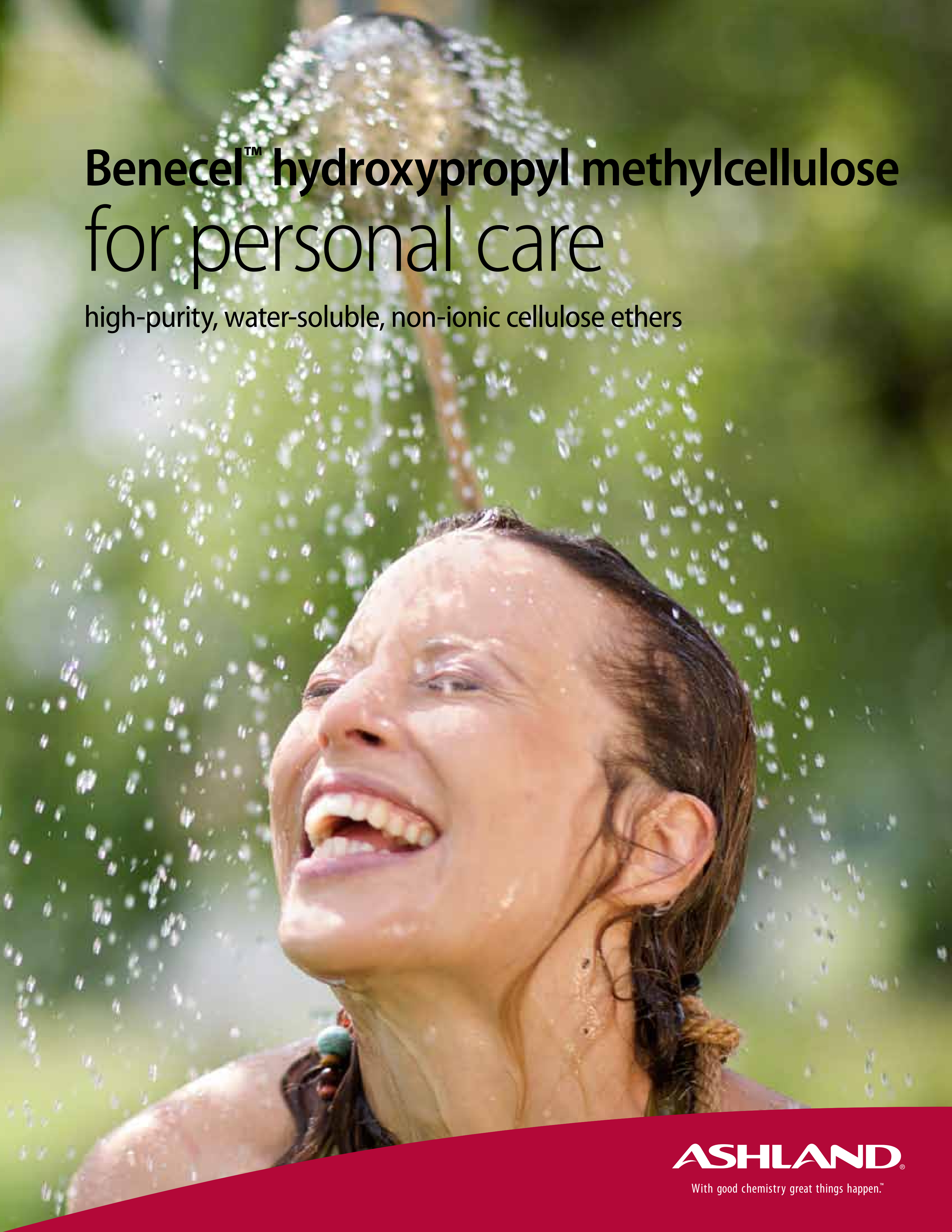
Benecel™ hydroxypropyl methylcellulose
for personal care

high-purity, water-soluble, non-ionic cellulose ethers



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Benecel™ Hydroxypropyl Methylcellulose

Benecel hydroxypropyl methylcellulose (HPMC) products are high-purity, water-soluble, non-ionic cellulose ethers designed for use in a broad range of personal care applications such as shampoos, body washes, shower gels, and shaving creams. Benecel HPMC products function as thickeners, lather enhancers, lather stabilizers, water-binders, and film-formers, as well as co-suspending and co-emulsifying agents. Importantly, Benecel HPMC is produced from cellulose – an abundant and renewable raw material source.

The following is intended to help formulators, from the personal care applications field, understand how Benecel HPMC is made, why it is a useful tool in personal care formulation, and what benefits it will deliver. A variety of formulations complete this booklet, which will help the formulator achieve rapid success at the bench top with products ready for market launch.

A Useful Tool for Cosmetic Formulators

Thickening and Rheology Control Rheology, the study of how fluids flow, is critically important to the perceptions that consumers have about the personal care products that they use on a daily basis. Thickened products that spread easily and leave no residual after-feel suggest luxuriousness to the consumer. In shampoos and body washes consumers take notice when a large amount of lather is generated quickly as this is an indication that the product is working. In the same respect, shaving creams and gels are expected to soften the skin and also provide a film that assists the razor in sliding smoothly across the skin.

The objective, which is thickened personal care products, can be achieved in several ways. Surfactants will thicken in the presence of simple salt–sodium chloride. High levels of surfactants can be used and the interaction at high micelle concentrations can lead to thickening. But there are drawbacks to using either of these techniques; salt thickening provides "Newtonian" rheology, that is, the consumer does not experience the easy spreading that they expect, and high concentrations of surfactant are expensive to use. Salts are much less effective when surfactant concentration is reduced either for mildness or economical reasons. In addition, formulas with high surfactant concentrations could leave skin feeling dry and could also be an irritant to the skin. Lather created with Benecel HPMC based formulas is much more lubricious than that with salt-based formulas.

Figure 2 Conditioning Shampoo with No Polymer

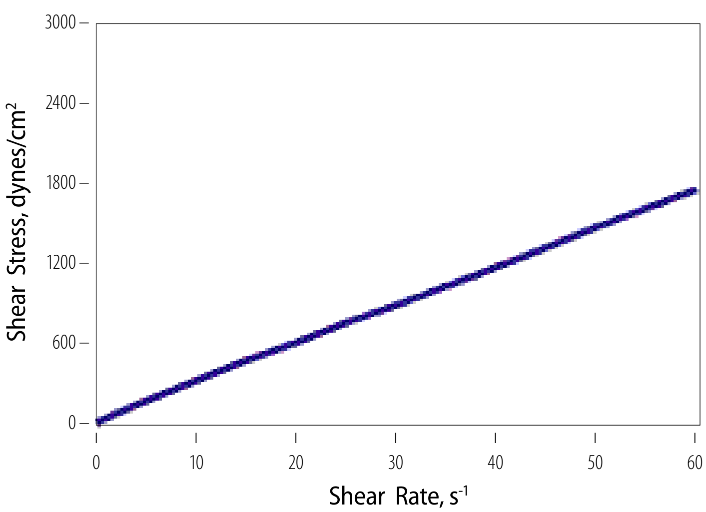
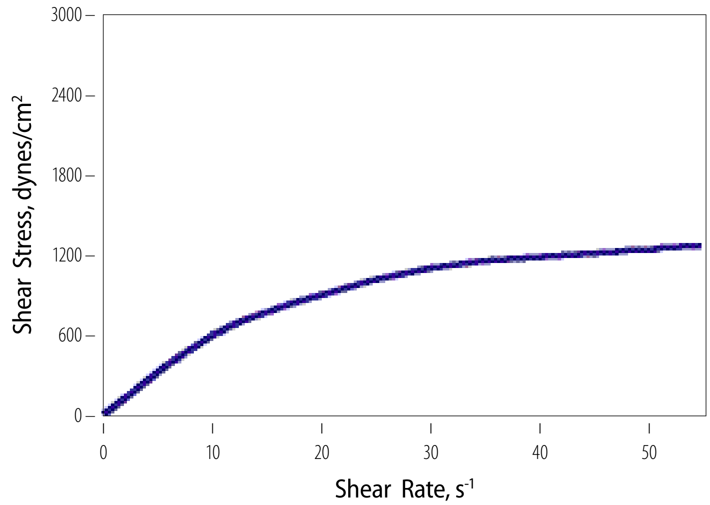


Figure 1 Conditioning Shampoo with 1% Polymer



The use of Benecel HPMC is a consumer friendly and cost effective way to achieve thickened surfactant systems with the desired properties. Adding 1.0% or less of Benecel HPMC to a formula containing surfactant can easily increase the viscosity of the solution to 6000 cps. Figures 1 and 2 show the difference in the rheological profiles between two shampoos, one thickened with Benecel HPMC and one that contains no cellulosic polymer. The shampoo with Benecel HPMC product is shear thinning. This feature allows the shampoo to pour as a rich thick solution from the container, and it is easily applied onto the hair because the viscosity decreases as the consumer uses it.

