



ACUSOL™ 801S Rheology Modifier

ACUSOL™ 801S Rheology Modifier is a synthetic hydrophobically-modified alkali swellable polymer emulsion (HASE) designed to thicken, control rheology, and stabilize a variety of detergent products: heavy-duty liquid laundry detergents, liquid hand dish soaps and all-purpose cleaners. Supplied in acid form as a low-viscosity liquid, ACUSOL™ 801S Rheology Modifier thickens instantly when neutralized with a base to produce clear solutions with a pseudoplastic rheology. ACUSOL™ 801S Rheology Modifier has a distinct ability to function efficiently in high levels of surfactant (up to 50%), a feature that makes it especially useful in highly concentrated liquid detergent formulations. It is also compatible with other types of thickening agents (carrageenan and xantham gums, and water soluble clays, for example) employed in detergents.

Apart from compatibility with surfactants, ACUSOL™ 801S Rheology Modifier exhibits the characteristics that have made anionic associative rheology modifiers popular. It offers the same appealing rheological characteristics—excellent thickening efficiency, high low-shear viscosity, pseudoplasticity (shear-thinning), and visually appealing flow characteristics ("short, non-stringy" rheology). ACUSOL™ 801S Rheology Modifier is liquid, and it is compatible with solvents, features that make it easy to handle and formulate. Unlike many thickeners, which are supplied as solid materials that must be dissolved and stirred before use, ACUSOL™ 801S Rheology Modifier can be added directly to the detergent formulation. Because it is anionic, it is easily neutralized with sodium hydroxide (NaOH) or other bases such as ammonium hydroxide (NH₄OH), soda ash (Na₂CO₃), or triethanolamine (TEA), and it is compatible with anionic and nonionic surfactants, builders and fillers. Finally, ACUSOL™ 801S Rheology Modifier is not vulnerable to degradation by microbial contaminants.

Features & Benefits

| Features | Benefits |
|--------------------------------|--|
| High surfactant tolerance | Suitable for formulations with high surfactant levels (up to 50%), and a wide range of surfactants. |
| Appearance | High clarity for product differentiation and consumer appeal. |
| Liquid form | Easy to handle and formulate in production. Instant neutralization with bases. |
| Pseudoplastic (shear-thinning) | Rapid viscosity recovery after pour. |
| High thickening efficiency | Lower raw material costs vs. other thickeners. Less opportunity for interactions that can adversely affect clarity. |

Features & Benefits (Cont.)

| Features | Benefits |
|--|--|
| High low-shear viscosity | Useful for gel formulations. Stable dispersions. Good suspendability. |
| Associative character | Uniform consistency, enhanced clarity. Nonfloculated dispersions. Possible interaction with other components to promote viscosity and stability. |
| Compatibility with typical detergent ingredients | Flexibility in choice of ingredients (solvents, surfactants, etc.). Resistant to microbial degradation. |

Typical Properties

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

| Property | Unit | Result |
|----------------------|-----------------|----------------|
| Appearance | | Milky emulsion |
| Solids content | % | 19.5–20.5 |
| pH | | 3.7 |
| Density | g/L | 1.06 |
| Brookfield viscosity | cP | 20 |
| Acid value | g KOH/g product | 0.044 |

The Advantages of Association

Many of the benefits offered by ACUSOL™ 801S Rheology Modifier derive from its ability to associate in the same fashion as surfactants. Like surfactants, ACUSOL™ 801S Rheology Modifier contains both hydrophilic and hydrophobic components. Consequently, just as the hydrophobic elements on surfactants associate to form micelles, so the hydrophobic groups of the thickener molecules associate to form large interlocking structures in the detergent formulation. The bulk of these structures is the major source of a formulation's viscosity.

The associative networks formed by ACUSOL™ 801S Rheology Modifier make it highly efficient at building low-shear viscosity. Indeed, ACUSOL™ 801S Rheology Modifier has a notable advantage in efficiency over cellulosic and carbomer thickeners in this respect. Thickening efficiency means relatively low levels of ACUSOL™ 801S Rheology Modifier are required. Moreover, the ACUSOL™ 801S Rheology Modifier molecules also associate with surfactants and particles in the nonaqueous phase (Figure 1). The result of the rheology modifier's associative activity is a dispersion that is more uniform than that created by purely nonassociative thickeners, which operate solely by binding water (Figure 2). The uniformity of the dispersion helps to promote the clarity of the detergent formulation.

