performance specialties

reference guide

Ashland™
always solving

ashland.com / efficacy usability allure integrity profitability™

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introduction

Ashland is a high-performance organization focused on innovation, commercial excellence, and world-class operations. The people of Ashland maintain a fundamental focus on safe, compliant and responsible operations. They are committed to doing business with integrity and respect for people and the planet. The company fosters continuous growth through a pipeline of innovation and technical excellence, and by capturing value delivered to customers while driving its own cost competitiveness.

Ashland acts as a true partner to its customers, providing customized solutions that add tremendous value to their products or their processes. We relentlessly pursue ways to transform the efficacy, usability, allure, integrity and profitability of our customers' products.

Each of these five qualities can manifest in different ways for different industries. Our customers enjoy better product integrity from ingredients that are of consistent quality, naturally derived, or have less environmental impact than competitive ingredients. Often, our team of solvers help our customers manufacture their products more profitably. Ultimately, downstream users – be they processors or end consumers – benefit from goods that are more effective, more easily used, more environmentally compatible, or more appealing. It is in these ways that Ashland's people around the globe are always solving.

chemical/product trade name cross-reference

chemical name	ashland brand	pg
acrylate polymer sodium salt	**rheothix™ 601**	56
acrylic acid polymers	**jaypol™, papifloc™**	54-55
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chemical/product trade name cross-reference

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chemical name	ashland brand	pg
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acetylenics

overview

vinyl monomers

cyclic N-vinyl lactam monomers are offered for polymerization applications and as reactive diluents for UV or EB (e.g. ink and adhesive) through vinyl functionality.

v-pyrol™ (inhibited or caustic stabilized) n-vinyl-2-pyrrolidone is water-soluble and undergoes free radical homo- and copolymerizations as well as grafting reactions. V-Pyrol n-vinyl-2-pyrrolidone is a low-viscosity reactive diluent for UV radiation curing processing.

v-cap™ n-vinyl-2-caprolactam is only slightly soluble in water, but can function in many applications similar to V-Pyrol n-vinyl-2-pyrrolidone.

Fully formulated UV-curable **Gafgard**™ coating systems impart abrasion and solvent resistance to a wide variety of surfaces.

surfactants

The **Surfadone**™ alkyl pyrrolidones are hydrophobic in nature, functioning as excellent wetting agents and effective dispersing and cleaning aids.

solvents and intermediates

pyrrolidones

This family of chemicals varies in properties as a function of substitution on the lactam nitrogen atom. All members are characterized by low vapor pressure, high flash point, high dipole moment, ready complex formation, surface activity as the alkyl chain lengthens, and biodegradability when the alkyl chain is linear.

- **2-pyrol**™ solvent (2-pyrrolidone)

  It is used as a humectant, cosolvent with water, coalescent aid and plasticizer.

The lower alkyl pyrrolidones, most notably M-Pyrol™ (n-methyl-2-pyrrolidone), are excellent polymer solvents, paint and photoresist strippers, paint coalescents, industrial cleaners and extraction solvents.

- **m-pyrol**™ solvent (n-methyl-2-pyrrolidone)

  Solvent, cosolvent and diluent. Used in cleaners, coating and photoresist strippers, coalescents and rechargeable battery manufacture.

- **HEP**™ solvent (n-hydroxyethyl-2-pyrrolidone)

  Cosolvent formulated individually or in combination with M-Pyrol solvent for strippers and cleaners and as an intermediate.

- **CHP**™ solvent (n-cyclohexyl-2-pyrrolidone)

  Individual cosolvent or in combination with M-Pyrol n-methyl-2-pyrrolidone and **BLO**™ gamma-butyrolactone solvents to enhance performance by broadening solubility range in circuit board fabrication, cleaning formulations, dyeing bath additive and paint strippers.

The common characteristic of these chemicals is high solubility in hydrophilic media.

- **butenediol**, having a cis double bond enters into Diels-Alder reactions, and Butanediol finds application as a plasticizer and humectant. All four alcohols function as precursors to numerous derivatives such as esters, carbamates, polyesters and urethanes.
- **THF** is an inert solvent for numerous polymer and organometallic reactions and is the precursor of polytetramethyleneglycol.
- **BLO**™ gamma-butyrolactone is a polar solvent for ionic substrates and functions as an acid donor in aqueous media at elevated temperatures.

performance polymers

The largest families of polymers produced by Ashland are based on n-vinyl-2-pyrrolidone and cellulose ethers. n-vinyl-2-pyrrolidone based performance polymers include polyvinylpyrrolidone (PVP) homopolymers and copolymers. The latter contain functionality from coreactants, including vinyl acetate (PVP/VA), alpha-olefin (Ganex™/Antaron), Dimethylaminoalkylene-methacrylate or

methacrylamide copolymers and their derivatives (Gafquat™, Copolymer, Viviprint™, Styleze™ and Setleze™), and styrene (Polectron™/Antara™ 430) copolymers. Many properties are shared among the groups, but each also has unique characteristics, varying with structure. The following are examples:

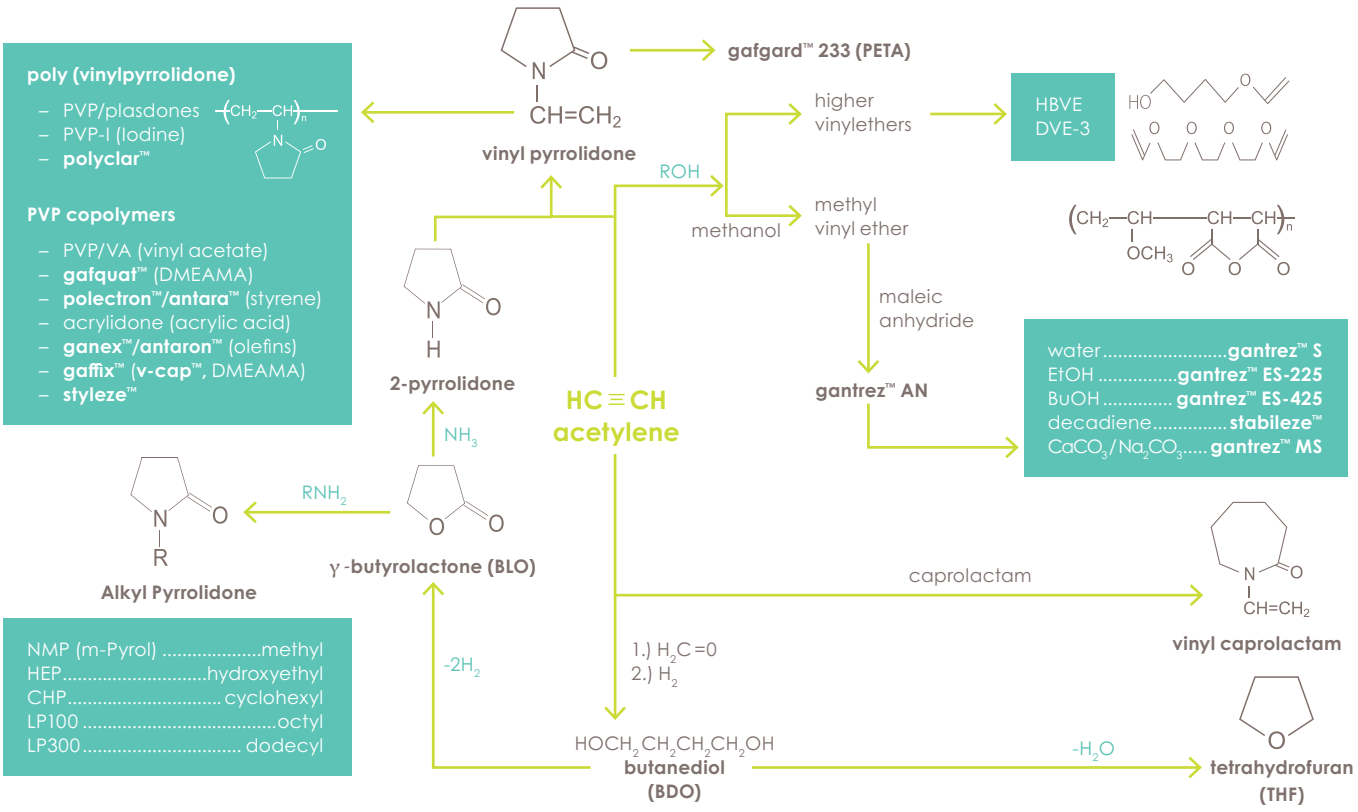
- PVP: high polarity, dispersancy, hydrophilicity, adhesion, cohesivity and high Tg.
- PVP/VA: thermoplasticity, oxygen permeability, varying hydrophilicity and adhesion.
- **ganex™/antaron™** copolymers: hydrophobicity, an emulsifier and dispersant for nonaqueous systems.
- **gafquat™, copolymer™, viviprint™, styleze™ and setleze™**: basicity, substantivity and high charge density.
- **styleze™ and aquaflex™** copolymers: basicity, substantivity and cross linkable.
- **polectron™/antara™** copolymers: thickening and opacifying emulsion.

Ashland also offers polymers based on V-Cap™ reactive monomer. These include vinylcaprolactam homopolymers, copolymers with vinylpyrrolidone and terpolymers containing both lactam monomers and dimethylaminoalkylene-methacrylate or -methacrylamide. These polymers are generally more hydrophobic than the V-Pyrol™ reactive monomer-based products mentioned above but offer many of the functional properties inherent in the lactam ring. Among other applications, Inhibex™ polymers are highly efficient as inhibitors of gas hydrate formation.

A range of alternating copolymers based on methylvinylether and maleic anhydride are produced by Ashland:

- The Gantrez™ AN family of methylvinylether/maleic anhydride copolymers is characterized by aprotic polar solvent solubility and reaction with protic compounds such as water, alcohols and amines with facile film formation.
- The hydrolyzed Gantrez™ S polycarboxylic acid resins function as dispersants, divalent cation binding agents and polymeric acidifiers.

multi-faceted acetylene chemistry



Ashland
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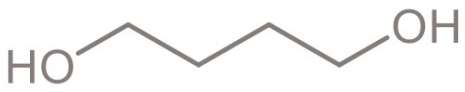
butanediol

1,4-butanediol



applications

Butanediol is used mainly as a co-monomer in classical diol-condensation reactions with:

- terephthalic acid to produce polybutylene terephthalate (PBT)
- diphenylmethane diisocyanate (MDI) yielding polyurethane foams, elastomers and adhesives
- adipic acid to yield polyesters with biodegradability characteristics

In general, polymers produced from butanediol exhibit greater hydrophobicity, crystallinity, strength, hydrolysis resistance and better low temperature flexibility than those produced from ethylene glycol.

- Physical properties of butanediol make it useful as a plasticizer and humectant.

physical properties

- boiling point 228°C
- vapor pressure <0.075mm Hg @ 24°C
- flash point 139°C
- viscosity 71.5 cP @25°C
- specific gravity 1.017 @ 25°C

chemistry

Butanediol's reactive sites are its hydroxyl groups, which undergo all the typical reactions of alcohols. In addition to the condensation reactions noted above, it can be converted to simple esters, halides, dehydrated to tetrahydrofuran and dehydrogenated to gamma-butyrolactone.

THF (tetrahydrofuran)

1,4-epoxybutane

applications

- solvent for vinyl polymers used in PVC pipe adhesives, industrial cleaning, magnetic tape coatings, vinyl fabric topcoats among others
- reaction medium for organometallic reagents, including linear low-density polyethylene catalyst manufacture
- monomer for polytetramethylene glycol, a Spandex™ intermediate

physical properties

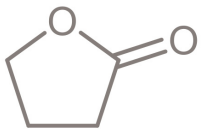
- boiling point 66°C
- vapor pressure 161mm Hg @ 20°C
- flash point -14°C
- freezing point -108.5°C
- viscosity 0.5 cP @20°C
- dipole moment 1.75D
- specific gravity 0.886 @ 25°C
- dielectric constant 7.52

chemistry

THF (stabilized with 250-400 ppm BHT) is an excellent polymer solvent, combining rapid dissolution and evaporation with significant solubilizing capacity for many high molecular weight polymers at moderate viscosity. It has unique characteristics in Grignard and other organometallic reactions. As noted above, THF undergoes an acid-catalyzed ring opening polymerization reaction to produce polytetramethylene glycol.

BLO™ / GBL (gamma-butyrolactone)

γ-butyrolactam



applications

- electrolyte dissociating solvent for non-aqueous capacitors
- photoresist stripper
- solvent for a wide spectrum of polymers and an effective substitute for chlorinated hydrocarbons
- paint strippers, industrial cleaners and lithographic developers
- hydrolyzed in water at elevated temperatures to yield 4-hydroxybutyric acid, leading to its use as an acid donor in nylon fiber dyeing
- stabilizes urea in fertilizers

physical properties

- boiling point 66°C
- vapor pressure 161mm Hg @ 20°C
- flash point -14°C
- freezing point -108.5°C
- viscosity 0.5 cP @20°C

chemistry

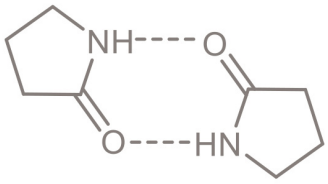
Although BLO is stable under a wide range of conditions, at elevated temperatures and in the presence of appropriate reagents, it serves as an intermediate in a variety of useful syntheses, such as:

- precursor to 2-pyrrolidone and the extensive family of alkyl pyrrolidones produced from ammonia and primary amines
- reacting with phenols to yield phenoxybutyric acid derivatives with applications in pharmaceuticals and as photographic coupling agents

pyrrolidones

The family of 2-pyrrolidones offered by Ashland has a variety of properties primarily derived from the unique features of the lactam ring and modified by substitution on the nitrogen atom. The general characteristics of these compounds result from the polar N-C=O linkage in the five-membered ring. The reactivity, physical properties and stability of these molecules result from the well-documented amide resonance. In anionic media, the partially positive nitrogen readily coordinates with negatively charged species while in acidic systems the electron-rich carbonyl oxygen is rapidly protonated.

2-pyrol™ (2-pyrrolidone)



applications

- solubilization of complex organic molecules in water
- humectant and cosolvent in digital printing inks
- coalescent or plasticizer for acrylic resins, especially in floor polishes, inks and adhesives

physical properties

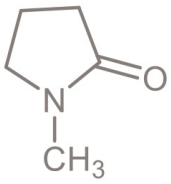
- boiling point 245°C
- vapor pressure <0.1mm Hg @ 20°C
- flash point 129°C
- freezing point 25°C
- viscosity 13.3 cP @ 25°C
- dipole moment 3.5D
- specific gravity 1.116 @ 25°C

chemistry

The reactive site of 2-Pyrol® is its labile hydrogen on the nitrogen. It can undergo vinylation with acetylene, alkylation with alkylhalides and acylation with acylhalides. Hydrolysis produces gamma-aminobutyric acid. It is also available as 95% active solution that freezes/solidifies at 12°C to ensure ease of handling.

m-pyrol™ (NMP)

N-methyl-2-pyrrolidone



applications

- high precision electronic cleaning agent
- polymerization medium for polyethersulfones, polyaramids, polyesters, polyamide-imides
- polyamide-imide diluent for wire enamel coatings
- paint and photoresist strippers
- coalescent in latex paints allowing excellent formulation latitude
- polydifluoroethylene solvent in rechargeable battery manufacture
- industrial cleaners; neat or in combination with numerous other solvents
- solvent for extraction of aromatics from lube oil
- solvent for separation of acetylene and butadiene from light hydrocarbon streams

physical properties

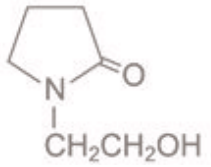
- boiling point 202°C
- vapor pressure 0.27 mm Hg @ 20°C
- flash point 90°C
- freezing point -24°C
- viscosity 1.7 cP @ 25°C
- dipole moment 4.06 Debye @ 25°C
- specific gravity 1.027 @ 25°C
- dielectric constant 32.2
- soluble in water and most organic solvents; sparingly soluble in aliphatic hydrocarbons

chemistry

M-Pyrol™ is resistant to hydrolysis from pH 2-10, even at elevated temperatures. Beyond these limits, hydrolysis to 4-(methylamino) butanoic acid occurs at a rate dependent on pH and temperature. A large body of chemistry has been developed on the reactions of strong nucleophiles with M-Pyrol™. High purity, low trace metal grades are sold under the Micropure™ and Pharmasolve™ tradenames for the electronic and pharmaceutical industries.

HEP™ solvent

N-hydroxyethyl-2-pyrrolidone



applications

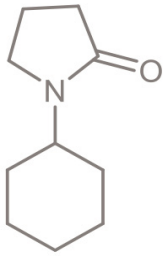
- photoresist strippers - used as a co-solvent, usually in combination with M-Pyrol™ (N-methyl-2-pyrrolidone) solvent, to enhance performance by broadening solubility range
- paint strippers - as a solvent in high temperature stripping applications for chemically resistance coatings
- silk screen cleaners - as a co-solvent in cleaning formulations to enhance removal of inks from silk screen fibers
- hard surface cleaners - used as a co-solvent with glycol ethers in oven cleaning formulations
- intermediate for alkoxylated derivatives used in gasoline additives

physical properties

- boiling point 295°C
- vapor pressure <0.005 mm Hg @ 20°C
- flash point 160°C
- freezing point 20°C
- viscosity 53 cP
- specific gravity 1.139 @ 25°C

CHP™ solvent

N-cyclohexyl-2-pyrrolidone



applications

- photoresist strippers - used as a co-solvent, usually in combination with M-Pyrol™ (N-methyl-2-pyrrolidone) and BLO (gamma- Butyrolactone) solvents, to enhance performance by broadening solubility range
- circuit board fabrication - used in chemical polishing of copper and copper alloys to increase the stability of hydrogen peroxide in acid brightening baths
- dye carrier or dyeing bath additive - used in dyeing of aromatic polyamide fibers (i.e. Dupont's Kevlar®*) as a swelling/diffusion agent to enhance dye and flame-retardant penetration
- paint strippers - as a solvent in high temperature stripping applications for chemically resistant coatings
- silk screen cleaners - as a co-solvent in cleaning formulations to enhance removal of inks from silk screen fibers

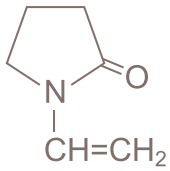
* trademark owned by a third party

physical properties

- boiling point 284°C
- vapor pressure <0.005 mm Hg @ 20°C
- flash point 145°C
- freezing point 12°C
- viscosity @ 25°C 11.5 cP
- specific gravity 1.026 @ 25°C

vinyl monomers

v-pyrol™ vinylpyrrolidone



N-vinyl-2-pyrrolidone

applications

- reactive diluent for radical initiated UV radiation curing used in vinyl flooring, wood coatings, release coatings, inks, etc.
- numerous conventional polymerizations to generate an array of materials with a variety of properties as noted in the following polymer section

physical properties

boiling point.....193°C @ 400 mm Hg

melting point..... 13°C

vapor pressure.....<0.10 mm Hg @ 20°C

flash point..... 96°C

viscosity..... 2 cP @ 25°C

chemistry

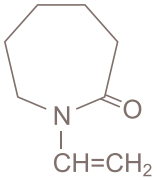
V-Pyrol vinylpyrrolidone is a clear liquid stabilized with insoluble sodium hydroxide or soluble N,N'-di-sec-butyl-p-phenylenediamine. The latter inhibitor is supplied in V-Pyrol vinylpyrrolidone at concentrations of 25 ppm and at 100 ppm, respectively, for radiation curing and nonradiation curing applications. This monomer is known to be a supercooled liquid well below its freezing point of 13 °C. It can remain as a liquid at room temperature for extended periods. Rapid, exothermic crystallization under these conditions should not be confused with bulk polymerization.

