



ACULYN™ 28 Rheology Modifier/Stabilizer **A Very Efficient Thickener for a Wide Array of Personal Care Formulations**

This bulletin focuses on our ACULYN 28 rheology modifier, a very efficient thickener for a wide array of personal care formulations. Our ACULYN rheology modifiers find utility in an ever-increasing breadth of personal care applications because of their unique ease of use, wide compatibility, cost effectiveness and favorable balance of rheological properties.

Rohm and Haas Company is committed to providing technology enhancement to the personal care industry. To learn how our expertise in polymers and preservatives can spark your own creativity, please contact us.

Description

ACULYN 28 rheology modifier is an anionic associative rheology modifier developed specifically for hair and skin care applications. This thickener is a hydrophobically modified alkali soluble polymer emulsion (HASE) with unusually high aqueous thickening and stabilizing efficiency. The polymer is a liquid, cold-processable product that instantaneously thickens upon neutralization, providing ease of handling and increased manufacturing efficiency.

ACULYN 28 is designed for clear formulations, stable from pH 5.5 to 10 and compatible with nonionic, anionic, Zwitterionic and some cationic ingredients, as well as peroxide and electrolytes. The lower pH neutralization makes it ideal for skin care applications.

CTFA/INCI Name: Acrylates/Beheneth-25 Methacrylate Copolymer

Features

- Liquid
- Broad pH range stability
- Instant neutralization/thickening
- Highly associative
- Cold-processable
- High surfactant synergy
- Higher efficiency/concentration ratio
- Synergistic rheology with inorganic clays
- Yields clear gels
- Very pseudoplastic
- Foam stabilizer
- High yield value
- Particulate stabilizer
- Thixotropic
- Salt tolerant
- Shear tolerant
- Peroxide compatible
- Formulation compatible
- Polar solvent compatible

Benefits

- Easy to handle
- Compatible with nonionic, anionic, Zwitterionic and some cationic surfactants
- No preparation necessary
- Non-hygroscopic
- Ability to stabilize suspensions
- Increased manufacturing efficiency
- Mild, soft, non-greasy, non-sticky
- Allows for use of continuous production processes with use of in-line static mixers
- Stable in pH 5.5 to 12 formulations
- Thickens and stabilizes hydrogen peroxide
- Can be processed with membrane pumps and, when diluted, with turbine mixers and high speed propellers
- Does not promote or support contamination, unlike natural thickeners
- Able to formulate clear products
- Supported by comprehensive environmental, health and safety data
- Can be used with electrolytes
- Synergistic interaction with surfactants, particulates and hydrophobic raw materials
- Stabilization of hydrophobic (low solubility) components

Applications

- Alcohol and glycol containing formulations
- Body washes and shower gels
- Crystal clear hair care gels
- Crystal clear skin care gels
- Emulsifier free formulations
- Hand and body lotions
- Liquid hand soaps
- Make-up creams and lotions
- Shampoos
- Sunscreen lotions
- Two component hair dye systems (hair dye developers, perm neutralizers)

Physical and Chemical Characteristics

The values presented in this chart should not be considered as product specifications.

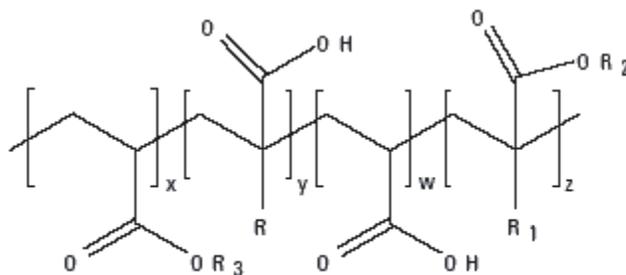
Chemistry	HASE polymer
Association	very high
Ionic nature	anionic
Appearance	milky liquid
Solvent	water
Solids, %	20
pH (as supplied)	3.0
Density	1.01
Equivalent weight*	253
Rheology	short, non stringy
Shear thinning	very high
Pseudoplastic index (viscosity @ 6 rpm/viscosity @ 60 rpm)	7.0 (0.7% solids in water)
Acid Number	45 mg KOH/g
Transparency (0.7% solids @ pH 8.5)	< 20 [NTU]
Viscosity, mPa s (as supplied)	20
Viscosity of 1% solids solution (after 24 hrs @ pH 8.5, Brookfield RVT Spindle 7, 10 rpm)	35,000 - 45,000 cps
INCI Name	Acrylates/Beheneth-25 Methacrylate Copolymer

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

ACULYN 28 Chemistry

ACULYN 28 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 28 is synthesized from acrylic acid, acrylate esters and a beheneth-20 methacrylate ester. The general structure for ACULYN 28 is shown to the right.