The Advantages of Association (Cont.)

Efficiency in Selected Surfactants

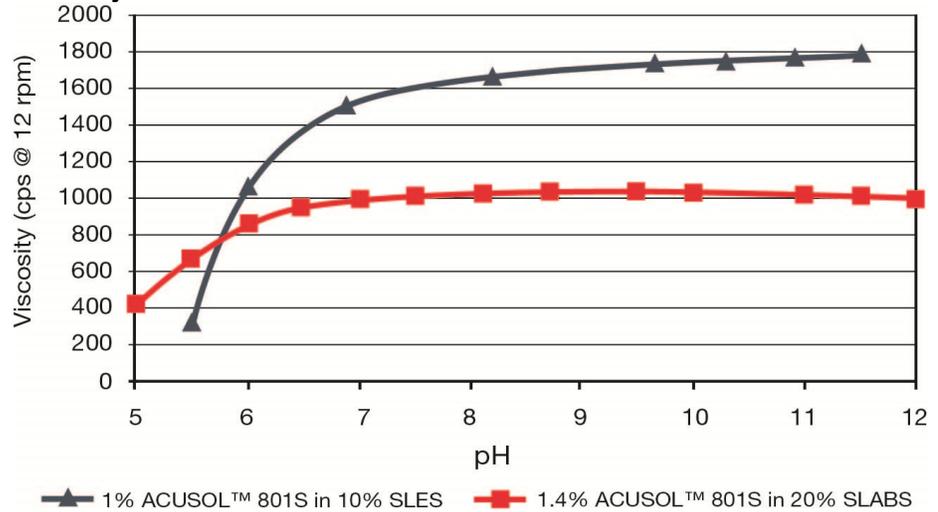


Figure 1: ACUSOL™ 801S Rheology Modifier Efficiency in SLES and SLABS as a Function of pH

The graphic representations are presented here for illustrative purposes only and should not be construed as product specifications.

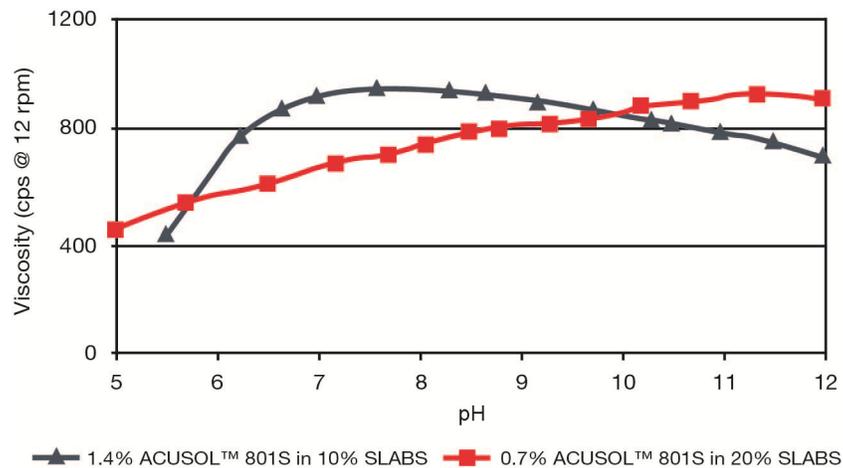


Figure 2: ACUSOL™ 801S Rheology Modifier Efficiency in SLABS as a Function of pH

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The Advantages of Association (Cont.)

Efficiency in Selected Solvents

ACUSOL™ 801S Rheology Modifier is very effective in thickening formulations containing solvents. Examples shown here are IPA (isopropanol) and DOWANOL™ PM (propylene glycol methyl ether).

