Home and Personal Care Solutions

ACUSOL™ Rheology Modifiers

For Home and Institutional Care Products

Technologies pioneered by The Dow Chemical Company have been used by formulating chemists worldwide to add value to home, fabric and institutional care products. Our expertise in polymer design has resulted in a growing portfolio of products for the home, fabric and institutional care industry.

This bulletin focuses on our ACUSOL™ rheology modifiers. Our ACUSOL™ rheology modifiers find utility in an ever- increasing breadth of home, fabric and institutional care applications because of their unique ease of use, wide compatibility, cost effectiveness and favorable balance of rheological properties.

The Dow Chemical Company is committed to providing technology enhancement to the home, fabric and institutional care industry.

To learn more, go to www.dow.com.

Key Features and Benefits of ACUSOL™ Rheology Modifiers

Features and Benefits

ACUSOL™ rheology modifiers offer a number of features and benefits that promote their use in household and institutional applications. The benefits supplied by the physical and chemical nature of the ACUSOL™ polymers impart performance enhancement and storage stability to formulated products, while maintaining the product safety that the formulator demands. ACUSOL™ rheology modifiers can be used to control pour flow properties, stabilize formulations, suspend particles and bubbles, provide vertical wall cling, product substantivity and reduce misting of spray products. They provide these benefits over a wide range of pH, solvents, and formulation compositions. ACUSOL™ rheology modifiers also allow for a wide breadth of possible formulations and product types, such as gels, emulsions and clear solutions. Applications include liquid laundry detergents, fabric softeners, hard surface cleaners, hand and machine dishwashing detergents, alcohol-based cleaners, acidic and basic cleaners, and solvent-based cleaners. ACUSOL™ rheology modifiers are safe and easy-to-handle liquids, which can reduce processing time, cost and difficulty in formulating with liquid systems.

Liquid Products for Manufacturing Efficiencies

All ACUSOL™ rheology modifiers are supplied as liquids and therefore can be directly incorporated into a formulation without any preparations (warming, de-clumping, dissolving, etc.) and without the concerns often associated with powders (dustiness, hygroscopic nature, expensive processing, etc.). As a result, significant manufacturing efficiencies can be achieved.

Environmental, Health and Safety Record

ACUSOL™ rheology modifiers are not classified as hazardous and are supported by comprehensive environmental and safety data developed by The Dow Chemical Company. ACUSOL™ rheology modifiers are also cleared under the major chemical inventories such as EINECS, TSCA, and AICS. A number of the products also have MITI clearance. Contact your local Dow sales representative for more information.

Features	Benefits
Versatile	• Can be used in a wide variety of applications and product forms
Liquids	• Easy to use • No preparation necessary (warming, declumping, dissolving) - direct incorporation into the formulation • Non-dusty, non-hygroscopic
Immediate Thickening Upon Neutralization	• Allows for use of continuous production processes with in-line static mixers
Shear Tolerance	• Can be processed with membrane pumps and, when diluted, with turbine mixers, high speed propellers and colloid mills
Gel Appearance	• Formulations can be clear and transparent if desired
Salt Tolerance	• Allows for broader formulation compatibility
Microbial Resistance	• Ease of preservation. ACUSOL™ rheology modifiers do not promote or support contamination, unlike natural thickeners (xanthans)
Toxicity	• Non-hazardous • Supported by comprehensive environmental, health and safety data (see individual product bulletins for details on each ACUSOL™ rheology modifier)
Registrations	• Cleared under EINECS/TSCA/AICS

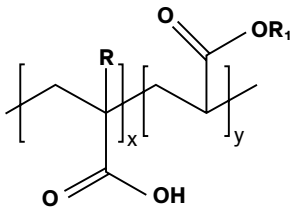
ACUSOL™ Rheology Modifier Chemistries

The ACUSOL™ product line consists of three different chemistries – Alkali Soluble Emulsion (ASE), Hydrophobically-modified Alkali Soluble Emulsion (HASE) and Hydrophobically-modified Ethoxylated URethane (HEUR). The availability of these different polymer types provides the formulator with the choices needed to develop products for most household, fabric and institutional care categories.

ASE Polymers

ASE polymers are synthesized from acid and acrylate co-monomers and are made through emulsion polymerization.