Film Forming and Lather Stability

Benecel HPMC has a unique property among cellulosic polymers. Water and surfactant solutions of Benecel HPMC will gel as they are heated. This gelation phenomenon stabilizes the air bubbles that are present in foams and lathers. When Benecel HPMC products are used as part of a surfactant formulation, the air bubbles in the foam are smaller, denser, and last much longer than the air bubbles created in a formulation that does not contain Benecel HPMC product. This benefit can be achieved regardless of the surfactants that are being used. Figure 3 shows the results of a test, similar to the Hart-DeGeorge lather drainage time test, between a shampoo made with and without Benecel HPMC. Other cellulosics, such as Natrosol™ hydroxyethylcellulose (HEC), which was also included in the test Figure 3 comes from, are not as effective in foam stabilization.

Foam stability was tested using a Turbiscan which determines air bubble size and coalescence by measuring the amount of light that is refracted when directed through a sample at predetermined time intervals. Figure 4 illustrates data gathered from a Turbiscan test comparing two shampoos, one thickened with salt and the other thickened with Benecel HPMC. The Benecel HPMC thickened shampoo has more uniform air bubbles and less change in bubble size for the duration of the test. Over a 30 minute period, the Benecel HPMC based shampoo foam also shows slower air bubble coalescence than the foam thickened with salt.

Combining Benecel HPMC and salt together is sometimes used as a cost-effective thickening mechanism in personal care products. Figure 5 shows varied concentrations of this combination still providing the benefits of using Benecel HPMC products in the form of bubble size reduction and slower air bubble coalescence.

Figure 3 Lather Stability Comparison for Surfactant Systems Thickened with NaCl, Natrosol 250 HHR HEC, and Benecel K200M HPMC

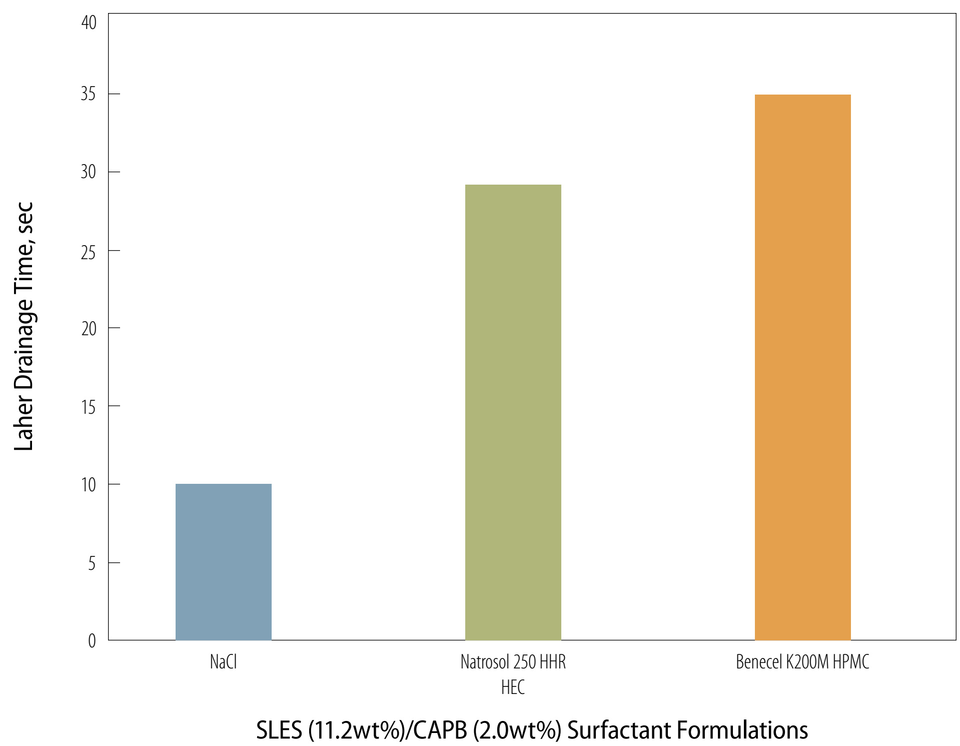
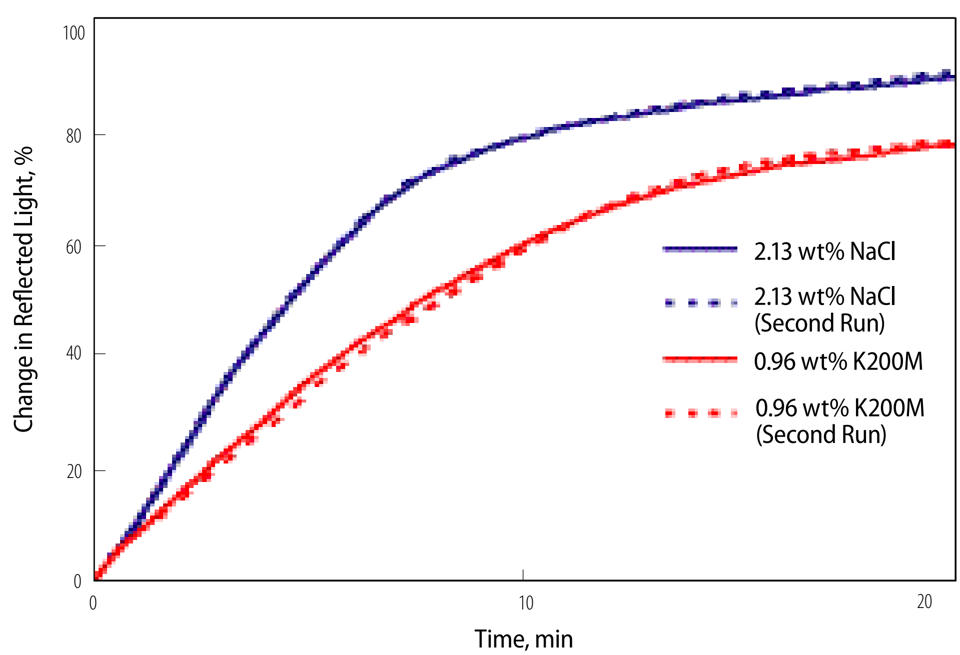


Figure 4 Lather Stability and Air Bubble Coalescence of the SLES Surfactant Thickened with NaCl vs. Benecel K200M HPMC



A Useful Tool for Cosmetic Formulators

The impact of the Benecel HPMC on foam stability and bubble size is perhaps best illustrated by the time-elapsed photographs below, which compare both SLES and ALS surfactant systems thickened either with salt or with Benecel K200M HPMC.

Figure 5 Lather Stability and Bubble Coalescence of SLES/CAPB Surfactants Thickened with Different Concentration Combinations of Benecel K200M HPMC and NaCl

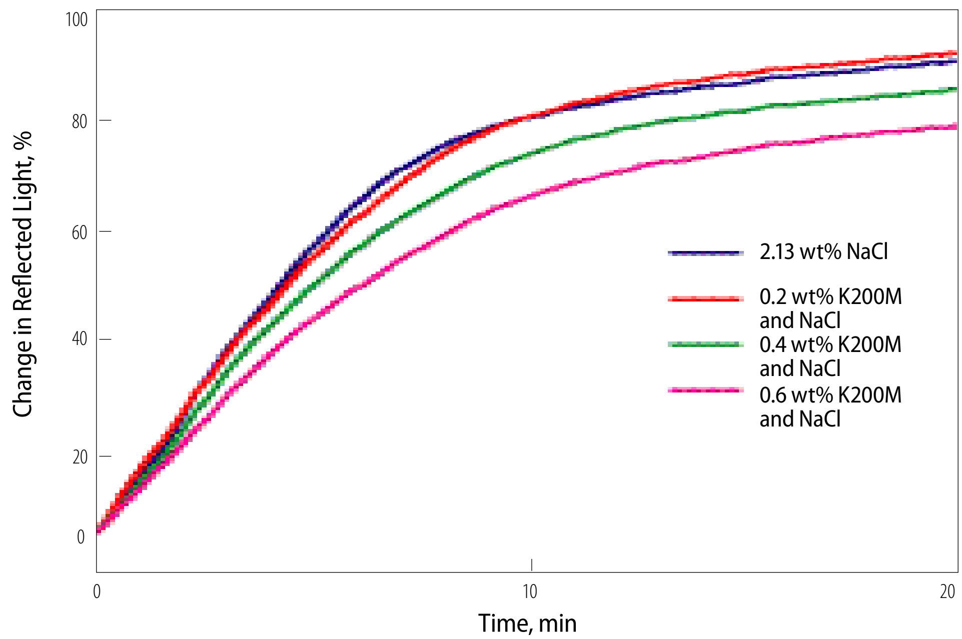
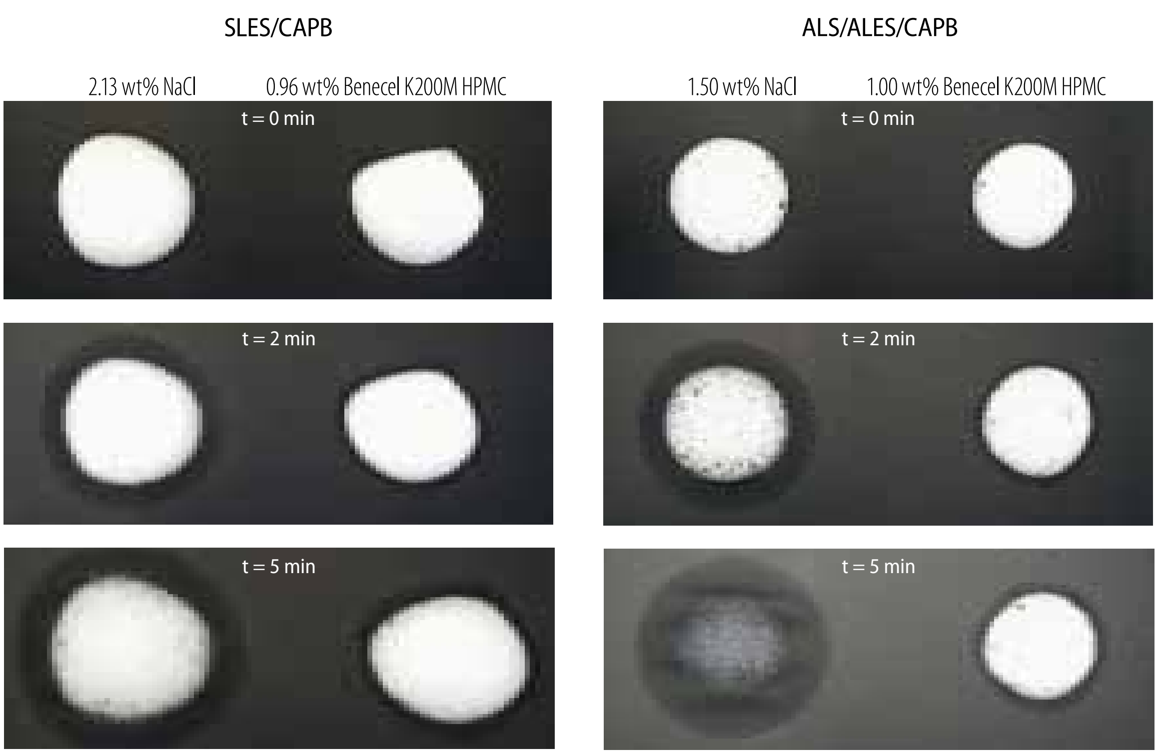


