	0.20	Neutralizer
7.	**Lauramine Oxide,** ***Chemoxide™ LO Surfactant***	**3.50**	**Surfactant**

Product Properties:

Appearance	Clear
Viscosity* (mPa·s)	2,000-3,000
pH	7.0-8.0

**Brookfield RVT @ 20 rpm 25° C, #4 spindle*

Light Duty Hard Surface Cleaners

Properties provided by products of Noveon® Consumer Specialties

Light duty hard surface cleaners are not intended to handle heavy dirt and grease, but only to remove light loads of dirt and oil films on surfaces that are already fairly clean. Generally, these products are expected to clean without rinsing and result in a streak-free shine.

- **Suitable rheology for spray applications**
- **Reduced misting for improved product application and consumer safety**
- **Increased contact time on vertical surfaces**

Streak Free "No-Drip" Window Cleaner

H-HS-0027

Novethix™ L-10 polymer is an excellent structuring agent especially providing vertical cling in systems with very low viscosity. The polymer provides the ability to provide vertical cling in a pump spray formulation. The polymer enhances the cleaning function of the system allowing to formulate at very low surfactant levels. The system provides good performance with no streaking and good sprayability.

	Chemical Name *Trade Name*	Weight %	Function
1.	Deionized Water	96.43	Diluent
2.	**Acrylic Emulsion Polymer** ***Novethix™ L-10 Polymer*** ***(30 wt% TS)***	***0.35***	***Rheology Modifier***
3.	Isopropanol	2.00	Solvent/Degreaser
4.	*Dowanol® PM*	1.00	Solvent/Degreaser
5.	Sodium Hydroxide (25%)	0.07	Neutralizer
6.	Sodium Alkylbenzene Sulfonate *Biosoft® D40 (38.5%)*	0.05	Surfactant
7.	**Lauramine Oxide,** ***Chemoxide™ LO Surfactant***	***0.05***	***Surfactant***
8..	*Kathon® CG*	0.05	Preservative

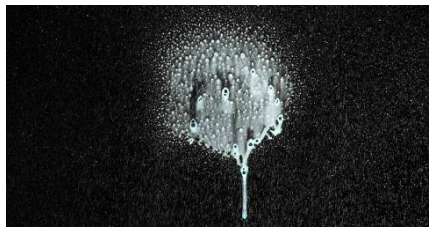
Product Properties:

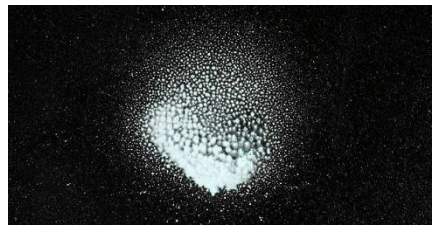
Appearance	Clear
Viscosity** (mPa·s)	10-20
Turbidity	5-20
Transmittance	90+
pH	7.5-8.5

***Brookfield RVT @ 20 rpm 25° C, #2 spindle*

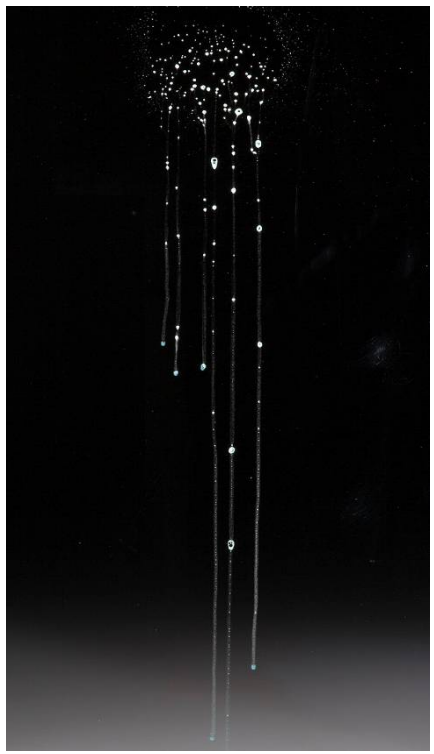
Vertical Cling Performance – Window Cleaner