- ACUSOL™ 810A
- ACUSOL™ 830 ER

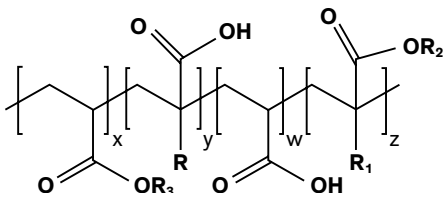


R, R_1 can equal Hydrogen or an alkyl chain.

HASE Polymers

HASE polymers are synthesized from an acid/ acrylate copolymer backbone and include an ethoxylated hydrophobe. These products are also made through emulsion polymerization.

- ACUSOL™ 801S
- ACUSOL™ 805S
- ACUSOL™ 820
- ACUSOL™ 823 ER
- ACUSOL™ Millennium ER

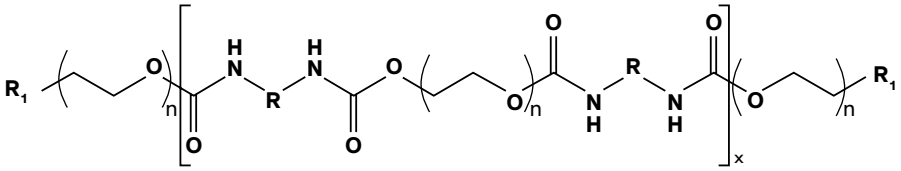


R_1 is an ethoxylated alkyl chain.
R_2 and R_3 can equal Hydrogen or an alkyl chain.

HEUR Polymers

HEUR polymers are synthesized from an alcohol, a diisocyanate and a polyethylene glycol.

- ACUSOL™ 880
- ACUSOL™ 882



R_1 can be Hydrogen or an alkyl chain. R is an alkyl chain.

Thickening Mechanisms

ASE Polymers

ACUSOL™ ASE polymers thicken via a non-associative mechanism. Non-associative rheology modifiers do not interact with surfactant structures, particulates or insoluble emulsion droplets.

Non-associative polymers thicken by structuring the continuous phase through chain-chain entanglement. This can stabilize pre-dispersed insolubles by significantly slowing their motion. Some non-associative thickeners, known as microgels, can also build viscosity through a unique mechanism. These emulsion particles rapidly swell upon neutralization, forming microgels, which build viscosity by volume exclusion. The swelled particles restrict fluid flow and build viscosity where suspension of insoluble particles or visual cues is required.

HASE Polymers

ACUSOL™ 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 expansion and entanglement through association of the extended hydrophobe groups.

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

When ACUSOL™ 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. This networking allows for vertical cling or pseudoplastic behavior, delivering enhanced clean-in-place benefits.

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

HEUR Polymer

ACUSOL™ HEUR rheology modifiers also thicken via an associative mechanism. The hydrophobic parts of HEUR polymers build up associations with other hydrophobes present in the formulation. However, because the polymers are nonionic in nature, no neutralization is needed.

Comparative Features of ASE, HASE, and HEUR Rheology Modifiers

The chart to the right shows features indicative of the comparative behavior of ASE, HASE and HEUR rheology modifiers under different conditions. Please note that these behaviors may vary to some extent according to formulation and choice of rheology modifier.

- ACUSOL™ rheology modifiers are easy to formulate, have good to excellent salt tolerance, compatibility with anionic and nonionic surfactants and low odor.
- ASE polymers have excellent solvent stability.
- HASE polymers have excellent shear thinning properties.
- HEUR polymers have excellent compatibility with low pH and cationic systems and excellent stability in peroxide systems.

Keep in mind that blending, especially of the ASE and HASE chemistries, can offer further enhancements and synergies.

Behaviors	ACUSOL™ Rheology Modifiers		
	ASE	HASE	HEUR
Ease of formulation	Excellent	Excellent	Good
Associative	No	Yes	Yes
Salt Tolerance			
NaCl	Good	Very Good-Excellent	Excellent
Di/trivalent ions	Good	Good	Excellent
Shear thinning behavior	Good	Excellent	Fair
Solvent compatibility	Excellent	Excellent	Good
High pH compatibility	Excellent	Very Good	Good
Low pH compatibility	No	Fair*	Excellent
Anionic compatibility	Excellent	Excellent	Good
Nonionic compatibility	Excellent	Excellent	Excellent
Cationic compatibility	No	Limited	Excellent
Peroxide stability	No	Some	Excellent

*with proper formulation techniques

Physical and Chemical Characteristics of ACUSOL™ Rheology Modifiers

The physical and chemical characteristics of Dow ACUSOL™ rheology modifiers vary according to the type of polymer (ASE, HASE, and HEUR) as noted in the charts below. All ACUSOL™ polymers are provided in liquid form at a certain % solids level.

