



## ACULYN™ 44 Polymer

### Description

ACULYN™ 44 Polymer is a nonionic thickener based upon Hydrophobically-modified Ethoxylated URethane (HEUR) chemistry designed for personal care applications. As with most other ACULYN™ rheology modifiers, the polymer is a liquid product for easier handling and manufacturing efficiency. ACULYN™ 44 Polymer is offered at 35% solids, is stable from pH 2 to 12 and compatible with peroxide and other oxidizing agents. The polymer has a well-established toxicological profile.

CTFA / INCI name: PEG-150/Decyl Alcohol/SMDI Copolymer

### Features

- Highly associative
- Broad compatibility
- Near Newtonian rheology
- Nonionic
- Minimum shear dependence
- Stable in anionic, cationic and nonionic systems
- Cold-processable
- Stable pH/viscosity response
- Liquid
- Acid compatibility
- Salt tolerant
- Peroxide stable
- Lack of odor
- Particulate stabilizer

### Applications

- Cationic silicone emulsions
- Creams
  - Non-medicated creams
  - Make-up
  - Mascara
- Hair products
  - Permanent waves
  - Hair rinse/conditioners
  - Particulate containing shampoos
  - 2 or 3 in ONE shampoos/conditioners
- Lotions
  - Deodorants
  - Astringents
- Peroxide-containing formulations
  - Hair bleaches/dyes
  - Hydrogen peroxide skin formulations

### Benefits

- Easy to handle
- Stabilization of hydrophobic (low solubility) components
- No neutralization necessary
- No preparation necessary
- Compatible with nonionic, anionic, Zwitterionic and cationic surfactants
- Non-hygroscopic
- Increased manufacturing efficiency
- Can be processed with membrane pumps and, when diluted, with turbine mixers and high speed propellers
- Thickens and stabilizes oxidizing media
- Able to formulate clear products
- Flexibility in choice of preservative system
- Mild, soft, non-greasy, non-sticky, creamy

## Benefits (Cont.)

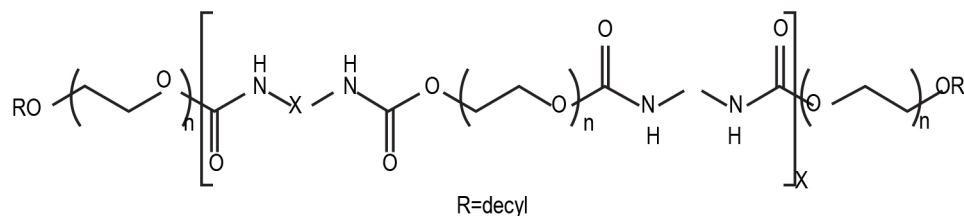
- Stable in pH 2 to 12 formulations
- Allows for use of continuous production processes with use of in-line static mixers
- Effective in thickening acid media such as solutions of organic acids
- Supported by comprehensive environmental, health and safety data
- Reproducible viscosity
- Can be used with electrolytes
- Cleared under CTFA/MITI/EINECS/TSCA/AICS/Canada
- Ability to stabilize suspensions

## Physical Properties

The following are typical properties of ACULYN™ 44 Polymer; they are not to be considered product specifications.

Chemistry:	HEUR polymer
Association:	Very high
Ionic nature:	Nonionic
Appearance:	Hazy liquid
Solvent:	60/40 propylene glycol/water
Solids, %:	35
pH (as supplied):	8 to 9
Density:	1.0–1.2
Rheology:	Stringy, tacky
Shear thinning:	Near Newtonian
Viscosity, mPa s (as supplied):	11,000
Pseudoplastic index: rpm/viscosity @ 60 rpm):	1.0 (2% polymer solids in water) (viscosity @ 6
INCI Name:	PEG-150/Decyl Alcohol/SMDI Copolymer

## Structure



**Figure 1**

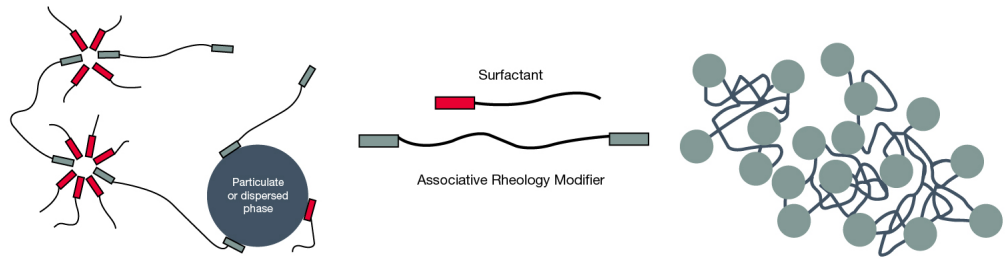
ACULYN™ 44 Polymer is a Hydrophobically-modified Ethoxylated Urethane (HEUR) and is synthesized from decyl alcohol, a diisocyanate and a polyethylene glycol as shown above.