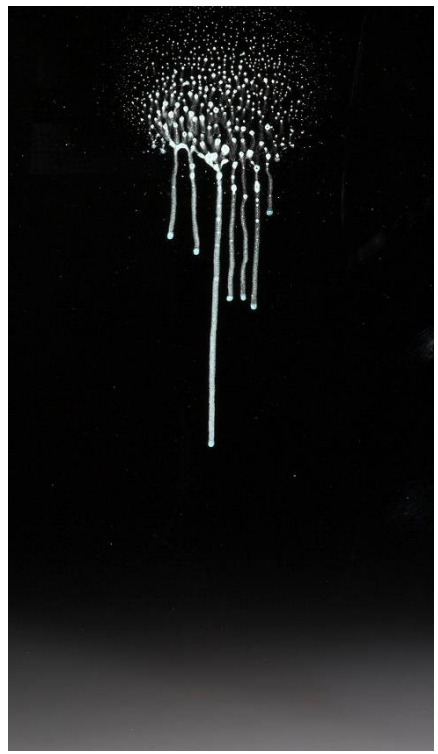
Initial





30 sec





Without Novethix™ L-10 Polymer

With Novethix™ L-10 Polymer

General Purpose Spray and Wipe Cleaner

H-HS-0024

Carbopol® EZ-4 polymer is an efficient rheology modifier designed to work well in surfactant systems and has good solvent compatibility. The formulation has good shear-thinning rheology. It can be used with a pump spray, providing good vertical cling and good surface contact time. Once applied, the rheology will allow easy wipe-up of surface being cleaned. These features increase the performance of the formulation and provide product appeal to the consumer.

	Chemical Name *Trade Name*	Weight %	Function
1.	Deionized Water	93.10	Diluent
2.	**Crosslinked Acrylic Acid Copolymer** ***Carbopol®* EZ-4 Polymer***	***0.15***	***Rheology Modifier***
3.	Alkylbenzene Sulfonic Acid, *Biosoft® D101 (97 wt%)*	0.25	Anionic Surfactant
4.	$C_{12\text{-}15}$ Alcohol Ethoxylate 8-9 EO, *Tomadol® 25-9 (100 wt% TS)*	1.00	Nonionic Surfactant
5.	*Dowanol® PM*	4.00	Degreaser
6.	Isopropanol	1.00	Hydrotrope
7.	Sodium Hydroxide (50%)	0.20	Neutralizer
8.	Methylisothiazolinone *Neolone™ PE*	0.30	Preservative

Product Properties:

Appearance	Clear
Viscosity** (mPa·s)	100-300
pH	8.0-9.0

***Brookfield RVT @ 20 rpm 25° C, #2 spindle*

Multi-Purpose Cleaning Spray

H-HS-0018 LA

This formulation demonstrates the benefits of the **Novethix™ L-10 polymer** in a multi-purpose cleaning pump spray. The system is designed to leave no streaks of residue on surfaces. The polymer provides efficient thickening with shear-thinning rheology ideally suited for non-aerosol spray applications. It imparts vertical cling and has controlled spray, reducing misting on product delivery.

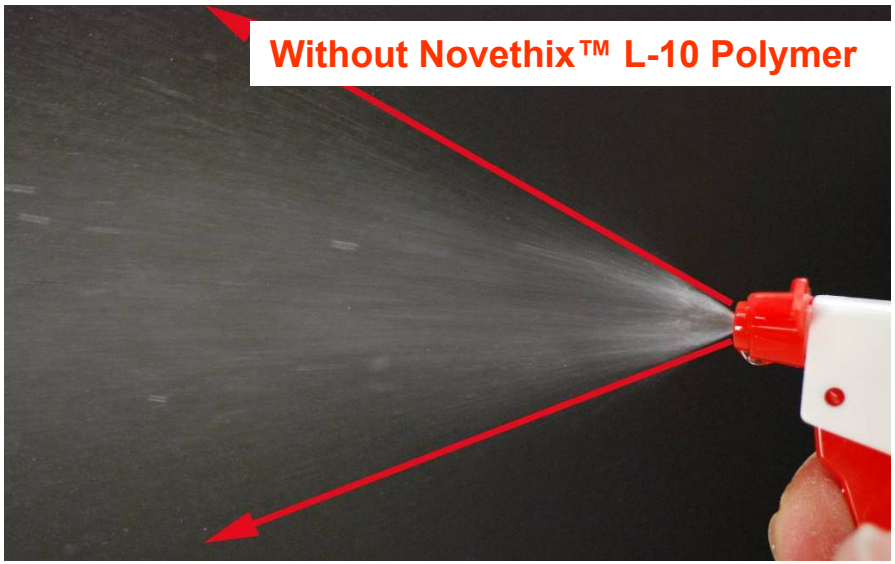
	Chemical Name *Trade Name*	Weight %	Function
1.	Deionized Water	88.55	Diluent
2.	**Acrylic Emulsion Polymer** ***Novethix™ L-10 Polymer* (30 wt% TS)**	***1.00***	***Rheology Modifier***
3.	Triethanolamine	1.00	Neutralizer
4.	Myristylamine Oxide (25 wt% TS) *Ammonyx® MO*	4.00	Surfactant
5.	Lauryl Alcohol 9-EO *Ultrol™* (100 wt% TS)	1.50	Surfactant
6.	Ethanol	3.00	Solvent/ Solubilizer
7.	Sodium Ethylenediamine Tetra Acetic Acid	0.50	Chelating Agent
8.	Methylisothiazolinone *Neolone™ PE*	0.05	Preservative
9.	Lavender Fragrance	0.25	Fragrance
10.	FD&C Blue No. 1 (0.1 wt% TS)	0.15	Dye