Figure 6 Time Elapse Photography of Foam[1] Stability



[1] Foam creation through Waring blender.

Aesthetics and Clarity

Benecel HPMC is an odorless, white to off-white powder with varying particle sizes, and when it is dissolved in water it yields a water white solution. Personal care products such as shampoos and body washes are efficacious, whether or not they are clear. However, clarity can be a marketplace differentiator and the formulator should be aware of formulation interactions that promote or detract from clarity. In most surfactant systems, Benecel HPMC products used alone provide very high viscosity and very high clarity, as measured by light transmittance (%T). When salt is used in combination with Benecel HPMC, clarity may be reduced depending upon surfactant type, salt concentration and the Benecel HPMC product type and concentration. Benecel HPMC is also sensitive to the concentration level of CAPBs which will influence clarity.

Figures 7, 8 and 9 show clarity levels in both ALS/ SLES/CAPB surfactant systems thickened with Benecel HPMC products. During each of the tests, a target viscosity of 6000cps was achieved before clarity was measured. In ALS surfactant systems, it is seen that using Benecel K200M HPMC and NH_4Cl in combination, as thickeners, causes virtually no loss of clarity. Because SLES/ CAPB surfactant systems are more sensitive to formulation variables clarity can become an issue. For this surfactant blend, if clarity is a concern, Benecel E10M HPMC and NaCl are the recommended thickening combination because the use of Benecel K200M HPMC will cause some loss of clarity.

Figure 7 Impact on Clarity on an ALS/ALES/CAPB Surfactant System When Benecel K200M HPMC Is Used (Viscosity held at 6000cps.)

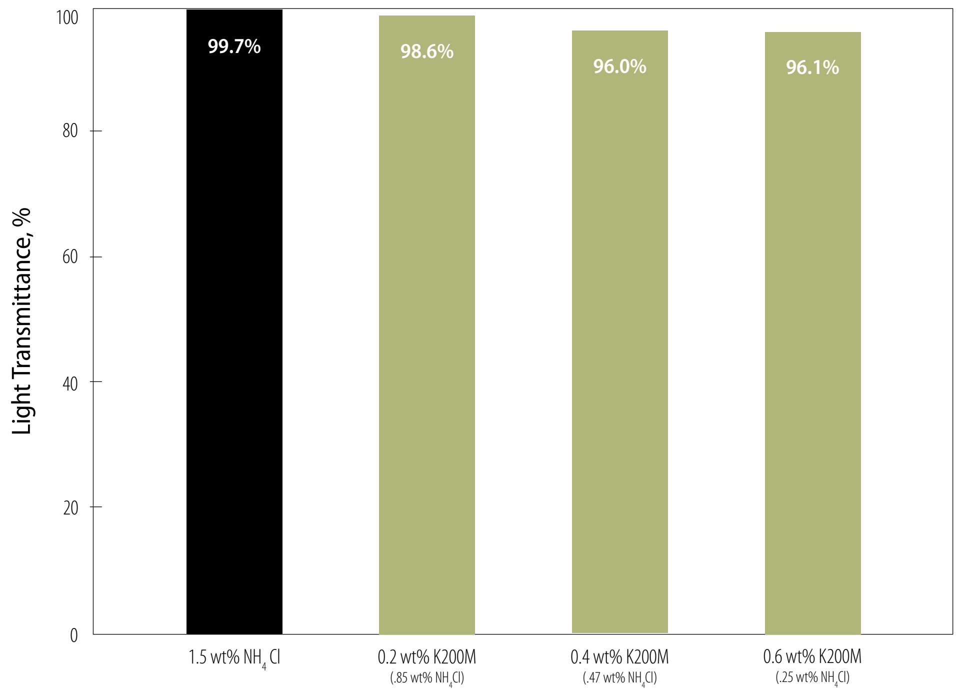
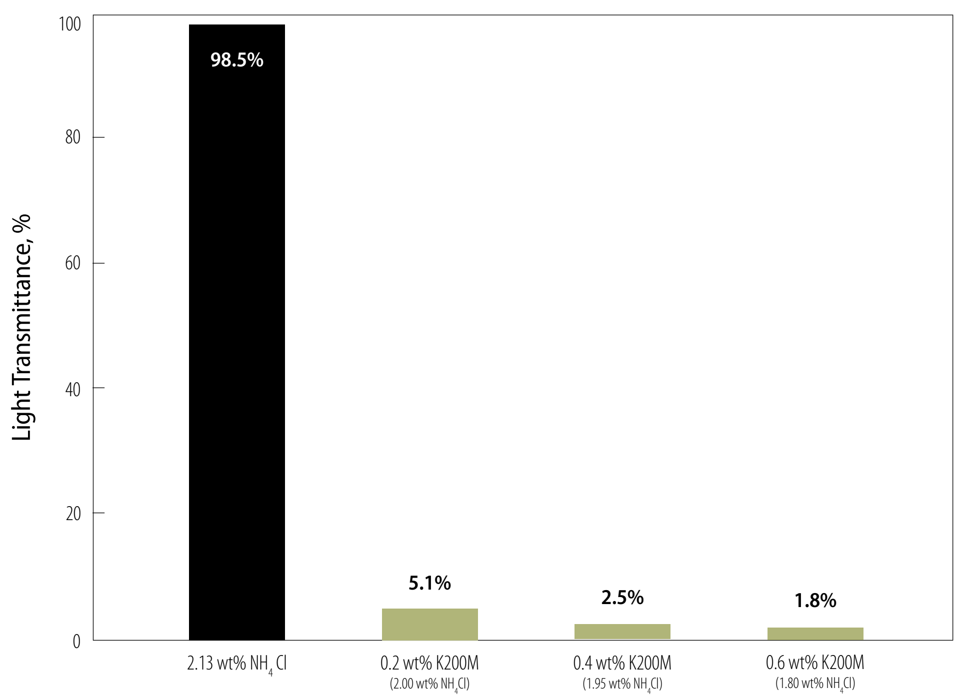


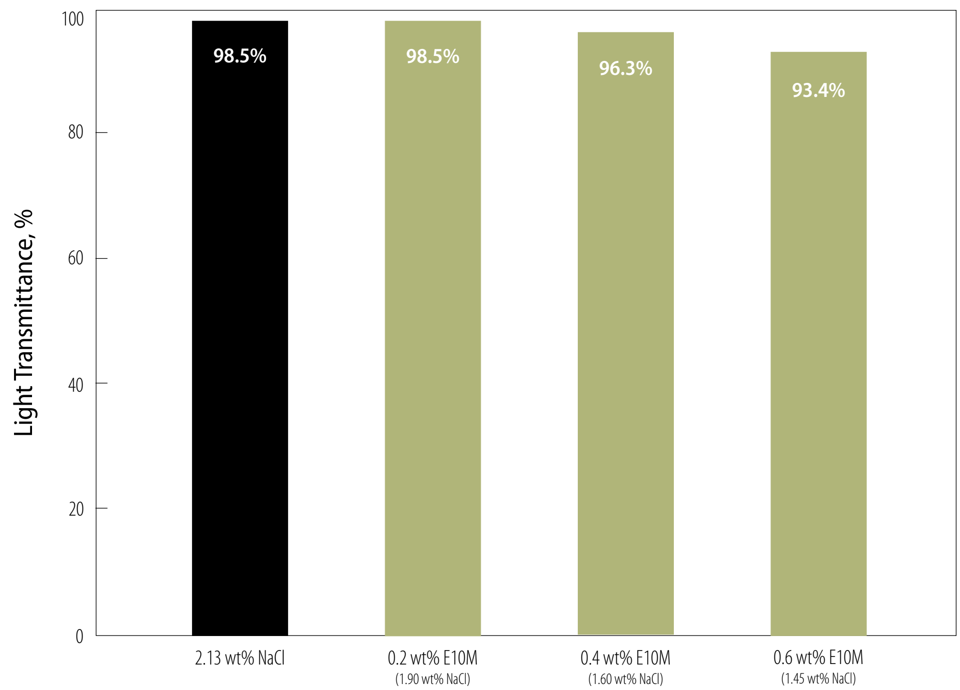
Figure 8 Impact on Clarity on an SLES/CAPB Surfactant System when Benecel K200M HPMC is Used (Viscosity held at 6000cps.)