V-Pyrol vinylpyrrolidone accelerates UV curing rates as the reactive diluent. Typically formulated with an acrylate oligomer, it imparts its unique solution viscosity reduction and enhanced adhesion to nonpolar substrates. The activated double bond of V-Pyrol vinylpyrrolidone facilitates its use in free radical homo- and copolymerizations and grafting reactions. The products of these reactions are either linear or crosslinked homopolymers and nonionic, anionic and cationic copolymers. Polymers from V-Pyrol vinylpyrrolidone are amorphous, and the pyrrolidone ring imparts hydrophilicity, adhesiveness, strength and complexing capability.

gafgard™ 233

Formulated UV-curable coating containing V-Pyrol vinylpyrrolidone and a multifunctional acrylate is used to impart high levels of abrasion resistance to coatings for plastic lenses, protective window films, credit cards, etc.

v-cap™ vinylcaprolactam



N-vinyl-2-caprolactam

applications

- reactive diluent for radical-initiated UV radiation curing used in inks (especially digital and silkscreening), vinyl flooring, wood coatings, release coatings, etc.
- conventional polymerizations to generate materials that have more hydrophobic character than analogous V-Pyrol vinylpyrrolidone based products

physical properties

boiling point.....116°C @ 10 mm Hg

melting point..... 35°C

vapor pressure..... <0.1 mm Hg @ 20°C

flash point.....114°C

viscosity.....3.5 cP @ 40°C

chemistry

V-Cap vinylcaprolactam is a pale yellow crystalline solid stabilized with either 10 ppm N,N'-di-sec-butyl p-phenylenediamine or 25ppm 4-hydroxy tempo and having chemical reactivity characteristics similar to those cited for V-Pyrol vinylpyrrolidone. Polymers synthesized from V-Cap vinylcaprolactam are significantly more hydrophobic than their V-Pyrol vinylpyrrolidone analogs but still exhibit the adhesiveness, strength and complexing capability characteristic of the lactam functionality. As with V-Pyrol vinylpyrrolidone, V-Cap vinylcaprolactam is a super-cooled liquid and can remain as a liquid at room temperature for extended periods. Rapid, exothermic crystallization under these conditions should not be confused with bulk polymerization.

V-Cap vinylcaprolactam accelerates UV curing rates as the reactive diluent. Typically formulated with an acrylate oligomer, it imparts unique solution viscosity reduction and enhanced adhesion to nonpolar substrates. The activated double bond of V-Cap vinylcaprolactam facilitates its use in free radical homo- and copolymerizations and grafting reactions. The products of these reactions are either linear or crosslinked homopolymers and nonionic, anionic and cationic copolymers. Polymers from V-Cap vinylcaprolactam are amorphous, and the caprolactam ring imparts hydrophobicity, adhesiveness, strength and complexing capability.

rapi-cure™ DVE-3

Triethyleneglycol divinyl ether

Rapi-cure™ DV E-3 is a reactive diluent/monomer for free radical curable coatings and printing inks. It provides benefits and properties for cationic systems.

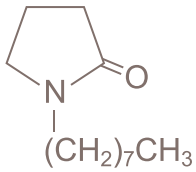
applications

- difunctional reactive diluent
- cationic systems with epoxy and vinyl ether functional oligomers
- good solvency for onium salt photoinitiators
- imparts flexibility to cured films
- facilitates pigment wetting/dispersion
- charge transfer systems with unsaturated polyester oligomers for wood coatings
- free radical and hybrid systems with acrylate oligomers

physical properties

physical form	colorless liquid with mild odor
purity	98.5% and 96%
boiling point	120-126°C @ 18 mm Hg
freezing point	- 8°C
flash point	119°C
viscosity	3 mPa•s @ 25°C
refractive index	1.4695 @ 25°C
Tg of homopolymer	20°C
skin irritation	minimal

surfadone™ LP-100
wetting agent/
surfactant/solvent



N-octyl-2-pyrrolidone (NOP)

applications

- soil penetrant and softener in hard-surface cleaners, laundry prespotters and metal cleaning
- wetting agent for dish washing, industrial and institutional cleaners
- isopropyl alcohol replacement in fountain solutions
- solvent for polymers and hydrophobic substances
- pigment dispersion aid and pigment conditioning solvent
- component of photoresist strippers
- low foam, high-efficiency wetting agent for aqueous systems
- component in microemulsifying systems

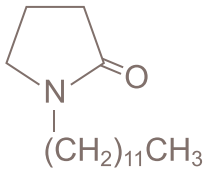
physical properties

boiling point	100°C @ 0.3 mm Hg
vapor pressure	<0.001 mm Hg @ 25°C
flash point	113°C
freezing point	-25°C
viscosity	8 cP @ 20°C
minimum equilibrium surface tension	28 mN/m @ 1200 ppm
minimum dynamic surface tension	35 mN/m @10 bubbles/sec

chemistry

Surfadone™ LP-100 wetting agent is a low-foaming, nonionic rapid wetting agent with an HLB of 6 and having no critical micelle concentration. Due to the electron delocalized lactam ring, Surfadone™ LP-100 wetting agent interacts with anionic surfactant micelles. This greatly enhances its water solubility, resulting in a synergistic surface tension reduction and wetting enhancement at low concentrations.

surfadone™ LP-300
wetting agent/
surfactant/solvent



N-dodecyl-2-pyrrolidone

applications

- high-boiling solvent for polymers and hydrophobic substances
- phthalate plasticizer replacement in PVC
- additive in hand or automatic dish washing detergents
- ingredient in pressure-sensitive adhesives

physical properties

boiling point	145°C @ 0.2 mm Hg
flash point	116°C
freezing point	10°C
viscosity	17 cP @ 25°C
minimum equilibrium surface tension	26 mN/m @ 20 ppm

chemistry

Surfadone™ LP-300 wetting agent is sparingly soluble in water (0.02 weight percent) and soluble in most organic solvents. It is a low-foaming, nonionic surfactant with an HLB of 3 and has no critical micelle concentration. Like its lower homolog,

Surfadone™ LP-300 wetting agent interacts with anionic surfactants forming mixed micelles that greatly enhances its solubility, resulting in a synergistic surface tension reduction and wetting enhancement.

Appropriate combinations of Surfadone™ LP-300 wetting agent and anionic surfactants produce viscous solutions and gels.

easy-wet™ 20
super wetting agent

applications

- hard-surface cleaners
- glass and tile cleaners
- industrial and institutional cleaners
- textile processing
- pigment wetting

benefits

- faster wetting
- lower use levels
- low contact angles
- water soluble, with improved spreading on most surfaces
- better equilibrium surface tension
- enhanced cleaning performance

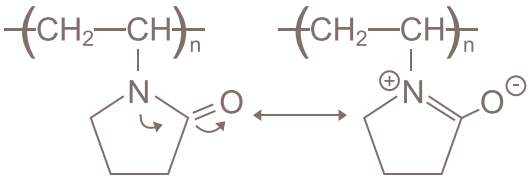
physical properties

physical form	Clear liquid
pH (10 wt% aq.)	4.0-6.0
viscosity	15-30 cP @ 25°C
specific gravity @ 25°C	0.92-0.95

chemistry

Easy-Wet™ 20 wetting agent is a proprietary super-wetting agent in a convenient-to-use liquid form. Easy-Wet™ 20 wetting agent is a cost-effective premium wetter/surfactant suitable for HI&I cleaning, textiles, pigments and other industrial applications where superior wetting and spreading performance is required.

PVP K-series



Polyvinylpyrrolidone is a hygroscopic, amorphous polymer supplied as a white, free-flowing powder or a clear aqueous solution. Available in several molecular weight grades, it is characterized by K-value and used in various applications.

applications

- dye transfer inhibition in detergents using PVP K-15 and K-30 to form complex fugitive
- textile dye stripping and strike rate control through complexation and dispersion with PVP K-30
- photoprocessing where sulfide salts are complexed by PVP K-30 in developing baths to inhibit redeposition on film
- laundry detergents where PVP K-30 inhibits soil redeposition
- emulsion polymerization where PVP K-30 latex stabilizer, functioning as a protective colloid, facilitates redispersion of a "broken" latex end-use application
- dispersions using PVP K-30 and K-90 for nonaqueous dye-and pigment-based writing ink delivery systems
- production of expandable polystyrene, with PVP K-90 used as the protective colloid
- polyvinylpyrrolidone and a number of its copolymers used as media components in digital inkjet printing
- hollow fiber membrane manufacture in which PVP K-90 and K-30 create voids and hydrophilic domains in polysulfone membranes
- in oilfield cementing, PVP K-30 and K-90 serve as fluid loss control agents
- on lithographic plates using hydrophobic inks, PVP K-15 provides enhancement of the nonimage area
- PVP K-85 and 90 in stearate-based adhesive sticks for arts and crafts applications
- on both ends of toilet paper rolls, PVP K-60 is used as an adhesive
- in fiberglass sizing, PVP K-30 and K-90's film-forming action promotes polyvinylacetate adhesion
- as combustible ceramic binders, PVP K-30 and K-90 enhance green strength
- in tablet binder formulations, PVP K-30 and K-90 are used for industrial and pharmaceutical applications
- in CRT fabrication using negative photoresist technology, PVP K-90 is used with a chemical crosslinker in water-based coating systems
- in production of electrolead hydrogels, PVP K-90 is crosslinked by E-beam irradiation to produce a conducting medium
- in metal quenchant bath, PVP K-60, K-90 and K-120
- PVP K-30 and K-90 are used for enzyme stabilization
- production of nano-sized metal pigments
- dispersant for carbon nano-fibers
- water and polar organics (e.g. alcohols) soluble rheology modifier

physical properties

grade*	K-value range	available as solid powder	PVP concentration in water	Brookfield viscosity cP as is @ 25 oC in water	molecular weight (GPC/MALLS)
K-12	10 - 14	yes			5,000
K-15	13 - 19	yes	30%	10 - 15	9,700
K-30	26 - 35	yes	30%	200 - 500	66,800
K-60	50 - 62	no	31%	2,800 - 4,500	396,000
K-60		no	47%	137,000	
K-76/81	83 - 88	yes			750,000
K-90	88 - 100	yes	10%	500	1,570,000
K-90		yes	15%	2,500 - 4,000	
K-90		yes	22%	29,000 - 62,000	
K-120	114 - 130	yes	12%	48,000 - 75,000	3,470,000

*other grades and intermediate MW are available—please contact your Ashland representative

water absorptivity ..... ~17% water @ 60% RH/20 °C

Tg.....130 - 180 °C, increases with Mw to Max. 180 °C

film formation.....hard, glossy, transparent, oxygen permeable

film refractive index .....~1.53 @ 25 °C

solubility characteristics

- soluble in water and most polar solvents
- insoluble in esters, ethers, ketones and hydrocarbons

PVP K-60 is currently available only as aqueous solutions. All other PVPs are available as dried powder or in solution.

chemistry

Polyvinylpyrrolidone (PVP) can be plasticized with water and most common organic plasticizers. It is considered to be physiologically inert. Applications take advantage of one or more properties inherent in the polymer, typically due to the lactam ring.

High polarity and the resultant propensity to form complexes with hydrogen donors, such as phenols and carboxylic acids, as well as anionic dyes and inorganic salts.

Dispersancy, where components in a mixture are uniformly distributed through the use of polyvinylpyrrolidone.

Hydrophilicity, where the substantial water solubility of PVP is its dominant feature and frequently a factor along with other properties valuable to numerous applications.

Adhesion, taking advantage of the higher molecular weight PVP formulating in aqueous media, then evaporating sufficient water to generate a solid product for the desired application.

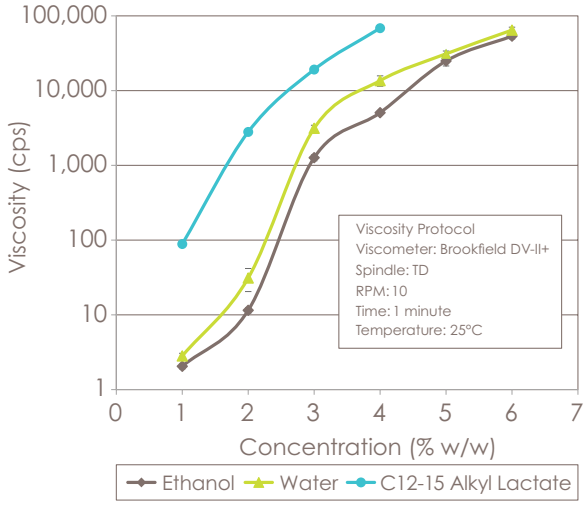
Cohesivity, where cohesive strength is achieved through a variety of dry blending and granulation techniques.

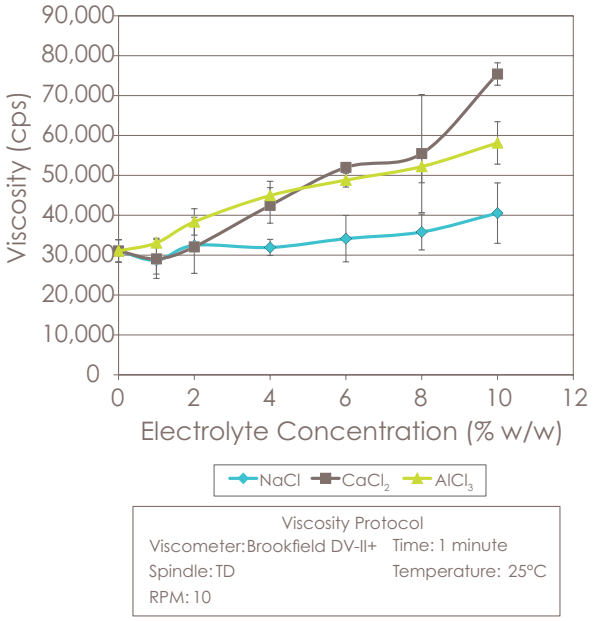
PVP is cross-linkable to a water-insoluble, swellable material either in the course of vinylpyrrolidone polymerization, by addition of an appropriate multifunctional comonomer or by post-reaction, typically through hydrogen abstraction chemistry.

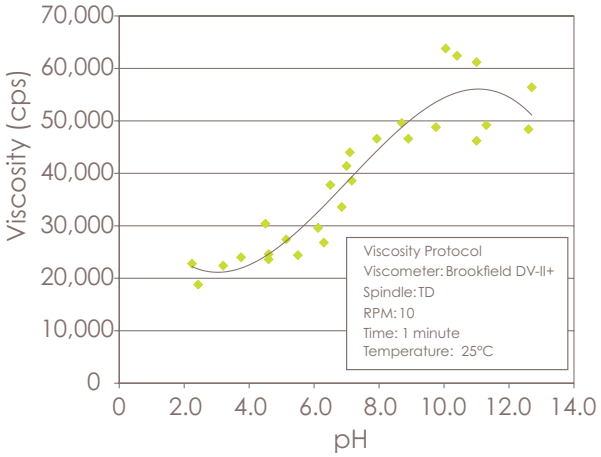
flexithix™

Polyvinylpyrrolidone

FlexiThix™ powdered rheology modifier is a cross-linked PVP (PVPP) that works under extreme conditions for aqueous or ethanolic or polar-oil based formulations. Capable of thickening aqueous and anhydrous formulations, rheology modifier is compatible with a wide range of ingredients, effective across a broad pH range (1-13) and has been shown to be stable with numerous solvents and acids. No neutralization is required.







disintex™ disintegrants

applications

– Tablet and granule disintegrants, high capillary activity and hydration capacity.

physical properties

physical properties	disintex™ 75 disintegrant	disintex™ 200 disintegrant
chemistry	PVPP	PVPP inert salt
particle size	75 µ	150 µ
use level	2%	2%
applications	– hard tablet – dish washing tabs	– hard tablet – dish washing tabs – water-softening tabs

chemistry

Disintex disintegrants are cross-linked homopolymers of vinylpyrrolidone (PVPP) and proprietary blends of PVPP, cellulose and/or inert salts. They are used extensively as disintegrants to accelerate release tablet active chemistries in laundry and dish washing detergent tablets, taking advantage of their swell volumes. The cross-linked PVPP homopolymers are highly hydrophilic and will rapidly absorb water on contact to swell and create internal stress points that will break up tablets.

polyplasdone™, polyclar™

Polyvinylpolypyrrolidone

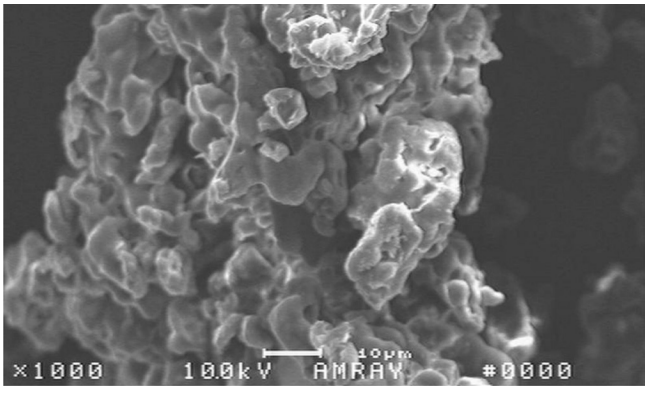
Polyplasdone, Polyclar and ViviPrint PS-10 polyvinylpolypyrrolidone (PVPP) are cross-linked homopolymers of vinylpyrrolidone (VP). These PVPPs are water-insoluble solids but retain many of the functional properties of polyvinylpyrrolidone (PVP). Many of the properties of PVPP are related to the unique pseudo cationic (zwitterionic) chemistry of pyrrolidone and effectively chemical complex phenolic and aromatic compounds (e.g. tannins, flavonoids and dyes within interior cavities) via hydrogen bonding and dipole interaction and adsorb a variety of materials including dyes, printing inks, aromatic species (e.g., polyphenols) and colors in wine. They have high capillary activity and hydration capacity. Surface area typically ranges 1 to 1.5 m2/g. Product grades range in D50 particle size from < 30 µm to > 200 µm. Smaller particle size grades (< 30 µm) can be used in digital printing applications with microporous silica as ink-receptive coatings to enhance drying of printed images, minimize impact on coating gloss, improve ease of formulation dispersion and reduce color variation and water resistance of printed images.

These highly crosslinked PVPPs are offered in a variety of particle size distributions, examples are summarized below.

product	particle size
polyplasdone™ INF-10	10u
viviprint™ PS - 10	15 - 20u
polyclar™ X - G	12 - 18u
polyclar™ V	25u

PVPP functionality

– disintegration
– dispersion
– complexation
– adsorption
– clarification

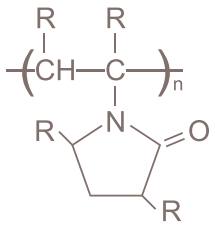


The copolymers of vinylpyrrolidone and a number of other vinyl monomers are described on the following pages. These products are used in applications that benefit from the unique characteristics of the pendant pyrrolidone ring in combination with the properties of the comonomers' functionalities.

ganex™/antaron™ polymers

alkylated polyvinylpyrrolidone

Sold as Antaron™ alkylated polyvinylpyrrolidone in Europe and Canada.



applications

Ganex™/Antaron™ alkylated PVP are relatively low molecular weight polymers varying in degree of hydrophobicity from water-soluble powder (P-904LC) to water-insoluble flaked solid (WP-660) and are useful in the following applications:

- emulsifiers and dispersants in nonaqueous systems
- desensitizer/wax dispersants in melt-cast explosives
- dye dispersants for candles and shoe polish
- water-resistant film formers in wood coatings
- kinetic inhibitors against hydrate formation in oilfield operations
- asphaltene dispersants
- pigment dispersants in solvent-based coatings and inks

physical properties

grade	copolymer composition[1]	Tg/ melting pt.	viscosity[2]	supplied as
P-904LC	90% VP, 10% C4 olefin	155°C	14 @ 25°C[(a)]	white powder
V-516	50% VP, 50% C16 olefin	150°C	300 @ 25°C[(b)]	50% active in IPA
V-216	20% VP, 80% C16 olefin	Melting Pt. 8.5°C	2500 @ 50°C[(c)]	viscous liquid
V-220	30% VP, 70% C20 olefin	Melting Pt. ~35°C	20M @ 80°C[(d)]	wax
WP-660[3]	20% VP, 80% C30 olefin	Melting Pt. ~63°C		flaked solid

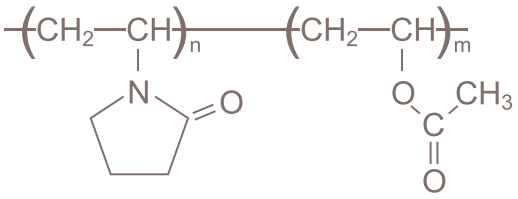
[1] VP= Vinylpyrrolidone, C4 alpha-olefin= 1-butene, C16 alpha-olefin= 1-hexadecene, C20 alpha-olefin= 1-eicosene, C30 alpha-olefin= 1-tricosene.
[2] Brookfield, cP: (a) RVT #2, 20 rpm/10% solids; (b) RVT #3, 20 rpm/as is; (c) RVT #2, 20 rpm/neat; (d) RVT #5, 20 rpm/neat.
[3] Material is not listed on the US EPA TSCA inventory.

chemistry

Ganex™/Antaron™ resins are copolymers produced from alpha-olefin and vinylpyrrolidone. The alkyl component varies from a C-4 to C-30 moiety in concentrations from 10 to 80%. The combination of vinylpyrrolidone and alkyl functionalities produces a balance of dispersing and waterproofing capacity in the Ganex™/Antaron™ line.