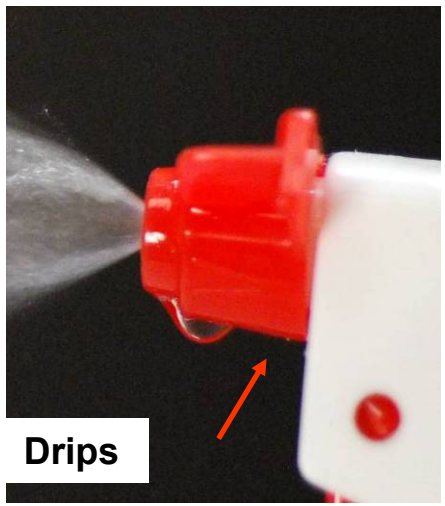
Typical Product Properties:

Appearance	Clear
pH	8.5-9.5
Viscosity** (mPa•s)	150-250
Clarity	5-20

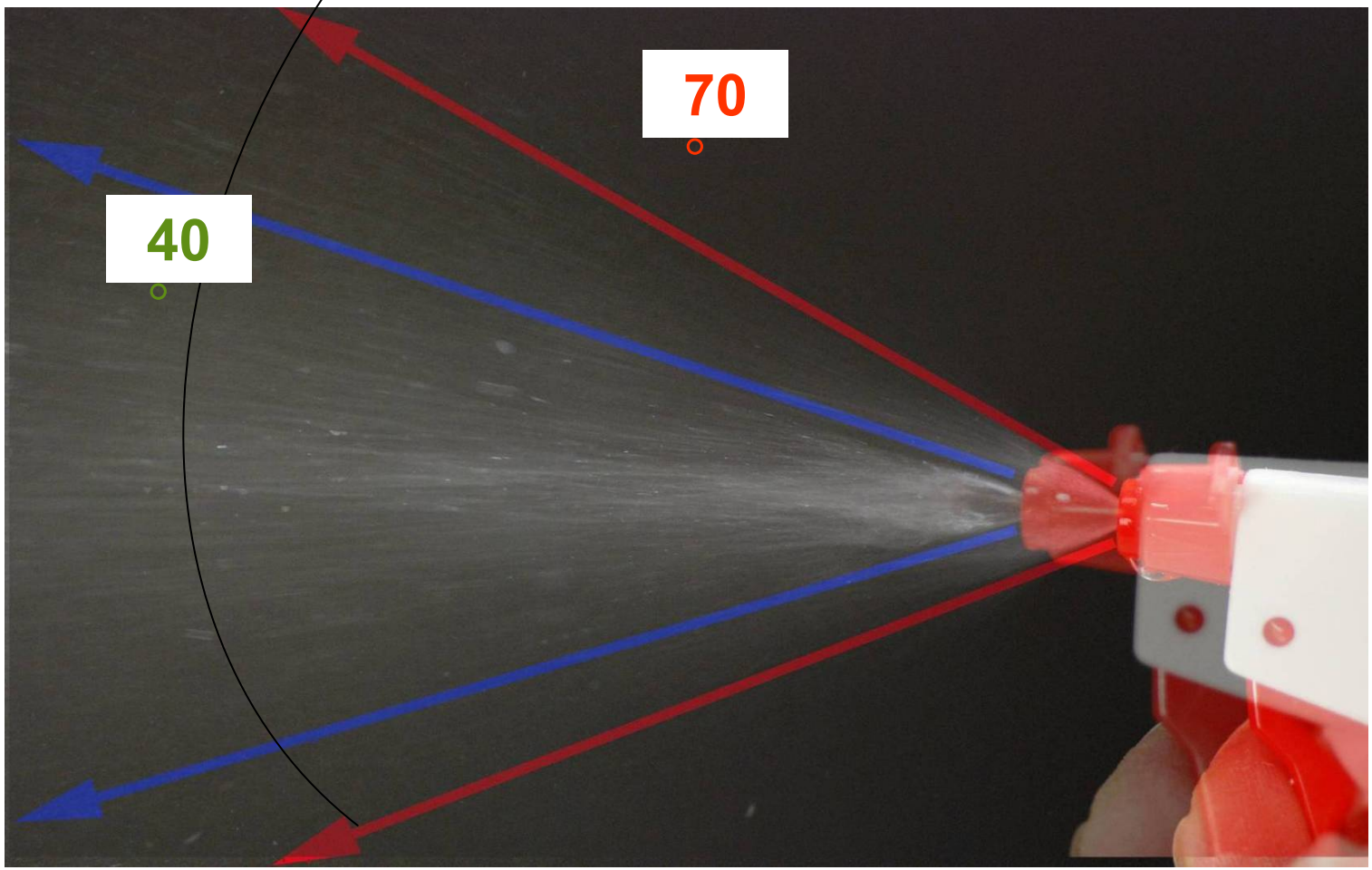
*** Brookfield RVT @ 20 rpm 25° C, #4 spindle*