## Mechanism of Action

ACULYN™ HEUR rheology modifiers thicken via an associative mechanism. The hydrophobic parts of HEUR polymers build up associations with other hydrophobes present in the formulation. However, because the ACULYN™ 44 Polymer is nonionic in nature, no neutralization is needed and the polymer will function equivalently in a pH range from 2 through 12.

The pendant hydrophobic groups in ACULYN™ HEUR polymers 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.

The chart below shows features indicative of the behavior of HEUR 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. HEUR polymers have excellent compatibility in low pH and cationic systems and excellent stability in one-part peroxide systems.

## Features of HEUR Rheology Modifiers

Ease of formulation	Good
Associative	Yes
Salt tolerance	
NaCl	Excellent
Di/trivalent ions	Excellent
Shear thinning behavior	Fair
Solvent compatibility	Good
Low pH compatibility	Excellent
Anionic surfactant compatibility	Good
Nonionic surfactant compatibility	Excellent
Cationic surfactant compatibility	Excellent
Zwitterionic surfactant compatibility	Excellent
Peroxide stability	
1 part system	Excellent
2 part system	Excellent
Lack of odor	Excellent

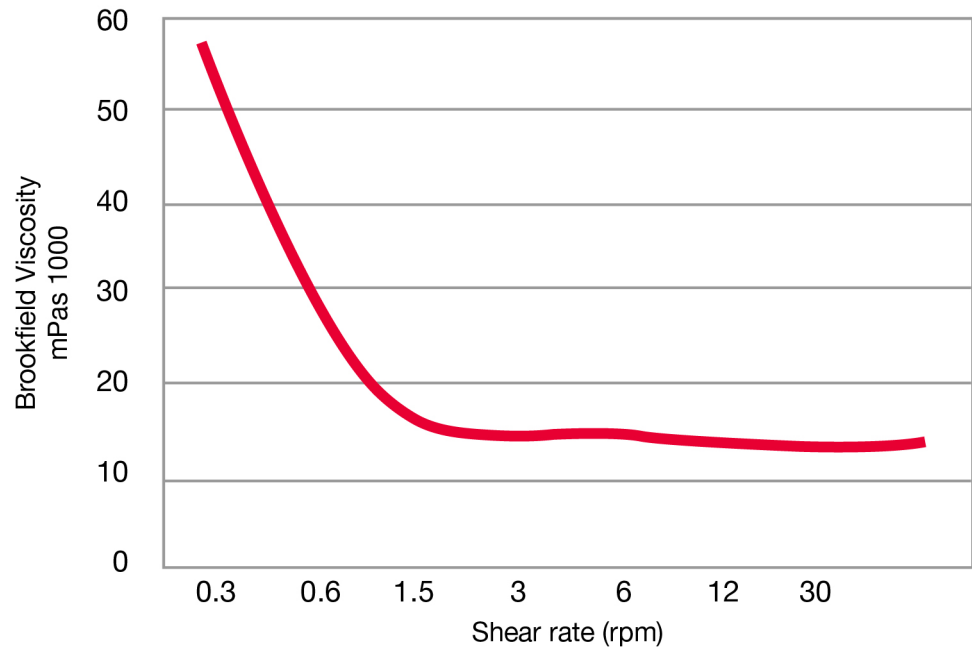
## ACULYN™ 44 Polymer Behavior Profile

ACULYN™ 44 Polymer possesses many properties that make this polymer an excellent choice for use in personal care applications, as shown in the data presented below.