As supplied, the pH of the emulsion products (ASE and HASE) range from 3.5 to 4.0 and viscosities (cPs) range from 100 to 150 cPs (Dow ACUSOL™ ASE and HASE rheology modifiers) up to 11,000 cPs (Dow ACUSOL™ HEUR rheology modifiers). Please note that these behaviors may vary to some extent according to specific formulations.

	ACUSOL 801S	ACUSOL 805S	ACUSOL 810A	ACUSOL 820	ACUSOL 823 ER	ACUSOL 830 ER	ACUSOL 880	ACUSOL 882	ACUSOL Millennium ER
Chemistry	HASE	HASE	ASE	HASE	HASE	ASE	HEUR	HEUR	HASE
Association	Very high	Very high	None	Very high	High	None	Very high	Very High	Very High
Ionic Nature	Anionic	Anionic	Anionic	Anionic	Anionic	Anionic	Nonionic	Nonionic	Anionic
Appearance	Milky liq.	Milky liq.	Milky liq.	Milky liq.	Milky liq.	Milky liq.	Hazy liq.	Hazy liq.	Milky liq.
Solids (%)	20	29	18	30	30	28	35	17.5	31
pH (as supplied)	3.7	2.7	2.7	2.7	3.2	3	Not Applicable	Not Applicable	3 to 4
Density	1.06	1.06	1.05	1.06	1.04	1.05	Not Applicable	Not Applicable	1.05
Eq Weight*	253	225	124	218	191	218	Not Applicable	Not Applicable	Confidential
Rheology	Short, Non-stringy	Short, Non-stringy	Long, Non-stringy	Short, Non-stringy	Short, Non-stringy	Short	Smooth	Non stringy, Tacky	Non-stringy
Suspension Capability	Low	Moderate to high	Low	Low	Low	Moderate	Low	Low	High
Shear Thinning**	Very high	Very high	Slight	Very high	Moderate	Moderate	Slight	Slight	Moderate
Viscosity cPs (as supplied)	20	<150	15	20	30	10	11,000	5,000	<100

* Grams of dry polymer neutralized by 1 equivalent (40 grams) of NaOH
**Shear thinning is measured in a typical formulation

NOTICE: These are typical properties, not to be construed as specifications.

Comparative Applications of ACUSOL™ Rheology Modifiers

The chart below is a guide for selecting the best Dow ACUSOL™ rheology modifier for specific home and institutional care applications. These recommendations are made based on many years of experience evaluating the performance of ACUSOL™ rheology modifiers in many different home and institutional care applications. Please note that these behaviors may vary to some extent according to specific formulations.

Product Application	ACUSOL 801S	ACUSOL 805S	ACUSOL 810A	ACUSOL 820	ACUSOL 823 ER	ACUSOL 830 ER	ACUSOL 880	ACUSOL 882	Acusol Millennium ER
Abrasive Cleaners		●		●	●				●
Acid Cleaners							●	●	●
Acid Rinse Aids							●	●	●
Alcohol-Based Formulations	●	●				●			●
All-Purpose Detergents	●	●		●					●
Fabric Softeners							●	●	
Floor Cleaners	●	●	●	●					
Hand Dishwashing Liquids		●	●	●	●				●
Hard-Surface Cleaners	●	●	●	●	●				●
High-Alkaline Laundry Liquids		●	●	●	●				
Household Laundry Detergents	●	●		●	●				●
Machine Dishwashing Detergents		●	●	●	●				
Nonpolar Solvent Formulations	●	●		●	●	●	●		
Oven/Grill Cleaners			●	●	●				
Peroxide-Containing Formulations	●						●		●
Polar Solvent Formulations	●					●	●		●
Rust and Scale Removers							●	●	●
Toilet Bowl Cleaners							●		●

Features and Applications of ACUSOL™ Rheology Modifiers

ACUSOL™ 801S

ACUSOL™ 801S rheology modifier is a hydrophobically-modified alkali swellable acrylic polymer emulsion designed to thicken, control rheology and stabilize a variety of detergent products. ACUSOL™ 801S has a unique ability to function efficiently and provide clarity in high levels of surfactant (up to 25%) and is compatible with solvents and other types of thickeners. This polymer exhibits all the properties of anionic associative rheology modifiers including excellent thickening efficiency, high low-shear viscosity, pseudoplasticity (shear thinning) and visually appealing flow characteristics. ACUSOL™ 801S is offered at 20% solids. The polymer has a well-established toxicological profile and is safe in normal use.