Multipurpose Cleaning Spray
H-HS-0018 LA





Spray Mist Angle of Delivery



Novethix™ L-10 polymer controls spray mist and eliminates dripping

Medium Duty Hard Surface Cleaners

Properties provided by products of Noveon® Consumer Specialties

Medium duty hard surface cleaners are expected to handle fairly heavy deposits of grease or dirt, and may require rinsing.

- **Stabilize chlorine bleach**
- **Improve vertical surface contact time**

No-Drip Caustic Multi-Purpose Cleaner

H-HS-0023

Carbopol® EZ-4 polymer is an efficient rheology modifier designed for surfactant systems. The formulation has excellent stability with good vertical cling that increases the surface contact time. This system can suspend beads if desired. The benefits of the formulation yield excellent cleaning performance providing good product appeal by the consumer.

	Chemical Name, *Trade Name*	Weight %	Function
1.	Deionized water	91.50	Diluent
2.	**Crosslinked Acrylic Acid Copolymer *Carbopol® EZ-4 Polymer***	***0.60***	***Rheology Modifier***
3.	C_{12-15} Alcohol Ethoxylate 7 EO, *Tomadol® 25-7 (100 wt% TS)*	1.50	Nonionic Surfactant
4.	**Sodium Laureth Sulfate 2-EO *Sulfochem™ ES-2 Surfactant (28%)***	***5.00***	***Anionic Surfactant***
5.	Sodium Hydroxide (50%)	0.20	Neutralizer
6.	Sodium Carbonate	1.00	Builder/Buffer
7.	Pine Scent	0.20	Fragrance

Product Properties:

Appearance	Clear
Viscosity** (mPa·s)	1,800-2,400
pH	10-11

***Brookfield RVT @ 20 rpm, 25° C, #4 spindle*

Clear Power Degreasing Gel

H-HS-0020

This formulation demonstrates the benefits of the **Novethix™ L-10 polymer** for a degreasing hard surface gel cleaner. The polymer provides efficient thickening with good shear-thinning rheology in this alkaline cleaning formulation. It provides unique flow properties which allows for controlled delivery and increased product contact time with the surface to be cleaned.

	Chemical Name *Trade Name*	Weight %	Function
1.	Deionized Water	63.45	Diluent
2.	**Acrylic Emulsion Polymer** ***Novethix™ L-10 Polymer* (30 wt% TS)**	***4.00***	***Rheology Modifier***
3.	Sodium Laureth Sulfate (28 wt% TS) *Zetesol™ NL-2*	25.00	Surfactant
4.	*Aminomethyl Propanol* *AMP-Ultra™*	1.00	Neutralizer
5.	Potassium Hydroxide (45% concentration)	1.00	Neutralizer
6.	Isopropyl Alcohol	1.50	Solvent/Solubilizer
7.	Sodium Carbonate	3.00	Water softener/ Buffer
8.	Citron 195583	0.30	Fragrance
9.	FD&C Blue No. 1 (0.1 wt% TS)	0.50	Dye
10.	D&C Green No. 5 (0.1 wt% TS)	0.25	Dye

Typical Product Properties:

Appearance	Clear
pH	12.0-12.5
Viscosity** (mPa•s)	2,000-2,300
Clarity (NTU)	5-10

*** Brookfield RVT @ 20 rpm, 25° C, #4 spindle*

Figure 6: Vertical Cling Properties of Power Degreasing Gel

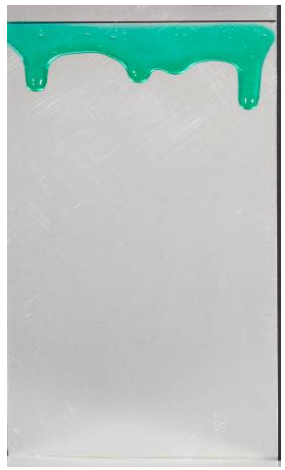
After 60 Sec

No Polymer

Novethix™ L-10 Polymer
(1.2 wt% TS)

Xanthan Gum

After One Hour



Chlorine Bleach Mold and Mildew Cleaner

H-HS-0007C LA

Carbopol® 676 polymer imparts vertical cling and increased contact time for this cleaner formulation. The product also provides improved usage and dosing in pump spray or brush applications. These features increase the performance of the formulation and provide convenience to the consumer.

	Chemical Name *Trade Name*	Weight %	Function
1.	Deionized Water	77.60	Diluent
2.	**Crosslinked Acrylic Acid Homopolymer** ***Carbopol® 676 Polymer***	***1.00***	***Rheology Modifier***
3.	Sodium Hydroxide (50%)	2.50	Neutralizer
4.	Sodium Hypochlorite (12.5% Av Cl_2)	8.00	Bleach

Typical Product Properties:

Appearance	Clear
pH	8.5-9.5
Viscosity** (mPa•s)	1,300-1,800
Clarity (NTU)	7-10

*** Brookfield RVT @ 20 rpm, 25° C, #4 spindle*

Toilet Bowl Cleaner with Chlorine Bleach

H-HS-0005 LA

Carbopol® 676 polymer imparts vertical cling and increased contact time for the cleaner formulation. The product also provides improved safety from reduced splashing. These features increase the performance of the formulation and provide convenience to the consumer.

	Chemical Name *Trade Name*	Weight %	Function
1.	Deionized water	66.65	Diluent
2.	**Crosslinked Acrylic Acid Homopolymer** ***Carbopol® 676 Polymer***	***1.25***	***Rheology Modifier***
3.	***Oxy-Rite™ 100 Rheology Stabilizer***	***0.10***	***Rheology Stabilizer***
4.	Potassium hydroxide (45%)	4.00	Neutralizer
5.	Potassium silicate (39%)	5.00	Builder/Buffer
6.	Potassium carbonate	5.00	Builder
7.	Sodium hypochlorite (12.50% Av Cl_2)	8.00	Bleach
8.	**Lauramine Oxide** ***Chemoxide™ LO Surfactant***	***10.00***	***Surfactant***

Product Properties:

Appearance	Opaque
pH	12.5-3.0
Viscosity** (mPa·s)	1,800-2,600

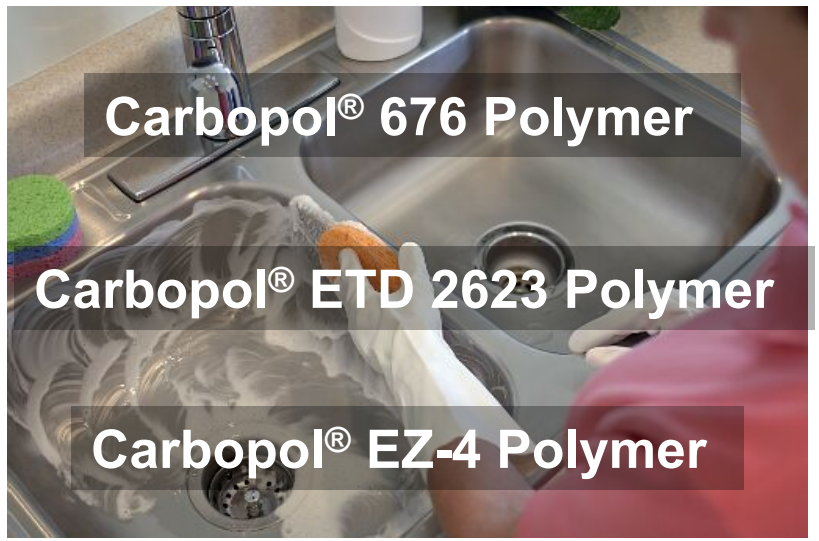
***Brookfield RVT @ 20 rpm 25° C, #4 spindle*

Heavy Duty Hard Surface Cleaners

Properties provided by products of Noveon® Consumer Specialties

Heavy duty hard surface cleaners typically include abrasives.

