



Technical Data Sheet

ACULYN™ 22 Polymer

INCI Name: Acrylates/Steareth-20 Methacrylate Copolymer

A very efficient thickener for difficult to thicken surfactant systems, designed for unique ease of use, wide compatibility, cost effectiveness and favorable balance of rheological properties.

Features & Benefits

- High efficiency
- Yields clear gels
- Highly associative
- Very pseudoplastic
- High surfactant synergy
- Synergistic interaction with inorganic clays
- Particulate stabilizer
- Emulsion stabilizer
- Foam stabilizer
- Broad pH range stability
- Peroxide compatible
- Salt tolerant
- Shear tolerant
- High yield value
- Instant neutralization/thickening
- Cold-processable
- Liquid
- Broad compatibility
- Easy to handle
- No preparation necessary
- Non hygroscopic
- Increased manufacturing efficiency
- Allows for use of continuous production processes with use of in-line static mixers
- Can be processed with membrane pumps and, when diluted, with turbine mixers and high speed propellers
- Able to formulate clear products
- Can be used with electrolytes
- Synergistic interaction with surfactants, particulates and hydrophobic raw materials
- Stabilization of hydrophobic (low solubility) components
- Compatible with nonionic, anionic, Zwitterionic and some cationic surfactants

Features & Benefits (Cont.)

- Ability to stabilize suspensions
- Mild, soft, non-greasy, non-sticky
- Stable in pH 5.5 to 12 formulations
- Thickens and stabilizes hydrogen peroxide
- Does not promote or support contamination, unlike natural thickeners
- Flexibility in choice of preservative system
- Supported by comprehensive environmental, health and safety data

Applications

- Anti-dandruff shampoos
- Bath foams
- Curl activators
- Depilatories
- Emulsifier free formulations
- Foaming facial cleansers
- Hair styling gels
- Liquid soaps
- Lotions
- Moisturizing creams
- Shampoos
- Shower gels
- Skin masks
- Waterless hand cleaners
- Wave sets

Typical Properties

Specification Writers: These values are not intended for use in preparing specifications.

Property	Unit	Result
Chemistry		HASE polymer
Association		Very high
Ionic nature		Anionic
Appearance		Milky liquid
Solvent		Water
Solids	%	30
pH (as supplied)		2.7
Density		1.06
Equivalent weight ¹		218
Rheology		Short, non stringy
Shear thinning		Very high
Viscosity, (as supplied)	mPas	100
Pseudoplastic index (viscosity @ 6 rpm/viscosity @ 60 rpm)		7.0 (2% solids in water)
INCI name		Acrylates/steareth-20 methacrylate copolymer

1. Grams of dry polymer neutralized by 1 equivalent (40 grams) of NaOH.

Description

ACULYN™ 22 Polymer is an anionic hydrophobically modified alkali-soluble acrylic polymer emulsion (HASE) with unusually high aqueous thickening and stabilizing efficiency. This thickener is a liquid, cold-processable product that instantaneously thickens upon neutralization providing ease of handling and increased manufacturing efficiency. ACULYN™ 22 Polymer is offered at 30% solids and is compatible with high levels of surfactants. The polymer has a well-established toxicological profile and is safe in normal use.

ACULYN™ 22 Polymer Chemistry

ACULYN™ 22 Polymer is a Hydrophobically-modified Alkali Soluble Emulsion (HASE). HASE polymers are synthesized from an acid/acrylate copolymer backbone and a monomer that connects the hydrophobic groups as side chains. The polymer is made through emulsion polymerization.

ACULYN™ 22 Polymer is synthesized from acrylic acid, acrylate esters and a steareth-20 methacrylate ester. The general structure for ACULYN™ 22 Polymer is shown to the right.

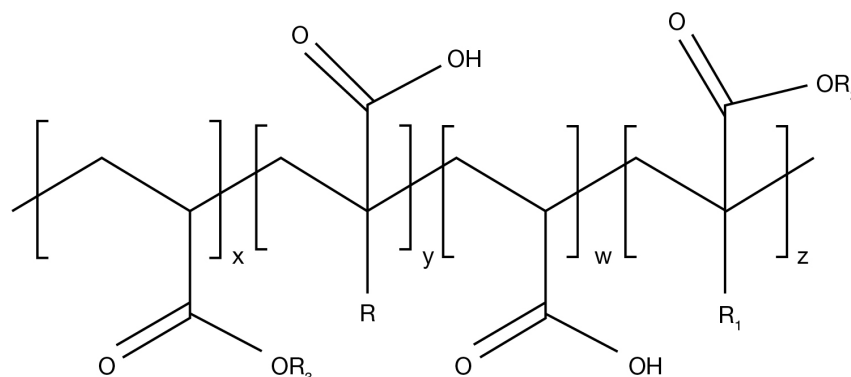


Figure 1

Mechanism of Action

ACULYN™ HASE rheology modifiers are able to thicken by two mechanisms that can act simultaneously and are synergistic, i.e. by the effect of charge-induced polyelectrolytic chain extension and by association of hydrophobe groups.