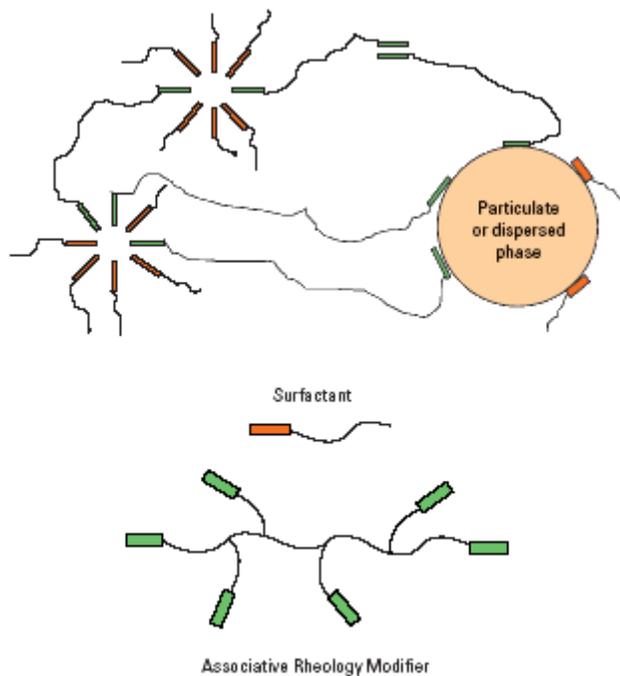
R_x= Acyl chain from 1 to 22 carbons

Mechanism of Action

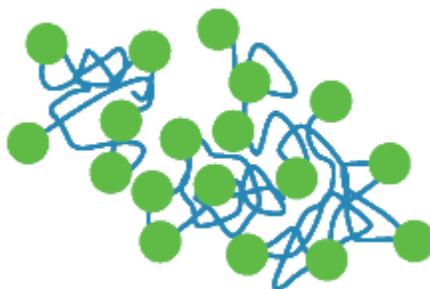
ACULYN HASE rheology modifiers are able to thicken by two mechanisms that can act simultaneously and are synergistic, i.e. by the effect of charge-induced polyelectrolytic chain extension and by association of hydrophobe groups.

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 28 thickens above pH 5.5. ACULYN HASE rheology modifiers dissolve and swell due to charge-charge repulsion.

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.



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



And because of the ethoxylated hydrophobic group on the rheology modifier, ACULYN 28 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 to the right 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.

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	
1 part system	No
2 part system	Excellent
Lack of odor	Excellent

ACULYN 28 Behavior Profile

ACULYN 28 rheology modifier possesses many properties that make this polymer highly desirable for use in personal care, as shown by the data presented below.

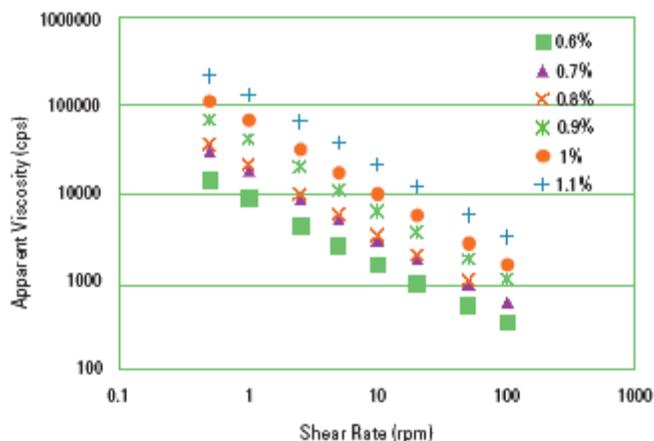
Rheology

The highly associative nature of ACULYN 28 has a significant affect on the viscosity of formulations, one that is much stronger than that created by the addition of electrolytes. The presence of the C₂₂ hydrophobe causes solutions of ACULYN 28 to be very pseudoplastic with a high yield value, in general showing a high degree of shear thinning. The high yield value also allows the thickener to stabilize suspensions while still being pourable.