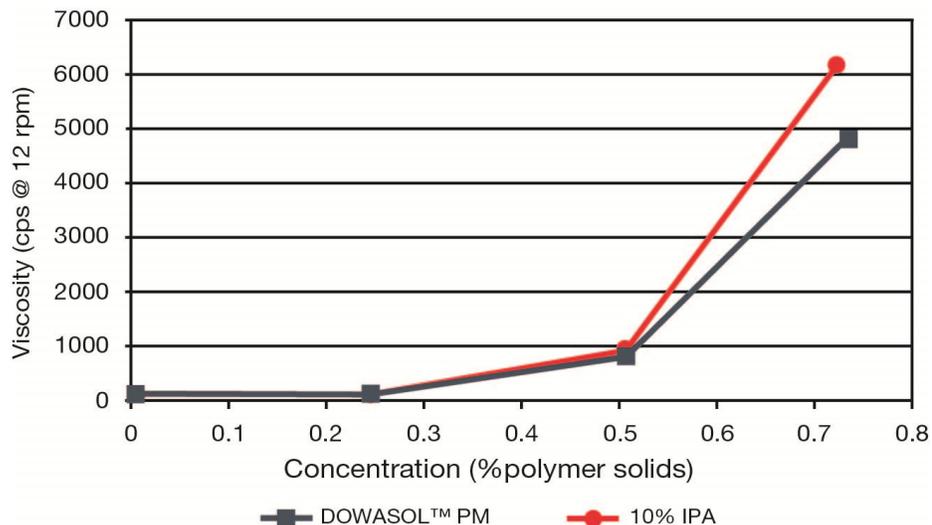


Figure 3: Viscosity of ACUSOL™ 801S Rheology Modifier in Solvents (as a Function of Polymer Concentration)

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Surfactant Compatibility

Perhaps the most distinctive feature of ACUSOL™ 801S Rheology Modifier is its ability to function in environments containing high levels of surfactants, which makes it especially appropriate for concentrated detergent formulations. These products typically obtain their cleaning properties from high surfactant loadings; levels of 15% to 50% are typical. Other associative thickening agents are often comparatively inefficient under these conditions. Formulators must use relatively high levels of thickener in these types of formulations, which can adversely affect costs and increase the potential for adverse interactions with surfactants that can detract from clarity.

Compatibility with Surfactants

| Surfactant | | 1% Active ACUSOL™ 801S Rheology Modifier | | 2% Active ACUSOL™ 801S Rheology Modifier | |
|--|----|--|-------------------------------|--|-------------------------------|
| Type | % | Brookfield Viscosity (cP, 6 rpm) | Turbidity (NTU ¹) | Brookfield Viscosity (cP, 6 rpm) | Turbidity (NTU ¹) |
| Sodium Linear Alkylbenzene Sulfonate ("SLABS") | 10 | 525 | 24.2 | 5,700 | 18.8 |
| | 20 | 2,700 | 75.0 | 9,000 | 77.4 |
| Sodium Laureth-3 Sulfate | 10 | 7,000 | 6.7 | 84,000 | 3.2 |
| | 20 | 400 | 14.6 | 6,800 | 6.9 |
| Sodium Lauryl Sulfate | 10 | 2,400 | 3.2 | 28,000 | 2.2 |
| | 20 | 275 | 7.1 | 1,900 | 4.1 |
| Sodium α-Olefin Sulfonate | 10 | 5,100 | 6.2 | 62,000 | 5.1 |
| | 20 | 325 | 21.5 | 14,000 | 11.6 |
| Sodium Oleate | 4 | 175,000 | 847 | 210,000 | Opaque gel |
| | 8 | 131,000 | 459 | | Opaque gel |
| Polydecyl Glucoside | 10 | 400 | 11.7 | 2,200 | 13.3 |
| | 20 | 275 | 42.7 | 2,200 | 17.6 |
| C14-15 EO 7 | 10 | 145,000 | 25.0 | 227,000 | 12.8 |
| | 20 | 183,000 | 20.1 | 230,000 | 9.7 |
| C12-15 EO 9 | 10 | 2,075 | 5.3 | 14,200 | 6.1 |
| | 20 | 1,825 | 4.6 | 6,050 | 5.2 |
| Cocamidopropyl Betaine | 10 | 180 | 12.6 | 25 | 5.9 |
| | 20 | 135 | 2.7 | 2,000 | 3.3 |

1. Nephelometric Turbidity Units

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Thickening Properties

ACUSOL™ 801S Rheology Modifier produces the combination of high low-shear viscosity and pseudoplasticity (shear thinning rheology) required by detergent products. High low-shear viscosity is important because it helps to maintain the stability of the dispersion. Without this stability, the detergent formulation is vulnerable to the separation of phases—a drawback from the standpoints of aesthetics, shelf life and performance. Pseudoplasticity is equally critical; just as high low-shear viscosity is important for stability, a lower viscosity at higher shear rates is important for pourability. Of course, it is not merely the basic viscosity profile that makes ACUSOL™ 801S Rheology Modifier thickener so appropriate for liquid detergent applications. This product also offers a so-called "short" rheology. It is not pituitous, that is, it produces a formulation that flows readily but does not leave long, stringy tendrils hanging from the mouth of the dispenser after the user has finished pouring.