When the acid groups present in the ACULYN™ HASE molecules are neutralized with inorganic bases or organic amines, they become anionically charged and water-soluble. ACULYN™ 22 Polymer thickens above pH 6.5. ACULYN™ HASE rheology modifiers dissolve and swell due to charge-charge repulsion and therefore thicken instantly.

When ACULYN™ HASE polymers swell, the pendant hydrophobic groups are free to build associations with one another and with other hydrophobes available in the formulation, such as surfactants, particulates, emulsion droplets and dyes. This phenomenon creates a network structure that results in a significant viscosity build.

Mechanism of Action (Cont.)

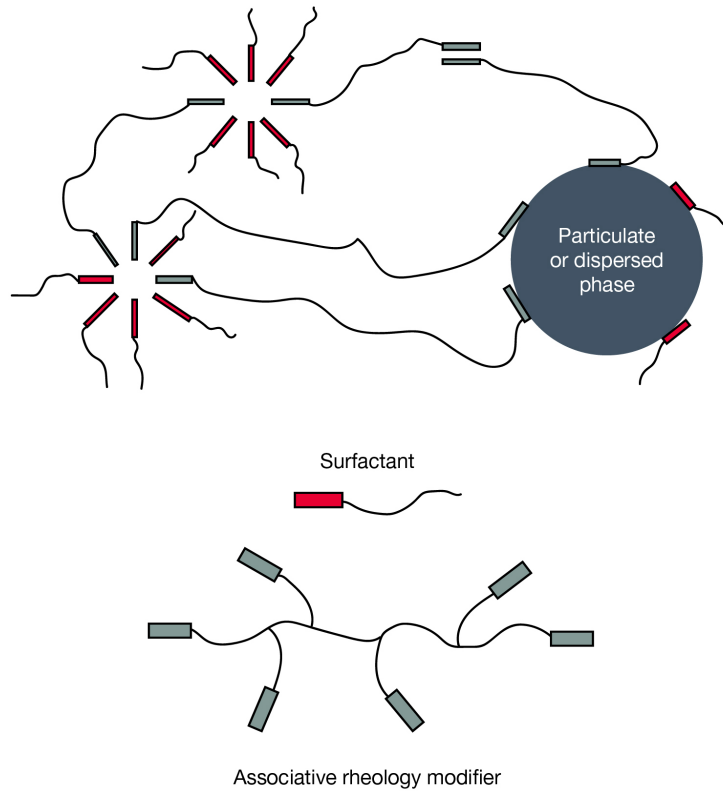


Figure 2

These associative structures can also act to stabilize and disperse particulates in a formulation.

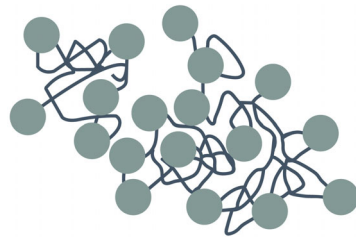


Figure 3

And because of the ethoxylated hydrophobic group on the rheology modifier, ACULYN™ 22 Polymer can also act as a primary emulsifier for some emulsion systems, such as water-resistant sunscreens, to minimize the level of surfactant or emulsifier.

Features of HASE Rheology Modifiers

The chart below shows features indicative of the behavior of HASE rheology modifiers under different conditions. Please note that these behaviors may vary to some extent according to specific formulations.

All ACULYN™ rheology modifiers are easy to formulate, have good to excellent salt tolerance, compatibility with anionics and nonionics and low odor. HASE polymers have excellent shear thinning properties and good stability in two-part peroxide systems. Blending of the ASE and HASE chemistries can offer further enhancements and synergies.

**Features of HASE
Rheology
Modifiers (Cont.)**

Ease of formulation	Excellent
Associative	Yes
Salt tolerance	
NaCl	Excellent
Di/trivalent ions	Good
Shear thinning behavior	Excellent
Solvent compatibility	Excellent
Low pH compatibility	Good
Anionic surfactant compatibility	Excellent
Nonionic surfactant compatibility	Excellent
Zwitterionic surfactant compatibility	Good
Cationic surfactant compatibility	Some
Peroxide stability	
One-part system	No
Two-part system	Excellent
Lack of odor	Excellent

**ACULYN™ 22
Polymer Behavior
Profile**

ACULYN™ 22 Polymer possesses many properties that make this polymer highly desirable for use in personal care applications, as shown by the data presented below.

Rheology

Effect of Shear Rate

ACULYN™ 22 Polymer thickener is a low-viscosity dispersion that becomes a highly viscous clear solution when neutralized with alkali. Provided that proper mixing conditions are used, ACULYN™ 22 Polymer thickens instantaneously upon addition of base, allowing rapid preparation of solutions and products. There is no need for pre-wetting, high shear mixing or long soak times.