In applications such as two part hair dye products, the shear profile allows for easy application with penetration of the dye, while reducing the dripping or running of hair dye products when developed and applied to the scalp.

The shear thinning behavior in the following graph is measured in water and the behavior can change in formulations.

Effect of Shear on Aculyn 28 at Various Concentrations



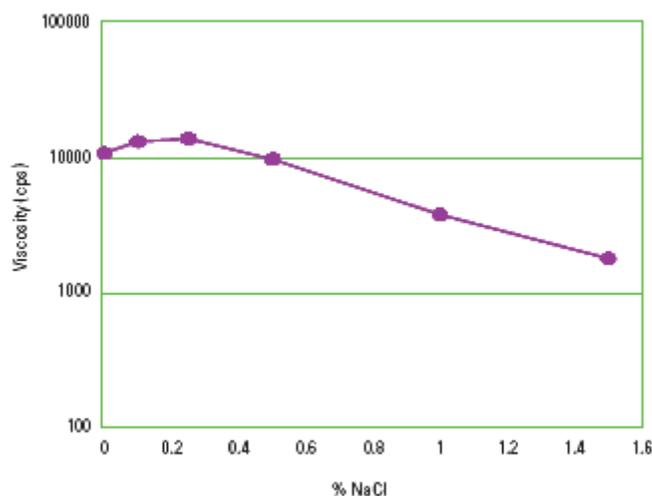
In the above graph, the shear profile is shown for various concentrations of Aculyn 28 (as solid polymer) using a Brookfield Rheometer

Compatibility

Salt Tolerance

ACULYN 28 exhibits outstanding salt tolerance. The polymer can significantly build viscosity even in the presence of 1.6% sodium chloride. This performance attribute makes ACULYN 28 the ingredient of choice in formulations that contain high levels of electrolytes, such as shampoos and shower gels, when the sodium salts of surfactants are employed, or when some raw materials have salt as a trace component.

Effect of Salt Concentration on Gel Viscosity of Aculyn 28

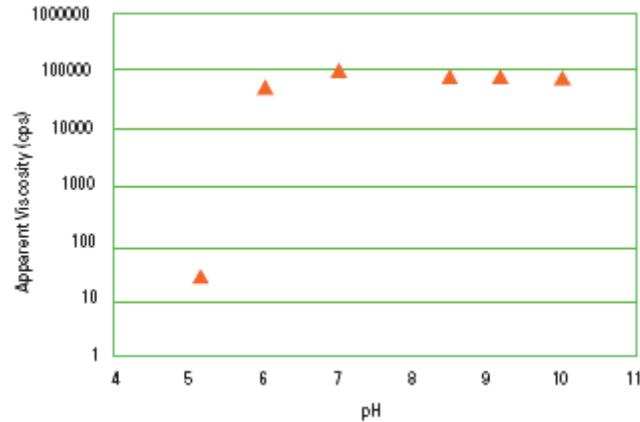


Polymer concentration: 0.7% solids
Neutralized with ammonium hydroxide to pH 8.5
Brookfield LVT, 12 rpm, LV spindle set

pH Tolerance

The thickening effect of ACULYN 28 develops above pH 5.5, when the polymer becomes solubilized and polymer chain extension occurs. In the following graph, where ammonium hydroxide was used as the neutralizing base, the viscosity reaches a maximum and remains steady over a pH range from 6 to 12. This profile will be similar for any neutralizing base.

Profile for Viscosity Versus pH for Aculyn 28



1% polymer solids aqueous solutions neutralized with hydroxide
Brookfield RVT DV II, 10 rpm, Heliopath spindle set

Surfactant Synergies

Given that ACULYN 28 is an associative thickener, its thickening efficiency can be significantly affected by the presence of surfactants. The type of surfactant and its concentration play a key role in the rheological properties of the polymer-surfactant system. The measurements of viscosity vs. surfactant concentration generally show an increase in viscosity for ACULYN 28-surfactant systems.