Features

- High Surfactant Tolerance
- Compatible with polar solvents
- High low shear viscosity
- High thickening efficiency
- Highly Associative
- Pseudoplastic
- Good vertical cling

Applications

- Household Detergents
- Floor Cleaners
- Hard Surface Cleaners
- Unit Dose Detergents
- High Active Liquid Detergents
- Alcohol Based Formulations
- Nonpolar Solvent Formulations
- Peroxide Containing Formulations
- Polar Solvent Formulations

ACUSOL™ 810A

ACUSOL™ 810A rheology modifier is a high molecular weight alkali swellable acrylic polymer emulsion that when neutralized thickens instantly to a highly viscous solution. ACUSOL™ 810A is offered at 18% solids and stabilizes dispersions of insoluble nonionic surfactants in alkaline solutions. The polymer has a well-established toxicological profile and is safe in normal use.

Features

- Stable at extremely high pH
- Stable in emulsions
- Low shear thinning
- Forms clear to semi-translucent solutions/gels

Applications

- Hand Dishwashing Liquids
- High-Alkaline Laundry Liquids
- Household Laundry Detergents
- Floor Cleaners
- Hard-Surface Cleaners
- Machine Dishwashing Liquids

ACUSOL™ 805S

ACUSOL™ 805S rheology modifier is a hydrophobically-modified alkali swellable acrylic polymer emulsion with unusually high aqueous thickening and suspending capabilities. When neutralized to a pH above 7, ACUSOL™ 805S thickens instantly to a highly viscous clear solution characterized by a complete lack of stringiness and tackiness and by shear thinning. ACUSOL™ 805S is offered at 29% solids, is compatible with electrolytes, behaves synergistically with surfactants, and is also an excellent emulsifier and emulsion stabilizer. The polymer has a well-established toxicological profile and is safe in normal use.

Features

- Highly associative
- Very pseudoplastic
- Excellent suspension capabilities
- Stable viscosity across a wide pH range
- High surfactant synergy
- Foam stabilizer
- Good vertical cling
- High efficiency/ concentration ratio

Applications

- Household Laundry Detergents
- Hand Dishwashing Liquids
- Hard-Surface Cleaners
- High-Alkaline Laundry Liquids
- Machine Dishwashing Liquids
- Abrasive Cleaners
- All-Purpose Detergents
- Floor Cleaners
- Alcohol-Based Formulations
- Nonpolar Solvent Formulations

ACUSOL™ 820

ACUSOL™ 820 rheology modifier is a hydrophobically-modified alkali swellable acrylic polymer emulsion with unusually high aqueous thickening and stabilizing efficiency. When neutralized to a pH above 7, ACUSOL™ 820 thickens instantly to a highly viscous clear solution characterized by a complete lack of stringiness and tackiness and by shear thinning. ACUSOL™ 820 is offered at 30% solids, is compatible with electrolytes, behaves synergistically with surfactants, and is also an excellent emulsifier and emulsion stabilizer. The polymer has a well-established toxicological profile and is safe in normal use.

Features

- High efficiency/ concentration ratio
- High surfactant synergy
- Foam stabilizer
- Good vertical cling
- Highly associative
- Very pseudoplastic
- Particulate stabilizer
- Stable viscosity across a wide pH range

Applications

- Hand Dishwashing Liquids
- High-Alkaline Laundry Liquids
- Household Laundry Detergents
- Machine Dishwashing Liquids
- Nonpolar Solvent Formulations
- Hard-Surface Cleaners
- Abrasive Cleaners
- All-Purpose Detergents
- Floor Cleaners

ACUSOL™ 823 ER

ACUSOL™ 823 ER rheology modifier is an alkali soluble acrylic polymer emulsion that when neutralized above pH 7 thickens instantly to a highly viscous solution. ACUSOL™ 823 ER is offered at 30% solids, is stable from pH 5 to 12 and compatible with high levels of salts and electrolytes. The polymer has a well established toxicological profile and is safe in normal use.

