CELLOSIZE Hydroxyethyl Cellulose for Coatings Applications

High Thickening Efficiency, Excellent Formulation Compatibility, and Available with Superior Enzyme Resistance

Coatings

CELLOSIZE Hydroxyethyl Cellulose Continues to Set the Standard in Thickening Performance for Latex Paints

CELLOSIZE™ hydroxyethyl cellulose (HEC) has long been recognized as an outstanding thickener for both interior and exterior latex paints. The major advantages that CELLOSIZE HEC offers as a paint thickener are:

- High Thickening Efficiency
- Excellent Enzyme Resistance
- Low Water Insolubles
- Excellent Color Development and Color Acceptance
- Compatibility with a Broad Range of Paint Ingredients
- Batch-to-Batch Uniformity
- Good Brush and Roller Application
- Non-Sagging Properties

CELLOSIZE HEC is a nonionic, water-soluble polymer that can thicken, suspend, bind, emulsify, form films, stabilize, disperse, retain water, or provide protective colloid action. It is readily soluble in hot or cold water and can be used to prepare solutions with a wide range of viscosities. It has outstanding tolerance for dissolved electrolytes.

For latex paint thickening, CELLOSIZE hydroxyethyl cellulose (HEC) is offered in standard viscosity grades from QP-300 to QP-52000H. CELLOSIZE enzyme resistant (ER) HEC products are also available in five grades, which have been specifically developed to improve their resistance to enzyme attack. The popular grades for paint thickening are QP-4400H and QP-15000H. For economy, higher viscosity grades may be used. The amount required for proper viscosity may, however, be less than the amount needed for other properties. The higher viscosity thickeners are usually employed in low-cost paints and in industrial coatings where storage and application conditions are moderate.

Table 1 shows the solution viscosities of the HEC grades that are useful for paint thickening. Table 2 shows typical properties of HEC grades.

Table 1
Viscosity Ranges of Aqueous CELLOSIZE Hydroxyethyl Cellulose Solutions[1]

Solution Concentration %	CELLOSIZE HEC Grade	Viscosity Range LVF Brookfield at 25°C, mPa•s	Spindle Number	RPM
	QP-300	300-400	2	60
2	ER-4400	4800-6000	4	60
	QP-4400H	4800-6000	4	60
1	QP-15000H	1100-1500	3	30
	QP-30000H	1500-2400	3	30
	QP-52000H	2400-3000	3	30
	ER-15M	1100-1500	3	30
	ER-30M	1500-1900	3	30
	ER-37M	1900-2400	3	30
	ER-52M	2400-3000	3	30

[1]Grade designations containing the QP prefix represent quick dispersing products; grade designations containing the ER prefix represent enzyme resistant products.

Table 2
Typical Properties of CELLOSIZE QP and ER Products

Property	QP-Grade	ER-Grade
Bulk Density, lbs/ft^3 (kg/m^3)	25-38 (400-600)	32-44 (500-700)
Bulking Value, gal/lb	0.087	0.090
Weight, lbs/gal (kg/L)	11.4 (1.37)	11.1 (1.33)
Color	Cream to white	Cream to white
Particle Size, % through U.S. 20 Mesh	98 minimum	98 minimum
Specific Gravity at 20/20°C	1.36-1.38	1.32-1.34
Volatile Matter, % by Weight	5 maximum	5 maximum

QP properties listed in this table represent material manufactured in North America. Properties of products manufactured in different locations may have different values.

Properties and Advantages

CELLOSIZE HEC is manufactured in a variety of viscosity grades. These versions differ principally in their aqueous solution viscosities and are offered to optimize performance in specific CELLOSIZE HEC applications.

The number of a CELLOSIZE HEC viscosity grade refers to its average two-percent solution viscosity. Your local technical sales representative will be glad to help you in selecting the most appropriate type for your specific applications.

Versatility in Formulating

CELLOSIZE HEC is nonionic and may be used over a pH range of 2 to 12. It is compatible with commercial latexes and with most other ingredients commonly used in paint, including many reactive pigments, many additives, and components with high levels of soluble salts or electrolytes.