- **Suspension of insoluble ingredients (abrasive particles)**
- **Stabilization chlorine bleach or hydrogen peroxide**



Calcium Carbonate Abrasive Cleaner without Bleach

H-HS-0009

Carbopol®* ETD 2623 polymer imparts vertical cling and increased contact time for the cleaner formulation. The product also provides improved suspension of abrasive particles. These features increase the performance of the formulation and provide convenience to the consumer.

	Chemical Name *Trade Name*	Weight %	Function
1.	Deionized water	67.25	Diluent
2.	**Crosslinked Acrylic Acid Copolymer** ***Carbopol® ETD 2623 Polymer***	***0.25***	***Rheology Modifier***
3.	Sodium hydroxide (50%)	0.20	Neutralizer
4.	C_{12-15} Ethoxylated Alcohol, 3 mole, *Neodol™ 25-3*	1.50	Surfactant
5.	Sodium alkyl Benzene Sulfonate, *Nacconol® 90G*	0.50	Surfactant
6.	Calcium Carbonate	30.00	Abrasive
7.	Methylisothiazolinone *Neolone™ PE*	0.30	Preservative

Product Properties:

Appearance	Opaque
pH	8.0-9.5
Viscosity** (mPa·s)	7,000-9,000

**Brookfield RVT @ 20 rpm 25° C, #5 spindle

Abrasive Cleaner with Bleach

H-HS-0022

Carbopol® 676 polymer imparts vertical cling and increased contact time for the cleaner formulation. The benefits increase the performance of the formulation and provide convenience to the consumer. The formula provides suspension of the abrasive particles for improved cleaning performance.

	Chemical Name *Trade Name*	Weight %	Function
1.	Deionized water	63.40	Diluent
2.	**Crosslinked Acrylic Acid Homopolymer** ***Carbopol® 676 Polymer***	***1.00***	***Rheology Modifier***
3.	Sodium hydroxide (50%)	2.40	Neutralizer
4.	Sodium Silicate RU (47%)	2.50	Builder
5.	Sodium Hypochlorite (10.4%)	9.70	Chlorine Bleach
6.	Natual Zeolite	20.00	Abrasive
7.	Sodium n-decyl dipenyloxide disulfonate, *Dowfax™ 3B2*	1.00	Surfactant

Product Properties:

Appearance	Opaque
pH	12.5-13.0
Viscosity** (mPa·s)	3,500-5,000
Performance	Removes marks and soils

***Brookfield RVT @ 20 rpm 25° C, #3 spindle*

Acetone Paint Stripper with Reduced Volatility

H-MC-0013

Using **Novethix™ L-10 Polymer** reduces the volatility of acetone allowing easier and safer handling conditions. A slower evaporation rate means more surface contact for greater efficacy of the solvent. This allows for controlled application and functionality.

	Chemical Name, *Trade Name*	Weight %	Function
1.	Deionized Water	21.57	Diluent
2.	***Novethix™ L-10 Polymer* (30 wt% TS)**	**3.33**	**Rheology Modifier**
3.	Acetone	75.00	Solvent/Paint Stripper
4.	Triethanolamine	0.10	Neutralizer

Product Properties:

Appearance	Clear
pH	7.0-9.0
Viscosity (mPa·s)**	15-30
Clarity (NTU)	10 NTU max
Appearance/color	Clear with slight amber
Stability: 25° C	Pass 8 weeks
Stability: freeze-thaw	Pass 3 cycles
Performance	Reduces volatility of acetone slowing down evaporation rate