## Rheology

### Near-Newtonian Rheology

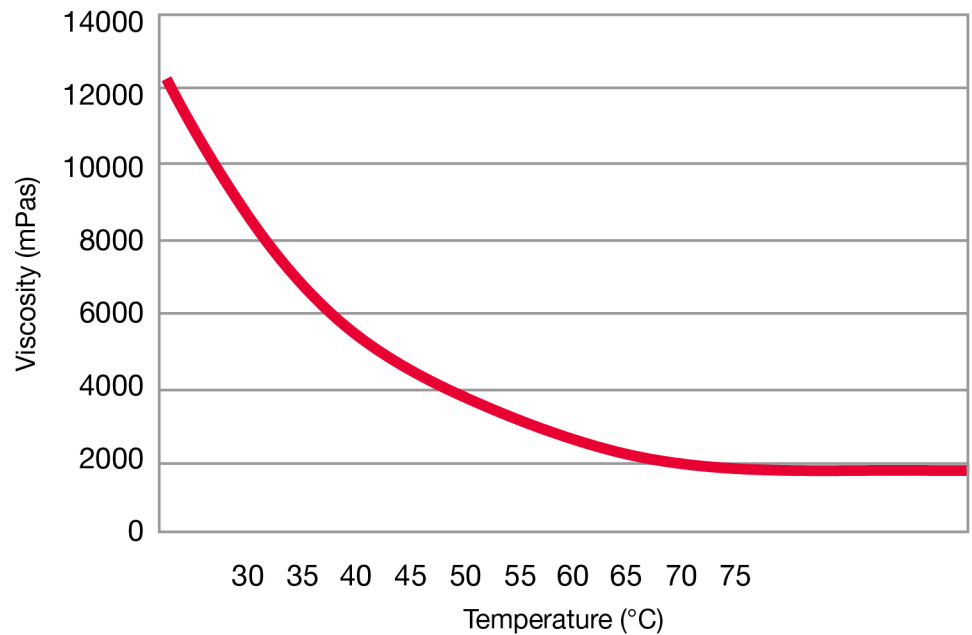
Formulations using ACULYN™ 44 Polymer show a slight drop in viscosity between 0.5 and 1.5 rpm (very low shear rate). For higher shear rates, the viscosity is nearly Newtonian. This behavior allows the thickened product to flow easily from the container when poured.



**Figure 3:** Effect of Shear Rate on Viscosity on ACULYN™ 44 Polymer

## Effect of Temperature on Viscosity

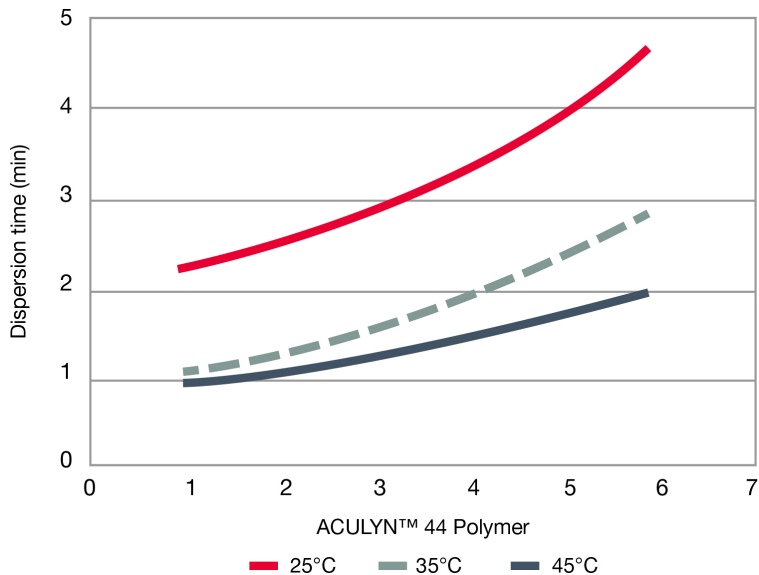
ACULYN™ 44 Polymer is supplied as a viscous liquid. To facilitate handling and dispersion the product can be heated up to 75°C, resulting in decreased viscosities with increasing temperatures.



**Figure 4:** Effect of Temperature on Viscosity of ACULYN™ 44 Polymer

## Effect of Temperature on Viscosity (Cont.)

The lowering of the viscosity by increasing the temperature also assists in the dispersion of ACULYN™ 44 Polymer. Although the polymer will disperse at room temperature, a slight increase in the water temperature will facilitate the dispersion in a shorter period of time. Below is a graph that indicates the approximate time for dispersion of various levels of ACULYN™ 44 Polymer (on a product basis). This work was done with a 3 blade propeller turning at 1000 rpm and a blade diameter to vessel ratio of 1 to 8.