The presence of the C₁₈ hydrophobe causes neutralized solutions of ACULYN™ 22 Polymer to be very pseudoplastic, in general showing a high degree of shear thinning because of easily broken van der Waals forces. The yield value also allows the thickener to stabilize suspensions, while still being pourable.

The alkaline solutions are clear, and their flow properties are characterized by a complete lack of stringiness and tackiness and by shear thinning. At the same time, the solutions are viscous at low shear rates. The log-log plot of apparent viscosity vs. shear rate is linear for the sodium salt over the range of spindle rotation rates between 0.5 and 60 rpm. The shear thinning behavior in the following graph is measured in water and the behavior can change in formulations.

**ACULYN™ 22
Polymer Behavior
Profile (Cont.)**

Effect of Shear Rate (Cont.)

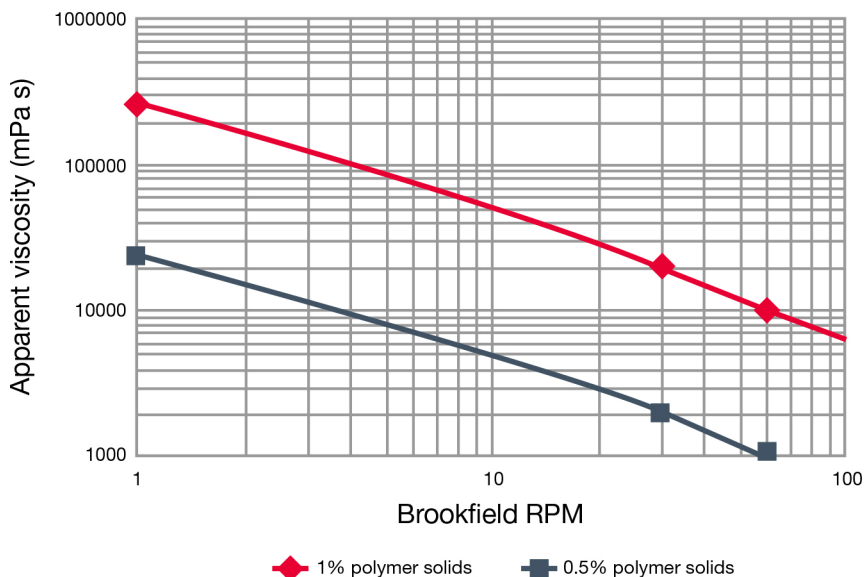


Figure 4: Effect of Shear Rate on Viscosity of Sodium Salt of ACULYN™ 22 Polymer

Effect of Temperature

Thickening with ACULYN™ 22 Polymer undergoes a modest decrease as the temperature rises from 20°C to 75°C.

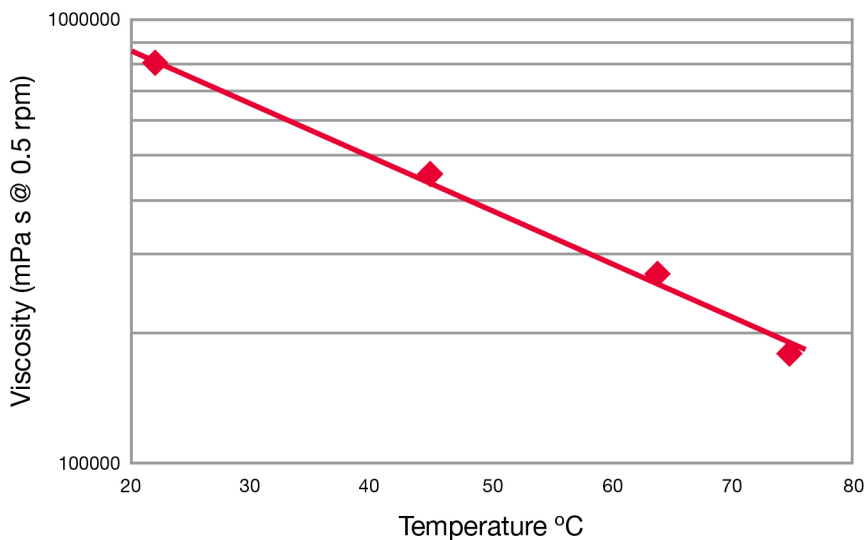


Figure 5: Effect of Temperature on Viscosity of Sodium Salt of ACULYN™ 22 Polymer (1.25% Polymer Solids)

**ACULYN™ 22
Polymer Behavior
Profile (Cont.)**

Compatibility
Surfactant Synergies

General Effect of Surfactants

Certain anionic and nonionic surfactants give a synergistic increase in the viscosity and thickening efficiency of neutralized ACULYN™ 22 Polymer solutions. 10 to 1000 fold increases in viscosity can be achieved. Each surfactant has an optimum concentration at which maximum viscosity is obtained.