A nonionic surfactant with a high HLB (Hydrophobic Lipophilic Balance), such as C₉₋₁₁ pareth-12, typically produces a significant increase in viscosity at low concentrations of surfactant that decreases at higher surfactant concentrations. A nonionic surfactant with a low HLB, such as C₁₄₋₁₅ pareth-74, leads to a gradual increase in viscosity, which will remain at a higher level even at higher surfactant concentrations.

In the case of an anionic surfactant such as Sodium Laureth Sulfate (SLES), there is usually a small increase in viscosity at very low surfactant concentrations followed by a gradual decrease at higher surfactant concentrations. The longer alkyl chain in ACULYN 28 reduces the decrease as compared to many other rheology modifiers.

Clarity in the Presence of Surfactants

Solutions of ACULYN 28 and various surfactants maintain their clarity. The table on the next page shows the clarity of solutions as can be seen from the NTU (Nephelometric Turbidity Units) readings above for each of the polymer / surfactant solutions. A solution with a reading below 10 NTUs would be clear. The pH of these solutions was adjusted to 8.5 with ammonium hydroxide, and each system was equilibrated to 20 to 25°C.

Clarity of ACULYN 28 (1% active) with Different Surfactants

Surfactant	% active	Brookfield Viscosity (cP, 6 rpm)	NTU*
None	0	128,667	<1.0
Sodium lauryl sulfate	5	2,040	5.3
	10	630	5.3
Sodium laureth-3 sulfate	5	17,456	3.1
	10	4,044	7.2
Sodium α -olefin sulfonate	5	10,438	2.7
	10	2,424	9.6
Cocamidopropyl betaine	5	4,979	5.7
	10	885	2.8
C ₁₄₋₁₅ pareth-7	10	2,067	5.3
	20	1,833	4.6

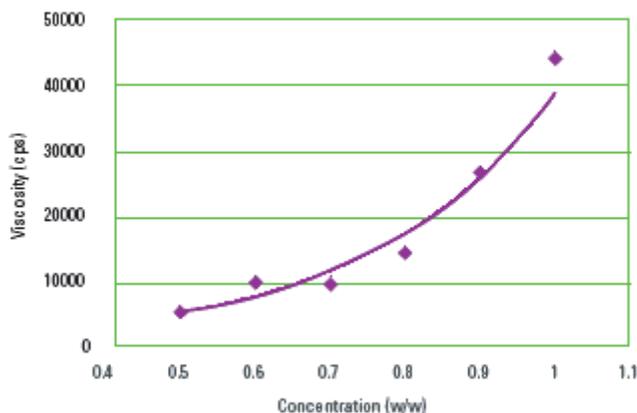
*NTU = Nephelometric Turbidity Units, a measure of clarity. Lower numbers correspond to a higher degree of clarity. A reading of 0 to 10 is clear, 10-20 is almost clear, 20-50 has a slight haze.

Performance

Extremely Efficient Thickener

The viscosity of neutralized aqueous solutions of ACULYN 28 as a function of the concentration of solids is shown in the graph opposite. The viscosity of solutions increases with increasing concentration, but even at low concentrations, the viscosity is increased significantly with ACULYN 28.

Viscosity of Neutralized Aculyn 28 with Increasing Concentration

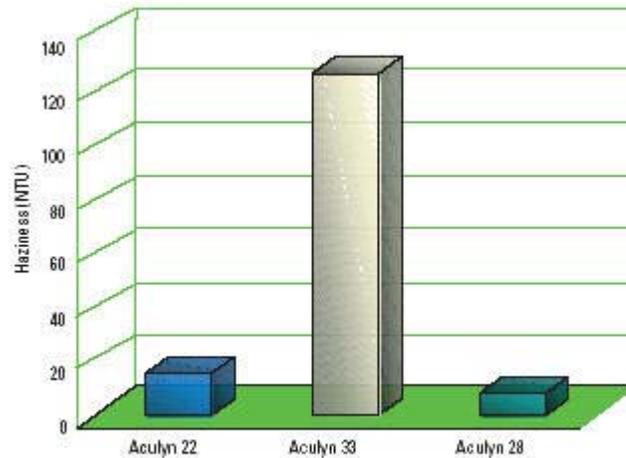


Polymer aqueous solutions neutralized with hydroxide to pH = 8.5
Brookfield RVT DV II, 10 rpm, Heliopath spindle set

Clarity of Solutions

The formulation of crystal clear gel products for hair and skin is an important global trend. Based on the low NTU values of the instrumental transparency measurements of aqueous ACULYN 28 gels, we recommend the use of this product for the preparation of crystal clear formulations.