Features

- High electrolyte tolerance
- High alkaline tolerance
- Compatible with surfactants
- Very clear solutions/gels
- Moderate viscosity
- Low shear thinning
- Compatible with inorganics
- Stable viscosity across a wide pH range

Applications

- High-Alkaline Laundry Liquids
- Household Laundry Detergents
- Machine Dishwashing Liquids
- Nonpolar Solvent Formulations
- Abrasive Cleaners
- Hand Dishwashing Liquids
- Hard-Surface Cleaners

ACUSOL™ 880

ACUSOL™ 880 rheology modifier is a nonionic thickener based upon HEUR chemistry and possesses a highly associative nature. As with other Dow rheology modifiers, the polymer is a liquid product for easier handling and manufacturing efficiency. ACUSOL™ 880 is offered at 35% solid (supplied in a water/propylene glycol co-solvent), is stable from pH 3 to 13 and compatible with peroxide and other oxidizing agents. The polymer has a well established toxicological profile and is safe in normal use.

Features

- No neutralization necessary
- Peroxide compatible
- Compatible in cationic systems
- Near-Newtonian viscosity in water
- Synergy with hydrophobic cationics
- Very electrolyte tolerant
- High concentration
- Stable pH/viscosity
- Acid compatible
- Highly associative

Applications

- Peroxide Containing Formulations
- Nonpolar Solvent Formulations
- Polar Solvent Formulations
- Rust and Scale Removers
- Acid Cleaners
- Fabric Softeners
- Acid Rinse Aids
- Toilet Bowl Cleaners

ACUSOL™ 830 ER

ACUSOL™ 830 ER rheology modifier is an alkali swellable acrylic polymer emulsion that when neutralized above pH 7 thickens instantly to a highly viscous solution. ACUSOL™ 830 ER is offered at 28% solids and is stable from pH 6.5 to 12 and compatible with polar solvents and electrolytes and exhibits minimal viscosity drift over time. The polymer has a well established toxicological profile and is safe in normal use.

Features

- Flat pH/viscosity response
- Compatible with polar solvents
- Forms clear to semi-translucent solutions/gels
- Pigment suspension
- Short flow (not stringy)
- No change of viscosity vs. time

Applications

- Alcohol-Based Formulations
- Nonpolar Solvent Formulations

ACUSOL™ 882

ACUSOL™ 882 rheology modifier is a nonionic thickener based upon HEUR chemistry and possesses a highly associative nature. As with other Dow rheology modifiers, the polymer is a liquid product for easier handling and manufacturing efficiency. ACUSOL™ 882 is offered at 17.5% solids (supplied in a water/butyl carbitol co-solvent) and is stable from pH 3 to 13 and compatible with peroxide and other oxidizing agents. The polymer has a well-established toxicological profile and is safe in normal use.

Features

- Compatible in cationic systems
- No neutralization necessary
- Near-Newtonian viscosity
- Synergy with hydrophobic cationics
- Highly associative
- Stable pH/viscosity
- Stable in acidic media

Applications

- Fabric Softeners
- Acid Cleaners
- Nonpolar Solvent Formulations
- Acid Rinse Aids
- Rust and Scale Removers
- Unit Dose Detergent

ACUSOL™ Millenium ER

ACUSOL™ Millennium ER polymer is a new Hydrophobically Modified Alkali Soluble Emulsion (HASE) rheology modifier offering distinctive suspension properties. ACUSOL™ Millennium ER rheology modifier thickens by swelling upon neutralization. Due to its hydrophobic nature, it can also associate with surfactants and other hydrophobes in the liquid matrix. The suspension performance of ACUSOL™ Millennium ER will be dependent on the total surfactant concentration and the types of surfactants used. The use level will need to be adjusted based upon formulation variables. ACUSOL™ Millennium ER has demonstrated versatility with a variety of surfactant systems and thus opens up new opportunities for formulators.

Features

- Excellent for suspension and clarity at low pH (2.5 to 7)
- Clarity and suspension in liquid surfactant matrices without the need for hydrotropes or co-solvents in acidic systems
- Stable in acidic systems
- Anionic, low viscosity liquid based on emulsion polymerization
- Builds rheology upon neutralization
- Forms clear, isotropic liquids
- Stable in high surfactant systems

Applications

- Hand dish washing formulations
- Neutral to Acidic hard surface cleaners
- Light duty or fine fabric liquid detergents (10 to 20% surfactant)
- Heavy duty liquid laundry (30% surfactant and higher)
- Unit Dose Detergent

Formulation and Use Guidelines

ASE and HASE Polymers

ACUSOL™ ASE and HASE rheology modifiers are compatible with surfactants, solvents, oils and electrolytes commonly found in household, fabric and institutional care products. These products undergo instantaneous thickening when neutralized with base.