PVP/VA polymers

vinylpyrrolidone/vinyl acetate copolymers



applications

PVP/VA polymers produce transparent, flexible, oxygen-permeable films that adhere to glass, plastics and metals. These properties, coupled with the ability to control their hydrophilicity through monomer composition, enable extensive industrial use:

- in remoistenable hot melt adhesives
- in repulpable pressure sensitive adhesives where the water solubility of pvp/va s-630 facilitates recycling
- in hot melt adhesives for diaper wetness indicator systems
- as a binder for dry-film photoresists
- in solder masks utilizing aqueous processing
- in inkjet coatings for improved print receptivity
- as a seed coating

physical properties

PVP/VA grade	supplied as	~Mw	Tg (°C) low to high Mw range
E-335, -535, -635, -735	50% ethanol solution	29,000-57,000	69, 96, 106, 117
I-335, -535, -735	50% IPA solution	13,000-22,000	71, 89, 108
W-635, -735	50% aqueous solution	15,000-27,000	99, 114
S-630	dry powder	51,000	110

polymer	%VP
series	100
E-735 I-735 W-735	70
W-635 S-630	60
E-535 I-535	50
E-335 I-335	30

increasing humidity resistance, flexibility, cohesive strength

iincreasing water solubility, film hardness, adhesive strength, glass transition temperature and propane/butane solubility

chemistry

PVP/VA polymer resins are linear, random copolymers produced by the free-radical polymerization of the monomers in ratios varying from 70/30 to 30/70 vinyl acetate to vinylpyrrolidone.

PVP/VA polymers are thermoplastic resins with molecular weights ranging from approximately 15 M - 60 M. Their glass transition temperatures vary from 70 to 115°C and hydrophilicity increases with vinylpyrrolidone content.

PVP/VA polymers are available as white powders or clear solutions in ethanol, isopropanol and water. Polymers in the four ranges of vinylpyrrolidone content (30, 50, 60 and 70%), are produced in ethanol or isopropanol. PVP/VA polymers with 60 and 70% vinylpyrrolidone content are available as solids or as 50% aqueous solutions.

In addition to being soluble in alcohols, PVP/VA polymers dissolve in esters and ketones but are insoluble in ethers and aliphatic hydrocarbons. The water-soluble PVP/VA polymers exhibit a 5% aqueous cloud point, i.e., the 60% vinylpyrrolidone content resin has a minimum critical solution temperature of 68°C.

polectron™ 430/antara™ polymer

Sold as Antara 430 PVP/Polystyrene latex in Europe and Asia Pacific.

applications

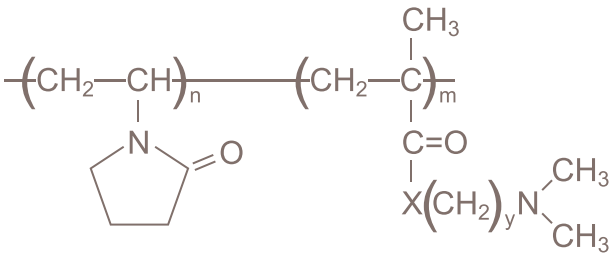
Polectron™ 430 polymer, with a glass transition temperature of approximately 100 °C, gives transparent thermoplastic films that readily adhere to glass, plastics and metals. The emulsion, compatible with many polymers and surfactants, is typically used as:

- an opacifier and thickener for cleaning products
- a hydrophobic coating for inkjet recording media
- an oil-resistant coating
- a cold-seal adhesive component

chemistries

Polectron™ 430 polymer is a white, thermoplastic, 38-41% solids latex produced as a graft, emulsion copolymer of 30% polyvinylpyrrolidone and 70% styrene in the presence of an anionic surfactant. The size distribution of the emulsion is such that 90% of the particles are <0.5 micron with a maximum 25°C viscosity of 750 cP @ pH 2.0-5.0. Polectron 430 polymer is thermally and mechanically stable in the presence of a variety of ionic compounds. The viscosity is unaffected after three freeze-thaw cycles between ambient and -20°C; the emulsion is unbroken at 25°C after 1/2 hr @ 10,000 rpm and does not coagulate on addition of 1% hydrochloric acid, calcium chloride, alum or sodium borate.

vinylpyrrolidone/alkylaminomethacrylate and alkylaminomethacrylamide copolymers



when X=O, y=2
when X=N, y=3

applications

These polymers have a number of unique properties such as substantivity to anionic materials that make them useful as:

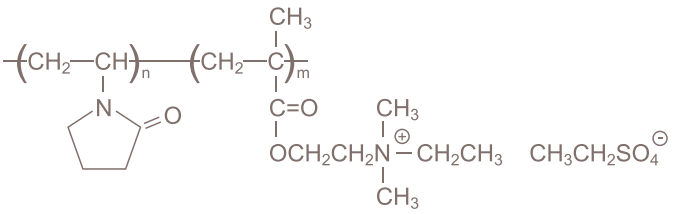
- dye receptors in inkjet and digital printing media
- adjuvants for electrodeposition of copper in printed circuit board fabrication

chemistries

The copolymers of vinylpyrrolidone and dimethylaminoethyl-methacrylate (VP/DMAEMA, X=O, y=2) or vinylpyrrolidone and dimethylaminopropyl-methacrylamide (VP/DMAPMA, X=N, y=3) are supplied as viscous solutions in either water or ethanol. These polymers serve to a great extent as precursors for cationic polymers through quaternization reactions on the pendant tertiary amino function. They are described on the following pages.

sorez™ HS-205, gafquat™ and copolymers

Vinylpyrrolidone/dimethylaminoethylmethacrylate copolymers (VP/DMAEMA)



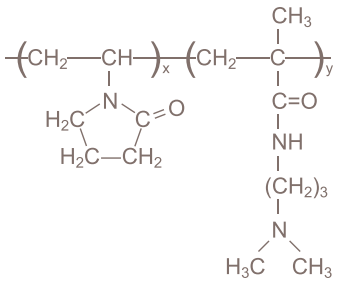
Two VP/DMAEMA copolymers are quaternized with diethylsulfate-producing Gafquat 755/755N and Gafquat™ 734 VP/DMAEMA, which give transparent, glossy, tack-free, flexible films. The polymers are substantive to negatively charged surfaces and compatible with anionic and amphoteric surfactants. They have good adsorption properties with anionic dyes and pigments to enhance digital ink media. These copolymers are cross-linkable with aziridine and epoxides.

physical properties

product	solution	Mw[1]	Tg	Brookfield viscosity[2]
copolymer 845	20% H_2O	1,000,000	172°C	20,000-70,000
gaffix™ 6443	20% H_2O	400,000	172°C	10,000
copolymer 937	20% H_2O	1,000,000	104°C	20,000-70,000
copolymer 958	50% ethanol	80,000-150,000	100°C	60,000-90,000
gafquat™ 755/755N VP/DMAEMA	20% H_2O	1,000,000	155°C/149°C	20,000-70,000
gafquat™ 734 VP/DMAEMA	50% ethanol	60,000-110,000	140°C	30,000-70,000
sorez™ HS-205 VP/DMAEMA	20% H_2O	1,000,000	172°C	20,000-70,000

[1] Determined by GPC using polyethyleneoxide standard.
[2] cP as is, @ 22-23 °C, RVT #7, 30 rpm.

styleze™ CC-10 and setleze™ 3000 (viviPrint™ 131) copolymers



Vinylpyrrolidone/dimethylaminopropyl-methacrylamide copolymer

applications

- digital printing media
- settling agent for hard-surface cleaner (setleze™ 3000 vinylpyrrolidone/dimethylaminopropylmethacrylamide copolymer)

physical properties

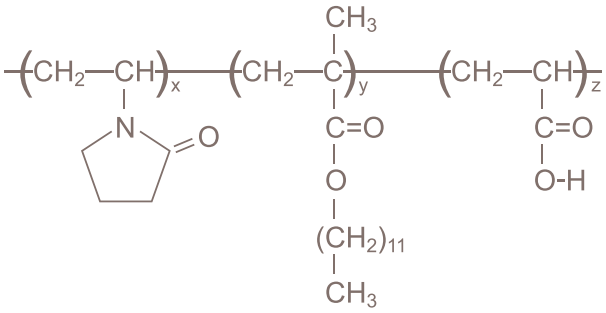
properties	styleze™ CC-10 vinylpyrrolidone/dimethylaminopropyl-methacrylamide copolymer	setleze™ 3000 (ViviPrint 131) vinylpyrrolidone/dimethylaminopropyl-methacrylamide copolymer
% solids	10%	10.0 – 12.0%
solvent	water	water
pH (as is)	6.0-8.0	6.5-7.8
viscosity (cP)	10,000-35,000	6,000-24,000
Mw	1,200,000-1,500,000	1,500,000-2,000,000
nanoparticles	No	Yes
neutralized	H_2SO_4	HCl
Tg	161°C	167°C

chemistries

These high molecular weight copolymers have a strong affinity for anionically charged substrates, which can be further enhanced through quaternization. They produce transparent, flexible, high-gloss coatings with improved water resistance. Cross-linking significantly improves water resistance. Presence of the amide linkage imparts greater hydrolysis resistance. Compatible with nonionic, cationic and amphoteric surfactants, soluble in ethanol and water, insoluble (Styleze™ CC-10 vinylpyrrolidone/dimethylaminopropylmethacrylamide copolymer) and partially soluble (Setleze™ 3000 vinylpyrrolidone/dimethylaminopropylmethacrylamide copolymer) in acetone. Setleze™ vinylpyrrolidone/dimethylaminopropylmethacrylamide copolymers are produced by a proprietary in-situ process resulting in a two-phase matrix consisting of soluble copolymer and nanoscale particles approximately 320 nm in size that impart improved water resistance, light fastness and curl resistance in digital media applications.

styleze™ 2000 and **acrylidone™ LM** polymers

vinylpyrrolidone/acrylic acid/lauryl methacrylate terpolymer



Acrylidone is not available in Europe.

applications

- high-efficacy styling gels
- rinse aid in automatic dish detergents
- metal quenching
- inkjet-receptive media

physical properties

physical form ..... white free-flowing powder

molecular weight ..... 1,010,000 (MALLS)

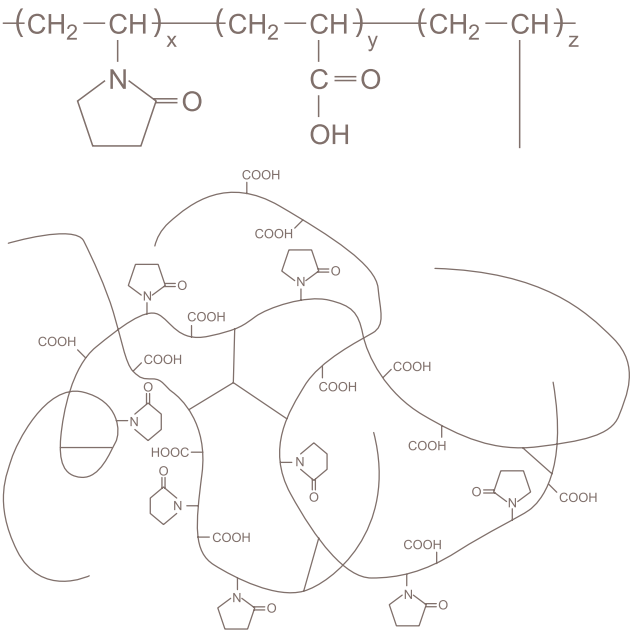
Tg ..... 176°C

chemistries

Styleze™ 2000 is a high molecular weight, film-forming anionic terpolymer composed of vinylpyrrolidone and an acrylate backbone with a hydrophobic pendant C-12 chain. It is insoluble in ethanol and water until neutralized for easy dispersion. It exhibits synergistic thickening when combined with associative rheology modifiers.

ultrathix™ P-100 crosspolymer

acrylic acid/VP crosspolymer



applications

- clear gels
- emulsion stabilizers

physical properties

physical form ..... white, powder

acid number 340-390

viscosity (1% aq., 75% neutralized) ..... 35,000-65,000 cP

chemistries

UltraThix™ P-100 is an anionic polymer. It is a shear-thinning rheology modifier with high Brookfield yield to suspend solids. Compatible with anionic, nonionic and some cationic polymers.

vinylcaprolactam polymers

applications

Vinylcaprolactam-derived polymers give hard, glossy transparent films with excellent adhesive and cohesive properties. These products are also available in 2-butoxyethanol for application as kinetic gas hydrate inhibitors. The polymers also find use in many of the markets noted for polyvinylpyrrolidone. In general, vinylcaprolactam imparts reduced water solubility and cloud point relative to vinylpyrrolidone-based polymers while enhancing the hydrophobicity of the resin.

V-Cap™ and V-Pyrol™ copolymers are available as kinetic hydrate inhibitors to interact with crytsal growth sites to delay hydrate nucleation in offshore production systems and to facilitate uninterrupted flow in natural gas field pipelines at varying environments defined by brine content, temperature, pressure, composition and residence time from field to collection point. They are cited below as Inhibex™ polymers.

physical properties

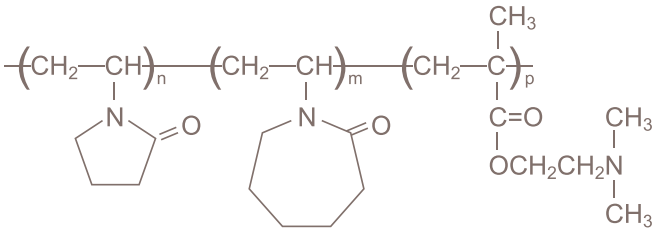
polymer	monomer composition	solution	Mw[1]	viscosity[2]
inhibex™ 501	50% VCL/ 50% VP	50% butoxyethanol	5,000-8,000	3,000-6,000
inhibex™ 101	v-cap™	50% butoxyethanol	1,000-5,000	2,000-3000
inhibex™ 901	95% VCL/ 5% VP	50% butoxyethanol	2,000-4,000	3,000-6,000
gaffix™ 6473	98% v-cap™	20% in water	50,000	100-300

[1] Determined by GPC using polyethylene oxide standard.
[2] Brookfield cP, as is, @ 25°C, RVT #3, 20 rpm.

gaffix™/copolymer VC-713/advantage™ S polymers

vinylpyrrolidone/vinylcaprolactam/ dimethylaminoethylmethacrylate terpolymer

Sold as Gaffix™ VC-713 vinylpyrrolidone/vinylcaprolactam/ dimethylaminoethylmethacrylate terpolymer in North America.



Advantage S. Advantage S is offered as a powdered Gaffix VC-713

applications

- gas hydrate inhibition
- flocculating agent
- film former in hair styling products
- inkjet-receptive media

physical properties

physical form*..... viscous ethanol solution

molecular weight..... 82,700

Tg..... 152°C

solids* .....35 - 39%

*advantage™ S is 100% active solid

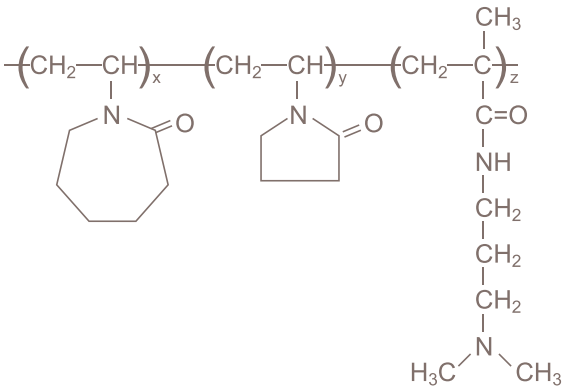
chemistry

Vinylcaprolactam imparts increased hydrophocity and reduces tack. Water-soluble film former, pseudo cationic functionality, substantive to negatively charged surfaces. Quaternization yields cationic polymer; compatible with anionic, nonionic and cationic surfactants, silicones and thickeners.

chromabond™ SF-40*

Sold as aquaflex™ sf-40 polymer in Europe and Asia Pacific.

vinylcaprolactam/vinylpyrrolidone/
dimethylaminopropylmethacrylamide terpolymer



applications

- film-forming polymer in hair styling products
- inkjet-receptive media

physical properties

physical form ..... clear solution

molecular weight 37,500

Tg ..... 119°C

% solids 40

solvents ..... ethanol

viscosity ..... Brookfield 1,500 cps

chemistry

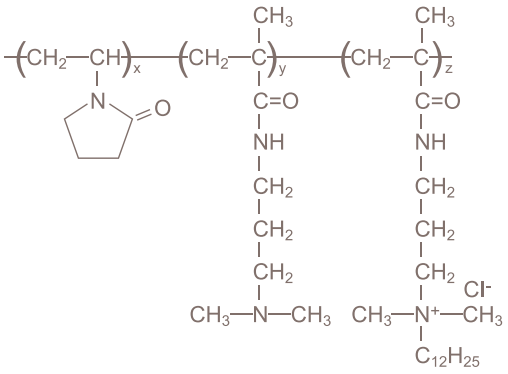
Transparent, flexible glossy films; pseudo cationic, substantive to negatively charged surfaces; quaternization yields cationic polymer; decreased tackiness and improved hydrocarbon compatibility due to V-Cap™ reactive monomer; water- and ethanol-soluble.

cationic vinylpyrrolidone copolymers

Ashland manufactures cationic co and terpolymers of vinylpyrrolidone/ methacrylamidopropyl trimethylammonium chloride (MAPTAC) which produce transparent, glossy and tack-free flexible films and are substantive to negatively charged surfaces. They are used as thickening agents and film-forming polymer in hair styling products and inkjet-receptive media. However, **these co and terpolymers are not listed on the US EPA TSCA inventory.**

styleze™ W polymers

vinylpyrrolidone/dimethylaminopropyl-
methacrylamide/methacryloylaminopropyl lauryl
dimethyl ammonium chloride terpolymer



physical properties

physical form ..... slightly hazy aqueous solution

solids content 10% (W-10), 20% (W-20)

pH (as is) 3.5-5.0

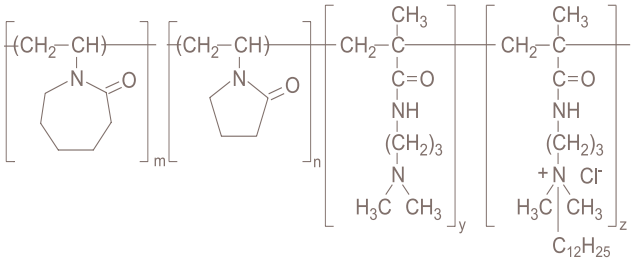
viscosity ..... <5000 cP (W-10)
40,000-100,000 cP (W-20)

molecular weight 2,700,000

Tg ..... 135°C

aquastyle™ 300 tetrapolymer

Tetrapolymer of vinylpyrrolidone, vinylcaprolactam, dimethylaminopropylmethacrylamide and methacryloylaminopropyl lauryl dimethyl ammonium chloride



physical properties

physical form .....aqueous-alcoholic viscous liquid

% active .....~30%

relative viscosity ..... 1.90 - 2.35
(1% in 0.2 N $LiNO_3$)