Suspending

On its own, Benecel HPMC does not work as a significant suspension agent, but it is very compatible with xanthan and carbomer. By combining xanthan or carbomer with any Benecel HPMC products, the formulator will create certain suspension properties that can be used in a variety of applications in personal care.

Figure 9 Impact on Clarity on an SLES/CAPB Surfactant System when Benecel E10M HPMC is Used (Viscosity held at 6000cps.)



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Chemistry and Manufacturing

The raw material that is the basis for Benecel HPMC is cellulose, one of the most abundant polymers on earth. Aqualon uses either cotton linters or wood fiber as the primary raw material for the production of cellulose ethers. These raw materials are purchased from sources that continually renew their crops.

The production of cellulose ethers starts by swelling the cellulose with alkali which reduces the polymer crystallinity. Methyl chloride and propylene oxide are then reacted with alkali-cellulose under rigidly controlled conditions to create Benecel HPMC. The resultant nonionic polymer is purified, dried and ground to a fine white powder which is readily soluble in cold water.

Typical Properties of Solutions

Table 1 Typical Benecel HPMC Physical Properties and Solution Properties

Physical Properties	
Purity, dry basis, %, Minimum	98
Softening temperature, °F, (°C)	284, (140)
Decomposition temperature, °F, (°C)	>428, (>220)
Bulk density, g/ml	0.25 - 0.50
Biological oxygen demand, mgO_2/mg product	0.0 - 0.1
Solution Properties	
Flocculation temperature, °F, (°C)	
A Types	122-167, (50 - 75)
E, F, K Types	140 - 194, (60 - 90)
pH, 2% solution	5.0 - 8.0
Surface tension, 0.1% solution, dynes/cm	45- 55
Specific gravity, 2% solution	1.0032

As Benecel HPMC products dissolve into water, the viscosity increases. This thickening effect is dependent upon the degree of polymerization/molecular weight and on the concentration of the Benecel HPMC product. As the degree of polymerization is increased, molecular weight of the Benecel HPMC also increases, which can be seen in Figure 10 and Table 2. Also, the viscosities of aqueous Benecel HPMC solutions increase exponentially with the concentration of cellulose ether. This increase in viscosity is particularly prominent for Benecel HPMC types with high molecular weight, which is shown in Figure 11. These graphs were created using Brookfield data and spindles were selected depending on torque limits. The maximum concentrations used in practice are between 2-3% for high-molecular weight cellulose ethers and between 5-8% for low-molecular weight products. Typical concentration levels in personal care products are from 0.5-2%.

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Figure 10 2% Solution Viscosities of Benecel HPMC as a Function of Molecular Weight (MW) and Degree of Polymerization (DP)

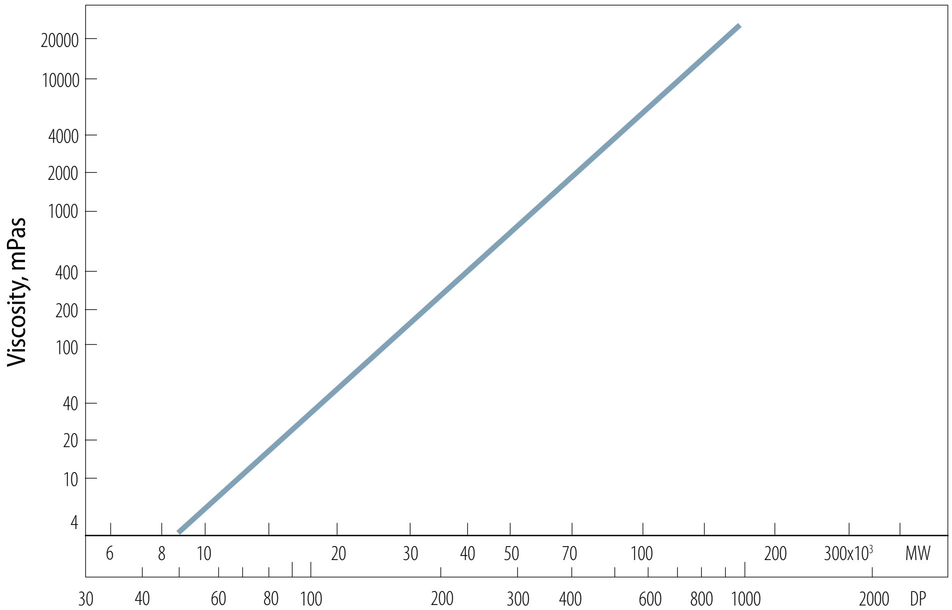


Table 2 Viscosity and Molecular Weight of Hydroxypropyl Methylcellulose

Solution Viscosity 2%, 20°C, mPa	Intrinsic Viscosity η, dl/g	Average Molecular Weight, Dalton	Average Degree of Polymerization, DP
10	1.4	13,000	70
40	2.05	20,000	110
100	2.65	26,000	140
400	3.9	41,000	220
1,500	5.7	63,000	340
4,000	7.5	86,000	460
8,000	9.3	110,000	580
15,000	11.0	120,000	650
19,000	12.0	140,000	750

Rheology and Thixotropy of Benecel HPMC Solutions

While Benecel HPMC solutions of low molecular weight behave comparably to Newtonian fluids, those of higher molecular weight behave in a more pseudoplastic manner. The viscosity of a pseudoplastic solution decreases with an increase in shear. When that shearing is interrupted, the original viscosity is instantaneously regained. These rheological properties of the solutions are affected by the degree of substitution, the molecular weight and concentration of the Benecel HPMC product which is evident in Figure 12. Thixotropic systems are solutions in which structural viscosity begins to dissipate under a shear influence, but once that influence is removed, they regain their original viscosity over time. Benecel HPMC solutions show little or no thixotropy.

Figure 11 Viscosity vs. Concentration % for Benecel K200M HPMC, Benecel E10M HPMC and Benecel F4M C HPMC

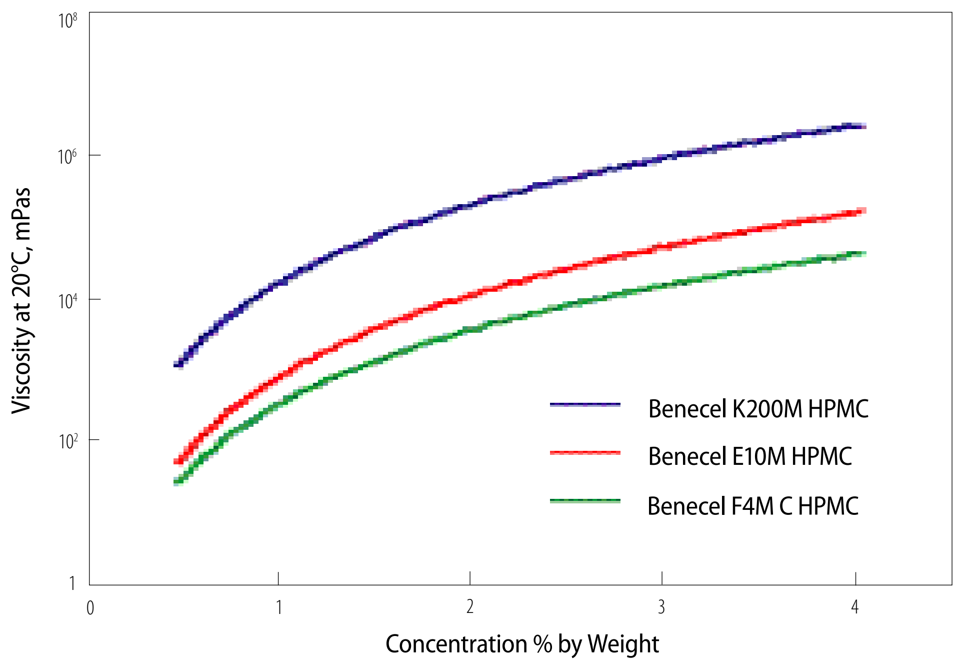
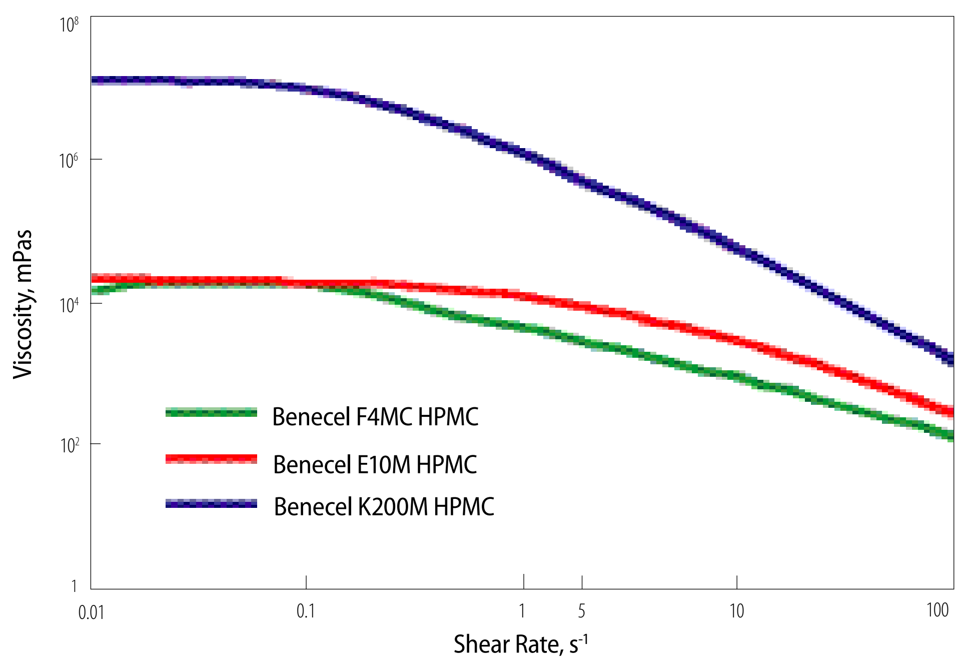