Formulation Stability

ACUSOL™ 801S Rheology Modifier is stable in a wide range of formulations.

Thickening Properties (Cont.)

Sample Formulation Using ACUSOL™ 801S Rheology Modifier High Surfactant Liquid Detergent

| Component | Concentration (%) |
|------------------------------------|-------------------|
| Linear Alkyl Benzene Sulfonate | 17.8 |
| Sodium Alcohol Ethoxylate Sulfate | 6.9 |
| Alcohol Ethoxylate (Neodol 23-6.5) | 10.0 |
| Sodium Citrate.2H ₂ O | 5.0 |
| Propylene Glycol | 5.0 |
| Ethanol | 2.0 |
| Sodium Xylene Sulfonate | 6.25 |
| Deionized Water | QS to 100% |

pH: 8.2 Viscosity: 400 cps (Brookfield @ 12 rpm) Appearance: clear

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Formulation Guidelines

ACUSOL™ 801S Rheology Modifier is compatible with high levels of surfactants, solvents, oils, salts, and other ingredients commonly found in detergent and cleaner products. As a result, manufacturers of detergents and cleaners have a great deal of flexibility in developing procedures for introducing ACUSOL™ 801S Rheology Modifier into their formulations.

General Mixing Procedures

The physical character of ACUSOL™ 801S Rheology Modifier (low viscosity liquid before neutralization), and its high thickening efficiency, permit it to be added to a mix at different stages. The following steps meet most formulating needs:

1. Introduce the ACUSOL™ 801S Rheology Modifier into the formulation water. This must provide at least a threefold dilution of the polymer.
2. Add nonionic surfactants (if any).
3. Add anionic surfactants (if any), low-pH first.¹
4. Add builders, fillers, particulates.
5. Add dyes, then perfume.
6. Neutralize with chosen alkali.

Since ACUSOL™ 801S Rheology Modifier undergoes instantaneous thickening when it comes in contact with a base, an in-line mixing technique using a static mixer with a simple pump affords a convenient, rapid means of producing thickened solutions and gels (see Figure 4). This technique produces solutions that are free from air bubbles. It is useful to dilute the polymer solution with water (3:1) to avoid the formation of gel particles.

¹Strongly acidic components, such as sulfonic acid surfactants, should be dispersed in the system and partially neutralized (to pH of approximately 4 to 5) before the polymer is added.

Thickening Properties (Cont.)

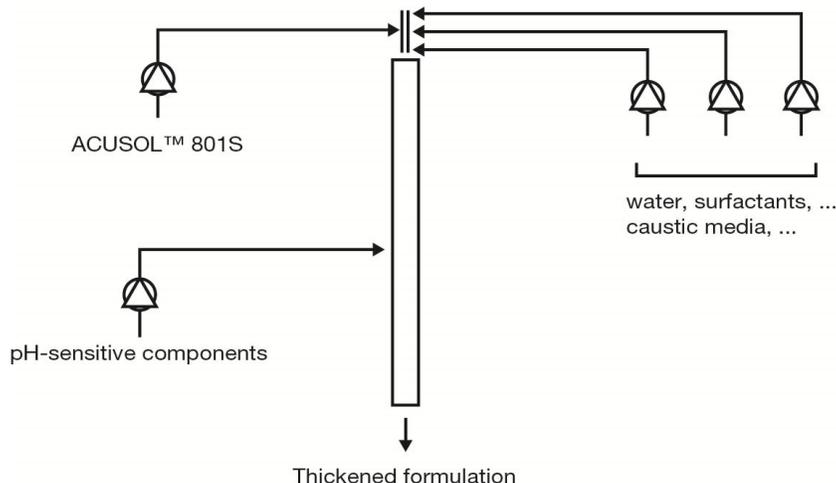


Figure 4: Schematic Representation of an In-line Mixer

The schematic representation is presented here for illustrative purposes only and should not be construed as product specifications.

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.

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Limitations

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

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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.

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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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