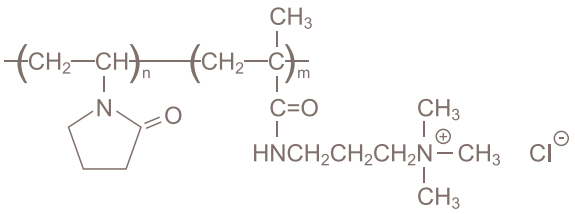
molecular weight.....~35,000

Tg..... 160°C

cloud point..... 46°C (4% solids in aqueous solution)

gafquat™ HS-100 polymers

Vinylpyrrolidone/methacrylamidopropyl trimethylammonium chloride copolymer

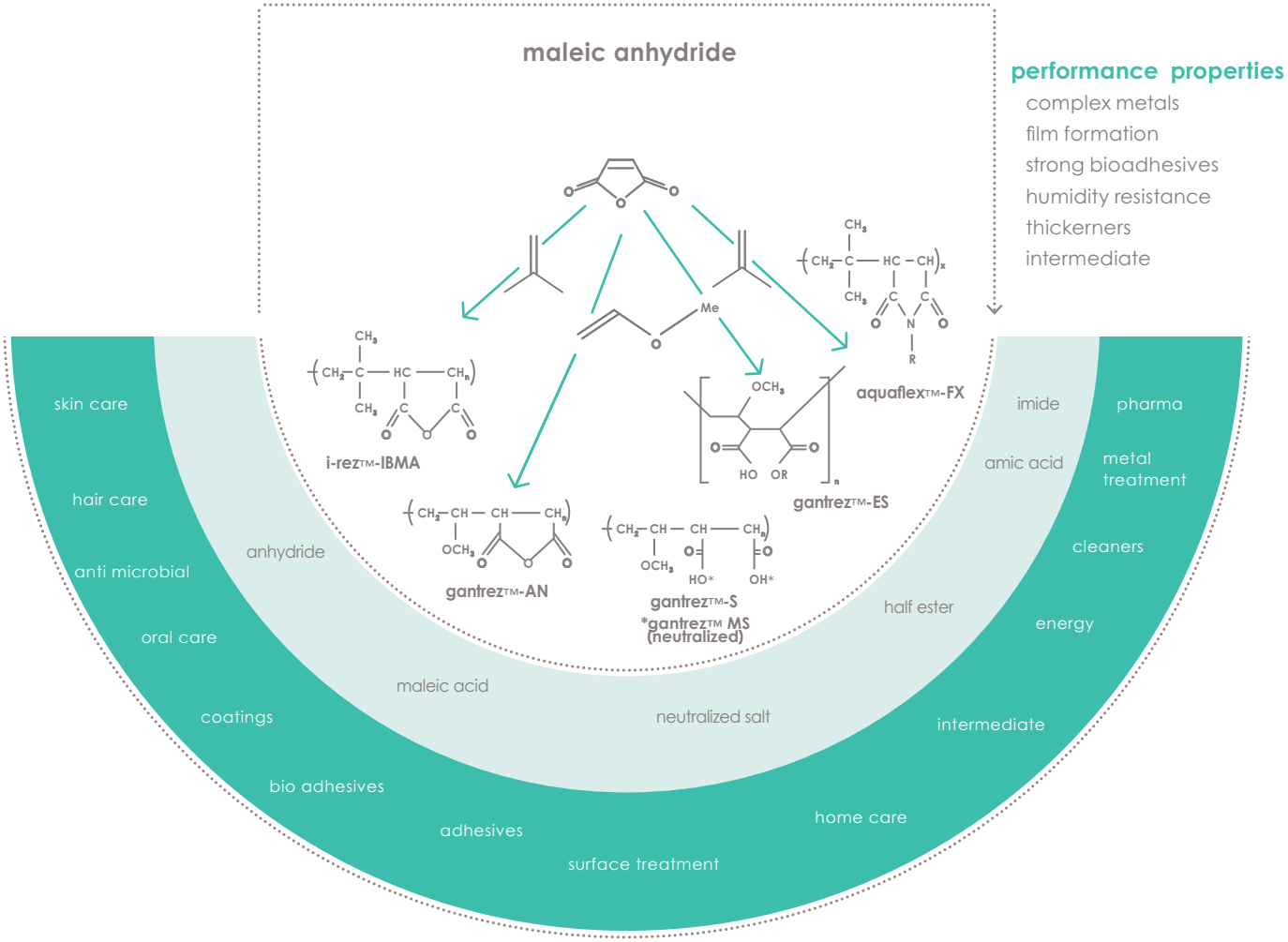


physical properties

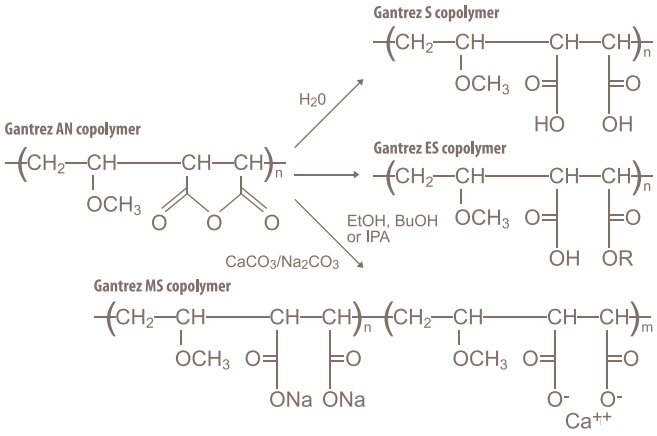
product	solution	Mw[1]	Tg	Brookfield viscosity[2]
gafquat™ HS-100 vinylpyrrolidone/ methacrylamidopropyl trimethylammonium chloride opolymer	20% H_20	900,000-1,200,000	184°C	50,000-125,000

[1] Determined by GPC using polyethyleneoxide standard.
[2] cP as is, @ 22-23 °C, RVT #7, 30 rpm.

performance polymers / maleic based polymers



gantrez™ copolymers



gantrez™ AN copolymers

polymethylvinylether/maleic anhydride copolymer

applications

Because of their unique chemical structure and reactivities, Gantrez copolymers function well as:

- dispersants for fluorescent light phosphors
- microcapsule clusterants in carbonless paper and latex systems
- complex coacervates with gelatin to form the microcapsule wall in carbonless paper
- calcium encrustation inhibitors in laundry detergents
- acid layers in diffusion transfer film to neutralize alkaline developers and dyes
- intermediates in adhesive applications and liquid laundry detergent stabilizers
- imide derivatives for anti-reflective layers on silicon wafers prior to photoresist coating and light exposure
- gas fade inhibitors for spandex* fibers
- water retention aids in concrete
- metal sequestrants
- anionic polyacids
- glue stick

physical properties:

grade	viscocity[1]	molecular weight[2]
AN-119	0.1-0.5	130,000
AN-139	1.0-1.5	690,000
AN-169	2.6-3.5	1,980,000

[1] cSt 1% in MEK @ 25°C, Cannon Fenske, tube size 100.
[2] Mn, SEC/LALLS detector.

Reaction of the anhydride functional group with essentially any molecule having an "active hydrogen" opens a wealth of opportunities to synthesize useful derivatives.

chemistry

Gantrez™ AN copolymers contain alternating units of methylvinylether and maleic anhydride. The fundamental character of this polymerization requires that a maleic anhydride unit must be adjacent to a methylvinylether unit and vice versa, resulting in a true alternating copolymer. As shown in the table above, Gantrez™ AN (anhydride form) copolymer is available in the molecular weight range of 0.13 M-2.5 M. The polymers are white hygroscopic powders soluble in tetrahydrofuran and M-Pyrol™ solvent; they are insoluble in aliphatic and halogenated hydrocarbons. All four grades have a glass transition temperature of 151-154 °C, independent of molecular weight, and form transparent, tack-free films.

gantrez™ S copolymers

poly(methylvinylether/maleic acid) copolymer

applications

- calcium encrustation inhibitors in laundry detergents
- dispersant aids
- aluminum surface conditioning
- diagnostic test strips
- base-activated adhesives for peel-apart instant film
- oral care (e.g. toothpastes / mouthwashes)
- metal coating

chemistry

Gantrez™ S-97 copolymer has repeating co-maleic acid units produced by hydrolysis of Gantrez™ AN copolymer. The polycarboxylic acid derivatives with a pH of ~2 at 5% concentration are available either as viscous solutions or white powders. The vicinal dicarboxylic acid functionality of these materials is useful in a number of applications. The free acid forms are water-soluble, giving clear and tacky films. Solution rheology can be modified by the addition of salts and bases.

gantrez™ S series	molecular weight (Mw):
gantrez™ S-97	1.5M

gantrez™ MS copolymers

poly(methylvinylether/maleic acid) mixed-salts copolymer

applications

- gioadhesives
- inkjet coatings

chemistry

Gantrez™ MS-955 copolymer is a mixed salt of sodium/calcium and is supplied as a free-flowing powder. The copolymer is soluble in water and produces solutions with high viscosity.

gantrez™ ES copolymers

poly(methylvinylether/maleic acid) half esters copolymer

applications

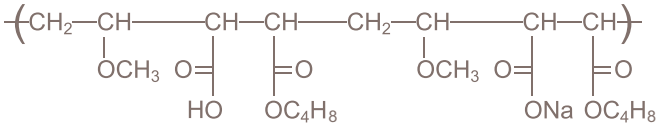
- pigment dispersants in cosmetic formulations
- ph-dependent soluble films (enteric coatings
- good adhesive strength, bio-adhesive
- substantive
- rust protectant

chemistry

Ethyl, and n-butyl half esters, Gantrez™ ES-225 and ES-425 are produced by opening up the anhydride in alcohol. These polymers, based on Gantrez™ AN-119 copolymer, are sold as 50% solutions in ethanol. They are water-soluble when neutralized greater than 40% using either an organic or inorganic base. Adhesive strength can be adjusted through controlling the degree of neutralization. Films are flexible, clear and glossy and have improved water resistance compared to Gantrez™ S copolymer.

easysperse™ polymeric dispersant range

polymethylvinylether/maleic acid -butyl ethyl ester, sodium salt



applications

- dispersants for hydrophobic insectides, fungicides, herbicides
- dispersants for hydrophobic organic compounds (fragrances, emollients, essential oils, etc.)

chemistry

EasySperse™ dispersant is a copolymer of the monobutyl/ethyl ester of poly (methyl vinyl ether/ maleic acid) partially neutralized with sodium hydroxide. The material is supplied as a 25% aqueous solution and is an excellent film former.

stabileze™ **QM** polymer

methylvinylether/maleic anhydride coploymer crosslinked with decadiene)

applications

Stabileze™ rheology modifiers yield clear, aqueous gels that are shear-thinning and slightly thixotropic, having good shear, temperature and UV-A radiation stability. Stabileze™ crosspolymer is effective as a rheology modifier for:

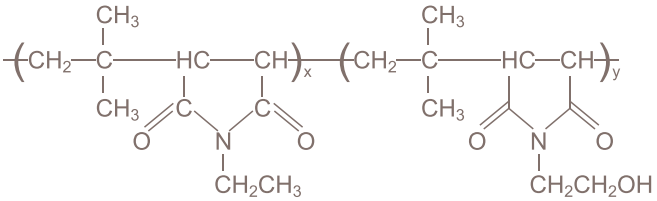
- thickeners
- coatings and inks
- sealants
- electroconductive gels
- deicing fluids
- pigment dispersants

chemistry

Stabileze™ QM polymer is produced in a manner similar to that of Gantrez™ AN copolymer but with the added monomer decadiene present to yield a crosslinked, water-swellable resin. The polymer is a white free-flowing powder with a glass transition temperature of approximately 150°C. The solid can be dispersed in water without coagulating, and the anhydride function will hydrolyze directly or through the action of base. A neutralized 0.5% solution in water at pH 7 and 25°C has a viscosity range of 45,000-70,000 cP.

aquaflex™ FX-64 copolymer

isobutylene/ethylmaleimide/
hydroxyethylmaleimide copolymer



applications

- film formers
- adhesive/cohesive properties

physical properties

physical form .....yellow viscous liquid

molecular weight.....39,000

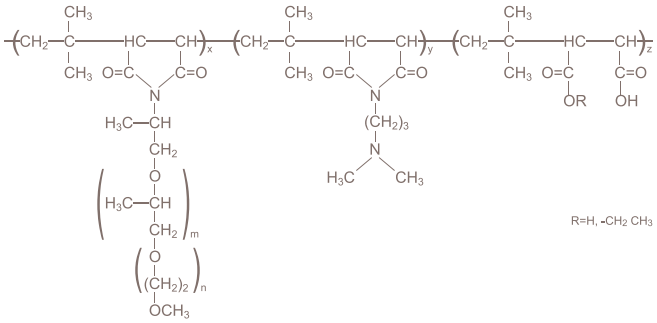
Tg..... 135°C

chemistry

Aquaflex™ FX-64 copolymer is an imidized isobutylene/maleic anhydride copolymer that produces low-tack, glossy films supplied as 40% hydroalcoholic solution. (Material is not listed on the US EPA TSCA inventory.)

aquaflex™ XL-30 copolymer

isobutylene/dimethylaminopropyl maleimide/
ethoxylatedmaleimide/maleic acid copolymer



applications

- film formers
- flexible coatings with low coefficient of friction

physical properties

physical form..... straw-like hazy, viscous aqueous solution

molecular weight..... 86,000

chemistry

Aquaflex™ XL-30 copolymer is an isobutylene dimethylaminopropylmaleimide/ethoxylated maleimide/maleic anhydride copolymer that produces highly flexible, glossy and humidity-resistant films and forms clear gels with anionic rheology modifiers. (Material is not listed on the US EPA TSCA inventory.)


Ashland
always solving
efficacy
usability
allure
integrity
profitability
I'm a solver.

cellulosics and derivatized natural polymers

overview

performance polymers

The largest families of polymers produced by Ashland are based on n-vinyl-2-pyrrolidone and cellulose ethers.

cellulose ethers

Cellulose ethers are divided into ionic and nonionic types. The ionic cellulose ethers, **Aqualon™/Blanose™/ Bondwell™/AquaVIS™** sodium carboxymethylcellulose, contain substituents that are anionic electrically charged. Nonionic cellulose ethers include **Natrosol™** hydroxyethylcellulose, **Benecel™** and **Culminal™** methylhydroxyethylcellulose, methylcellulose and methylhydroxypropylcellulose, **Klucel™** hydroxypropylcellulose and **Aqualon™** ethylcellulose and carry electrically neutral substituents. Nonionic cellulose ethers can be further classified by their solubility in cold, warm or hot water, and in organic solvents.

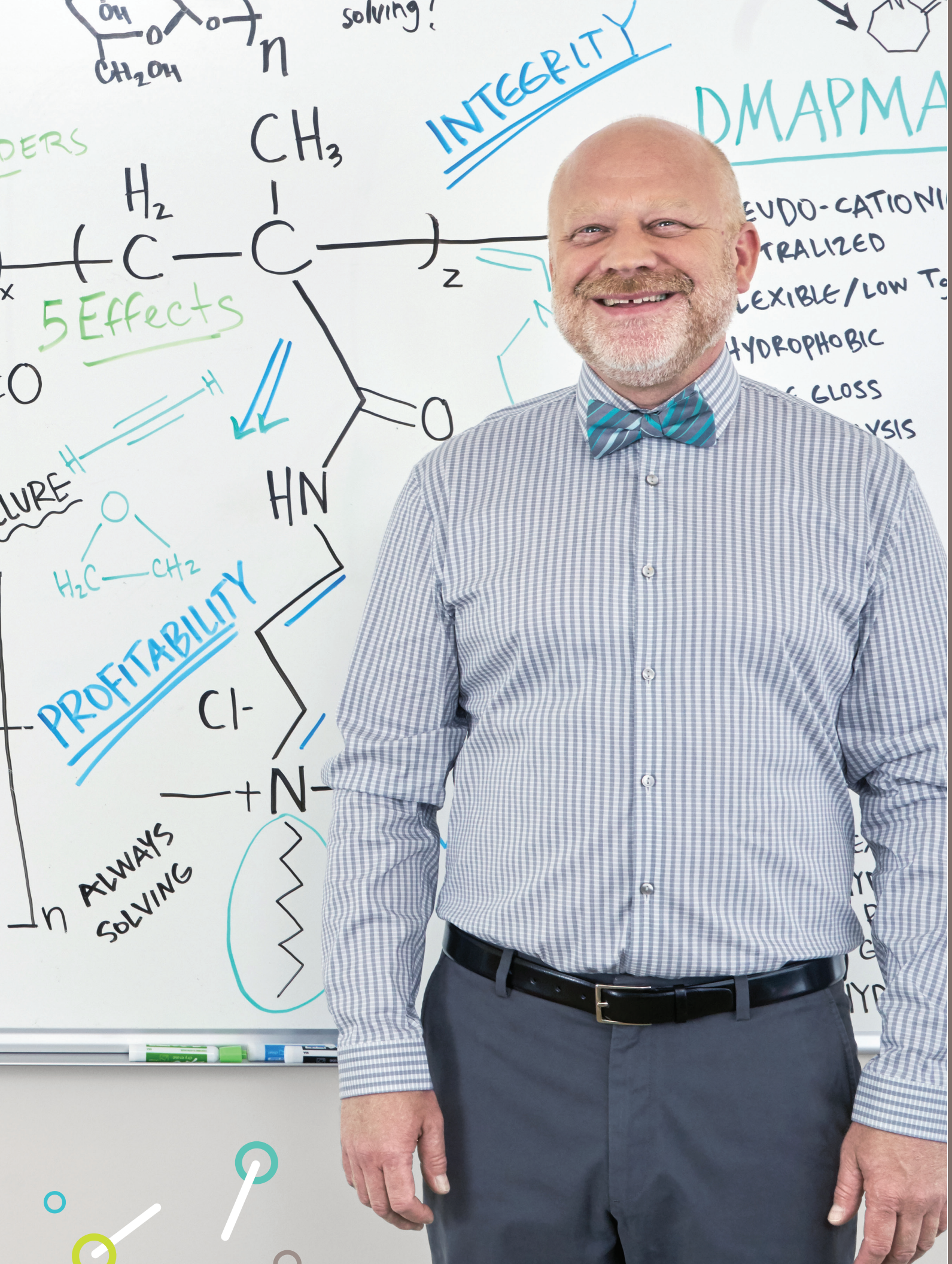
Cellulose is a polysaccharide composed of anhydroglucose units, which are linked through beta-glycosidic bonds. The number "n" of anhydroglucose units in the polymer chain is defined as the degree of polymerization (DP).

Each anhydroglucose ring carries three free-OH groups at positions 2, 3 and 6. Ethers of cellulose are formed by substituting one or more of the three hydroxyl groups. The distribution of the substituents introduced onto the polymer chain is largely determined by the relative reactivity of these three-OH groups.

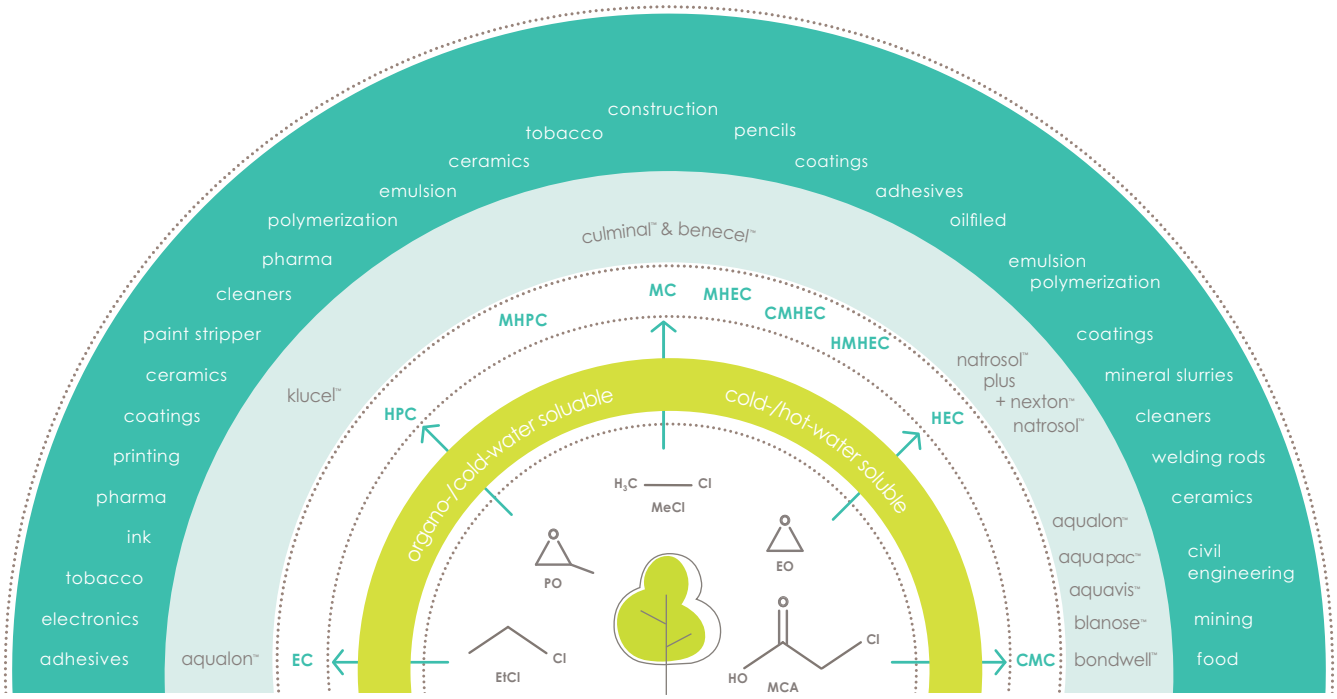
The averaage number of substituted hydroxyl groups per anhydroglucose unit is expressed as DS or average degree of substitution. The DS can vary between 0 and 3. In the case of alkoxylation, the molar ratio of alkoxy groups in the side chains to cellulose is specified and expressed as the average molecular substitution (MS). Instead of DS and MS, the weight percent of the substituents in the cellulose ether is often quoted. The use of one etherification agent in the substitution process results in a simple cellulose ether, whereas using different kinds of agents leads to mixed ethers. Industrial cellulose ethers are alkyl, alkylhydroxyalkyl, hydroxyalkyl and carboxyalkyl ethers.