Figure 12 Viscosity vs. Shear Rate of 2% Benecel K200M HPMC, Benecel E10M, and Benecel F4MC HPMC Solutions



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Effect of Temperature on Benecel HPMC Solutions

Upon heating, Benecel HPMC starts to become less soluble in water and will build up a gel. The resulting gel strength and corresponding gel temperatures are determined by its chemistry and concentration in a solution. Gelation temperatures for Benecel HPMC are shown in Table 3. The flocculation temperature is dependent upon the solution concentration as is seen in Figure 13. This and the gelation process are completely reversible; upon cooling, Benecel HPMC products will fully dissolve again. The presence of salts in a solution will reduce the flocculation and gel temperatures, whereas alcohols such as methanol and ethanol will lead to an increase in flocculation and gel temperature.

The solution viscosity of cellulose ethers is dependent on the temperature. As the solution temperature increases, the viscosity initially decreases. Once the gelling temperature has been reached, the viscosity sharply rises until the flocculation temperature is reached. See Figure 14.

pH Stability

The viscosities of Benecel HPMC solutions are almost completely independent across the pH scale. Benecel HPMC can lose viscosity in extremely acidic or alkaline systems.

Figure 13 Concentration vs. Flocculation Temperature for Typical Benecel HPMC Solutions

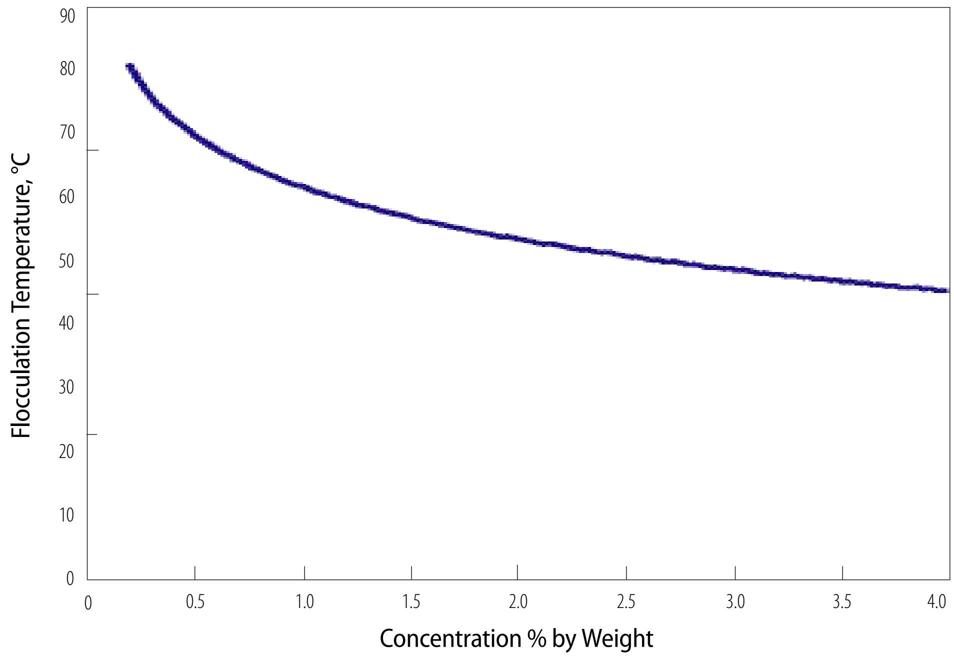
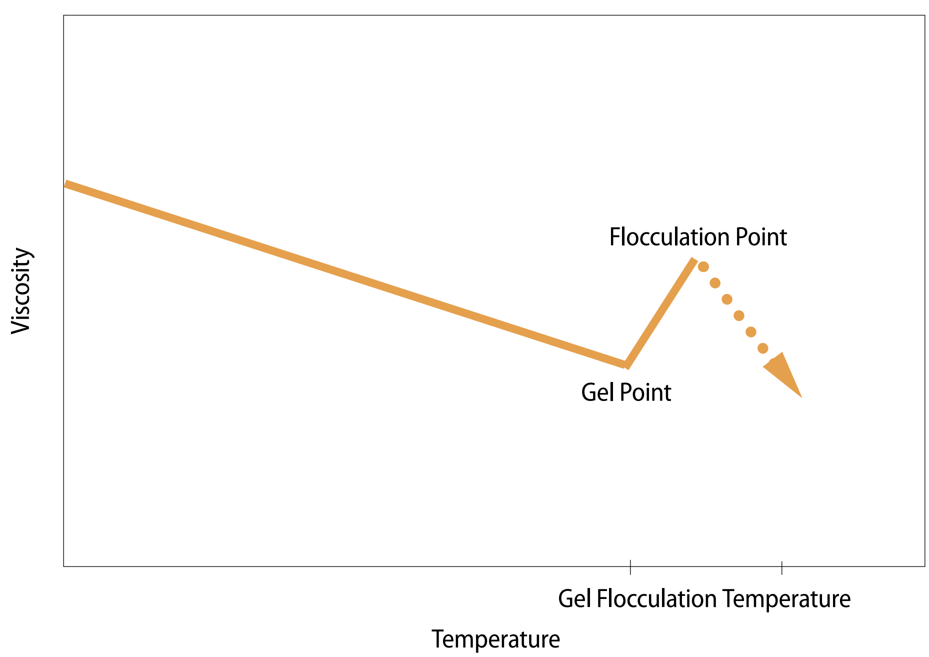


Table 3 Gelation Temperatures

Benecel HPMC Type	Gelation Temperatures, °C
E Chemistry	~58
F Chemistry	59 - 67
K Chemistry	75 - 85

Figure 14 Viscosity Curve with Increasing Temperature Up to Flocculation Temperature



Surface and Interfacial Activity

Benecel HPMC is surface active and reduces interfacial tension depending upon the type of substituents and degree of substitution. Because of these surface active properties, Benecel HPMC solutions tend to foam. The influence of the type of substituent on surface and interfacial tension of aqueous Benecel HPMC solutions is demonstrated in Table 4 (0.1% aqueous solutions at 20°C; water for comparison).

Table 4 Substitute Influence on Surface and Interfacial Tension

	Surface Tension, mN/m	Interfacial Tension vs. Paraffin Oil, mN/m
Water	72	45
HPMC	46 - 51	17 - 18.5

Guide to Surfactant Compatibility

Benecel HPMC products are compatible with most surfactants and many other materials. Tables 5 and 6 show some of the most commonly used surfactants and their compatibility with Benecel HPMC. Other formulation additives could affect the solubility of Benecel HPMC.