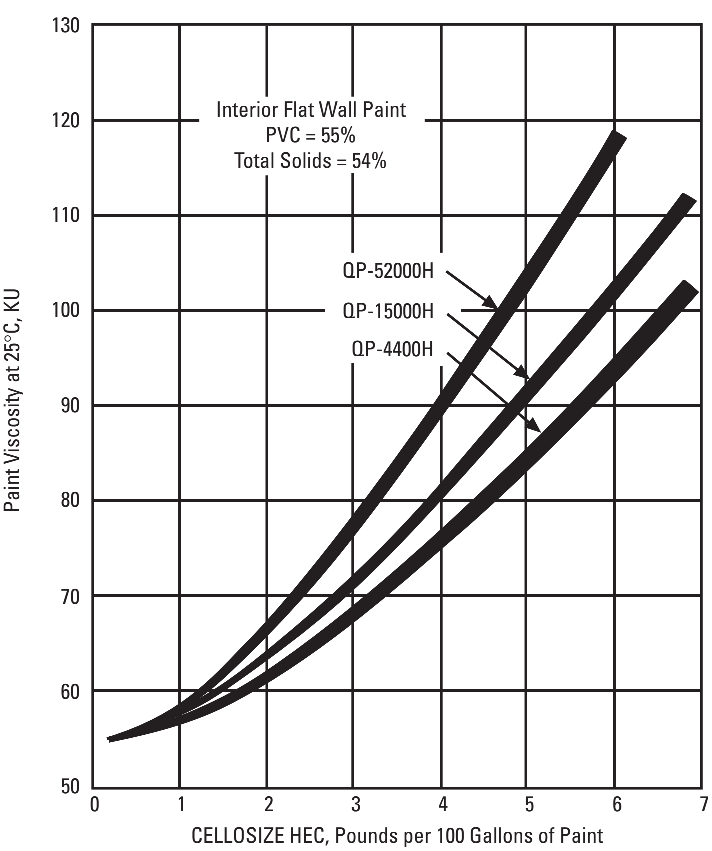
Enzyme Resistant Products

Dow has developed a series of HEC products which have significantly increased resistance to enzyme attack and, in turn, provide much improved viscosity stability in the presence of cellulolytic enzymes. CELLOSIZE Enzyme Resistant (ER) HEC products are manufactured to the same tight specifications as conventional CELLOSIZE HEC and exhibit the same outstanding performance properties.

Excellent Application Properties

Paints thickened with CELLOSIZE HEC are pseudoplastic and can be applied efficiently by brush, roller, pad, or spray with minimal dripping, spattering, or running. Good-to-excellent flow and leveling can be achieved.

Figure 1
Concentration of CELLOSIZE HEC vs Paint Viscosity



Freedom from Film Defects

CELLOSIZE HEC does not significantly lower the surface tension of the aqueous phase and, therefore, does not contribute to foaming during manufacturing or application. Paint films are less likely to have craters or pinholes associated with foam.

Excellent Color Acceptance

CELLOSIZE HEC has long been recognized for yielding excellent color stability and color uniformity with a wide variety of colorants and vehicles.

Reliable Thickening Action

The narrow viscosity limits for each grade of CELLOSIZE HEC provide batch-to-batch reproducibility of thickening action in the paint manufacturing process.

Ease of Dispersion

CELLOSIZE HEC is readily added to the paint batch. Solutions can also be quickly prepared with simple mixing equipment using either hot or cold water.

Extended Shelf Life

Pigment dispersion and suspension are maintained in the paint can during prolonged storage. Water layering is minimized or eliminated, as is color floating. Viscosity is stable to wide temperature fluctuations.

CELLOSIZE Enzyme Resistant Hydroxyethyl Cellulose for Coatings

All cellulosic thickeners and natural gums, even those materials listed as bioresistant, are susceptible to enzymatic degradation by a variety of ubiquitous bacteria and fungi. These microbes secrete cellulase enzyme, which attacks and degrades cellulose polymers.