ASE and HASE polymers are supplied as low pH, low viscosity emulsions 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. ACUSOL™ ASE and HASE polymers are also cold processable.

Rapid Mixing Technique

ACUSOL™ HASE and ASE rheology modifiers undergo instantaneous thickening when a base is added. An in-line mixing technique using a static mixer along with a simple pump affords a convenient, rapid means of producing thickened solutions and gels. The solutions prepared by this technique are free from air bubbles. Upon neutralization, ACUSOL™ ASE and HASE emulsions become clear, highly viscous dispersions.

For example, pumping solutions of ACUSOL™ 820 (diluted to 4% polymer solids) and sodium hydroxide (0.74% solids) at equal rates through a static mixer gave 115 kg/hr of a clear foam-free gel (Brookfield viscosity 2 x 106 mPa s at 0.5 rpm) containing 2% ACUSOL™ 820 solids. A small laboratory pump run at maximum speed gave the same output rate as in pumping deionized water. Although this example used only two feed streams, more feeds could be combined, depending on the type of formulation and the compatibility of the ingredients.

HEUR Polymers

ACUSOL™ HEUR rheology modifiers are compatible with cationic surfactants, acids and peroxides as well as other ingredients commonly found in household, fabric and institutional care products.

HEUR polymers are shipped as relatively viscous water/co-solvent based liquids which thicken on addition to a formulation due to interactions with a surfactant or dispersed phase. ACUSOL™ HEUR rheology modifiers 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 flocculation due to highly localized thickener concentrations.

HEUR Formulation Tips

To ensure optimum performance of ACUSOL™ HEUR rheology modifiers, the following procedure is recommended:

1. Introduce most of the formulation water into the mixer. (If there is an opportunity to use warm water or mildly heat the HEUR rheology modifier to 30-35°C, pour characteristics and dissolution times will be improved.)
2. Add ACUSOL™ HEUR 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. Introduction of gently warmed HEUR thickeners allows for easier handling and quicker incorporation in the formulation matrix.

ASE and HASE Formulation Tips

The preferred order of addition when using ACUSOL™ ASE and HASE rheology modifiers in aqueous formulations is as follows:

1. Add ACUSOL™ rheology modifiers to the water.
2. Add other ingredients from the most acidic to the most alkaline. (Note: strongly acidic components should be at least partly neutralized before adding to emulsions of ACUSOL rheology modifiers)
3. Add the neutralizing agent.

If this sequence is not desirable, ACUSOL™ ASE and HASE polymers can be added directly to an alkaline formulation after first diluting the ACUSOL™ 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 completely dissolve).

Storage and Handling

ASE and HASE Polymers

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 temperatures outside this range.

The coagulation process is irreversible.

HEUR Polymers

ACUSOL™ HEUR products are supplied as 17.5 to 35% solids with maximum viscosities of 11,000 mPa.s at room temperature (25°C). They are supplied as clear to slightly opaque liquids that thicken to a clear liquid.

These materials can be extremely viscous and may coagulate at high temperatures. If stored at high temperatures, they may have to be stirred before use.

The recommended storage temperature is 4°C to 49°C. Keep from freezing. Product, once frozen, will not perform appropriately.

Material Safety Data Sheets (MSDSs) are available for all Dow Chemical Company products. These sheets contain pertinent information that you may need to protect your employees and customers against any known health or safety hazards associated with our products.

We recommend that you obtain copies of the MSDS from your Dow Chemical Company technical representative or from the sales office nearest to you, before using our products in your facilities. 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 product in the workplace.

Upon initial shipment of non-OSHA- hazardous and OSHA-hazardous products (including samples), The Dow Chemical Company sends the appropriate MSDS to the recipient.

If you do not have access to one of these MSDS, please contact your local Dow 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).

We also suggest that you contact your suppliers of other materials recommended for use with our products for appropriate health and safety precautions before using them.

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

For more information about ACUSOL™ rheology modifiers, please contact us at **www.dow.com**.

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