Solution Clarity of Aculyn 22, Aculyn 33 and Aculyn 28 Gels

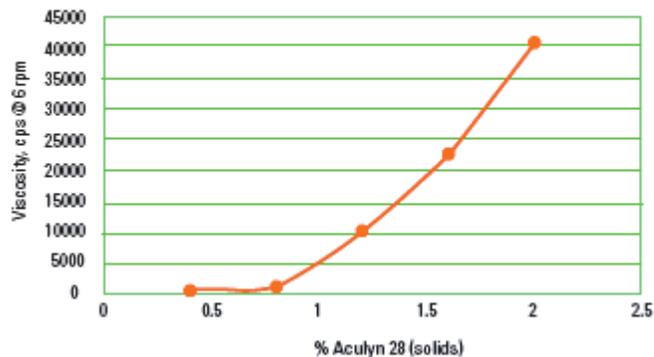


0.7% polymer solids aqueous solutions.
Neutralized with ammonium hydroxide to pH 8.5.

Thickening of Alcohols and Polar Solvents

ACULYN 28 can be used to thicken polar solvents such as ethanol, isopropanol or propylene glycol.

Thickening of 25% Ethanol with Aculyn 28



Formulation and Use Guidelines

ACULYN 28 rheology modifier 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 28 is also cold processable.

Because thickening occurs instantaneously upon neutralization with base, in-line mixing with static mixers is possible. Upon neutralization, the ACULYN 28 emulsion becomes a clear, highly viscous solution.

The preferred order of addition when using ACULYN 28 rheology modifier in aqueous formulations is as follows:

1. Add ACULYN 28 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 28 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 28 thickener can also be used to make oil-in-water emulsions of organic liquids such as mineral oil, lanolin or kerosene. ACULYN 28 can also be used to suspend fillers and pigments, such as calcium carbonate, silicate clays and titanium dioxide, in water.

If ACULYN 28 is being used in an emulsion formulation, the general order of addition is as follows:

1. Add ACULYN 28 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 28 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 g/kg non-toxic
Dermal LD ₅₀ – rabbit	>5 g/kg non-toxic
Eye irritation – rabbit	Moderately irritating (US); Non irritating (EEC)
Skin irritation – rabbit	Slightly irritating (US); Non irritating (EEC)

US — United States classification

EEC — European Economic Community classification

Sensitization Toxicity Profile

Toxicity data for a compositionally similar product are shown below:

Test/Species	Results
Sensitization, Guinea pig	Non sensitizer

Genetic Toxicity Profile

Test/Species	Results
Ames Test	Non mutagenic with and without metabolic activation
In vitro Chromosomal Aberration Test	Non mutagenic with and without metabolic activation

Human Toxicity Profile

Test/Species	Results
HRIPT	Non sensitizing and Non irritating
Phototoxicity	Negative
Photoallergy	Negative

Ecotoxicity Profile

Toxicity data for a compositionally similar product are shown below:

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 28 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, as well as non-irritating or sensitizing in Human Patch testing. This material is safe and appropriate for use in a broad range of rinse-off and leave-on personal care applications.

ACULYN 28 is cleared under the major chemical inventories such as CTFA, MITI, EINECS, TSCA, AICS and Canada.

Storage and Handling

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.

Material Safety Data Sheets

Rohm and Haas Material Safety Data Sheets (MSDS) contain pertinent information that you may need to protect your employees and customers against any known health or safety hazards associated with our products. Under the OSHA Hazard Communication Standard, workers must have access to and understand MSDS on all hazardous substances to which they are exposed. Thus, it is important that you provide appropriate training and information

to your employees and make sure they have available to them MSDS on any hazardous products in the workplace.

Upon initial shipment of non-OSHA-hazardous and OSHA-hazardous products (including samples), Rohm and Haas Company sends the appropriate MSDS to the recipient. If you do not have access to one of these MSDS, please contact your local Rohm and Haas representative for a copy. Updated MSDS are sent upon revision to all customers of record. MSDS are also sent annually to all customers receiving products deemed hazardous under the Superfund Amendments and Reauthorization Act (SARA). MSDS should be obtained from suppliers of other materials recommended in this bulletin.

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