In paints, enzymatic degradation is evidenced by a progressive loss of viscosity until the base viscosity of the paint without thickener is reached (about 60 KU). This may take several days or several months, depending on the level of enzyme present and the paint formulation. Formulations can be rethickened but their viscosity may or may not be stabilized. Not all formulations lose viscosity at the same rate or to the same extent.

Dow offers a variety of biocides (see sidebar) that are specifically formulated to kill enzyme-producing microbes. However, since the cellulase enzyme is a non-living protein, it cannot be deactivated by the biocide.

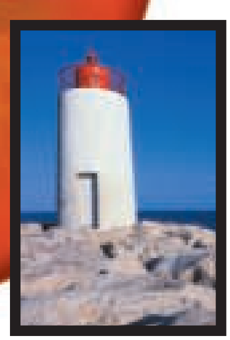
As an alternative to the use of preservatives, CELLOSIZE Enzyme Resistant (ER) HEC products may be substituted for conventional HEC materials. CELLOSIZE HEC ER provides increased resistance to enzyme attack and much improved viscosity stability in the presence of cellulolytic enzymes.

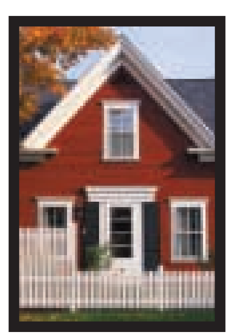
Biocides for Paint and Coatings

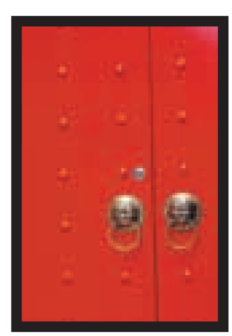
Dow offers an array of biocides that are ideal for paint and coatings applications. These products are found under the BIOBAN™, DOWICIL, DOWICIDE*, and UCARCIDE™ tradenames.*

CELLOSIZE ER HEC is produced in five viscosity grades. Viscosity specification, hydration time, and performance are equivalent to comparable CELLOSIZE HEC QP-grades, with the added advantage of significantly increased resistance to enzyme degradation.

To improve handling characteristics and reduce tendency of caking, a flow control additive is incorporated in CELLOSIZE ER HEC. As a result, aqueous solutions will exhibit a slight turbidity compared to solutions of conventional CELLOSIZE HEC.







*Trademark of The Dow Chemical Company

Enzyme-Resistant Grades Deliver Superior Viscosity Retention Without Sacrificing In-Can and Film Properties

Resistance to enzyme degradation of CELLOSIZE ER HEC was compared with conventional CELLOSIZE HEC and competitive bioresistant products. Thickeners of comparable viscosity grade were incorporated in semi-gloss formulations based on UCAR™ Acrylic 518 and on "Rhoplex" AC-388 (see page 9). To minimize variability in testing, a master batch of each paint was prepared, exclusive of the thickener. Each paint was then thickened to a viscosity of 85 to 90 KU using a 2.5 percent solution of each thickener. The thickened paints were then inoculated with 1.0 ppm of a cellulolytic enzyme derived from a

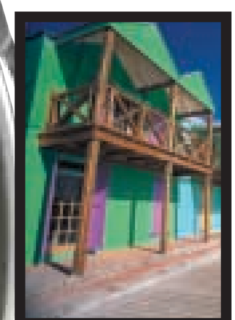
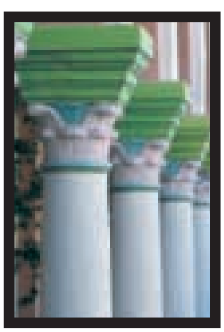


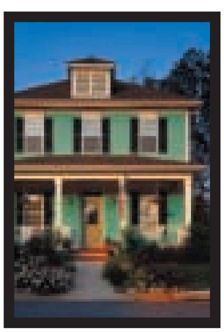
Table 3
Thickening Performance of HEC

Paints Based on UCAR Acrylic 518			
Thickener	Initial Viscosity(1), KU	Viscosity, KU, 6 Months	% Viscosity Retained
CELLOSIZE ER HEC	85	82	96
Competitive Bioresistant Product	88	82	93
Conventional CELLOSIZE HEC	84	54	64