Viscosity¹ of Thickened Surfactants²

ACULYN™ 22 Polymer (% Solids)	C ₁₄₋₁₆ Olefin Sulfonate	TEALS ³	SLES ³	SLS ³
0	50	50	50	50
1.0	800	900	525	550
1.5	14,600	4,500	4,900	1,400
2.0	54,000	21,000	15,200	4,600

1. Brookfield viscosity @ 12 rpm, cps
2. Surfactant level 15% solids, pH 7 to 9
3. Surfactant legend: TEALS = Triethanolamine lauryl sulfate, SLES = Sodium lauryl ether sulfate, SLS = Sodium lauryl sulfate

With sodium lauryl sulfate (SLS), for example, the maximum occurs at a level of 40% based on the concentration of ACULYN™ 22 Polymer thickener. The effect of SLS on solution viscosity as a function of the level of ACULYN™ 22 Polymer thickener and the effect of SLS as a function of SLS concentration are shown in the graphs below.

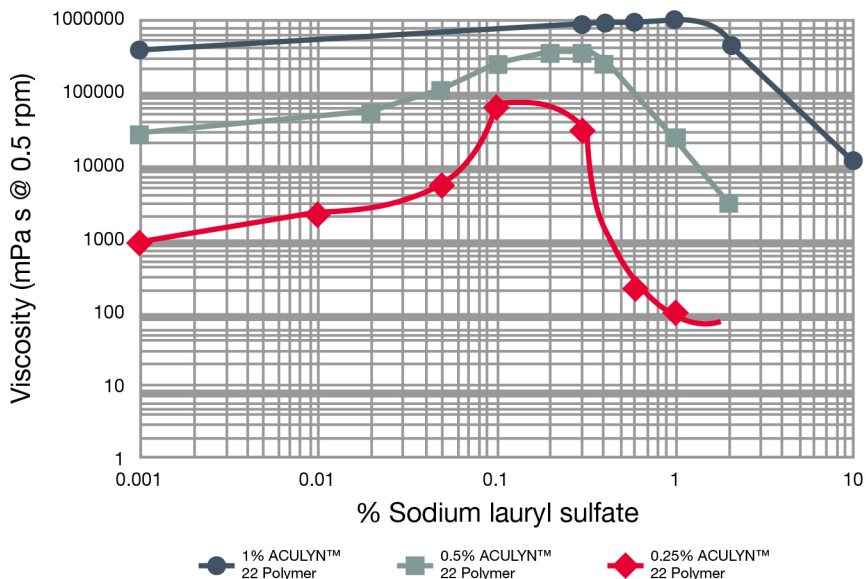


Figure 6: Effect of Sodium Lauryl Sulfate (SLS) on Viscosity of Sodium Salt of ACULYN™ 22 Polymer

ACULYN™ 22 Polymer Behavior Profile (Cont.)

Thickening of Acid-Containing Surfactants Solutions

At high levels of anionic surfactants, acid-containing aqueous solutions with ACULYN™ 22 Polymer display a high degree of thickening. By using a mixture of two surfactants, one an anionic (major component) and the other an amide (minor component), clear thickened compositions are obtained with ACULYN™ 22 Polymer at pH 1 to 7. The presence of amide surfactant is necessary to ensure clarity in these formulations. Applications for these formulations include clear, low pH shampoos.

To correctly prepare these products, the ACULYN™ 22 Polymer is dispersed in the water and the two (or more) anionic surfactants are added with stirring. The solution is neutralized with caustic or other base and allowed to stir for 15 minutes. Finally, the acidity is adjusted to the required level by adding citric acid (pH 4.5 to 7) or hydrochloric acid (pH 1 to 7) to the neutralized solution of the surfactants and thickener. Addition of cationic ingredients, if any, should occur after the pH is lowered to 6.0 or less to minimize the potential interaction of the carboxyl functionality.

The graph and table below show the Brookfield viscosity of a typical formulation over a broad range of low pH.