***Brookfield RVT @ 20 rpm, 25° C, #2 spindle, measured at 24 hours*

Lubrizol

Ingredients for Household and I&I Applications

noveon®
Consumer Specialties

Polishes

Formulate with Confidence™

Polishes and Protectants

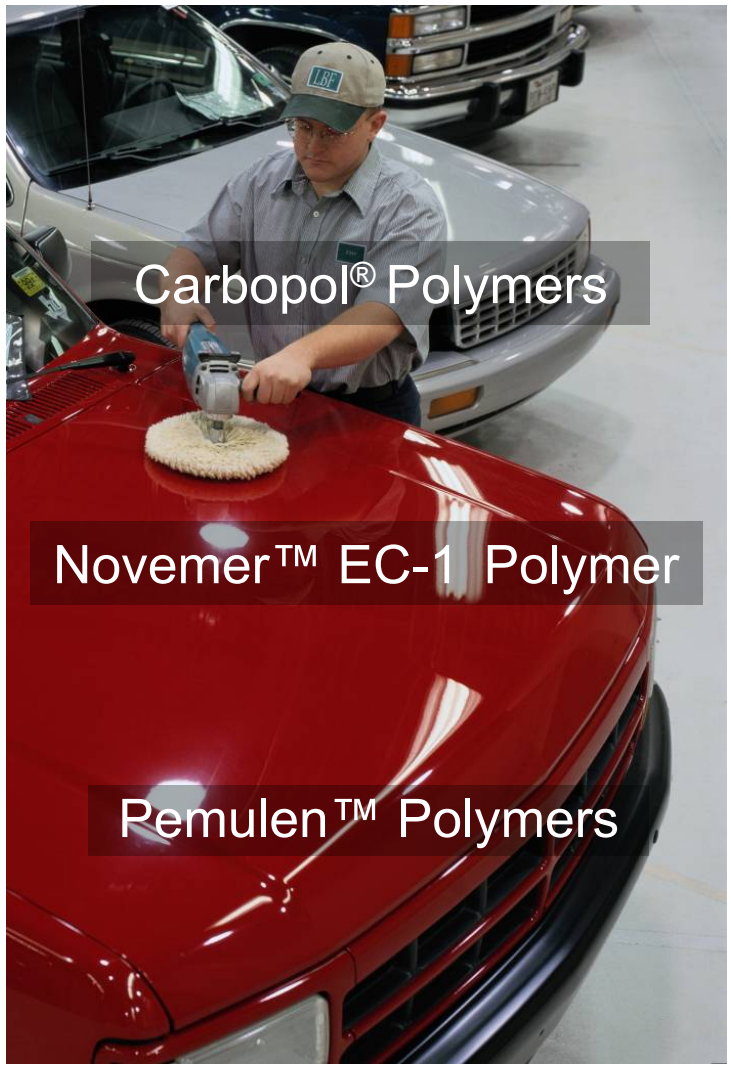
Properties provided by products of Noveon® Consumer Specialties

Stabilize oil-in-water emulsions

- Provide suspension and stabilization
- Impart vertical cling

Emulsions with no surfactant *required*

- High efficiency: 0.10 to 0.50 wt%
- Water resistant films
- Rinse aid (shear-thinning rheology)
- Impart vertical cling
- Improve contact time



Liquid Car Polish

H-AC-0010

Pemulen™ 1622 Polymer imparts vertical cling properties, excellent wetting and improves durability and water resistance. These properties improve the durability and performance of the formulation and increase the convenience for the consumer. **Schercemol™ IDO** provides shine and solvency to the formula.

		Chemical Name *Trade Name*	Weight %	Function
A	1.	1000 cSt Silicone Oil, *Dow Corning® 200 Fluid*	5.00	Shine Agent
	2.	Carnauba Wax	1.50	Wax
	3.	Oleic Acid	1.50	Emulsifier
	4.	***Schercemol™ IDO Ester***	***12.00***	***Shine Agent/Solvent***
B	5.	Deionized Water	69.45	Diluent
	6.	**Crosslinked Acrylic Acid Copolymer** ***Pemulen™ 1622 Polymer***	***0.25***	***Rheology Modifier/ Emulsifier***
	7.	Morpholine	1.60	Neutralizer
	8.	C_{12-15} Ethoxylated Alcohol 7-EO, *Tomadol® 25-7*	0.40	Co-Emulsifier
C	9.	Kaolin Clay, *Kaopolite® SF*	8.00	Abrasive
	10.	Methylisothiazolinone *Neolone™ PE*	0.30	Preservative

Product Properties:

Appearance	Opaque Lotion
pH	8.5-9.5
Viscosity** (mPa·s)	1600

***Brookfield RVT @ 20 rpm, at 25° C, #4 spindle*

Creamy Car Polish

H-AC-0018

Novemer™ EC-1 polymer provides an easy to make cream car polish. The polymer provides a smooth shear-thinning rheology to enable easy application by the consumer. **Novemer™ EC-1 polymer** also stabilizes and provides coemulsification. **Aquaslip™ wax** and **Schercemol™* IDO ester** provides shine and solvency to the formulation..

	Chemical Name, *Trade Name*	Weight %	Function
1.	Deionized Water	69.40	Diluent
2.	C_{12-15} Ethoxylated Alcohol 12-EO, *Tomadol® 25-12*	0.50	Emulsifier
3.	10,000 cSt Silicone Oil, *Dow Corning® 200 Fluid*	5.00	Shine Agent
4.	**Carnuba Wax** ***Aquaslip™ 952 wax***	**6.00**	**Wax**
5.	***Schercemol™ IDO Ester***	***12.00***	***Shine Agent/Solvent***
6.	**Sodium Polyacrylate Copolymer** ***Novemer™ EC-1 Polymer***	**1.00**	***Rheology Modifier/ Emulsifier***
7.	Kaolin Clay, *Kaopolite® SF*	6.00	Abrasive
8.	*Kathon® CG*	0.10	Preservative