Paints Based on "Rhoplex" AC-388			
Thickener	Initial Viscosity(2), KU	Viscosity, KU, 6 Months	% Viscosity Retained
CELLOSIZE ER HEC	88	81	92
Competitive Bioresistant Product	85	76	89
Conventional CELLOSIZE HEC	84	59	70

(1)Viscosity before thickening and inoculation with 1.0 ppm of a cellulolytic enzyme derived from a selected strain of *Aspergillus niger*. 1000 = 61 KU
(2)Viscosity before thickening and inoculation with 1.0 ppm of a cellulolytic enzyme derived from a selected strain of *Aspergillus niger*. 1000 = 64 KU





selected strain of *Aspergillus niger*. The paints were stored at ambient temperature, and viscosity was monitored periodically for up to six months. Typical enzyme resistance, expressed as a function of percent viscosity retained, is summarized in Table 3.

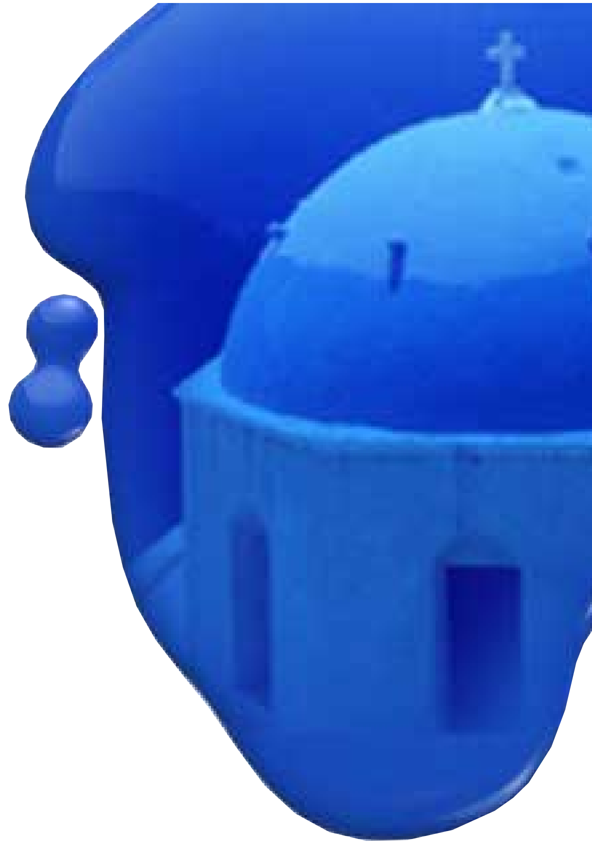
The data show that paints thickened with CELLOSIZE ER HEC will retain greater than 90 percent of their original viscosity for six months or more in the presence of high levels of cellulolytic enzyme. On the other hand, paints thickened with conventional HEC drop quickly to the viscosity range of the unthickened paint under the same conditions.

Enzyme resistance of ethyl hydroxyethyl cellulose (EHEC) was also compared with CELLOSIZE ER and conventional HEC in the same UCAR Acrylic 518-based paint. Typical enzyme resistance, expressed as a function of percent viscosity retained, is shown in Table 4. Again, the results illustrate the superior enzyme resistance of CELLOSIZE ER HEC.

Table 4
Viscosity Retention in Paints Based on UCAR Acrylic 518

Thickener	Initial Viscosity(1), KU	Viscosity, KU 4 Months	% Viscosity Retained
CELLOSIZE ER HEC	90	88	98
Conventional CELLOSIZE HEC	90	65	72
EHEC	89	65	73

(1)Viscosity before thickening and inoculation with 1.0 ppm of a cellulolytic enzyme derived from a selected strain of *Aspergillus niger* 1000 = 66 KU



CELLOSIZE ER HEC Paint Performance Properties

Key paint properties such as gloss, scrub resistance, freeze/thaw stability, and color development were measured to compare the performance of CELLOSIZE ER HEC versus conventional CELLOSIZE HEC and a competitive bioresistant product. The results, shown in Table 5, indicate that paints formulated with CELLOSIZE ER HEC exhibit the same excellent balance of properties characteristic of conventional CELLOSIZE HEC thickeners with the added advantage of significantly increased resistance to enzyme degradation.