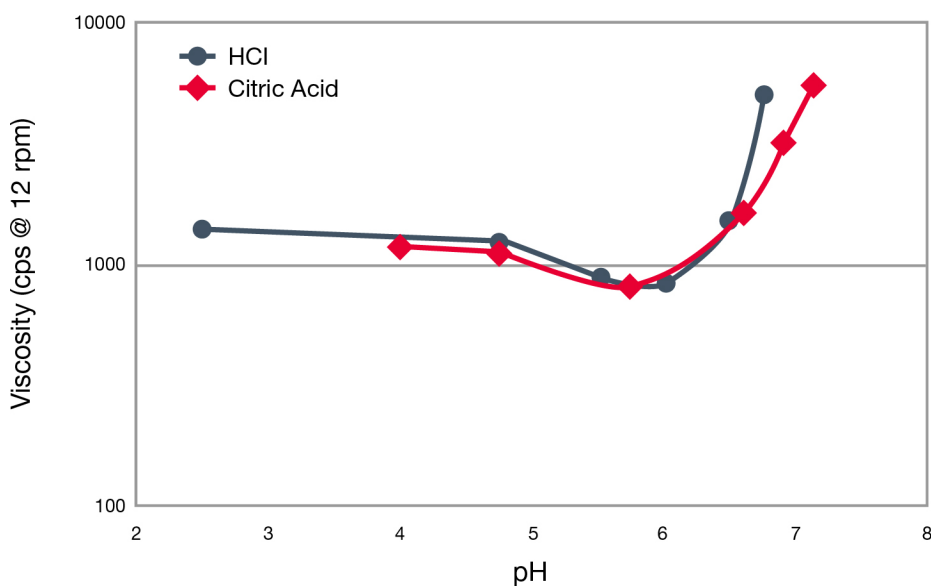


Figure 7: Effect of pH on Viscosity of SLS Solutions Thickened with ACULYN™ 22 Polymer

Acid Shampoos

	SLS (28%)		SLES (27%)		TEALS (40%)		AOS (40%)	
	Solids	As Supplied	Solids	As Supplied	Solids	As Supplied	Solids	As Supplied
Surfactant	17.0	60.7	17	63.0	17	42.5	17	42.5
Lauramide DEA	3.0	3.0	3.0	3.0				
Cocamide DEA					3.0	3.0	3.0	3.0
Miranol C2MSF (70%)					1.0	1.4		
ACULYN™ 22 Polymer (30%)	1.0	3.3	1.5	5.0	2.0	6.7	1.5	5.0
NaOH (10%)	0.09	0.9	0.14	1.4	0.18	1.8	0.14	1.4
Water		32.1		27.6		44.6		48.1
Citric acid to pH 4.5 to 5.2								
Viscosity, Brookfield, cps @ pH 5, 12 rpm		2100		900		3000		5700

ACULYN™ 22 Polymer Behavior Profile (Cont.)

Thickening of Acid-Containing Surfactants Solutions (Cont.)

The graph below presents the effect of pH on the viscosity of formulations based on various anionic surfactants with ACULYN™ 22 Polymer.

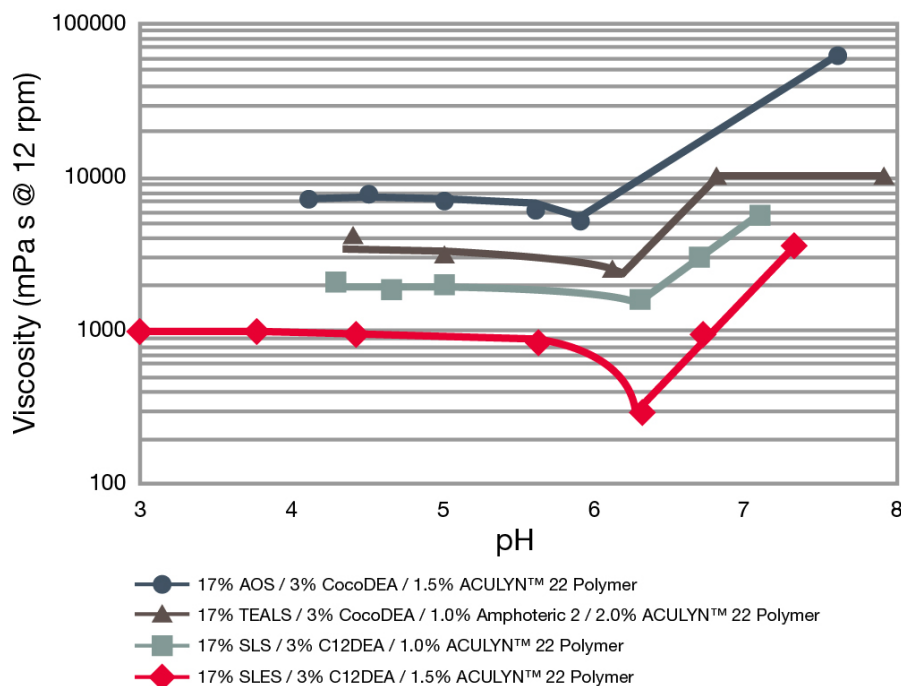


Figure 8: Effects of pH on Viscosity of Shampoo Systems Thickened with ACULYN™ 22 Polymer

Note: The levels of ACULYN™ 22 Polymer and surfactants as listed in the above chart are on a 100% solids basis.

**ACULYN™ 22
Polymer Behavior
Profile (Cont.)**

Salt Tolerance

Neutralized solutions of ACULYN™ 22 Polymer can thicken salt solutions. The thickening efficiency decreases with increasing level of salt, and solutions with low concentrations of thickener are particularly sensitive to the presence of salt. Addition of low levels of surfactant, even when salts are present, substantially increases the thickening efficiency of ACULYN™ 22 Polymer.