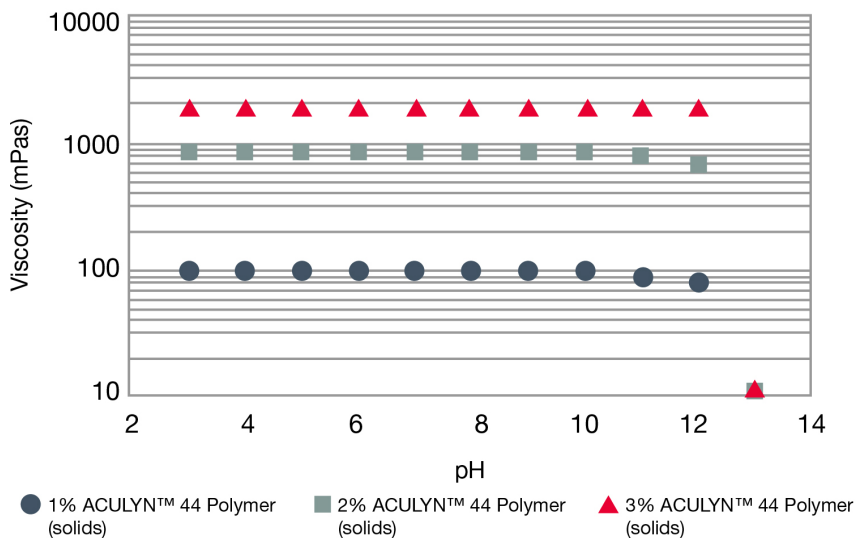


**Figure 5:** Dispersion Time vs Concentration at Various Temperatures for ACULYN™ 44 Polymer

## Compatibility

### pH Tolerance

ACULYN™ 44 Polymer has a constant pH response at very low or very high pH's as shown below.

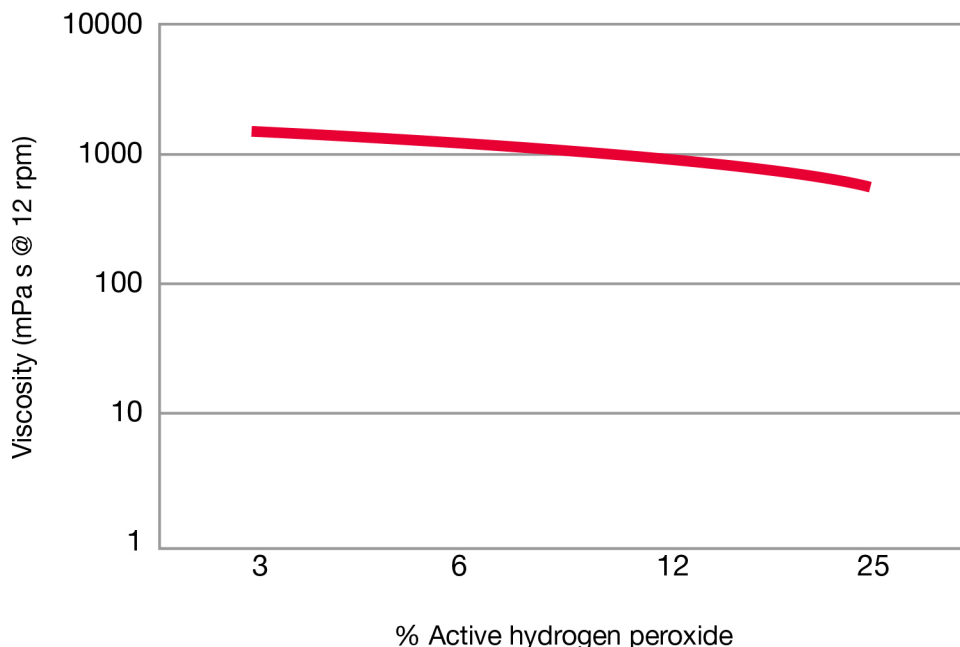


**Figure 6:** Effect of pH on Viscosity on ACULYN™ 44 Polymer

**Compatibility  
(Cont.)**

**Peroxide Compatibility**

ACULYN™ 44 Polymer is compatible with peroxides and does not induce loss of active oxygen. To obtain significant viscosity and stability over time, an appropriate surfactant should be used in combination with ACULYN™ 44 Polymer.



**Figure 7:** Hydrogen Peroxide Thickening with ACULYN™ 44 Polymer

ACULYN™ 44 Polymer has good stability in hydrogen peroxide. The stability of the polymer can be improved by combining the polymer with a surfactant that will associate with the ACULYN™ 44 Polymer.