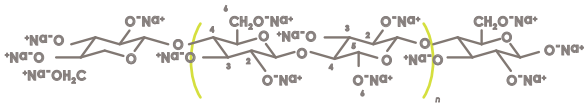
guar derivatives

Galactasol™ polymers are based on modified or derivatized guar gum, a polysaccharide produced from the seed of guar, a leguminous plant. Guar gum contains a linear mannose chain with side chain galactose sugars. Ashland Aqualon™ has a range of derivatized guars types modified with various nonionic, anionic and cationic functionalities. These functionalities provide enhanced performance attributes to the guar polymer.


INTEGRITY
DMAPMA
5 Effects
PROFITABILITY
ALWAYS SOLVING
HYDROPHOBIC
GLOSS
Cl-

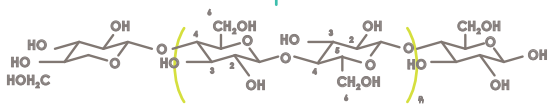
performance polymers / cellulosics





alkali cellulose

NaOH



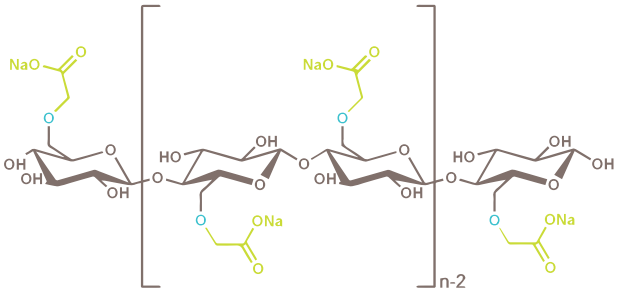
cellulose

performance properties

thickening
suspension
flow/leveling
water retention
colloid stabilization
film formation
adhesive strength
binding / stabilizing
surface activity
crystal growth modification

bondwell™, blanose™, aqualon™

carboxymethylcellulose



CMC is a cellulose ether, produced by reacting alkali cellulose with sodium monochloroacetate under controlled conditions. It is an anionic water-soluble polymer.

applications

markets	applications	product types or functions
batteries / electronics	lithium ion batteries, carbon dispersant	binder, film former, dispersant
civil engineering, building and construction		rheology modifier, suspension agent, binder, water flow blocking agent
commercial and institutional - light industry	industrial cleaners	anti-redeposition aid, rheology controller
mining and extraction	mineral processing, mining	selective flotation depressant, pellet binder, mineral dispersant
adhesives and sealants	adhesives and sealants	suspension agent, thickener, film former
advanced ceramics	granulation, dry pressing, slip/tape casting, extrusion	binder (plasticizer and green strength), rheology modifier, controlled water release, suspension agent
ceramics, pottery and porcelain	ceramic glazes, traditional ceramics	binder, film former, rheology modifier, suspension agent, thickener, water-retention agent
foundries and refractories	refractories	binder, green strength enhancer, rebound or sumping reducer, stabilization agent
housewares and consumer	freezer gel	gel enhancer, rheology modifier, stabilization agent, thickener
textiles	textiles	film former, rheology modifier, sizing agent, thickener
tobacco	reconstituted tobacco, leaf glue	binder, suspension agent
pulp and paper	paper, paper coatings, pigment slurries	rheology modifier, suspension and stabilization agent, thickener, water-retention enhancer

physical properties

CMC category		DS type			viscosity limits, mPa•s @ 25 °C	
grade	type	7	9	12	range	concentration
L	ultra low	7UL		12UL	10 - 25	6%
	extra low	7EL			20 - 60	6%
	low-low	7L1			90 - 130	6%
	low-medium	7L2			150 - 250	6%
		7L3			400 - 750	6%
	low-high	7L			25 - 50	2%
M	medium-low	7M1			50 - 100	2%
		7M2	9M2		100 - 200	2%
	medium	7 M			300 - 600	2%
		7M8	9M8	12M8	200 - 800	2%
	medium-high	7M31	9M31	12M31	1500 - 3100	2%
		7M65	9M65		3000 - 6500	2%
H	high-low	7H			1500 - 2500	1%
	high	7H4	9H4		2500 - 4500	1%
		7H5S			3500 - 5500	1%
	high-high	7H9			4000 - 9000	1%

It is a derivatized cellulose. These, in turn, are composed of two anhydroglucose units (ß-glucopyranose residues). In this structure, n is the number of anhydroglucose units (which are joined through 1,4 glucosidic linkages), or the degree of polymerization, of cellulose.

Each anhydroglucose unit in the polymer contains three hydroxyl groups. By substituting carboxymethyl groups for some of the hydrogens of these hydroxyls, as shown in the figure, sodium carboxymethylcellulose is obtained. The average number of hydroxyl groups substituted per anhydroglucose unit is known as the "degree of substitution," or DS. For example, DS Type "7" has a DS of 0.7. If all three hydroxyls are replaced, the maximum theoretical DS of 3.0 (impossible in practice) results.

Polymers with higher MW and lower DS tend to be exhibit greater non-Newtonian properties and lower MW with higher DS more Newtonian. CMC can also be cross-linked with multi-valent metals to create gels.

aquasorb™ A200, A380, A500 and **A800** CMC

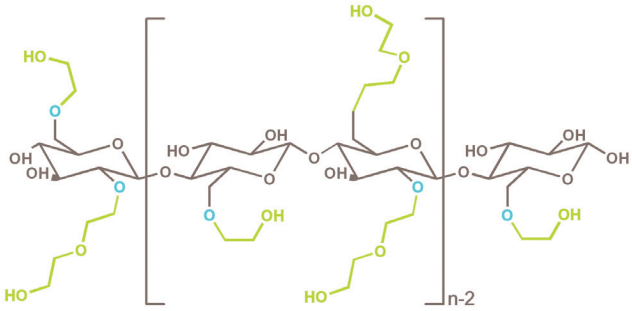
AQUASORB sodium carboxymethylcellulose is a high purity, high molecular weight powdered superabsorbent. It is used in industrial, food, medical, personal care and many other products, that require high absorbency of aqueous fluids. AQUASORB sodium carboxymethylcellulose is physiologically inert and is available in various particle sizes.

applications

- underground electrical cable casings
- bakery products, to control water content in dough to improve shelf life and to increase volume.
- wound dressings and ostomy products
- baby diapers
- adult incontinence pads
- meat packaging

natrosol™, natrosol™ B, batrosol™ plus

hydroxyethylcellulose and hydrophobically modified hydroxyethylcellulose



Natrosol™ hydroxyethylcellulose (HEC), a nonionic, a sustainable raw material, is a white, free-flowing granular powder. Solutions of Natrosol™ HEC are generally pseudoplastic or shear-thinning. Shear thinning behavior increases with increasing molecular weight. Natrosol™ HEC is easily dissolved in cold or hot water to give crystal-clear solutions of varying viscosities. Furthermore, low to medium molecular weight types are fully soluble in glycerol and have good solubility in hydro-alcoholic systems containing up to 60 percent ethanol. Natrosol™ HEC is generally insoluble in organic solvents.

chemistry

The Natrosol™ HEC is a water-soluble polymer based on wood or cotton cellulose, a sustainable starting polymer. The cellulose molecule is comprised of anhydroglucose units. By treating cellulose with sodium hydroxide and then ethylene oxide, the ethylene oxide reacts at the hydroxyls in the cellulose chain and can polymerize to form a side chain. The average number of moles of ethylene oxide attached to each anhydroglucose unit in the cellulose, is called moles of substituent or MS. Natrosol™ 250, which has optimum solubility in water, typically has an MS of approximately 2.5.

Selection of appropriate Natrosol™ HEC grade starts with molecular weight and MS. Natrosol HEC can be further modified. "B" grades modify substitution pattern of the ethylene oxide to improve biostability and enhance resistance to enzymatic degradation. Natrosol™ HEC "R" Grades are treated to provide a powder that displays improved dispersion and dissolution properties without lumping when added to water. This treatment does not alter the solution viscosity.

applications

markets	applications	product types or functions
building and construction	external insulation and finishing systems (eifs), joint compound, spray textures, tile adhesives, caulks and sealants,	bond strengthener, lubricity and workability enhancer, rheology modifier, stabilizer, suspension agent
commercial and institutional	fiberglass, industrial cleaners	formation aid, rheology controller, thickener
adhesives and sealants	wallpaper adhesives latex adhesives plywood adhesives	thickening and lubricity thickening and water-binding thickening and solids holdout
advanced ceramics	extrusion and slurries	suspension agent, extrusion binder
ceramics, pottery and porcelain	glazes, engobes	suspension agent, rheology modifier
paint and coatings	emulsion polymerization, waterborne architectural coatings	protective colloid, surface activity, rheology modifier
energy / civil engineering	hydraulic cements cement slurries, completion/workover fluids	cement extender, filtration control additive, rheology modifier
emulsion and suspension polymerization	pvac and acrylic latices, pvc suspension, styrene polymerization	protective colloid and surface activity, suspension polymerization
paper	paper coatings, size press solutions	water-binding and rheology control, water-binding and solids holdout
textiles	latex-back sizes glass-fiber size printing pastes	thickening film-former thickening and water-binding
binders	welding rods ceramic glaze foundry cores	water-binding and extrusion aid water-binding and green strength water-binding

natrosol™ HEC, natrosol™ B HEC (continued)

viscosity specification of Natrosol™ (mPa•s) at 25 °C

B-types[1]	non-B	non-R	viscosity measured at a concentration of			Brookfield LVF setting		molecular weight[2]
			1%	2%	5%	spindle	RPM	
–	HHR-P*	–	5,000-6,500	–	–	4	30	1.3 x 106
HHBR	HHR	HH	3,400-5,000	–	–	4	30	1.3 x 106
H4BR	H4R		2,600-3,300	–	–	3	30	1.1 x 106
HBR	HR	H	1,500-2,500	–	–	3	30	1.0 x 106
MHBR	MHR	–	1,000-1,500	–	–	3	30	–
MBR	MR	M	–	4,500-6,500	–	4	60	7.2 x 105
–	KR	–	–	1,500-2,500	–	3	30	–
–	GR**	G	–	250-450	–	2	60	3.0 x 105
–	–	E	–	25-105	–	1	30	–
–	JR	–	–	–	250-400	2	60	–
–	–	J	–	–	150-400	2	60	–
–	LR	L	–	–	100-180	1	30	9.0x 104

[1] B-biostable grade.
[2] molecular weight is estimated or calculated from intrinsic viscosity measurements.
* 210HHR 1% viscosity 6,000 - 8,000cps
** also available as Natrosol™ 180GR (180 - 500cps)

natrosol™ plus, natrosol™ HE 3KB and natrosol™ HE 10K

Natrosol™ Plus, Natrosol™ HE 3KB and Natrosol™ HE 10K are nonionic water-soluble polymers, hydrophobically modified hydroxyethylcellulose (HMHEC). The hydrophobic modification consists of long-chain alkyl groups chemically bound to the polymer. The physical properties of unmodified HEC and HMHEC contribute increased solution viscosity and altered rheological properties.

natrosol™ plus HMHEC physical properties

physical form ..... white to off-white powder

moisture, max 5%

ash, max[1] 10%

particle size, on U.S. 40, max 10%

viscosity, 1% in water[2] grade 330 ..... 150-750 cP

solution appearance ..... clear

solution pH 6.0-8.5

physical properties

grade	natrosol™ plus 330	natrosol™ plus 550	natrosol ™ HE10K
physical form	white to off-white powder		
moisture, max	5%		
ash max[1]	8%	8%	5%
particle size, on U.S. 40	10%		
viscosity, 1 % solution	150–750 cP	7,000–11,000	9,000–16,000
solution appearance	clear		
solution pH	5.5–8.5		

[1] calculated as Na_2S0_4.
[2] Brookfield at 6 rpm.

Hydrophobically modified HEC builds viscosity through hydrogen bonding with water molecules (as with traditional cellulosics), chain entanglement and association of the hydrophobic groups. Aqueous solutions of Natrosol™ Plus, Natroso™l HE 3KB and Natrosol™ HE 10K are highly pseudoplastic (shear-thinning), with Natrosol™ HE 10K most pseudoplastic as a result of association of the hydrophobes. This association breaks down under shear, and viscosity drops quickly. The amount of pseudoplasticity is greater for Natrosol™ Plus, Natrosol™ HE 3KB and Natrosol™ HE l0K than for Natrosol™. Unlike aqueous solutions, aqueous latex systems thickened with Natrosol™ Plus, Natrosol™ HE 3KB and Natrosol™ HE 10K HMHEC have superior rheology and are less pseudoplastic than Natrosol™ HEC.

- improved rheology
- outstanding spatter resistance
- viscosity stability of latex systems
- biostability (similar to Natrosol™ B HEC)
- color acceptance and development

admiral™, liberty™ and **batrosol™**

fluidized polymer suspensions

Ashland offers a series of fluidized polymer suspensions (FPS) of hydroxyethylcellulose (HEC) and carboxymethylcellulose (CMC) that are easily dispersed and dissolved in cold or hot water to produce solutions of varying viscosities. Ashland FPS formulations vary in active content from 15 to 45% and are environmentally friendly. Hydroxyethylcellulose and carboxymethylcellulose FPS suspensions are used as fluid rheology modifiers, fluid loss reducers, suspending agents or lubricants, particularly in applications where powdered products cannot be handled.

benefits

- easy to handle and meter
- low viscosity, pumpable
- quick ,lump free and complete dissolution
- eliminates filtration problems
- addition of higher MW polymers

applications

- drilling muds
- paper coatings
- completion/workover fluids
- gravel packing
- civil engineering
- cement slurries
- spacers/flushers
- cuttings injection
- catalyic washcoats

product	cellulose	carrier	MW
admiral™ 1089	HEC	water	low
admiral™ 3089	HEC	water	medium
admiral™ 3171PB	HEC	water	medium
admiral™ 3334	HEC	water	high
admiral™ 3966	HEC	water	medium
admiral™ 3987	xanthan gum	water	high
admiral™ 5151	HEC	water	medium
admiral™ MO1030	CMC	mineral oil	high
ecodura™ FLA 3962	HEC	water	low
ecodura™ TA 4283	HEC	water	high
ecodura™ TA 4451	HEC	water	low
ecodura™ TA 4641	HEC	water	medium
liberty™ 3794	CMC	mineral oil	medium
liberty™ 4969	CMC	mineral oil	high
liberty™ 6681	CMC	mineral oil	high
liberty™ 6170	CMC	mineral oil	high
natrosol™ 250 MHB FPS	HEC	water	medium
natrosol™ FPS MH	HEC	water	medium
natrosol™ FPS-H4B	HEC	water	high
natrosol™ FPS-LO MHR	HEC	water	Medium
natrosol™ Liquid HHRP FPS	HEC	mineral oil	high
natrosol™ Liquid MR	HEC	mineral oil	medium
natrosol™ MBR FPS	HEC	water	medium
natrosol™ Plus 330 FPS	HEC	water	medium
primaflo™ MP3295A CS	HPMC	water	medium
SC-50™	CMC	mineral oil	high

ambergum™ water-soluble polymers

Ambergum™ water-soluble polymers are low molecular weight cellulose polymers supplied as either powder or aqueous solution. Solutions are 30 - 40% active eliminating the need to handle powders. They provide viscosity control and wetting uniformity. In addition, the anionic versions of Ambergum™ water-soluble polymers show dispersion properties useful in many applications to stabilize particles.

product	charge	physical Form	% active
ambergum™ 1221	anionic	free-flowing powder	100%
ambergum™ 3021	anionic	amber liquid	30%

applications

- dispersant and protective colloid: Ambergum™ 1221 water soluble polymer can be used as a pigment dispersant, binder, stabilizer and protective colloid

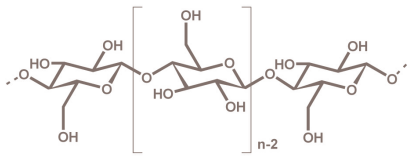
culminal™ and **benecel**™

methylcellulose and its derivatives

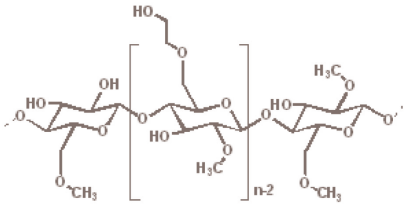
chemistry

Methylcellulose and its derivatives are made under rigidly controlled conditions.

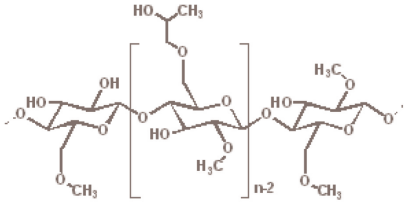
- MC is made by reacting alkali-cellulose with methyl chloride
- MHEC is made using a combination of methyl chloride and ethylene oxide
- MHPC is made using a combination of methyl chloride and propylene oxide



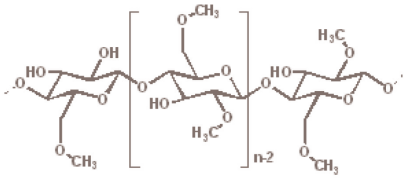
Cellulose



Methylhydroxyethyl Cellulose MHEC



Methylhydroxypropyl Cellulose MHPC



Methylcellulose MC

methylcellulose and derivatives

application properties / features

- cold water solubility
- quality of solution - higher substitution leads to clearer solutions
- solubility in organic solvents (special substitution)
- water retention - higher viscosities have better water binding properties
- rheology control/thickening/stabilizing effect
- thermogelling -applications utilize methylcellulose's reversible high temperature thermo gelation properties which are determined based on polymer substitution and molecular weight driven by hydrophobic interactions typically from 40° to > 100°C and modified by inclusion of salts, surfactants, solvents and alcohols
- binding
- protective colloid/suspension/emulsion effect
- adhesive power - lower viscosities giver better adhesion than higher viscosities lower substitution level types give more adhesion
- film formation
- controlled release properties

MC derivatives are used in many end applications such as:

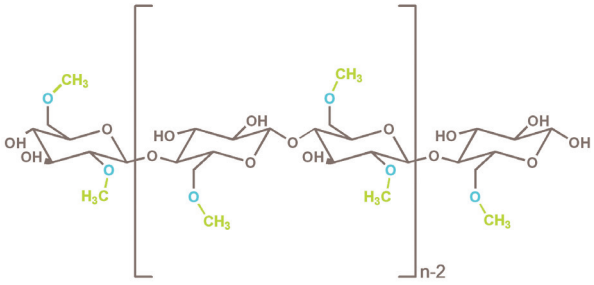
- adhesives
- agchem
- ceramics
- emulsions
- metal processing
- mineral slurries
- mining
- paint removers
- paper coatings
- polymerization
- pulp & paper
- suspension
- tile adhesives
- tobacco

functioning as:

- adhesives
- binders
- extrusion aids
- film formers
- open time enhancers
- plastifiers
- protective colloids
- rheology modifiers
- stabilizers
- thickeners

culminal™, benecel™

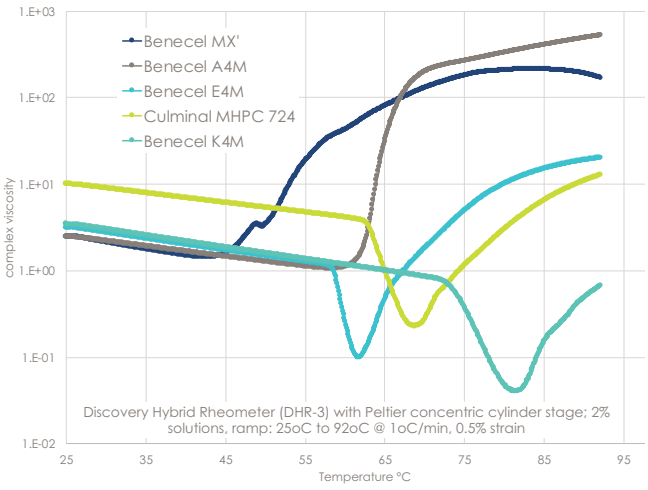
Methylcellulose



- Designed for use as water retention aids, thickening and film-forming agents, protective colloids, and suspending and emulsifying agents.
- Thermogelling properties (temperature lower than MHPC and MHEC).