Table 5
In-Can and Film Properties of CELLOSIZE ER HEC

	Paints Based on UCAR Acrylic 518			Paints Based on "Rhoplex" AC-388		
Thickener	CELLOSIZE ER HEC	Conventional CELLOSIZE HEC	Competitive Bioresistant Product	CELLOSIZE ER HEC	Conventional CELLOSIZE HEC	Competitive Bioresistant Product
Viscosity, KU	92	91	90	92	92	92
ICI Viscosity, Poise	1.1	1.1	1.1	0.9	0.8	0.8
Scrub Resistance (ASTM D-2486), Failure at 1000 Cycles	None	None	None	None	None	None
Freeze/Thaw Stability Viscosity, KU, After 3 Cycles	93	90	91	93	88	92
Color Development						
Phthalocyanine Green	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent
Yellow Oxide	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent
Lampblack	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent
60° Gloss						
Phthalocyanine Green	50	50	50	61	61	60
Yellow Oxide	56	54	56	61	64	64
Lampblack	53	53	53	59	55	61

Table 6
UCAR Acrylic 518

Semi-Gloss Trim Enamel Formulation

Ingredients	Pounds	Gallons
PIGMENT GRIND		
Water	100.63	12.09
Dispersant[1]	9.57	1.04
TRITON™ Nonionic Surfactant N-57	3.11	0.36
TRITON Nonionic Surfactant X-207	3.11	0.38
Propylene Glycol	44.90	5.20
Antifoam[2]	0.94	0.13
Titanium Dioxide[3]	259.87	7.81
Preservative[4]	1.03	0.11
LET DOWN		
UCAR Acrylic 518	541.05	59.93
UCAR Filmer IBT	20.58	2.60
Antifoam[2]	2.91	0.41
TRITON Anionic Surfactant GR-7M	1.14	0.14
Ammonium Hydroxide, 28% Aqueous Solution	3.85	0.52
Water	77.20	9.28
TOTAL	1069.89	100.00

Suppliers:
[1]Dispersant—"Tamol" 731 (Rohm and Haas) or equivalent.
[2]Antifoam—"Colloid" 691 (Rhone-Poulenc) or equivalent.
[3]Titanium Dioxide—"Ti-Pure" R-902 (Du Pont) or equivalent.
[4]Preservative—"Nuosept" 95 (Creanova) or equivalent.

Paint Properties:
Pigment Volume Concentration (PVC) 21.7%
Weight per Gallon 10.7 lb
pH 9.2
Total Solids by Weight 50.5%
Viscosity before Thickening 61 KU

Table 7
"RHOPLEX" AC-388[1]

Semi-Gloss Trim Enamel Formulation

Ingredients	Pounds	Gallons
PIGMENT GRIND		
Propylene Glycol	76.93	9.05
Dispersant[2]	11.90	1.24
Antifoam[3]	2.56	0.34
Titanium Dioxide[4]	261.57	7.52
LET DOWN		
"Rhoplex" AC-388	508.77	57.61
Preservative[5]	5.13	0.41
UCAR Filmer IBT	21.54	2.70
TRITON Anionic Surfactant GR-7	0.51	0.10
Propylene Glycol	20.51	2.37
Antifoam[3]	2.56	0.31
Ammonium Hydroxide, 28% Aqueous Solution	2.05	0.25
Water	151.61	18.10
TOTAL	1065.64	100.00

Suppliers:
[1]Rohm and Haas
[2]Dispersant—"Tamol" SG-1 (Rohm and Haas) or equivalent.
[3]Antifoam—"Deefo" 495 (Ultra Adhesives) or equivalent.
[4]Titanium Dioxide—"Zopaque" RCL-9 (Millennium) or equivalent.
[5]Preservative—"Nuosept" 95 (Creanova) or equivalent.

