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/Stabilizer, 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.

Dow 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/Stabilizer 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 Properties

The following are typical properties of ACULYN™ 28 Rheology Modifier/Stabilizer; they are not to be considered 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: ........................................ 7.0
(viscosity @ 6 rpm/viscosity @ 60 rpm): ... (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: ....................... 35,000 - 45,000 cps
(after 24 hrs @ pH 8.5, Brookfield RVT Spindle 7, 10 rpm)
INCI name: .................................................. Acrylates/Beheneth-25 Methacrylate Copolymer
*grams of dry polymer neutralized by 1 equivalent (40 grams) of NaOH.

Structure

ACULYN 28™ Rheology Modifier/Stabilizer is a Hydrophobically-modified Alkali Soluble Emulsion (HASE). HASE polymers are synthesized from an acid/acylate 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 above.

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 Rheology Modifier/Stabilizer 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 Rheology Modifier/Stabilizer can also act as a primary emulsifier for some emulsion systems, such as water resistant sunscreens, to minimize the level of surfactant or emulsifier.

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.

ACULYN™ 28 Rheology Modifier/Stabilizer 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 effect on the viscosity of formulations, one that is much stronger than that created by the addition of electrolytes. The presence of the C$_{22}$ 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.

**Compatibility**

**Salt Tolerance**

ACULYN™ 28 Rheology Modifier/Stabilizer 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.
**pH Tolerance**

The thickening effect of ACULYN™ 28 Rheology Modifier/Stabilizer 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 Rheology Modifier/Stabilizer**

**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 C_{9-11} 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 C_{14-15} 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 Rheology Modifier/Stabilizer and various surfactants maintain their clarity. The table below 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 Rheology Modifier/Stabilizer (1% active) with Different Surfactants

<table>
<thead>
<tr>
<th>Surfactant</th>
<th>% active</th>
<th>Brookfield Viscosity (cP, 6 rpm)</th>
<th>NTU*</th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
<td>0</td>
<td>128,667</td>
<td>&lt;1.0</td>
</tr>
<tr>
<td>Sodium lauryl sulfate:</td>
<td>5</td>
<td>2,040</td>
<td>5.3</td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>630</td>
<td>5.3</td>
</tr>
<tr>
<td>Sodium laureth-3 sulfate</td>
<td>5</td>
<td>17,456</td>
<td>3.1</td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>4,044</td>
<td>3.1</td>
</tr>
<tr>
<td>Sodium α-olefin sulfonate:</td>
<td>5</td>
<td>10,438</td>
<td>2.7</td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>2,424</td>
<td>9.6</td>
</tr>
<tr>
<td>Cocamidopropyl betaine:</td>
<td>5</td>
<td>4,979</td>
<td>5.7</td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>885</td>
<td>2.8</td>
</tr>
<tr>
<td>C14-15 pareth-7</td>
<td>10</td>
<td>2,067</td>
<td>5.3</td>
</tr>
<tr>
<td></td>
<td>20</td>
<td>1,833</td>
<td>4.6</td>
</tr>
</tbody>
</table>

* 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 Rheology Modifier/Stabilizer as a function of the concentration of solids is shown in the graph below. 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 Rheology Modifier/Stabilizer with Increasing Concentration

![Graph showing viscosity of ACULYN™28 Rheology Modifier/Stabilizer with increasing concentration.](image-url)
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 Rheology Modifier/Stabilizer gels, we recommend the use of this product for the preparation of crystal clear formulations.

Solution Clarity of ACULYN™ 22 Rheology Modifier/Stabilizer, ACULYN™ 33 Rheology Modifier/Stabilizer and ACULYN™ 28 Rheology Modifier/Stabilizer Gels

ACULYN™ 28 Rheology Modifier/Stabilizer can be used to thicken polar solvents such as ethanol, isopropanol or propylene glycol.

Thickening of 25% Ethanol with ACULYN™ 28 Rheology Modifier/Stabilizer

ACULYN™ 28 Rheology Modifier/Stabilizer 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 Rheology Modifier/Stabilizer emulsion becomes a clear, highly viscous solution.

The preferred order of addition when using ACULYN 28 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).

Neutralized ACULYN™ 28 Rheology Modifier/Stabilizer 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

Toxicity
For product safety information, refer to Safety Data Sheet (SDS).

Handling Precautions
Before using this product, consult the Material Safety Data Sheet (MSDS)/Safety Data Sheet (SDS) for details on product hazards, recommended handling precautions and product storage.

Storage
Store products in tightly closed original containers at temperatures recommended on the product label.

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.
Dow is a member of the American Chemistry Council (ACC) and is committed to the ACC's Responsible Care® Program.

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