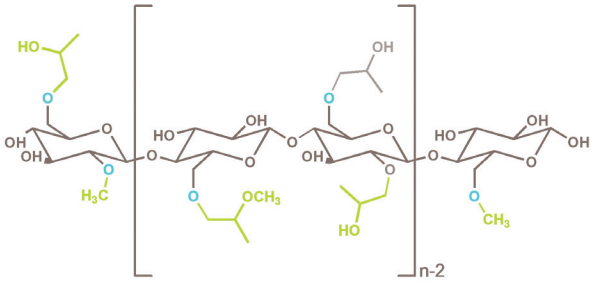
physical properties

type	average viscosity Brookfield RVT (mPa•s)§	OCH3 20% <=> 30%
benecel™ A15C	1600	high
benecel™ A4C	450	high
benecel™ A4M	4000	high
benecel™ MX	15000	high
culminal™ MC 2000 S	2500	very high
culminal™ MC 3000 P	4000	high



culminal™, benecel™

methylhydroxypropylcellulose (MHPC)



- designed for use as adhesives, binders, extrusion aids, plasticizers, protective colloids, rheology modifiers, stabilization agents, thickeners and water-retention agents
- thermogelling properties depending on the substitution pattern

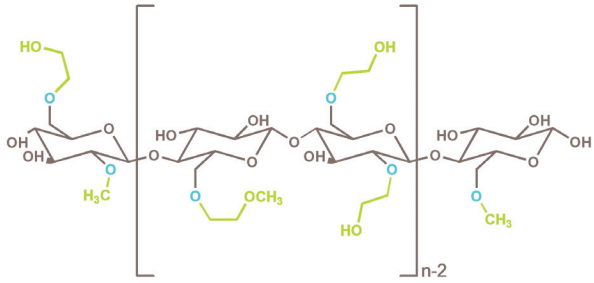
physical properties

type	average viscosity Brookfield RVT (mPa•s) @ 20 °C §	OCH3 20% <=> 30%	POOH 2% <=> 12%
culminal™ MHPC 400 R	450	high	low
culminal™ MHPC 500 PF	500	high	low
benecel™ K4M	4,000	low	high
culminal™ MHPC 3000 P1R	4,000	high	low
benecel™ E4M	4,100	high	high
benecel™ E10M	6,700	high	high
benecel™ K15M	10,000	low	high
culminal™ MHPC 814	10,000	high	high
culminal™ MHPC 1014	10,000	low	high
culminal™ MHPC 724	18,500	high	medium
benecel™ K35M	19,000	low	high
culminal™ MHPC 20000 S	22,000	very high	low
culminal™ MHPC 20000 P	24,000	high	low
culminal™ MHPC 20000 R	24,000	high	low
benecel™ K100M	35,000	low	high
benecel™ K200M	70,000	low	high

§ Reported typical Brookfield RV viscosity unless noted; Benecel CoA specify USP Convention Brookfield LV method and may be higher than reported RV

culminal™

methylhydroxyethylcellulose (MHEC)



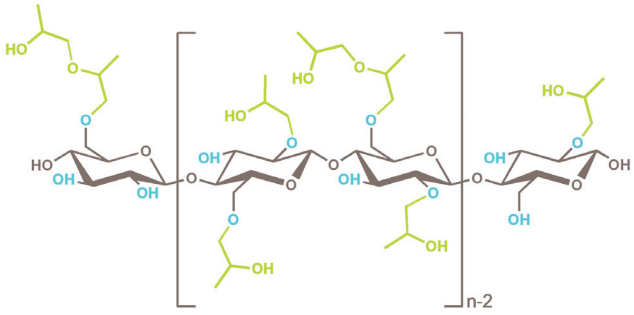
- designed for use as adhesives, binders, extrusion aids, plasticizers, protective colloids, rheology modifiers, stabilization agents, thickeners and water-retention agents
- thermogelling properties depending on the substitution pattern (higher than MHPCs)

physical properties

type	average viscosity Brookfield RVT (mPa•s) @ 20 oC	OCH3 20% <=> 30%	EOOH 1% <=> 10%
culminal™ CT 3000 R	4,000	high	low
culminal™ CT 6000 R	7,000	high	low
culminal™ MHEC 6000 PR	7,000	high	low
culminal™ MHEC 8000	10,000	low	high
culminal™ MHEC 15000 PFS	20,000	low	high
culminal™ CT 25000 R	30,000	low	high
culminal™ MHEC 35000 P1R	40,000	low	high

klucel™ HPC

hydroxypropylcellulose



Klucel™ hydroxypropyl cellulose (HPC) is a nonionic water-soluble cellulose ether with a unique combination of properties, soluble in cold water and polar organic solvents, surface active, forms films of exceptional flexibility without addition of plasticizers and is a thermoplastic polymer that can be extruded or injection molded.

applications

markets	applications
printing & inks	lithography – alcohol replacement water & solvent inks – thickener
suspension polymerization	PVC secondary protective colloid, controls porosity
injection molding	formation of intricate parts, binder for filler or active material
ceramics	processing aid, water retention, green body strength
specialty coatings	zinc rich primers
tobacco	binder, film former, processing aid for reconstituted tobacco
paint removers	thickener, retard solvent loss, cling on vertical surface
adhesives	solvent-based systems or hot melts
encapsulation	stabilizer, wall-forming polymer

physical properties

	concentration in water Brookfield viscosity (25 °C, LVF, moisture free)				
	1 wt%	2 wt%	5 wt%	10 wt%	Mw
grade					
H	1,275 - 3,500	-	-	-	1,150,000
M*	-	3500 - 7500	-	-	850,000
G	-	125 - 400	-	-	370,000
J	-	-	125 - 450	-	140,000
L	-	-	65 - 175	-	95,000
E	-	-	-	250 - 800	80,000

* Klucel MWD

chemistry

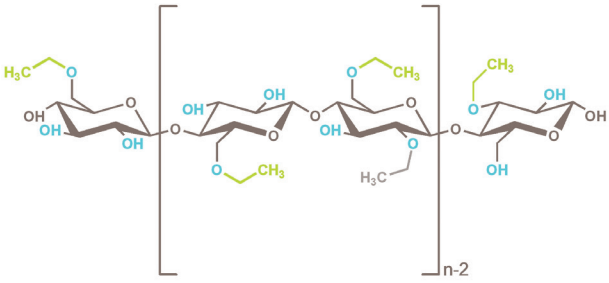
Hydroxypropylcellulose is manufactured by reacting alkali cellulose with propylene oxide at elevated temperatures and pressures. The propylene oxide can be substituted on the cellulose through an ether linkage at the three reactive hydroxyls present on each anhydroglucose monomer unit of the cellulose chain. Published information suggests that etherification takes place in such a way that hydroxypropyl substituent groups contain almost entirely secondary hydroxyls. The secondary hydroxyl present in a side chain is available for further reaction with the oxide, and chaining out may take place. This results in formation of side chains containing more than one mole of combined propylene oxide.

a. clear and smooth	
acetic acid (glacial)	isopropyl alcohol (95%)
acetone: water (9:1)	methanol
benzene: methanol (1:1)	methyl cellosolve™
cellosolve™	methylene chloride: methanol (9:1)
chloroform	morpholine
cyclohexanone	m-pyrol™
dimethyl formamide	propylene glycol
dimethyl sulfoxide	pyridine
dioxane	t-butanol: water (9:1)
ethyl alcohol	tetrahydrofuran
ethylene chlorohydrin	toluene: ethanol (3:2)
formic acid (88%)	water
glycerin: water (3:7)	
b. moderately granular and/or hazy	
acetone	methyl acetate
butyl acetate	methyl ethyl ketone
butyl cellosolve™	methylene chloride
cyclohexanol	naphtha: ethanol (1:1)
isopropyl alcohol (99%)	tertiary butanol
lactic acid	xylene: isopropyl alcohol (1:3)
c. insoluble	
aliphatic hydrocarbons	methyl chloroform
benzene	mineral oils
carbon tetrachloride	soybean oil
dichlorobenzene	toluene
kerosene	gasoline
trichloroethylene	glycerin
xylene	linseed oil

Solvents were tested using G viscosity types at 2% solids concentration by weight. All ratios indicated in this table are on a by-weight basis.

aqualon™ EC

ethylcellulose



Aqualon™ ethylcellulose (EC) is a cellulose ether distinguished by its versatility. As a unique product with wide-ranging solvent solubility and film flexibility at low temperatures, ethylcellulose is frequently used in electronics in addition to a variety of other applications. EC provides high solution clarity, good thermal stability and even burnout and has very low decomposition temperatures.

Aqualon™ EC is a key binder for gravure printing inks as well as a thickening binder in flexographic and screen printing inks. In these applications, Aqualon™ EC polymers provide scuff resistance, adhesion, fast solvent release, film formation and outstanding rheology control.

Aqualon™ EC is soluble in a wide range of organic solvents, but is not water-soluble.

applications

markets	applications	product types or functions
electronics	solar cells plasma display panels	binder, film former, rheology modifier, thickener
packaging, converting and printing	inks	binder, film former, rheology modifier, thickener
coatings	specialty, glass conductive	thickener, film former
adhesives	solvent-based adhesives, hot melts	rheology modifier, adhesion, flexibility
pigments	solvent-based slurries	rheology modifier, binder, colloid
wood finishing	lacquers, varnishes	rheology modifier, hardness, low-water pick-ups, low ash
plastics	thermoplastics	handling, toughness
pharmaceutical	tablets	binder release, control
inks	solvent-based inks, printed circuit boards	film former, rheology binder
specialty coatings	solvent based specialty coatings and lacquers	film former, rheology binder

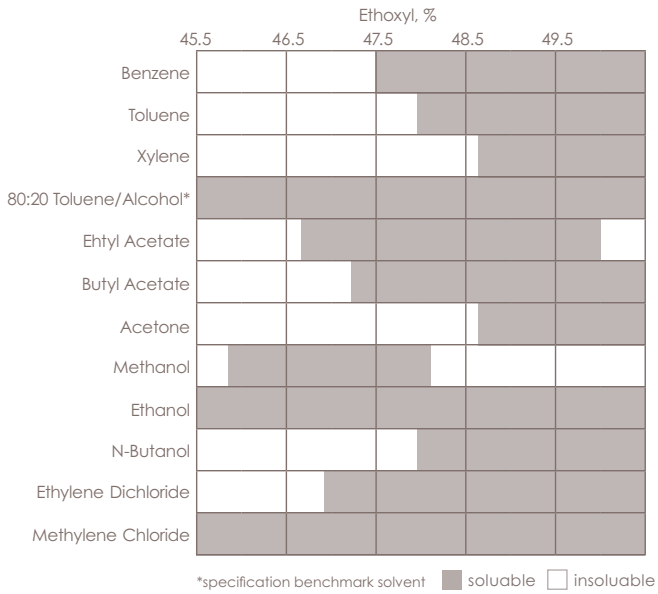
physical properties

viscosity[1] types		ethoxyl grade[2] and ethoxyl percent		
		N-grade	T-grade	X-grade
designation	limits (cps)	48.0-49.5%	49.6-51.5%	50.5-53.8%
4	3.0-5.5	•	—	—
7	5.6-8.0	•	—	—
10	8.0-11	•	•	—
14	12-16	•	—	—
22	18-24	•	—	•[3]
50	40-52	•	•	—
100	80-105	•	•	—
200	150-250	•	•	•
300	250-350	•	•	—

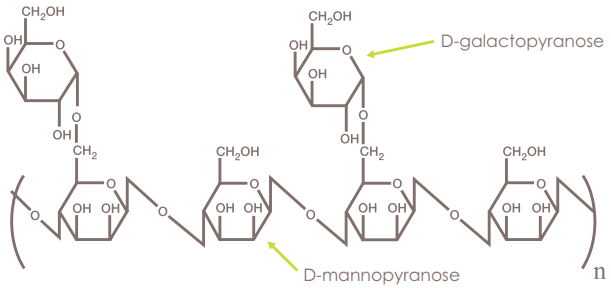
[1] 5% solution at 25 °C. Viscosity is determined in 80:20 toluene:ethanol by weight on oven-dried EC sample.
[2] Types produced are designated X.
[3] Viscosity is 18-35 cP.

chemistry

Ethylcellulose is a cellulose ether made by the reaction of ethyl chloride with alkali cellulose, as expressed by the reaction RONa + $C_2H_5Cl \rightarrow ROC_2H_5$ + NaCl, where R represents the cellulose moiety. The structure for the cellulose molecule is a chain of β anhydroglucose units joined together by acetal linkages. This is indicated in the figure above. These long, oxygen-linked anhydroglucose-unit chains have great strength, which is passed on to cellulose derivatives such as ethylcellulose. The properties of flexibility and toughness in these derivatives are directly attributable to this long-chain structure. The commercial product has a substitution value between 2.25 and 2.60 ethoxyl groups per anhydroglucose unit, or 44-52% ethoxyl content.



galactasol™ derivatized guar



Ashland's derivatizes guar to offer nonionic hydroxypropyl guar as well as anionic and cationic guars. They are not affected by ionic strength or pH, but will degrade at pH extremes at temperature (e.g., pH 3 at 50 °C). They remain stable in solution over pH range 5-7. Strong acids cause hydrolysis and loss of viscosity, and alkalis in strong concentration also tend to reduce viscosity. They are insoluble in most hydrocarbon solvents. Derivatized guar shows high low-shear viscosity but is strongly shear-thinning. They are very thixotropic above 1% concentration, but below 0.3%, the thixotropy is slight. Examples of nonionic, anionic and cationic Ashland derivatized guars are shown, contact your Ashland representative for additional offerings.

applications

markets	applications
textile	used in printing and dyeing carpets
paper	used in the manufacturing of white and cardboard paper for dry strength fiber retention and improving drainage and yields
fire fighting	used as a viscosifier in fire-retardant solutions dropped from airplanes to control the spread of forest fires
explosives	used as a water-blocking agent
mining	used in electrowinning (copper purification) and froth flotation
ag chem	used for hydromulching, hydroseeding and drift control
ink receptive	for printing, textiles and coatings

chemistry

Guar gum is a polysaccharide composed of the sugars galactose and mannose. The backbone is a linear chain of β 1,4-linked mannose residues to which galactose residues are 1,6-linked at every second mannose, forming short side-branches. Examples of commercial Ashland derivatized guars are listed below.

physical properties

product	charge	approx viscosity	hydration rate	comments
galactasol™ 40HFDS1	nonionic hydroxypropyl (HPG)	4,500 cps @ 1%	self-hydrating	dispersable type
galactasol™ 60H3FDS	Anionic carboxymethyl hydroxypropyl guar (CMHPG)	3,000 cps @ 1%	self-hydrating	mix to disperse
galactasol™ 80H1F	cationic	2,000 cps @ 1%	fast	mix to disperse

synthetic polymers

overview

rheology modifiers

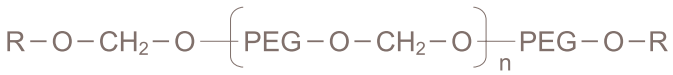
Aquaflow™ nonionic synthetic associative thickeners (NSATs) are efficient thickeners for high-performance waterborne coatings. These easy-to-handle liquids build rheology in paints and coatings through self-association and interaction with other ingredients. Aquaflow™ rheology modifiers are based on hydrophobically modified polyacetal-polyether (HM-PAPE) chemistry and are designed to optimize liquid flow and leveling properties and can also function as drop-in replacements for urethane-type (HEUR) thickeners.

acrylate chemistry

Ashland offers a portfolio of acrylate chemistries including rheology modifiers and dispersants, that work as processing aids and performance enhancers for applications as diverse as paint and coatings, cleaning products, oilfield chemicals, textile manufacture, water treatment and more.

aquaflow™

hydrophobically modified polyacetal-polyethers



Aquaflow™ rheology modifiers are nonionic synthetic associative thickeners (NSAT). Thickening results from self-association and association with the latex particles. They are surface active, stable over a broad pH range (4-12), and more salt tolerant than commercial HEURs (hydrophobe-modified ethoxylated urethanes). The Aquaflow™ product line contains both high-shear and low-shear nonionic thickeners.

applications

- inks
- water-based adhesives
- water-based coatings
- water-based latexes

chemistry

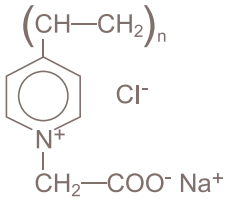
Aquaflow polymers have poly(acetal- or ketal-polyether) backbones that are either linear or branched. The polyethers (as precursors for the final polymer) are water-soluble polyalkylene oxide or copolymers of polyalkylene oxides. The hydrophobes are chosen to balance rheological properties and hydrophobic/hydrophilic interactions.

physical properties

	XLS-500	XLS-525	XLS-530	NLS-200	NLS-210	NLS-220	NMS-450	NMS-460	NHS-300	NHS-310	NHS-350	NHS-360
product properties												
rheology profile												
low-shear (brookfield)	★	★	●	●	●	●						
low-shear (KU/stormer)	★	★	★	★	★	★	●	●			●	
high-shear (ICI/cone and plate)							●	●	★	★	●	★
product features												
solvent free[1]	✓	✓	✓			✓	✓	✓	✓	✓	✓	✓
APEO-free	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
balance of sag and leveling	★	★	★				●	●			●	
improved viscosity retention on tinting	★	★	★									
high efficiency in effective shear range	★		●	●	★	●	●	●	●	●	●	●
active solids (%)	25.0	20.0	20.0	25.0	25.0	20.0	19.0	27.0	20.0	20.0	17.5	20.0
viscosity, maximum as supplied (mPa.s)	2,000	2,000	4,500	5,500	5,000	2,000	6,000	6,000	6,500	2,000	4,000	4,000
starting-point application recommendations[2]												
architectural paints by interaction with latex												
styrene-acrylic	★	★	★	★	★	★	●	●	★	★	●	★
acrylic	★	★	★	★	★	★	●	●	★	★	●	★
vinyl- acrylic			★	●	●	●	★	★	●	●	★	●
vinyl acetate-ethylene			★	●	●	●	★	★	●	●	★	●
architectural coatings finishes												
flat/eggshell/satin			●	●	●	●	●	●	★	★	●	★
semi-gloss	●	●	●	●	●	●	★	★	★	★	★	★
high-gloss			●	●	●	★	★	★	★	★	★	★
industrial coatings												
airmix	●	★							★	★		★
airless		★							★	★		★
HVLP			★			★						
airspray	●		★			★						
flow coating			●			●	★	★			★	
vacuum coating			●				★	★			★	
curtain coating			●				★	★			★	
brush			●	★	★	★			★	★		★
roller			●	★	★	★			★	★		★

[1] excluding water
[2] recommendations based on single use of a particular additive

chromabond™ polymers



chromabond™ S-100
dye-complexing polymer

applications

- dye transfer inhibitors
- hard-surface cleaners

physical properties

physical form ..... aqueous solution
% solids 38-42%
viscosity ..... 850 cP
molecular weight 35,000
pH (5% solution) 4-7

chemistry

Chromabond™ polymer contains betaine (S-100) functionalities. Chromabond™ dye-complexing polymer is a premium dye transfer inhibitor (DTI), developed and used in color-safe laundry detergents. Chromabond™ polymer demonstrates superior complexing of fugitive dyes at cost-effective levels under different temperatures and surfactant environments. Its chemical structure promotes dye complexation up to 60°C, while resisting interaction with anionic surfactants. Chromabond™ polymer is soluble in water and water-alcohol mixtures but insoluble in most other solvents.

sorez™ **100** copolymer

polyethylene glycol polyester copolymer

applications

- soil release agent in laundry detergents, fabric softeners and pre- and post-wash stain removers
- ironing aid

physical properties

physical form ..... slightly turbid amber liquid
% solids 75-77%

chemistry

A modified polyester copolymer concentrate in water-soluble form. The product imparts wicking properties to hydrophobic textiles. It provides soil release and anti-redeposition properties while reducing the electrostatic charge of treated polyester. The polymer forms a thin film on the substrate, enabling effective soil removal during subsequent wash cycles.

acrylates

acrylate copolymer dispersant

Jaypol HS62R is a low molecular weight polyacrylate dispersant copolymerized with a sulfonated monomer. It has improved scale-inhibition compared to AA homopolymers in some applications with higher temperature and salt tolerance stability, improved threshold inhibition, crystal growth inhibition and particulate dispersion. Applications include control of calcium carbonate, calcium sulfate, calcium phosphonate and colloidal iron stabilization

product	type	active solids (%)	pH	Mw	PD
jaypol™ HS62R	sulphonated	40	~4	5500-6500	1.5 - 2.0

methacrylic acid/ethylacrylate copolymers

Methacrylic acid/ethylacrylate copolymers act as thickeners. They are alkali-swellable (ASE) or hydrophobically modified alkali-swellable (HASE) polymers. They are generally used in aqueous, highly filled and surfactant systems.