Table 5 Benecel K200M HPMC Surfactant Compatibility

	0.5% Benecel K200M HPMC		1.0% Benecel K200M HPMC	
Surfactant	**6% Surfactant**	**12% Surfactant**	**6% Surfactant**	**12% Surfactant**
Ammonium lauryl sulfate Trademark: Stephanol AM (Stepan Co.)	Yes	Yes	Yes	Yes
Ammonium laureth sulfate (1 EO) Trademark: Standapol EA-1 (Cognis Corp.)	Yes	Yes	Yes	Yes
Ammonium laureth sulfate (2 EO) Trademark: Steol CA230-D (Stepan Co.)	Yes	Yes	Yes	Yes
Ammonium laureth sulfate (3 EO) Trademark: Steol CA330 (Stepan Co.)	Yes	Yes	Yes	Yes
Sodium lauryl sulfate Trademark: Stephanol LCP (Stepan Co.)	Yes	Yes	Yes	Yes
Sodium laureth sulfate (1 EO) Trademark: Standapol CS130 (Stepan Co.)	Yes	Yes	Yes	Yes
Sodium laureth sulfate (2 EO) Trademark: Steol CS230 (Stepan Co.)	Yes	Yes	Yes	Yes
Sodium laureth sulfate (3 EO) Trademark: Steol CS330 (Stepan Co.)	Yes	Yes	Yes	Yes
Cocamidopropyl betaine Trademark: Amphasol CA (Stepan Co.)	Yes	Yes	Yes	Yes
Alkylpolyglucosides Trademark: Plantaren 2000N UP (Cognis Corp.)	Yes	No	Yes	No
Lauramine oxide Trademark: Ammonyx LO (Stepan Co.)	Yes	Yes	Yes	Yes
Sodium cocoamphoacetate Trademark: Amphosol 1C (Stepan Co.)	Yes	No	Yes	No
Disodium cocoamphodipropionate Trademark: Amphosol 2CSF (Stepan Co.)	Yes	Yes	Yes	Yes

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Table 6 Benecel E10M HPMC Surfactant Compatibility

Surfactant	0.5% Benecel E10M HPMC 6% Surfactant	0.5% Benecel E10M HPMC 12% Surfactant	1.0% Benecel E10M HPMC 6% Surfactant	1.0% Benecel E10M HPMC 12% Surfactant
Ammonium lauryl sulfate Trademark: Stephanol AM (Stepan Co.)	Yes	Yes	Yes	Yes
Ammonium laureth sulfate (1 EO) Trademark: Standapol EA-1 (Cognis Corp.)	Yes	Yes	Yes	Yes
Ammonium laureth sulfate (2 EO) Trademark: Steol CA230-D (Stepan Co.)	Yes	Yes	Yes	Yes
Ammonium laureth sulfate (3 EO) Trademark: Steol CA330 (Stepan Co.)	Yes	Yes	Yes	Yes
Sodium lauryl sulfate Trademark: Stephanol LCP (Stepan Co.)	Yes	Yes	Yes	Yes
Sodium laureth sulfate (1 EO) Trademark: Standapol CS130 (Stepan Co.)	Yes	Yes	Yes	Yes
Sodium laureth sulfate (2 EO) Trademark: Steol CS230 (Stepan Co.)	Yes	Yes	Yes	Yes
Sodium laureth sulfate (3 EO) Trademark: Steol CS330 (Stepan Co.)	Yes	Yes	Yes	Yes
Cocamidopropyl betaine Trademark: Amphasol CA (Stepan Co.)	Yes	Yes	Yes	Yes
Alkylpolyglucosides Trademark: Plantaren 2000N UP (Cognis Corp.)	Yes	No	Yes	No
Lauramine oxide Trademark: Ammonyx LO (Stepan Co.)	Yes	Yes	Yes	Yes
Sodium cocoamphoacetate Trademark: Amphosol 1C (Stepan Co.)	Yes	Yes	Yes	Yes
Disodium cocoamphodipropionate Trademark: Amphosol 2CSF (Stepan Co.)	Yes	Yes	Yes	Yes

Influence of Other Water-Soluble Polymers

Benecel HPMC products are compatible with solutions of most other water-soluble polymers, such as Aqualon™ CMC or Blanose™ CMC, xanthan, carbomer, starch, guar, karaya and locust bean gum, carrageenan, pectin and alginates. A synergistic increase of viscosity will be observed upon addition of CMC or xanthan.

Preservation

Solid Benecel HPMC is highly resistant to microorganisms; however, preservation of Benecel HPMC is recommended if it is to be stored for a longer period, or is mixed with non-sterile additives. Examples of preservatives are the esters of p-hydroxy benzoic acid, benzoic acid, sodium benzoate, sorbic acid and potassium sorbate. Manufacturers' instructions for use of preservatives should be carefully observed, as well as regulatory restrictions of its use.

Recommended Grades for Personal Care Applications

Aqualon provides a wide range of Benecel HPMC types for personal care applications. The generally recommended polymers for surfactant based applications where elevated thickening levels and lather stability are desired are Benecel K200M and E10M HPMC. These high molecular weight, hydrophilic polymers meet the requirements for many personal care applications. For those applications where film formation is more important than viscosity build – for instance in shaving creams and gels, a lower molecular weight grade such as F4M C or K4M is generally recommended.

Table 7 Benecel HPMC Grades

Benecel HPMC Type	2% Water Viscosity	Methyl Content, %	Hydroxypropyl Content, %
E50	40 - 60[1]	28 - 30	7 - 12
E4M	2,700 - 5,040[2]	28 - 30	7 -12
E10M	7,500 - 14,000[2]	28 - 30	7 - 12
F4M C	2,700 - 5,040[2]	19 - 30	3 - 12
K99 C	80 - 120[1]	20 - 24	7 - 12
K4M	2,700 - 5,040[2]	20 - 24	7 - 12
K15M	13,500 - 25,200[2]	20 - 24	7 - 12
K35M	26,250 - 49,000[2]	20 - 24	7 - 12
K100M	75,000 -140,000[2]	20 - 24	7 - 12
K200M	150,000 - 280,000[2]	20 - 24	7 - 12

[1] EP Ubbelohde viscosity.
[2] EP Brookfield viscosity.

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Recommended Techniques for Making Benecel HPMC Solutions

Benecel HPMC powders have been developed for "hot-cold" water blending or dry blending with other powdered materials. Such dry blends allow lump free dispersion of Benecel HPMC products in water. For dissolving pure Benecel HPMC powder the following "hot-cold" water method is recommended.

Hot-Cold Water Dispersion

This method of dispersion utilizes the insolubility of Benecel HPMC products at higher water temperature. As a result of the insolubility the Benecel HPMC product can be continually mixed until all particles have been hydrated. Once this is achieved colder water is added to achieve solubility. The viscosity of solutions can be increased if higher stirring speeds are used during formation as can be seen in Figure 15. Also observed is that the temperature of the make-up water used in the formulation will have an effect on the viscosity of the solutions which can be seen in Figure 16.

Figure 15 Viscosity Development of Typical Benecel HPMC Solutions as a Function of Stirring Speed

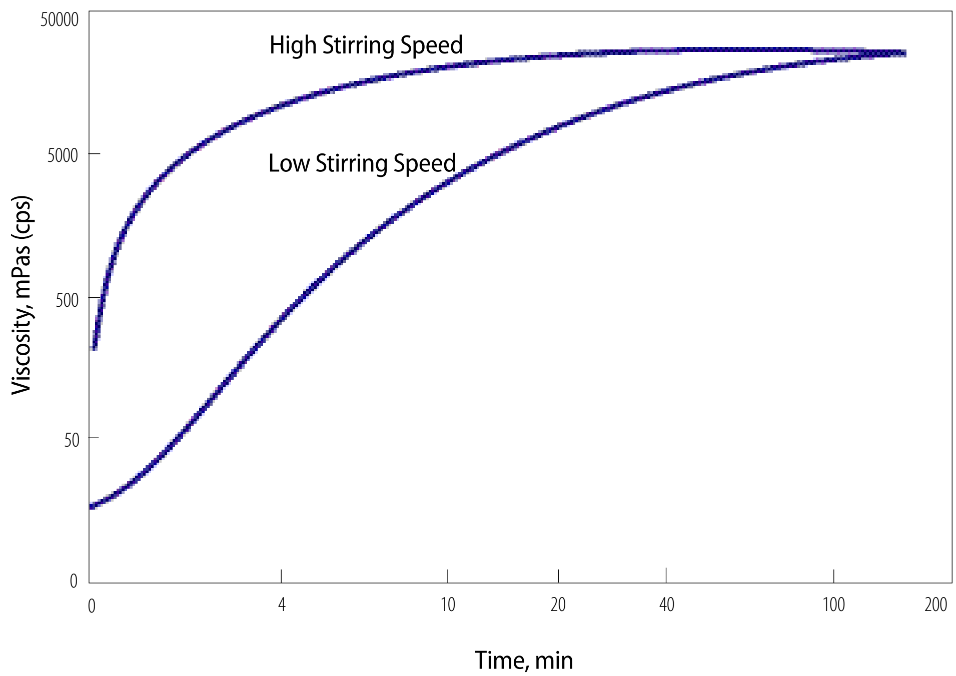
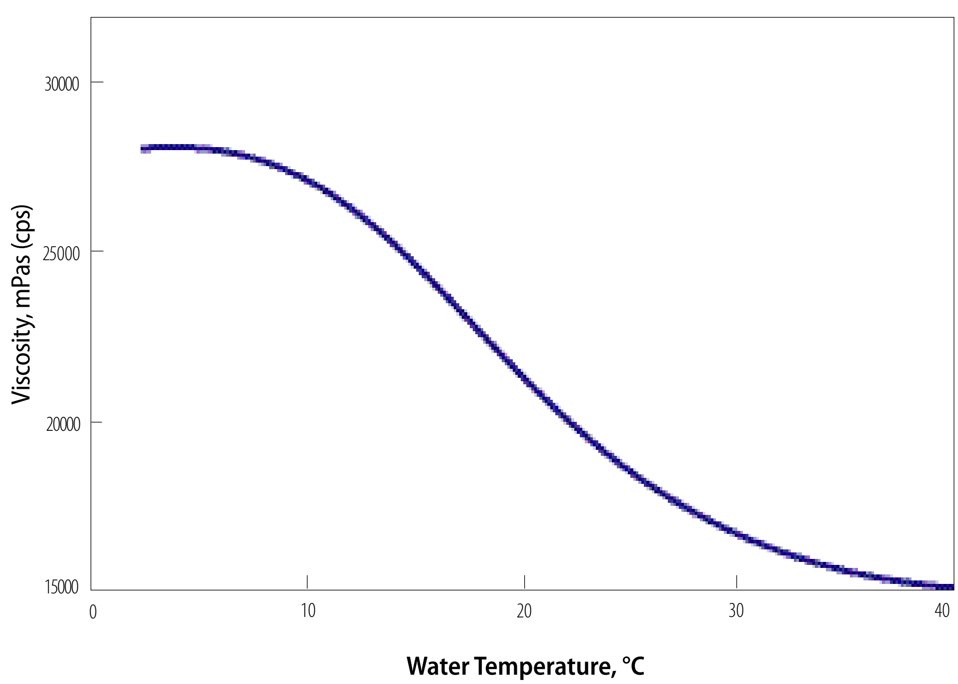


Figure 16 Solution Viscosity of a 2% Benecel HPMC Solution in Relation to the Temperature of the Make-up Water



"Hot-Cold" Dispersion Steps

1. Heat 1/5 of the total amount of water needed for the solution to 80 - 90°C (176 - 194°F).
2. Agitate the water and sift in the Benecel HPMC. Continue agitation until the product is completely slurried.
3. Add the remaining water at a temperature of 5°C (41°F).
4. Continue to stir the solution for an additional 30 minutes, or until solution is smooth and lump-free.