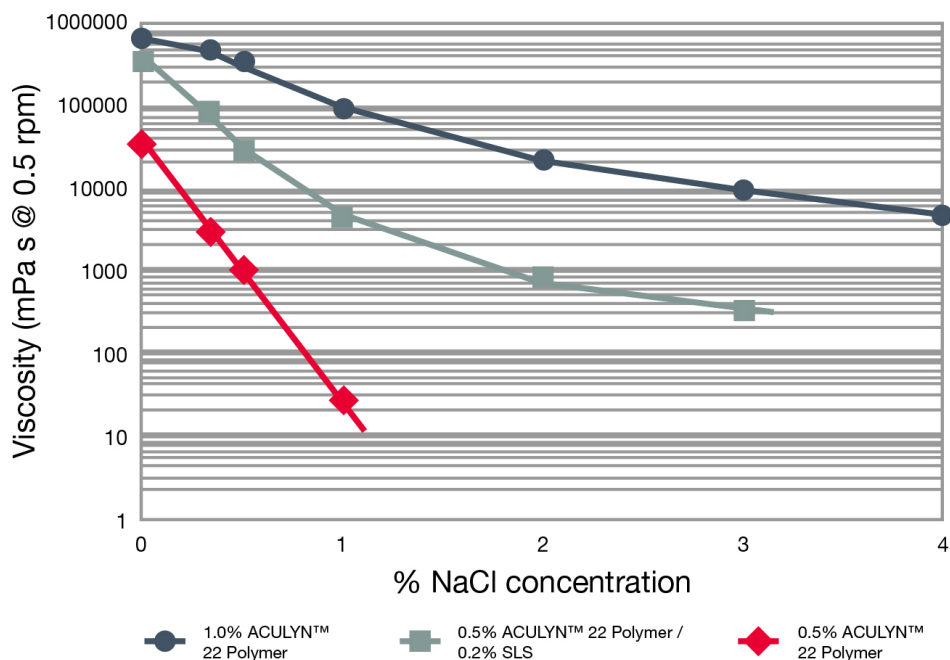


Figure 9: Effect of Sodium Chloride on Viscosity of Sodium Salt on ACULYN™ 22 Polymer

ACULYN™ 22 Polymer also has a tolerance for other salts. Divalent salts such as magnesium chloride will have an impact on viscosity, more of an impact than monovalent salts such as sodium chloride or sodium acetate.

**ACULYN™ 22
Polymer Behavior
Profile (Cont.)**

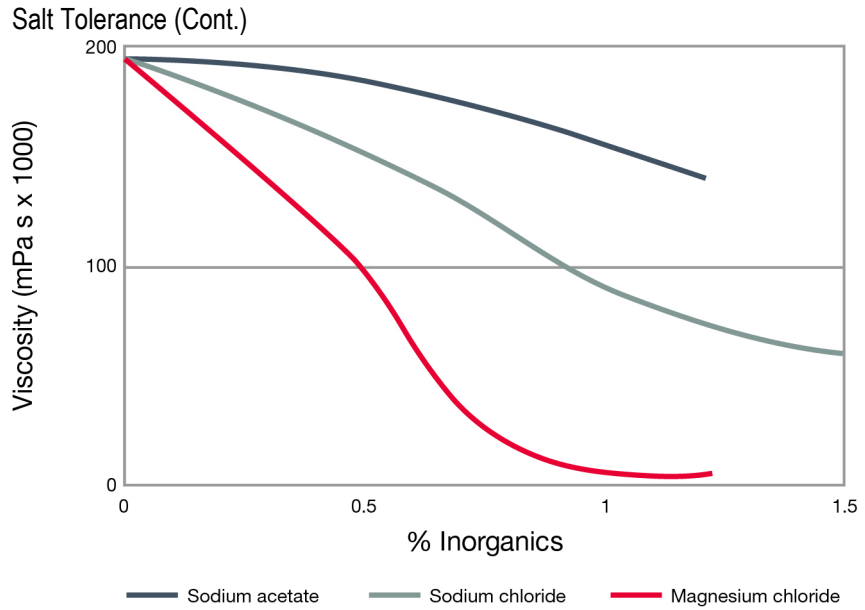


Figure 10: Viscosity vs. Concentration with Various Salts of Neutralized ACULYN™ 22 Polymer

Synergies with Inorganic Clays

Adding low-cost bentonite clays appreciably increases the thickening efficiency of neutralized ACULYN™ 22 Polymer. Combining appropriate levels of ACULYN™ 22 Polymer thickener and bentonite clays can produce free-standing gels.