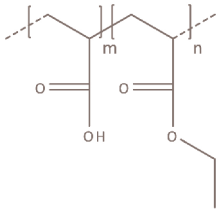
applications

product	area
jaypol™AT4	– matt/emulsion paint – adhesives – wood coatings – screen printing inks – HI&I
surfathix™ N	– gloss coatings – clear formulations – HI&I – personal care

physical properties

product	type	active solids (%)	salt tolerance	temperature tolerance	solution quality	rheology type (at 0.8% solution)
jaypol™ AT4	HASE	30	High	Low	clear water white	pseudo-plastic; drop flow/ gel
surfathix™ N	HASE	30	Moderate	Low	clear water white	pseudo-plastic;

chemistry



Methacrylic acid/ethylacrylate copolymers are supplied as aqueous emulsions at pH 2 to 3 with typical molecular weights of 20,000 to 40,000. They are supplied with a range of cross-linking and hydrophobicity to optimize rheological properties and develop rheology by the swelling mechanism of the addition of suitable alkali with optimum rheology development between pH 6 to 12.

liquid dispersion polymers

Jaypol™ AL is a range of high molecular weight liquid dispersion polymers, which when added to water swell to give thickening. The polymers are effective over a pH range of 4 to 12. They are a one-shot additive that can be incorporated at any stage of the formulation manufacturing process and can provide an opacifier effect.

product	active solids (%)	textural response	pH	Paint	adhesives/ sealants	textiles	HI&I
jaypol™ AL	60	Promoting texture, spreadability – non-flow rheology	~7	s	p	p	s
jaypol™ AL2	60		~6		p	p	
jaypol™ 213	50	Secondary effect produces opacity	~4				p

p = preferred
s = standard

rapithix™ A-100

polymer

RapiThix™ A-100 polymer is a free-flowing, fully active white powder sodium polyacrylate for rheology. RapiThix™ A-100 polymer is designed for use in cold mix processes and is easy to use, shear-tolerant, shear-thinning and effective at low use levels.

- no pre-set oil phase
- makes oil-free systems possible
- high solids content for higher efficiency

applications

- aud viscosifier, shale swell inhibition and friction reducer in oilfield and civil engineering
- anti-capping, erosion control, improved water filtration, hydro-seeding lubricants and water absorbents in agriculture
- alternative rheology modifiers for extreme acid and alkali formulations

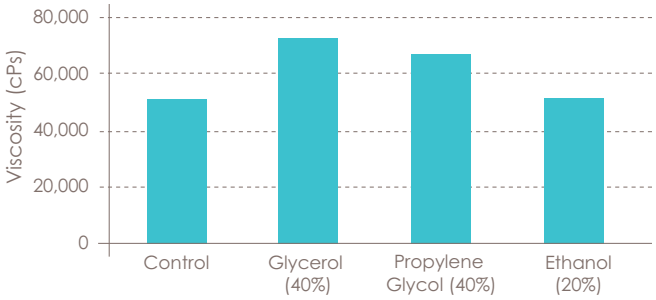
physical properties

physical form ..... fine powder

solids content..... 85-95%

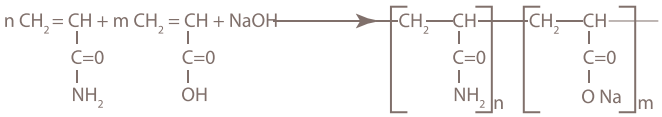
viscosity (1% solution).....28,000-38,000 cP

pH (1% solution..... 5.7-6.7



rheothix™ 601 thickening agent

Sodium polyacrylate



applications

- adhesives
- caulking
- sealants

physical properties

physical form ..... off-white milky dispersion

% active 57-59

viscosity ..... 500 - 2,000 cP

chemistry

RheoThix™ 601 thickening agent is an anionic, pseudo-plastic thickening agent, emulsifying and stabilizing ingredient that improves performance. It can be incorporated into the water phase, into the oil phase and after the oil is emulsified to provide uniform thickening without neutralization, pre-swelling or pre-heating. The recommended use level is 0.2 - 2.5% based on solid content.

homo- and copolymers of acrylamide

Ashland acrylamide homo and copolymers are supplied in a wide range of physical forms: solution, liquid dispersion, and (LDP), emulsion or powder grade. Anionic and cationic products (Rapifloc™ A and C series) are available along with the nonionic powder Rapifloc™ N-1000. Polymers are offered in a range of molecular weights, cross linking, charge densities and active contents to meet specific desired application requirements.

rapifloc™ A2-MG

polymer

Rapifloc™ A2-MG polymer is a high molecular weight anionic polyacrylamide supplied as a free-flowing granular powder. It is completely soluble in water-producing solutions of high viscosity. It is of very high anionic charge.

benefits

- cost-effective
- completely water-soluble
- improved process efficiencies

applications

Rapifloc™ A2-MG polymer has found application in a wide variety of mineral processing and civil engineering applications. It is essentially nitrogen-free, and its use in brine clarification does not give rise to the formation of nitrogen trichloride in subsequent electrolysis.

applications include:

- alkaline leach uranium circuits
- civil engineering
- brine clarification

physical properties

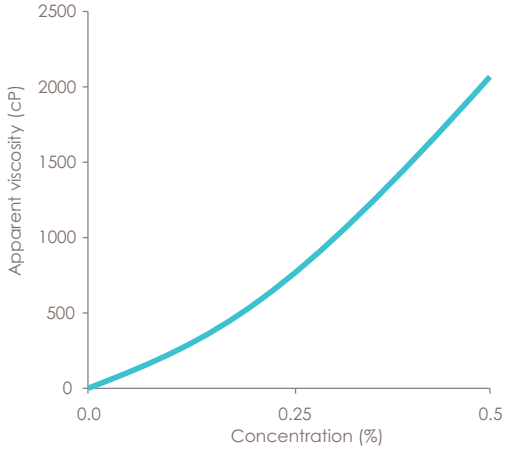
physical form ..... off-white granular solid

particle size ..... 99% < 2000 µm

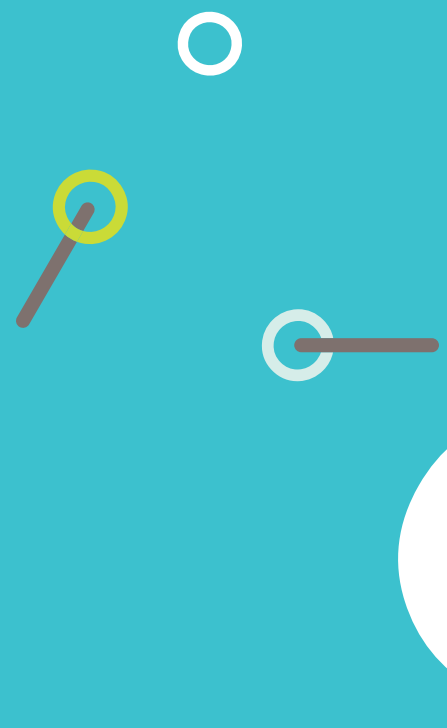
bulk density ..... approx. 0.85 g/m^3

pH (0.5% solution, 25 °C) ..... approx. 6.0

Viscosity - concentration graph
Brooksfield viscometer @ 25°C



always solving™



specialty chemicals

overview

surfactants

The Surfadone™ alkyl pyrrolidones are hydrophobic in nature, functioning as excellent wetting agents and effective dispersing and cleaning aids.

Dextrol™ and Strodex™ phosphate ester surfactants are leading technologies within our extensive portfolio of high-quality additives. These high-performance specialty surfactants exhibit superior wetting and emulsifying properties and are unique in that their compositions can be modified to achieve specific properties. Dextrol™ and Strodex™ phosphate ester surfactants demonstrate a strong viscosity profile and broad compatibility as well as good stability to a wide range of temperatures, pH and hard water. They provide corrosion inhibition, emulsification and dispersion properties.

emulsifiers, dispersants and lubricants

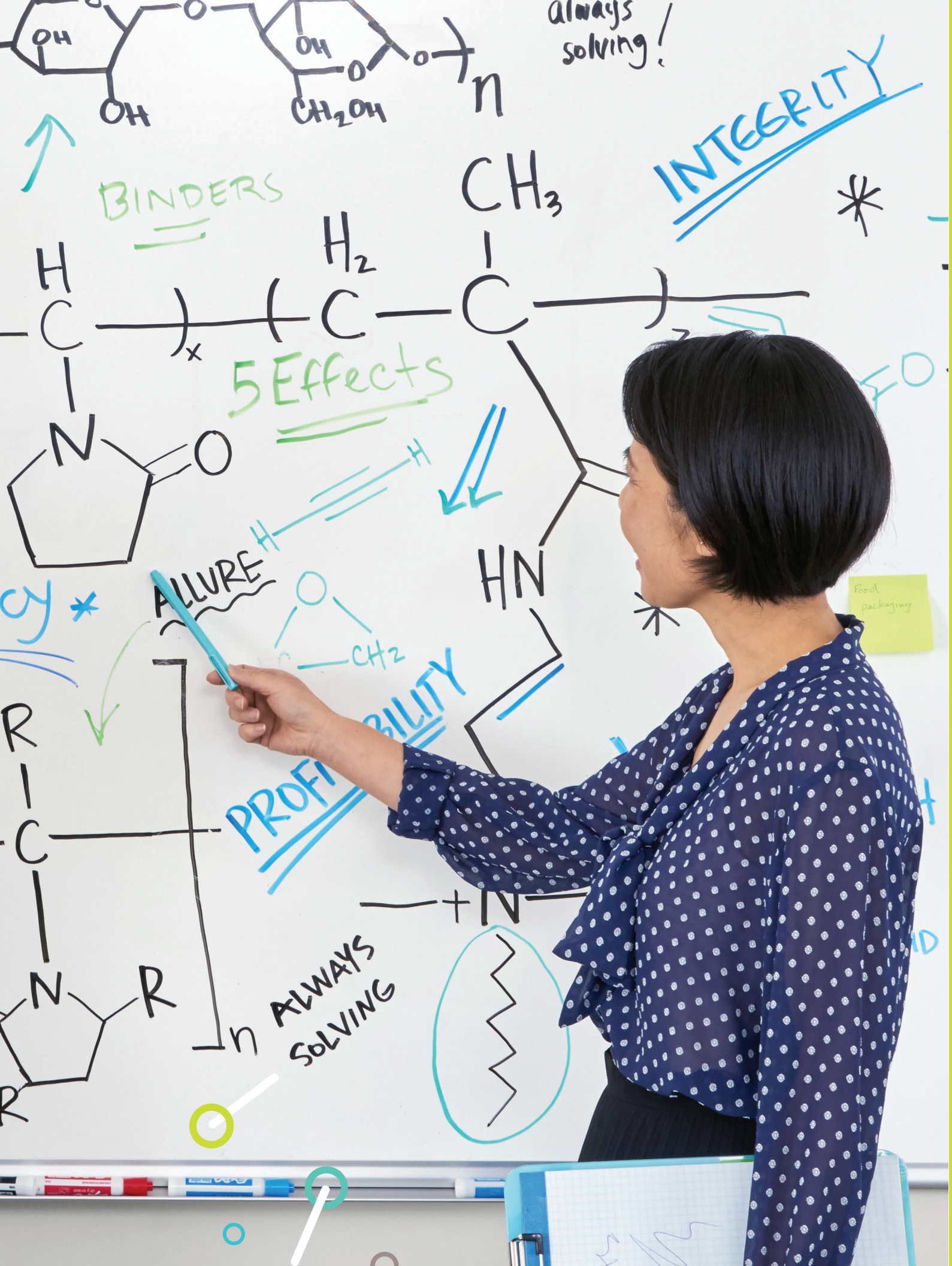
Ashland has a broad family of water-insoluble esters and hydroxyesters sold under the Ceraphyl™ and Cerasynt™ trademarks as a carrier, dispersant, emulsifier and skin care preparation lubricant. These chemicals typically are surface active and find use in HI&I, plastics, textile, photography, inks and coatings markets. A variety of esters is available with a range of properties, including liquids and waxy solids. In addition, amide and quaternary-ammonium salts are available.

carbonyl iron powder

Micropowder™ iron powders are characterized as fine, high-purity, micron-size spherical particles with superior electronic and magnetic properties.

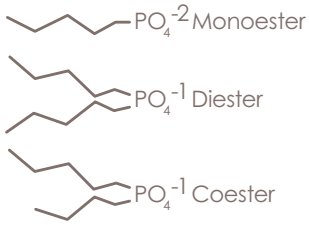
foam control agents

Drewplus™ and Advantage™ defoamers comprise a range of proprietary products that effectively control foam and entrained air in industrial processes and wastewater systems. In addition to collapsing or breaking down existing foam, the products remain on the water's surface to prevent the formation of future foam. Ashland offers a range of highly efficient, hydrocarbon-, vegetable oil-, polysiloxane- and polyglycol-based antifoaming agents.


always solving!
INTEGRITY
BINDERS
5 Effects
ALLURE
PROFITABILITY
ALWAYS SOLVING
Food packaging

phosphate esters and specialty surfactants

Dextrol™ and Strodex™ phosphate ester surfactants are leading technologies within our ever-expanding portfolio of high-performance additives. Dextrol and Strodex surfactants have been developed for high performance in a variety of end-use applications by engineering specific chemistries under precisely controlled reaction conditions. Dextrol and Strodex are unique mono- and diester phosphates as well as specialty surfactants that provide wetting, improve dispersion and emulsion stabilization, and provide corrosion protection.



product	salt form	chemical description/ moles of EO	typical active content [%]	typical viscosity [cP at 25 °C]	surface tension: 0.1 active wt% in water; pH ~7[dynes/cm]	relative solubility in water
dextrol™ OC-20/22	h	phosphate ester of nonylphenol ethoxylate (10 moles)	97	5,600	35.3	hydrophilic
dextrol™ OC-15	h	phosphate ester of nonylphenol alcohol ethoxylate (6 moles)	97	3,600	30.3	
dextrol™ OC-110	h	phosphate ester of nonylphenol alcohol ethoxylate (3 moles)	97	36,000	33.4	hydrophobic
dextrol™ OC-70	h	phosphate ester of tridecyl alcohol ethoxylate (10 moles)	97	800	36.2	hydrophillic
dextrol™ OC-60	h	phosphate ester of tridecyl alcohol ethoxylate (6 moles)	97	800	30.1	
dextrol™ OC-40	h	phosphate ester of tridecyl alcohol ethoxylate (3 moles)	97	800	26.5	hydrophobic
strodex™ FT-100	h	phosphated alcohol	99	4,000	50	hydrophilic
strodex™ P-100	h	phosphate coester of alcohol and aliphatic ethoxylate	98	600	29.8	
zenix™ 4617	h	phosphate ester of oleyl alcohol ethoxylate	98	3,300		
strodex™ MO-100	h	phosphated alcohol	98	1,300	43	hydrophobic

product	phosphate acid source	salt form	chemical description/ moles of EO	typical active content [%]	typical viscosity [cP at 25 °C]	surface tension: 0.1 active wt% in water; pH ~7 [dynes/cm]	relative solubility in water
dextrol™ OC-7525	dextrol™ OC-70	NH4	10	25	600	36.2	hydrophilic
dextrol™ OC-6025	dextrol™ OC-60	NH4	6	25	600	26.5	
dextrol™ OC-180	dextrol™ OC-60	K	6	45	600	30.1	
dextrol™ OC-180HS	dextrol™ OC-60	Na	6	90	2,000		
dextrol™ OC-50	dextrol™ OC-15	Na	6	90	6,000	30.3	
dextrol™ OC-4025	dextrol™ OC-40	NH4	3	25	600	26.5	hydrophobic
strodex™ FT-50K	strodex™ FT-100	K	phosphated alcohol	50	< 100	50	hydrophilic
strodex™ SEK-50D	strodex™ SE-100	K	phosphate coester aliphatic ethoxylate mixture	50	100	27.9	
strodex™ TH-100		K	proprietary blend	81	300	33.7	
strodex™ FT-427		K	proprietary blend	89	100		
strodex™ FT-428		K	proprietary blend	76	350		
strodex™ PLF-100		Na	phosphate coester	82	1,500		
strodex™ LFK-70		K	phosphate coester	70	400	35.8	
strodex™ PSK-28		K		55	50	28.4	
strodex™ NB-20	proprietary blend	Na		99	500		
strodex™ PK-90	strodex™ P-100	K	phosphate coester alcohol and aliphatic ethoxylate	90	7,000	29.8	
strodex™ PK-85NV	strodex™ P-100	K	phosphate coester alcohol and aliphatic ethoxylate	65	250	29.8	
strodex™ PK-OVOC	strodex™ P-100	K	phosphate coester alcohol and aliphatic ethoxylate	35	280	30.5	
strodex™ MOK-70	strodex™ MO-100	K	phosphated alcohol	70	partial gel >100k	36.9	
strodex™ KM-400LV	strodex™ MO-100	K	phosphated alcohol	60	100	43	
strodex™ EHK-70		K	phosphated alcohol	70	partial gel >100k	43	hydrophobic

emulsifiers, dispersants and lubricants

Ashland has a broad family of water-insoluble esters and hydroxyesters sold under the Ceraphyl™ and Cerasynt™ trademarks as carrier, dispersant, emulsifier and for skin care preparation lubricant. These chemicals typically are surface active and find use in specialty, HI&I, plastics, textile, photography, inks and coatings markets. A variety of esters is available with a range of properties, including liquids and waxy solids. In addition, amide and quaternary-ammonium salts are available.

A representative group of this product line is shown below.

product	chemical name	applications	
ceraphyl™ 28	hexadecyl lactate	– tissue paper lotion	– printing plate protection
ceraphyl™ 31	lauryl lactate	– tissue paper lotion	
ceraphyl™ 41	C12 - C15 alkyl lactate	– plasticizing effects	
ceraphyl™ 50	tetradecyl lactate	– viscosity regulator in laundry detergents	
ceraphyl™ 55	tridecyl neopentanoate		
ceraphyl™ 230	diisopropyl adipate	– plasticizing effects – lubricant – hard-surface cleaners	– erasable markers – mold release agent – inkjet inks
ceraphyl™ 368 M	2-ethylhexyl palmitate	– circuit board cleaning – pigment dispersment inkjet inks – hard-surface cleaners	– tissue paper lotion – lubricant
ceraphyl™ 375	isostearyl neopentanoate	– pigment dispersion	
ceraphyl™ 424	tetradecyl tetradecanoate	– hard surface cleaner – dispersant in magnetic recording media	
ceraphyl™ 494	isocetyl stearate		
ceraphyl™ 791	isocetyl stearoyl stearate	– pigment dispersions	
ceraphyl™ 847	octyldodecyl stearoyl stearate	– pigment dispersions – polycarbonate mold release agent	
ceraphyl™ HD	isohexadecanol	– pigment dispersions – mold release	– graffiti removal – polyester finishing agent
ceraphyl™ ODS	octyldodecyl stearate	– polycarbonate mold release agent	
ceraphyl™ RMT	castor oil monomaleate		
ceraphyl™ SLK	isodecyl neopentanoate		
ceraphyl™ 945	glyceryl stearate and polyoxyethylene lauryl ether	– inkjet inks, pigment dispersion	
ceraphyl™ IP	2-hydroxyethyl stearate and ethylene glycol	– opacifier and pearlizing agent	
ceraphyl™ M	2-hydroxyethyl stearate	– pearlizing agent – liquid detergent compositions	
ceraphyl™ PA	propylene glycol monostearate	– hard-surface cleaners – asphalt microdispersions	– circuit board defluxing detergents
cerasynt™ SD	glyceryl stearate		
emulsynt™ 1055	polyglyceryl-4-oleate	– emulsifier	
emulsynt™ GDL	glyceryl dilaurate	– emulsifier	

phlex™

Neutralizing additive

pHLEX™ neutralizing additive is a proprietary organoamine blend that raises pH and provides buffering effects to waterborne paints and coatings. It is designed as a functional drop-in replacement that is an economic alternative to other common amine-based neutralizers, but also offers a low-odor stabilizing alternative to ammonia, NaOH and other common bases.

pHLEX™ neutralizing additive also offers reduced VOC compared to other organoamine neutralizers and lower odor levels for in-plant handling benefits.

benefits

- effective ph neutralizer
- provides ph stability over time
- inhibits in-can corrosion
- helps prevent flash rusting
- lower odor for handling and manufacturing
- can reduce odor of waterborne paints
- can reduce demand of anionic dispersant

physical properties

product	physical form	viscosity (cPs or mPa•s)	specific gravity @ 25 °C	pH (1.0 wt % solution)
pHLEX™ 100	clear to light-yellow liquid	~15	1.052	11-11.5
pHLEX™ 110	clear to light-yellow liquid	~15	1.055	11-11.5

specialty chemicals

iron pentacarbonyl (IPC)

$Fe(CO)_5$

applications

Iron pentacarbonyl is an intermediate that has found utility in a variety of applications. In the past, it has been used as a fuel antiknock agent, a photochemical additive and an intermediate for many iron products. The most important current applications are:

- catalyst for coal liquefaction, Fischer-Tropsch hydroformylation, olefin isomerization and water gas shift reactions
- precursor for chemically pure iron, iron oxides, iron catalysts and thin iron films
- desulfurization removal of sulfur from coal and petroleum products

physical properties

boiling point ..... 103°C

melting point ..... -20°C

specific gravity 1.453

chemistry

Iron pentacarbonyl is a specialty chemical that is produced as an intermediate during the manufacture of carbonyl iron powders. It is produced from a high-pressure reaction between high-grade iron and carbon monoxide. This organometallic compound exists as a liquid at room temperature. It may ignite spontaneously in air and is decomposed by heat to metallic iron and carbon monoxide. In air it decomposes to iron oxides and in sunlight to iron nonacarbonyl. While Fe(CO)5 is highly reactive, it is stable in dark storage under nitrogen. It is soluble in common organic solvents such as acetone or toluene and insoluble in water or liquid ammonia.
It is unreactive with most acids.