Dry Blending Dispersion

This method of blending involves combining Benecel HPMC with other dry powders prior to adding water. The Benecel HPMC particles are separated by the addition of the other dry powders. This separation allows for complete hydration when water is eventually added.

Dry Blending Dispersion Steps

1. Combine and thoroughly blend the Benecel HPMC powder with all other powder ingredients.
2. Add the combined powders to the total amount of water as it is being agitated.
3. Continue agitation until the Benecel HPMC product is fully dissolved in the water, and the solution is lump-free.

Formulation 02-1022

Clear Conditioning Shampoo With Benecel K200M HPMC and AquaCat™ Clear Cationic Solution

This shampoo provides thorough cleansing with subtle conditioning due to the cationic guar and cocoate superfatting agent. Benecel K200M HPMC, used at a level of only 0.4 weight percent, yields a clear shampoo with pseudoplastic flow and excellent shelf stability.

Ingredients	Weight %
Deionized water	q.s. to 100%
Ammonium lauryl sulfate (28%)[1]	28.50
Cocamidopropyl betaine (30%)[2]	7.00
PEG-7 glyceryl cocoate[3]	1.00
AquaCat CG518 clear cationic solution	2.50
Benecel K200M HPMC	0.40
Phenoxyethanol and methylparaben and ethylparaben and propylparaben and butylparaben[4]	0.30
Citric acid	to pH 6.0

Suppliers:

	(1) Stepanol* AM	Stepan Co.
	(2) Amphosol* CA	Stepan Co.
	(3) Tegosoft* GC	Goldschmidt Chemical
	(4) Phenonip*	Clariant Corporation

Procedure:

1. Dissolve the Benecel K200M HPMC using the Hot/Cold method: Heat 1/3 of the water to ~80°C and chill the balance of the water to 5°C. While agitating, disperse the polymer in the hot water then add the balance of the cold water while mixing.
2. Mix the polymer solution until smooth and uniform.
3. Add the remaining ingredients, one at a time, mixing well between additions.
4. Adjust pH to 6.0 with citric acid.

Properties of the Formulation:

Viscosity @ 25°C	4300 cP (Brookfield LVT @ 30 RPM, Spindle 4)
pH	6.0
Appearance	Clear, slightly yellow

CTFA/INCI Nomenclature: Benecel K200M - hydroxypropyl methylcellulose
AquaCat CG518 - guar hydroxypropyltrimonium chloride

Formulation 02-1023

Clear Conditioning Shampoo With Benecel K200M HPMC

This shampoo provides thorough cleansing with subtle conditioning due to the wheat protein and cocoate superfatting agent. Benecel K200M HPMC, used at a level of only 0.3 weight percent, yields a clear shampoo with pseudoplastic flow and excellent shelf stability.

Ingredients	Weight %
Deionized water	q.s. to 100%
Ammonium lauryl sulfate (28%)[1]	28.50
Cocamidopropyl betaine (30%)[2]	7.00
PEG-7 glyceryl cocoate[3]	1.00
Hydrolyzed wheat protein[4]	0.50
Benecel K200M HPMC	0.30
Phenoxyethanol and methylparaben and ethylparaben and propylparaben and butylparaben[5]	0.30
Citric acid	to pH 6.0

Suppliers:

Suppliers:	(1) Stepanol* AM	Stepan Co.
	(2) Amphosol* CA	Stepan Co.
	(3) Tegosoft* GC	Goldschmidt Chemical
	(4) Hydrotriticum* 2000	Croda Inc.
	(5) Phenonip*	Clariant Corp.

Procedure:

1. Dissolve the Benecel K200M HPMC using the Hot/Cold method: Heat 1/3 of the water to ~80°C and chill the balance of the water to 5°C. While agitating, disperse the polymer in the hot water then add the balance of the cold water while mixing.
2. Mix the polymer solution until smooth and uniform.
3. Add the remaining ingredients, one at a time, mixing well between additions.
4. Adjust pH to 6.0 with citric acid.

Properties of the Formulation:

Viscosity @ 25°C	2400 cP (Brookfield LVT @ 30 RPM, Spindle 3)
pH	6.0
Appearance	Clear, slightly yellow

CTFA/INCI Nomenclature: Benecel K200M - hydroxypropyl methylcellulose

Formulation 02-1024

Two-in-One Shampoo With Benecel K200M HPMC

The dimethicone and wheat protein provide the after shampoo conditioning in this two-in-one formulation. Benecel K200M HPMC effectively stabilizes the glycol distearate pearl, yielding a viscous shampoo with good shelf stability.

Ingredients	Weight %
Deionized water	q.s. to 100%
Ammonium lauryl sulfate (28%)[1]	21.00
Cocamidopropyl betaine (30%)[2]	7.00
Dimethicone propyl PG-betaine[3]	1.50
Hydrolyzed wheat protein[4]	1.00
Sodium C14-16 olefin sulfonate and glycol distearate and cocamidopropylbetaine and sorbitan laurate[5]	1.00
Benecel K200M HPMC	0.60
Phenoxyethanol and methylparaben and ethylparaben and propylparaben and butylparaben[6]	0.30
Citric acid	to pH 6.0

Suppliers:		
	(1) Stepanol* AM	Stepan Co.
	(2) Amphosol* CA	Stepan Co.
	(3) Abil* B 9950	Goldschmidt Chemical
	(4) Hydrotriticum* 2000	Croda Inc.
	(5) Tego* Pearl S33	Goldschmidt Chemical
	(6) Phenonip*	Clariant Corp.

Procedure:

1. Dissolve the Benecel K200M HPMC using the Hot/Cold method: Heat 1/3 of the water to ~80°C and chill the balance of the water to 5°C. While agitating, disperse the polymer in the hot water then add the balance of the cold water while mixing.
2. Mix the polymer solution until smooth and uniform.
3. Add the remaining ingredients, one at a time, mixing well between additions.
4. Adjust pH to 6.0 with citric acid.

Properties of the Formulation:

Viscosity @ 25°C	10,200 cP (Brookfield LVT @ 30 RPM, Spindle 4)
pH	6.0
Appearance	Pearlescent

CTFA/INCI Nomenclature: Benecel K200M - hydroxypropyl methylcellulose

Formulation 02-1025

Clear and Mild Shampoo With Benecel K200M HPMC

This shampoo is near water-white in clarity and color. The amphoteric surfactant, in combination with SLES and ALS, is the basis of this mild cleansing formula. Addition of only 0.3 weight percent Benecel K200M HPMC is needed to yield a viscous yet smooth pouring shampoo. This is possible due to the thickening efficiency of Benecel K200M HPMC and the pseudoplastic rheology it imparts.

Ingredients	Weight %
Deionized water	q.s. to 100%
Ammonium lauryl sulfate (28%)[1]	27.50
Disodium cocoamphodiacetate[2]	6.90
Sodium laureth sulfate (28%)[3]	12.21
Benecel K200M HPMC	0.30
DMDM hydantoin[4]	0.30
Methylparaben[5]	0.10
Citric acid	to pH 5.5

Suppliers:

Suppliers:	(1) Stepanol* AM	Stepan Co.
	(2) Miranol* C2M Conc. NP	Rhodia
	(3) Texapon NSO-NA*	Cognis
	(4) Glydant*	Lonza
	(5) Nipagin* M Sodium	Clariant Corp.

Procedure:

1. Dissolve the Benecel K200M HPMC using the Hot/Cold method: Heat 1/3 of the water to ~80°C and chill the balance of the water to 5°C. While agitating, disperse the polymer in the hot water then add the balance of the cold water while mixing.
2. Mix the polymer solution until smooth and uniform.
3. Add the remaining ingredients, one at a time, mixing well between additions.
4. Adjust pH to 5.5 with citric acid.