**Stability of  
ACULYN™ 44  
Polymer in  
Hydrogen Peroxide  
Solutions**

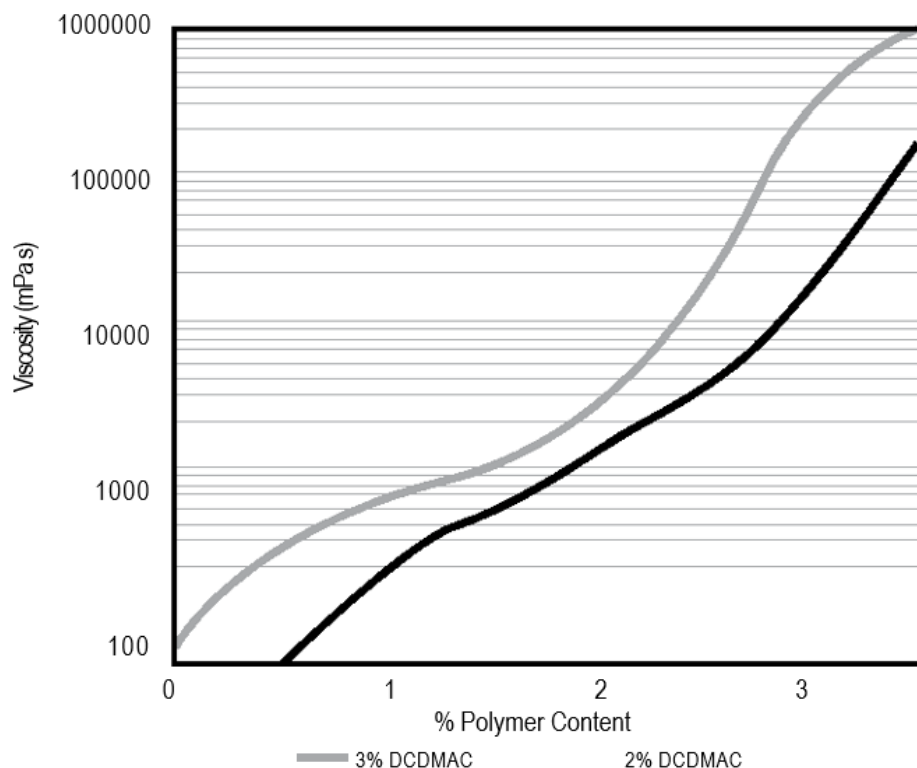
**Viscosity, mPa s (12 rpm)**

3% ACULYN™ 44 Polymer	Initial	2 Weeks
3% H <sub>2</sub> O <sub>2</sub>	1525	1300
6% H <sub>2</sub> O <sub>2</sub>	1250	1070
12% H <sub>2</sub> O <sub>2</sub>	960	880
25% H <sub>2</sub> O <sub>2</sub>	565	450

**Surfactant Synergies**

ACULYN™ 44 Polymer works by association. This means that the hydrophobic parts of the HEUR polymer build up associations with other hydrophobes present in the formulation. This property allows ACULYN™ 44 Polymer to demonstrate a marked synergistic effect when used in conjunction with fatty surfactants, pigments, particulates, and dyes. The following graph shows the synergy of ACULYN™ 44 Polymer with dicetyl dimethyl.

## Stability of ACULYN™ 44 Polymer in Hydrogen Peroxide Solutions (Cont.)



**Figure 8:** Cationic Used was a Dicetyl Dimethyl Ammonium Chloride  
Viscosities measured by a Brookfield RVT

## Formulation and Use Guidelines

ACULYN™ 44 Polymer is compatible with cationic surfactants, acids and peroxides as well as other ingredients commonly found in cosmetic and toiletry products.

ACULYN™ 44 Polymer is shipped in a water/propylene glycol solvent that thickens directly upon addition to a formulation. To facilitate handling and dispersion, the product can be heated up to 75°C, resulting in decreased viscosities.

ACULYN™ 44 Polymer should be added slowly and steadily near the periphery of the mixing tank. The rate of addition should be adjusted to allow uniform incorporation of the thickener. Rapid addition may cause excessive thickening or gelling due to highly localized thickener concentrations.

To facilitate optimum performance of the ACULYN™ 44 Polymer, the following procedure is recommended:

1. Introduce most of the formulation water into the reactor.
2. Add ACULYN™ 44 Polymer and stir vigorously for a minimum of 5 minutes (see note).
3. Add the most hydrophilic (high HLB) surfactants and ingredients and stir for a minimum of 5 minutes.
4. Add the remaining components, saving the most hydrophobic component for last.

Note: If the formulation does not contain a surfactant that helps dispersion, Step 2 should be extended to a minimum of 40 minutes. Either low speed paddle stirrers or high spin turbines are suitable.

<b>Toxicity</b>	For product safety information, refer to Safety Data Sheet (SDS).
<b>Handling Precautions</b>	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.
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