Micropowder™ Iron

carbonyl iron powders (CIP)

applications

Carbonyl™ iron powder is manufactured by the chemical decomposition of iron pentacarbonyl. The resulting iron particles are uniform gray microscopic spheres with only traces of carbon, oxygen and nitrogen. Over 25 different grades of iron powder are manufactured through this process and marketed under the trade name Micropowder. Specific applications include:

- radar absorbing materials (RAM)
- precision electronic cores
- electromagnetic interference shielding products (EMI/RF)
- metal injection molding (MIM)
- high-performance powder metallurgy products
- magnetic fluids
- halogen solvent waste remediation
- pharmaceutical iron supplement Ferronyl iron

physical properties

The fine size and high purity of the carbonyl iron powders are the principal reasons for their superior properties compared to other forms of elemental iron powders. Distinct characteristics of the Micropowder Iron products include:

- very fine spherical size
- submicron to 10 micron particle diameter
- high purity with up to 99.5% iron content
- unique onionskin structure with cubic crystalline lattice
- superior electromagnetic properties
- uniform particle size distribution

carbonyl iron grades

carbonyl iron grades	properties			applications		
	average diameter (Microns)	% iron	additive	powder metallurgy	electronics	aerospace & defense
S-1100	4 – 6	>97	no silica	X		
S-1281	4 – 6	>97	silica			
S-1640	3 – 5	>97	no silica	X		
S-1641	3 – 5	>97	silica	X		
S-1651	3 – 5	>97	silica		X	
S-2101	2 – 4	>97	silica		X	
S-2701	2 – 4	>97	silica	X		
S-3000	1 – 3	>98	no silica		X	
S-3001	1 – 3	>97	silica		X	
S-3700	1 – 3	>97	no silica	X		
S-5000	6 – 7	>97	no silica			X
S-5641	3 .4 – 5.0	>97	silica			X

NOTE: These properties represent typical numbers but are not considered sales specifications.
Contact Ashland for technical information on other grades.

drewplus™/advantage™ defoamers

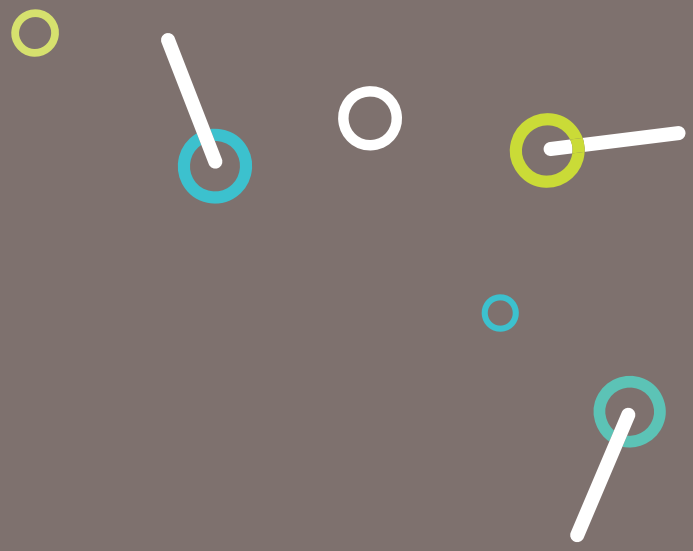
Ashland's foam control agents are versatile and economical to use. They have been developed for use in a variety of water-based industrial applications including coatings, water-based adhesives, graphic arts, emulsion polymers and polymer dispersions to provide superior foam control performance activity and compatibility. They range in dispersibility and compatibility providing excellent long-term foam control persistency and are highly effective on entrained, surface macro-foam and micro-foam. Ashland foam control agents are offered in a wide range of chemistries (silica, polysiloxane, organically modified polysiloxanes, mineral oil, wax, etc.). For high-performance coatings, Drewplus™ polysiloxane-based compounds and emulsions deliver proven results using proprietary quick bubble-break and dissolution technologies to control foam. As a starting point, bolded products are typically recommended for initial screen (application dependent)

technology	trade name	description	applications
mineral oil-based	**drewplus™ L-475**	silica	graphic art, pigment dispersion, oil well cementing, psa adhesives
	drewplus™ L-477K	silica	kosher printing ink
	drewplus™ L-493	silica, self-emulsifying	industrial inks
	drewplus™ L-140	silica, self-emulsifying	FDA, adhesives, inks, industrial coatings
	drewplus™ L-108	silica, self-emulsifying	S-PVC, pressure sensitive adhesives, EP emulsions
	drewplus™ L-198	silica, self-emulsifying	EP, SBR, PVC, PVA, Acrylic emulsions, PSA adhesives
	drewplus™ Y-281	silica, self-emulsifying	adhesives, EP, emulsions, SBR, PVA
	drewplus™ Y-381*	wax	inks and latex systems
	Drewplus L-464	silica / wax	inks and latex systems
	Drewplus TW-4503	silica / wax, self-emulsifying	fracturing, S-PVC, acrylic emulsions, industrial inks
	Drewplus Y-250	silica / wax, self-emulsifying	natural and synthetic metal working cutting oils, adhesives
boosted mineral oil	**drewplus™ T-4507***	silica	adhesives and coatings, acrylic PVA SBR
	drewplus™ T-4304*	silica, self-emulsifying	adhesives and coatings, acrylic PVA SBR, easy to incorporate
	drewplus™ TS-4400	silica + polysiloxane, self-emulsifying	industrial process, paints, wastewater
	drewplus™ W-4502	wax	paint, ink, adhesives
	drewplus™ W-4300*	wax, self-emulsifying	all in one defoamer for let down and grind in, paints, industrial process and wastewater

*** teal products recommended for initial screen (application dependent)**

technology	trade name	description	applications
polysiloxane based	drewplus™ L-419	silicone/silica, self-emulsifying	graphic art: pigment dispersion gravure art: screen printing inks
	drewplus™ L-418*	silicone/silica, self-emulsifying	graphic art: pigment dispersion gravure art: screen printing inks
	drewplus™ L-405 LV	polysiloxane copolymers + silica, self-emulsifying, low-VOC	gravure art: flexographic inks, high-gloss alkyds, epoxy systems, pigment dispersion
	drewplus™ TS-4385*	polysiloxane copolymers + silicas, elf-emulsifying	gravure: screen printing, anticorrosive primers wood & reducible alkyd, pigment dispersions
	drewplus™ TS-4387	polysiloxane copolymers + silica, self-emulsifying, low-VOC	graphic art: pigment dispersion; gravure art: flexographic inks, screen printing inks
quick bubble break (OM Polysiloxane) based technology	drewplus™ S-4288	polysiloxane copolymer emulsion	high-gloss coatings, inks
	drewplus™ S-4386*	polysiloxane copolymers + silica, emulsion	graphic art: pigment dispersion gravure art: flexographic inks; coatings (low PVC), overprint varnish
	drewplus™ S-4273	polysiloxane copolymer emulsion	gravure art: flexographic inks, pigment dispersion
dissolution	drewplus™ S-4480	polysiloxane copolymers + silica	graphic art: pigment dispersion; gravure art: flexographic inks, screen printing inks oil well cementing, fracturing, coatings
	drewplus™ L-3500	polysiloxane copolymers + silica	graphic art, clear coat, high shear / spray coating application
	drewplus™ TS-4481*	polysiloxane copolymers + silica	graphic art: pigment dispersion; gravure art: flexographic inks, screen printing inks, wood coatings
	drewplus™ L-3510	polysiloxane copolymers + silica	graphic art, high shear / spray coating application
	drew™ 210-862	polysiloxane copolymers + silica, low VOC	graphic art: pigment, dispersion; gravure art: flexographic inks, screen printing inks oil well cementing, fracturing, wood coatings
	drewplus™ S-4374	polysiloxane copolymers emulsion	overprint varnish, pigmented inks, gravure, flexographic & screen inks, wood coatings
	drewplus™ L-3200	polysiloxane copolymers emulsion	inks, flexo/screen printing, pigment dispersion
	drewplus™ L-3210	polysiloxane copolymers emulsion	inks, flexo/screen printing, pigment dispersion
powder	drew™ RE 5500	free-flowing white powder	oil well cementing, civil engineering, grout, mortar, cement

* teal products recommended for initial screen (application dependent)



performance specialties charts

The following tables are cross-references of the products cited throughout the text and their uses in a wide variety of industrial applications and their fundamental functional properties.

cross reference chart by application

class	acetylenics																
family	vinyl monomers		surfactants, wetting agents, solvents		performance polymers												
subfamily	vinyl monomers		alkyl pyrrolidone		pvp	pvpp	vinylpyrrolidone copolymers								maleic based polymers		
applications	**v-pyrol**™ vinylpyrrolidone	**v-cap**™ vinyl caprolactam	**surfadone**™ wetting agents	**easy-wet**™ wetting agents	PVP polymers	**disintex**™ disintegrants, **polyclar**™ polyvinyl-polypyrrolidone, **polyclar**™ crospovidone, **viviprint**™ PS 10	**ganex**™/**antaron**™ polymers	PVP/VA polymers	**polectron**™/**antara**™ polymer	**sorez**™ **HS-205** copolymers	**gafquat**™ polymers	**styleze**™ copolymers	**setleze**™ (**viviprint**™)	**ultrathix**™ crosspolymer, **rapithix**™ polymer	**gaffix**™/copolymer VC-713 polymer	**gantrez**™ copolymer	**easysperse**™ polymeric dispersant ranges	**aquaflex**™ copolymer
adhesives	●	●	●		●			●	●		●			●		●		●
advanced ceramics					●													
batteries					●													
cables																		
ceramics					●													
civil engineering																		
electronics	●		●		●			●								●		
emulsions & suspension polymerization	●				●													
explosives																		
inks & printing	●	●	●	●	●	●	●	●	●		●		●	●	●	●	●	●
membranes					●			●			●				●			
metal processing			●	●	●					●				●			●	
mineral slurries																		
mining																		
paint removers																		
paper coatings/ pulp & paper					●						●							
plastics			●															
refinery additives	●		●															
specialty coatings	●	●		●	●		●	●	●		●	●	●	●	●	●		●
textiles & leather										●								
tissue & towel																		
tobacco																		
welding rods																		

class	cellulosics and derivatized naturalpolymers							synthetic polymers				specialty chemicals							
family	performance polymers							synthetic polymers				surfactants, wetting agents, solvents				specialty chemicals			
subfamily	cellulosics						derivatized guar	specialty polymers		acrylates		phosphate esters		esters & lubricants		neutralizer	iron powder	iron pentacarbonyl intermediate	foam control
applications	**bondwell™, blanose™, aqualon™** carboxymethylcellulose	**natrosol™** hydroxyethylcellulose	**culminal™** methylcellulose derivatives	**benecel™** methylcellulose derivatives	**klucel™** hydroxypropylcellulose	**aqualon™** ethylcellulose	**galactasol™** derivatized guar	**aquaflow™** rheology modifiers	**chromobond™** S100 polymers	**rheothix™** thickening agent	**rapifloc™** acrylates	**dextrol™** phosphate ester surfactants	**strodex™** phosphate ester surfactants	**ceraphyl™** emulsifiers	**cerasynt™** emulsifiers	**phlex™** neutralizing agents	micropowder™ iron	iron pentacarbonyl	**crewplus™/advantage™** defoamers
adhesives	●	●	●	●	●	●	●			●	●	●	●						●
advanced ceramics	●		●																
batteries	●																		
cables	●																		
ceramics	●																		
civil engineering	●										●								
electronics			●		●	●													
emulsions & suspension polymerization		●	●		●							●							●
explosives	●						●												
inks & printing	●	●		●	●	●		●	●		●	●	●	●		●			●
membranes																			
metal processing	●											●	●		●	●	●		●
mineral slurries											●	●	●						
mining	●						●				●								
paint removers			●		●														
paper coatings/ pulp & paper	●																		●
plastics	●				●									●					
refinery additives																		●	
specialty coatings	●	●	●	●	●	●		●				●	●			●			●
textiles & leather									●										●
tissue & towel	●																		
tobacco				●															
welding rods	●																		

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cross reference chart by functional properties (a - e)

class	acetylenics																	
family	vinyl monomers		surfactants, wetting agents, solvents		performance polymers													
subfamily	vinyl monomers		alkyl pyrrolidone		pvp	pvpp	vinylpyrrolidone copolymers									maleic based polymers		
functional properties	**v-pyrol**™ vinylpyrrolidone	**v-cap**™ vinyl caprolactam	**surfadone**™ wetting agents	**easy-wet**™ wetting agents	PVP polymers	**disintex**™ disintegrants, **polyclar**™ polyvinyl-polypyrrolidone, **polyclar**™ crospovidone, **viviprint**™ PS 10	**ganex**™/**antaron**™ polymers	PVP/VA polymers	**polectron**™/**antara**™ polymer	**sorez**™ **HS-205** copolymers	**gafquat**™ polymers	**styleze**™ copolymers	**setleze**™ (**viviprint**™)	**ultrathix**™ crosspolymer, **rapithix**™ polymer	**gaffix**™/copolymer VC-713 polymer	**gantrez**™ copolymer	**easysperse**™ polymeric dispersant ranges	**aquaflex**™ copolymer
activity inhibitor					●										●			
adhesive					●			●							●	●		●
anti-agglomerant																		
anti-soil redeposition					●					●						●	●	
anti-static											●							
binders and pelletization					●			●								●		
bioadhesive																●		
catalyst																		
chemical intermediate	●	●														●		
cohesive					●			●	●		●				●	●		●
complexes			●		●	●				●			●			●		
corrosion inhibitor					●											●		
crosslinkable	●	●									●	●	●			●		●
crystal inhibitor					●		●								●		●	
defoamer																		
distintegrant						●												
dispersant			●	●	●		●	●		●						●	●	
dye fixative, transfer, inhibitor					●	●					●					●		
electrical conductor, electrical resistor, emi protector																		
emulsifier			●	●			●											
encapsulation																●		

class	cellulosics and derivatized naturalpolymers							synthetic polymers				specialty chemicals							
family	performance polymers							synthetic polymers				surfactants, wetting agents, solvents				specialty chemicals			
subfamily	cellulosics					derivatized guar		specialty polymers		acrylates		phosphate esters		esters & lubricants		neut-ralizer	iron powder	iron penta-carbonyl intermediate	foam control
applications	**bondwell™, blanose™, aqualon™** carboxymethylcellulose	**natrosol™** hydroxyethylcellulose	**culminal™** methylcellulose derivatives	**benecel™** methylcellulose derivatives	**klucel™** hydroxypropylcellulose	**aqualon™** ethylcellulose	**galactasol™** derivatized guar	**aquaflow™** rheology modifiers	**chromobond™** S100 polymers	**rheothix™** thickening agent	**rapifloc™** acrylates	**dextrol™** phosphate ester surfactants	**strodex™** phosphate ester surfactants	**ceraphyl™** emulsifiers	**cerasynt™** emulsifiers	**phlex™** neutralizing agents	micropowder™ iron	iron pentacarbonyl	**crewplus™/advantage™** defoamers
activity inhibitor																•			•
adhesive	•				•														
anti-agglomerant											•								
anti-soil redeposition	•																		
anti-static																			
binders and pelletization	•	•	•	•	•	•													
bioadhesive																			
catalyst																	•	•	
chemical intermediate																		•	
cohesive	•				•	•				•									
complexes									•										
corrosion inhibitor												•	•			•			
crosslinkable	•	•			•		•												
crystal inhibitor																			
defoamer																			•
distintegrant																			
dispersant	•				•				•			•	•	•					
dye fixative, transfer, inhibitor									•										
electrical conductor, electrical resistor, emi protector																	•		
emulsifier												•	•	•	•				
encapsulation																			

cross reference chart by functional properties (f - z)

class	acetylenics																
family	vinyl monomers		surfactants, wetting agents, solvents		performance polymers												
subfamily	vinyl monomers		alkyl pyrrolidone		pvp	pvpp	vinylpyrrolidone copolymers								maleic based polymers		
functional properties	**v-pyrol**™ vinylpyrrolidone	**v-cap**™ vinyl caprolactam	**surfadone**™ wetting agents	**easy-wet**™ wetting agents	PVP polymers	**disintex**™ disintegrants, **polyclar**™ polyvinyl-polypyrrolidone, **polyclar**™ crospovidone, **viviprint**™ PS 10	**ganex**™/**antaron**™ polymers	PVP/VA polymers	**polectron**™/**antara**™ polymer	**sorez**™ **HS-205** copolymers	**gafquat**™ polymers	**styleze**™ copolymers	**setleze**™ (**viviprint**™)	**ultrathix**™ crosspolymer, **rapithix**™ polymer	**gaffix**™/copolymer VC-713 polymer	**gantrez**™ copolymer	**easysperse**™ polymeric dispersant ranges	**aquaflex**™ copolymer
film former					●		●	●	●		●	●	●		●	●		●
flocculant																		
fluid loss additive																		
lubricant					●		●											
metal sequestrant																●		
oil solubility							●											
opacifier									●									
plasticizer			●															
rheology modifier/ thickener					●									●		●		
soil release agent										●								
solvent	●	●	●		●													
stabilizer					●												●	
substantive											●	●			●			●
surface active			●	●			●	●							●			
suspending agent														●		●		
tack modifier					●			●										
thermoplastic								●										
uv protector/ adsorber																		
water resisting						●	●											
water-holding																		
wax inhibitor							●											

class	cellulosics and derivatized naturalpolymers							synthetic polymers				specialty chemicals							
family	performance polymers							synthetic polymers				surfactants, wetting agents, solvents				specialty chemicals			
subfamily	cellulosics					derivatized guar		specialty polymers		acrylates		phosphate esters		esters & lubricants		neut-ralizer	iron powder	iron penta-carbonyl intermediate	foam control
functional properties	**bondwell™, blanose™, aqualon™** carboxymethylcellulose	**natrosol™** hydroxyethylcellulose	**culminal™** methylcellulose derivatives	**benecel™** methylcellulose derivatives	**klucel™** hydroxypropylcellulose	**aqualon™** ethylcellulose	**galactasol™** derivatized guar	**aquaflow™** rheology modifiers	**chromobond™** S100 polymers	**rheothix™** thickening agent	**rapifloc™** acrylates	**dextrol™** phosphate ester surfactants	**strodex™** phosphate ester surfactants	**ceraphyl™** emulsifiers	**cerasynt™** emulsifiers	**phlex™** neutralizing agents	micropowder™ iron	iron pentacarbonyl	**crewplus™/advantage™** defoamers
film former	•	•	•	•	•	•													
flocculant											•								
fluid loss additive	•						•				•								
lubricant							•			•		•	•	•	•				
metal sequestrant																			
oil solubility						•								•	•				
opacifier														•					
plasticizer														•					
rheology modifier/ thickener	•	•	•	•	•	•	•	•		•	•								
soil release agent	•																		
solvent														•					
stabilizer							•												
substantive																			
surface active					•							•	•	•	•				•
suspending agent	•				•		•			•									
tack modifier																			
thermoplastic					•	•													
uv protector/ adsorber																			
water resisting						•													
water-holding	•																		
wax inhibitor																			

global headquarters

Ashland LLC.
8145 Blazer Drive
Wilmington, DE 19808 U.S.A.
Tel: +1 302 594 5000

regional centers

North America
Wilmington, DE
Tel: +1 302 594 5000

Latin America
São Paulo, Brazil
Tel: +55 11 3649 0455

Mexico City, Mexico
Tel: +52 55 5276 6110

Asia Pacific
Singapore
Tel: +65 6775 5366

Shanghai, P.R. China
Tel: +86 21 60906606

Europe
Schaffhausen, Switzerland
Tel: +41 52 560 5500

Middle East and Africa
Dubai, U.A.E.
Tel: +971 4 352 3003

Mumbai, India
Tel: +91 22 61484646

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