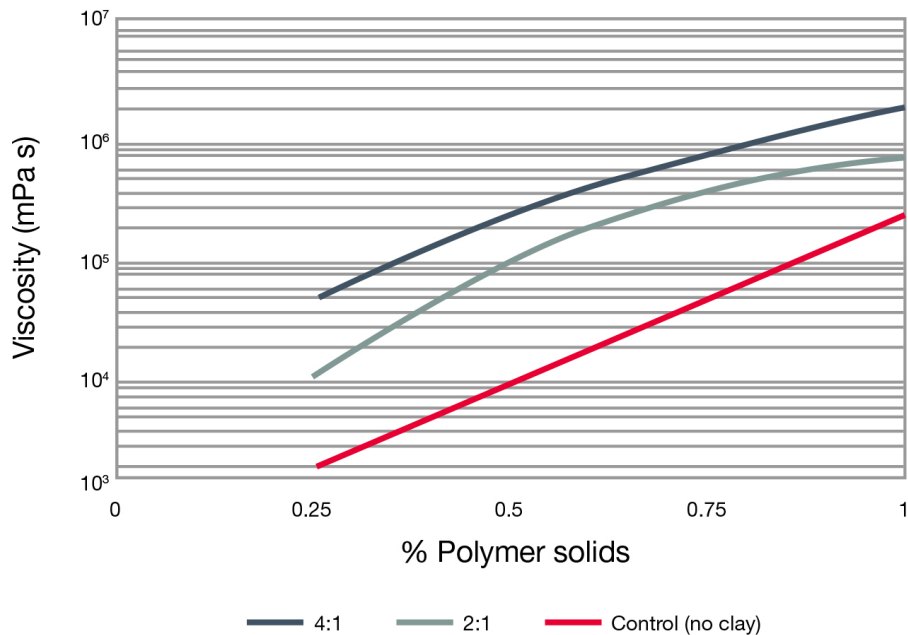


Figure 11: Effect of Bentonite Clay on Viscosity of Neutralized ACULYN™ 22 Polymer

ACULYN™ 22 Polymer Behavior Profile (Cont.)

Synergies with Inorganic Clays (Cont.)

Values are low shear viscosities (Brookfield RVT at 0.5 rpm).

The figures give the ratios of clay to polymer for each curve.

Mixes of Bentonite with the ACULYN™ 22 Polymer show a significant yield stress (point).

pH Tolerance

Thickening drops precipitously below pH of about 7, a range in which the polymer is insoluble. With sodium hydroxide as the base, the viscosity reaches a maximum and remains steady over the pH range from 7.5 to 12. ACULYN™ 22 Polymer can thicken aqueous solutions containing a high level of surfactant below pH 6.5.

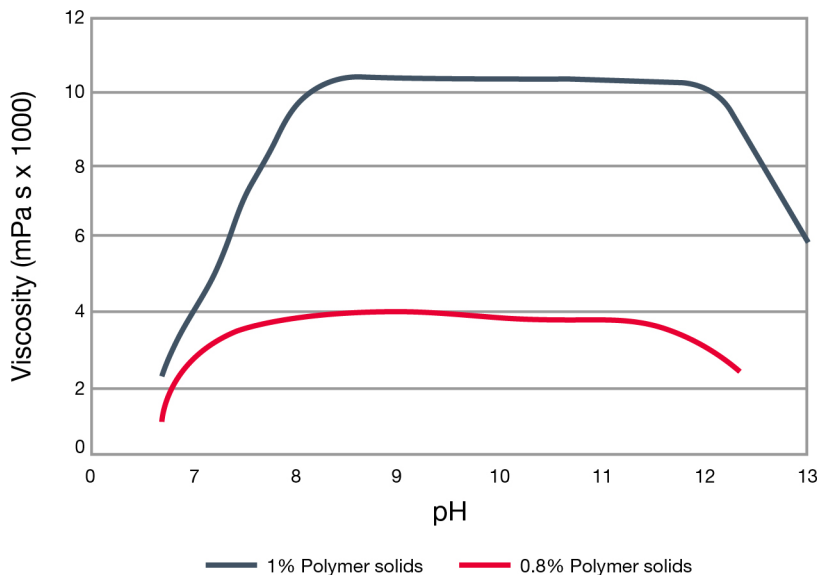


Figure 12: Effect of pH on Viscosity of Sodium Salt of ACULYN™ 22 Polymer (1% Polymer Solids)

Performance

Extremely Efficient Thickener

ACULYN™ 22 Polymer achieves thickening of solutions at very low concentrations and is therefore very efficient and cost effective. The thickening efficiency of ACULYN™ 22 Polymer is significantly superior compared to other types of thickeners such as cellulose and carbomers. ACULYN™ 22 Polymer can be neutralized with sodium hydroxide, ammonia, soda ash (sodium carbonate), and triethanolamine as well as other bases.

Formulation and Use Guidelines

ACULYN™ 22 Polymer is compatible with surfactants, solvents, oils and salts commonly found in cosmetic and toiletry products. These products undergo instantaneous thickening when neutralized with base.

This product is supplied as a low viscosity emulsion and can be incorporated directly into formulations with none of the concerns about dissolution, particulate clumping or dusting problems that can be encountered with dry products. ACULYN™ 22 Polymer is also cold processable.

Formulation and Use Guidelines (Cont.)

Because thickening occurs instantaneously upon neutralization with base, in-line mixing with static mixers is possible. Upon neutralization, the ACULYN™ 22 Polymer emulsion becomes a clear, highly viscous solution.