Properties of the Formulation:

Viscosity @ 25°C	13,900 cP (Brookfield LVT @ 30 RPM, Spindle 4)
pH	5.5
Appearance	Near water-white

CTFA/INCI Nomenclature: Benecel K200M - hydroxypropyl methylcellulose

Formulation 02-1026

Clear and MIld Shampoo With Benecel F4M C HPMC

This shampoo is near water-white in clarity and color. The amphoteric surfactant, in combination with SLES and ALS, is the basis of this mild cleansing formula. Addition of only 0.6 weight percent Benecel F4M C HPMC is needed to yield a viscous yet smooth pouring shampoo. This is possible due to the thickening efficiency of Benecel F4M C HPMC and the pseudoplastic rheology it imparts.

Ingredients	Weight %
Deionized water	q.s. to 100%
Sodium lauryl sulfate (28%)[1]	27.50
Disodium cocoamphodiacetate[2]	6.90
Sodium laureth sulfate (28%)[3]	11.40
Benecel F4M C HPMC	0.60
Methyldibromo glutaronitrile phenoxyethanol[4]	0.40
Citric acid	to pH 5.5

Suppliers:		
	(1) Ifrapon* nls 28	Ifrachimie
	(2) Miranol* C2M Conc. NP	Rhodia
	(3) Texapon NSO-NA*	Cognis
	(4) Euxyl* K400	Schulke and Mayr

Procedure:

1. Dissolve the Benecel F4M C HPMC using the Hot/Cold method: Heat 1/3 of the water to ~80°C and chill the balance of the water to 5°C. While agitating, disperse the polymer in the hot water then add the balance of the cold water while mixing.
2. Mix the polymer solution until smooth and uniform.
3. Add the remaining ingredients, one at a time, mixing well between additions.
4. Adjust the pH to 5.5 with citric acid.

Properties of the Formulation:

Viscosity @ 25°C	2100 cP (Brookfield LVT @ 30 RPM, Spindle 3)
pH	5.5
Appearance	Near water-white

CTFA/INCI Nomenclature: Benecel F4M C - hydroxypropyl methylcellulose

Formulation 02-1027

Gentle Everyday Shampoo With Benecel F4M C HPMC

This mild shampoo is suitable for everyday use. Sodium lauroyl sarcosinate, which contributes gentle cleansing and anti-irritation properties, is especially difficult to thicken. The combination of Benecel F4M C HPMC and PEG-150 distearate yields a clear, pale yellow viscous shampoo with excellent heat stability.

Ingredients	Weight %
Deionized water	q.s. to 100%
Benecel F4M C HPMC	1.20
Sodium laureth sulfate – 3EO (28%)[1]	19.60
Cocamidopropyl betaine (30%)[2]	12.83
Sodium lauroyl sarcosinate[3]	9.60
PEG-150 distearate[4]	2.90
Phenoxyethanol and methylparaben and ethylparaben and propylparaben and butylparaben[5]	0.30
Citric acid	to pH 7.0

Suppliers:		
	(1) Steol* CS330	Stepan Co.
	(2) Amphosol* CA	Stepan Co.
	(3) Crodasinic* LS30	Croda Inc.
	(4) Stepan* PEG 6000DS	Stepan Co.
	(5) Phenonip*	Clariant Corp.

Procedure:

1. Heat the water to ~75°C with agitation.
2. Sift the Benecel F4M C HPMC into the vortex of the heated water to disperse.
3. Add the surfactants, one at a time, mixing well between additions.
4. Add the PEG and mix until dissolved.
5. Cool to 25°C and add the preservative below 40°C.
6. Adjust the pH to 7 as needed.

Properties of the Formulation:

Viscosity @ 25°C	2500 cP (Brookfield LVT @ 30 RPM, Spindle 3)
pH	7.0
Appearance	Clear, slightly yellow

CTFA/INCI Nomenclature: Benecel F4M C - hydroxypropyl methylcellulose

Formulation 02-1028

Gentle Everyday Shampoo With Benecel E10M HPMC

This mild shampoo is suitable for everyday use. Sodium lauroyl sarcosinate, which contributes gentle cleansing and anti-irritation properties, is especially difficult to thicken. The combination of Benecel E10M HPMC and PEG-150 distearate yields a clear, pale yellow viscous shampoo with excellent heat stability.

Ingredients	Weight %
Deionized water	q.s. to 100%
Benecel E10M HPMC	1.20
Sodium laureth sulfate – 3EO (28%)[1]	19.60
Cocamidopropyl betaine (30%)[2]	12.83
Sodium lauroyl sarcosinate[3]	9.60
PEG-150 distearate[4]	2.90
Phenoxyethanol and methylparaben and ethylparaben and propylparaben and butylparaben[5]	0.30
Citric acid	to pH 7.0

Suppliers:		
	(1) Steol* CS330	Stepan Co.
	(2) Amphosol* CA	Stepan Co.
	(3) Crodasinic* LS30	Croda Inc.
	(4) Stepan* PEG 6000DS	Stepan Co.
	(5) Phenonip*	Clariant Corp.

Procedure:

1. Heat the water to ~75°C with agitation.
2. Sift the Benecel E10M HPMC into the vortex of the heated water to disperse.
3. Add the surfactants, one at a time, mixing well between additions.
4. Add the PEG and mix until dissolved.
5. Cool to 25°C and add the preservative below 40°C.
6. Adjust the pH to 7 as needed.

Properties of the Formulation:

Viscosity @ 25°C	5800 cP (Brookfield LVT @ 30 RPM, Spindle 4)
pH	7.0
Appearance	Clear, slightly yellow

CTFA/INCI Nomenclature: Benecel E10M - hydroxypropyl methylcellulose

Formulation 02-1029

Value Brand Shampoo With Benecel K200M HPMC

This mild shampoo is suitable for everyday use. Benecel K200M HPMC, used at a level of only 0.5 weight percent, yields a shampoo with excellent pseudoplastic flow.

Ingredients	Weight %
Deionized water	q.s. to 100%
Ammonium lauryl sulfate[1]	9.00
Ammonium laureth sulfate – 3EO[2]	3.00
Ammonium chloride	0.80
Cocamide MEA[3]	1.00
Benecel K200M	0.50
EDTA	0.50
Propylene glycol	0.50
Phenoxyethanol/ethylhexylglycerin[4]	0.50

Suppliers:

Suppliers:	(1) Texapon ALS Benz*	Cognis
	(2) Steol* CA-460	Stepan Co.
	(3) Rewomid* C212	Evonik-Goldschmidt
	(4) Euxyl* PE 9010	Schulke and Mayr

Procedure:

1. Dissolve the Benecel K200M HPMC using the Hot/Cold method: Heat 1/3 of the water to ~80°C and chill the balance of the water to 5°C. While agitating, disperse the polymer in the hot water then add the balance of the cold water while mixing
2. Mix the polymer solution until smooth and uniform.
3. Add the remaining ingredients, one at a time, mixing well between additions.
4. Adjust pH to 5.5 with citric acid.

Properties of the Formulation:

Viscosity @ 25°C	5200 cP (Brookfield LVT @ 30 RPM, Spindle 4)
pH	6.0
Appearance	Near water-white

CTFA/INCI Nomenclature: Benecel K200M – hydroxypropyl methylcellulose

Formulation 02-3019

Cleansing Milk With Benecel F4M C HPMC

Benecel F4M C HPMC in combination with the carbomer provides a product with an improved rheology. When applied to and rubbed into the skin it creates a cosmetically better, richer impression than corresponding emulsions containing only one of the hydrocolloids alone.

Ingredients	Weight %
A: DI-water	q.s. to 100%
Propylene glycol	4.00
Carbomer	0.30
B: DI-water	15.00
Benecel F4M C HPMC	0.30
C: Mineral oil	8.00
Iso-propyl palmitate	3.00
Ceteareth-25[1]	2.00
Ceteareth-6 and stearyl alcohol[2]	2.00
Octyl palmitate[3]	2.00
Glycol stearate[4]	2.00
Cetyl alcohol[5]	1.00
D: TEA	0.42
E: Phenoxyethanol methyldibromo glutaronitrile[6]	0.15

Suppliers:		
	(1) Cremophor* A25	BASF
	(2) Cremophor* A6	BASF
	(3) Crodamol* OP	Croda
	(4) Tegin* G	Evonik-Goldschmidt
	(5) Crodacol* C90	Croda
	(6) Euxyl* K400	Schulke and Mayr

Procedure:

1. Prepare A and heat till 75-80°C. In a separate container prepare B.
2. Melt the ingredients of C and heat till 75-80°C.
3. Add C to A under constant mixing at 75-80°C. Neutralize the solution with D and cool till 60°C.
4. Add B at 60°C and homogenize the mixture for approx. 5 minutes.
5. Cool the solution further to below 30°C and add the preservative of E and fragrance. When necessary adjust the pH to 6.0.

Properties of the Formulation:

Viscosity @ 25°C	25000 cP (Helipath @ 10 RPM, Spindle C)
pH	5.5 - 6.0
Appearance	White, smooth

CTFA/INCI Nomenclature: Benecel F4M C – hydroxypropyl methylcellulose

Polymers for hair care

- Shampoos
- Conditioners
- Styling gels
- Styling mousse

Polymers for oral care

- Toothpaste
- Denture adhesive
- Mouthwash

Polymers for skin care

- Bubble bath
- Body wash
- Liquid hand soap
- Shave gels
- AP/DEO
- Color cosmetics
- Creams, lotions and ointments

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