Product Properties:

Appearance	Opaque Lotion
pH	8.5-9.5
Viscosity** (mPa·s)	1600

***Brookfield RVT @ 20 rpm, at 25° C, #5 spindle*

"No Run" Tire Shine

H-AC-0017

Novemer™ EC-1 polymer is a multifunctional polymer used to provide rheology modification, which prevents "running" and "dripping" of the tire shine when applied to tires. **Novemer™ EC-1 polymer** is also an effective emulsifier, reducing the need for additional emulsifying ingredients. The small amount of mineral oil contained in **Novemer™ EC-1 polymer** enhances the shine performance.

	Chemical Name, *Trade Name*	Weight %	Function
1.	Deionized water	62.65	Diluent
2.	**Sodium Polyacrylate Copolymer *Novemer™ EC-1 Polymer***	**1.25**	***Rheology Modifier/ Emulsifier***
3.	$C_{12\text{-}15}$ Ethoxylated Alcohol – 7 EO, *Tomadol® 25-7*	1.0	Co-emulsifier
4.	Light Mineral Oil, *Drakeol® 7*	15.0	Shine Agent
5.	5000 cSt Silicone Fluid, *Dow Corning® 200 Fluid*	20.0	Shine Agent
6.	Fragrance	0.10	Fragrance

Product Properties:

Appearance	Opaque
pH	7.0-7.5
Viscosity** (mPa·s)	12,000-15,000

*** Brookfield RVT @ 20 rpm 25° C, #5 spindle*

Polishes and Protectants

Properties provided by Noveon® Consumer Specialties

- **Stabilizes oil in water emulsion**
- **Emulsifies or stabilizes a broad range of oils**
- **Suspends inorganic ingredients**
- **Provides smooth non-tacky emulsions**
- **Improves pick-up**

Furniture Polish

H-HS-0012

Carbopol®* EZ-2 Polymer provides suspension of insoluble ingredients and oils in this furniture polish formulation. These properties improve the overall stability and aesthetics of the product.

		Chemical Name *Trade Name*	Weight %	Function
A	1.	Deionized water	91.05	Diluent
	2.	**Crosslinked Acrylic Acid Homopolymer** ***Carbopol® EZ-2 Polymer***	***0.20***	***Rheology Modifier***
	3.	Triethanolamine	0.20	Neutralizer
B	4.	*Cardis™ Wax 36*	0.25	Wax
	5.	*Licowax® Wax E*	0.25	Wax
	6.	Oleic Acid	0.08	Emulsifier
	7.	Morpholine	0.10	Neutralizer
	8.	Deionized water	1.82	Diluent
C	9.	Silicone emulsion, *SM2133*	4.00	Shine/Gloss
	10	Silicone emulsion, *SM2135*	2.00	Shine/Gloss
	11	*Kathon® CG*	0.05	Preservative

Product Properties:

Appearance	Opaque
pH	7.0-8.5
Viscosity** (mPa·s)	9,000-10,000

***Brookfield RVT @ 20 rpm at 25° C, #5 spindle*

Rheology Modifiers Control Flow for Surface Care

- **Carbopol® polymers exhibit both viscous and elastic flow properties**
- **Rheology modifiers help to produce products from gels to pump spray liquids**
- **Shear-thinning rheology provides flow control by giving vertical cling**
  - Minimized dripping on surface and spray nozzle
  - Increases contact time and cleaning effectiveness
  - Control misting in spray systems
- **Improve ingredient compatibility**
  - Suspending of insolubles
  - Emulsification
- **Provide stabilization**
- **High efficiency**

Formulate with Confidence™ using Lubrizol Rheology Modifiers

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Thank you . . .

For more information, samples and/or starting formulations with complete processing instructions and supplier references please contact:

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Appendix

Formulate with Confidence™

Rheological Properties of Carbopol® and Pemulen™ Polymers

Rheological Property	Symbol	Information Obtained
Viscosity (measured at different shear rates)	$\eta(\dot{\gamma})$	Shear thinning behavior
Yield Stress	τ_{yld}	The larger the value, the better the suspending ability
Thixotropic Index	T.I.	The larger the value, the lower the gel strength and the greater the chance for irreversible structure breakdown. Also a measure of viscosity recovery.
Rigidity Coefficient	G^0	The larger the value, the more rigid the gel; the smaller the value, the softer the gel.

Measuring Yield Stress: Constant Stress Rheometer