The preferred order of addition when using ACULYN™ 22 Polymer in aqueous formulations is as follows:

1. Add ACULYN™ 22 Polymer to the water
2. Add other ingredients from the most acidic to the most alkaline
3. Add the neutralizing agent

If this sequence is not desirable, ACULYN™ HASE and ASE polymers can be added directly to an alkaline formulation after first diluting the ACULYN™ 22 Polymer product with two parts of water. Addition of the water prevents gel particles (small particles with neutralized swollen surfaces and unneutralized cores that will take considerable time to dissolve completely).

Preparation of Emulsions and Dispersions

Neutralized ACULYN™ 22 Polymer thickener can also be used to make oil-in-water emulsions of organic liquids such as mineral oil, lanolin or kerosene. ACULYN™ 22 Polymer can also be used to suspend fillers and pigments, such as calcium carbonate, silicate clays and titanium dioxide, in water.

If ACULYN™ 22 Polymer is being used in an emulsion formulation, the general order of addition is as follows:

1. Add ACULYN™ 22 Polymer to the water phase at temperature
2. Add the other water phase ingredients
3. Mix separately the oil phase ingredients at temperature
4. Mix the oil phase into the water phase maintaining temperature
5. Neutralize the ACULYN™ 22 Polymer polymer
6. Cool the mixture with constant stirring
7. Add the preservative (if any) at a safe temperature

Environmental, Health and Safety Record

Toxicology

Acute Toxicity Profile

Test/species	Results
Oral LD ₅₀ – rat	> 5.0 g/kg non-toxic
Dermal LD ₅₀ – rabbit	> 5.0 g/kg non-toxic
Eye irritation – rabbit	Non irritating (US and EEC)
Skin irritation – rabbit	Slightly irritating (US); non irritating (EEC)

US — United States classification

EEC — European Economic Community classification

Environmental, Health and Safety Record (Cont.)

Toxicology (Cont.)

Sensitization Toxicity Profile

Test/species	Results
Sensitization, Guinea pig	Non sensitizer

Genetic Toxicity Profile

Test/species	Results
Ames test	Non mutagenic with and without metabolic activation

Ecotoxicity Profile

Test/species	Results
Daphnia magna EC ₅₀ — 48 hr	> 1000 mg/L — non toxic
Rainbow Trout LC ₅₀ — 96 hr	> 1000 mg/L — non toxic
Bluegill Sunfish LC ₅₀ — 96 hr	> 1000 mg/L — non toxic

Overall Evaluation

ACULYN™ 22 Polymer is considered non-toxic by single oral and dermal exposure, produces minimal to no irritation to the eyes and skin, a non-sensitizer, non-mutagenic in the Ames assay and non-toxic to aquatic organisms. This material is safe and appropriate for use in a broad range of rinse-off and leave-on personal care applications.

ACULYN™ 22 Polymer is cleared under the major chemical inventories such as CTFA, MITI, EINECS, TSCA, AICS and Canada.

Handling Precautions

PRODUCT SAFETY INFORMATION REQUIRED FOR SAFE USE IS NOT INCLUDED IN THIS DOCUMENT. BEFORE HANDLING, READ PRODUCT AND SAFETY DATA SHEETS AND CONTAINER LABELS FOR SAFE USE, PHYSICAL AND HEALTH HAZARD INFORMATION. THE SAFETY DATA SHEET IS AVAILABLE ON THE DOW WEBSITE AT DOW.COM, OR FROM YOUR DOW SALES APPLICATION ENGINEER, OR DISTRIBUTOR, OR BY CALLING DOW CUSTOMER SERVICE.

Usable Life and Storage

Keep from freezing; material may coagulate. The minimum recommended storage temperature for these materials is 1°C/34°F. The maximum recommended storage temperature is 49°C/120°F. These materials may coagulate if exposed to temperature outside this range. The coagulation process is irreversible.

Limitations

This product is neither tested nor represented as suitable for medical or pharmaceutical uses.

Health and Environmental Information

To support customers in their product safety needs, Dow has an extensive Product Stewardship organization and a team of product safety and regulatory compliance specialists available in each area.

For further information, please see our website, dow.com or consult your local Dow representative.

Disposal Considerations

Dispose in accordance with all local, state (provincial) and federal regulations. Empty containers may contain hazardous residues. This material and its container must be disposed in a safe and legal manner.

It is the user's responsibility to verify that treatment and disposal procedures comply with local, state (provincial) and federal regulations. Contact your Dow Technical Representative for more information.

Product Stewardship

Dow has a fundamental concern for all who make, distribute, and use its products, and for the environment in which we live. This concern is the basis for our product stewardship philosophy by which we assess the safety, health, and environmental information on our products and then take appropriate steps to protect employee and public health and our environment. The success of our product stewardship program rests with each and every individual involved with Dow products - from the initial concept and research, to manufacture, use, sale, disposal, and recycle of each product.

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