Paint Properties:
Pigment Volume Concentration (PVC) 22.6%
Weight per Gallon 10.7 lb
pH 9.2
Total Solids by Weight 49.1%
Viscosity before Thickening 64 KU

How to Add CELLOSIZE HEC in Paint Manufacturing

Method 1 • Thickener Addition at Start of Pigment Grind

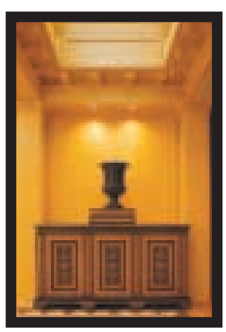
1. Place initial charge of water in tank under a high-shear mixer.
2. Start mixer and run continuously at low speed.
3. Sift in CELLOSIZE HEC.
4. Allow to mix until particles are wetted out.
5. Add a preservative and any alkaline agents, such as pigment dispersants or ammonium hydroxide.
6. After thickening is completed, add the remaining ingredients of the grind.

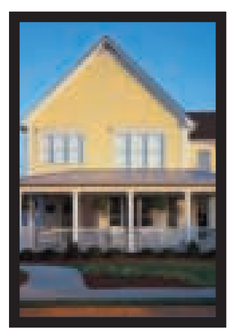
The very short time required per batch when this direct dispersion method is used and the wide latitude in adding ingredients that it provides (for example, ethylene glycol and wetting and filming agents are frequently combined in the initial water charge) undoubtedly account for its popularity among paint makers.

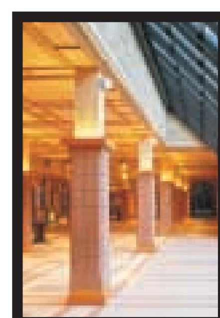
Method 2 • Addition as a Stock Solution

This method generally involves the preparation of a stock solution in sufficient quantity to thicken a number of batches of paint. While affording greater flexibility, especially in the post-thickening of critical formulations, it requires a separate preparation step, as well as a suitable storage facility.

In general, this process is the same as given for Method 1, Steps 1 through 5. It does not, however, require a high-shear mixer. It uses any equipment capable of maintaining the particles in suspension during the hydration period and turning over the finished solutions. Always include a preservative in thickener stock solutions.







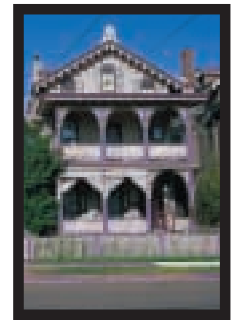
Method 3 • Addition as Slurry

CELLOSIZE HEC can be dispersed during or after the processing of the paint, if it is added in slurry form with good agitation. Organic liquids that are poor solvents for the thickener can be used to make the slurry. The most suitable liquids would be those included in the formulation for other purposes. Among the suitable candidates would be ethylene or propylene glycol or any of a number of filming agents, such as hexylene glycol or UCAR Filmer IBT.

In some instances, sufficient water may be held out to make an aqueous slurry. Use cold water and pH values below 7 to retard hydration.

Add the slurry to the paint immediately. CELLOSIZE HEC may swell if left standing in some organic liquids and will start to dissolve and thicken if left standing in water. Add the slurry slowly with good agitation. Thickening of the paint should begin almost immediately. Continue mixing until solution is complete and the paint is homogeneous.

A typical slurry might be six parts of solvent or cold water to one part of CELLOSIZE HEC. The time before appreciable swelling or hydration occurs may be 5 to 30 minutes, depending on temperature, solvent, pH, and slurry concentration. Process water during summer months may be warm enough to start swelling very quickly; hence, aqueous slurries should be made and added to the batch immediately.



Preparation of Thickener Stock Solutions

CELLOSIZE hydroxyethyl cellulose is supplied in a finely granulated form that has proved easy to handle and easy to dissolve when a few simple procedures are followed.

- Agitate continuously during and after the addition of thickener. Don't stop the mixer until the solution is smooth and clear.
- Sift the thickener into the water. Don't dump or shovel it in.
- Note that the pH and the temperature of the process water have marked effects on dissolving time.

Figure 2
Typical Effect of pH on Hydration Time and Dissolving Rate of CELLOSIZE HEC QP-Type

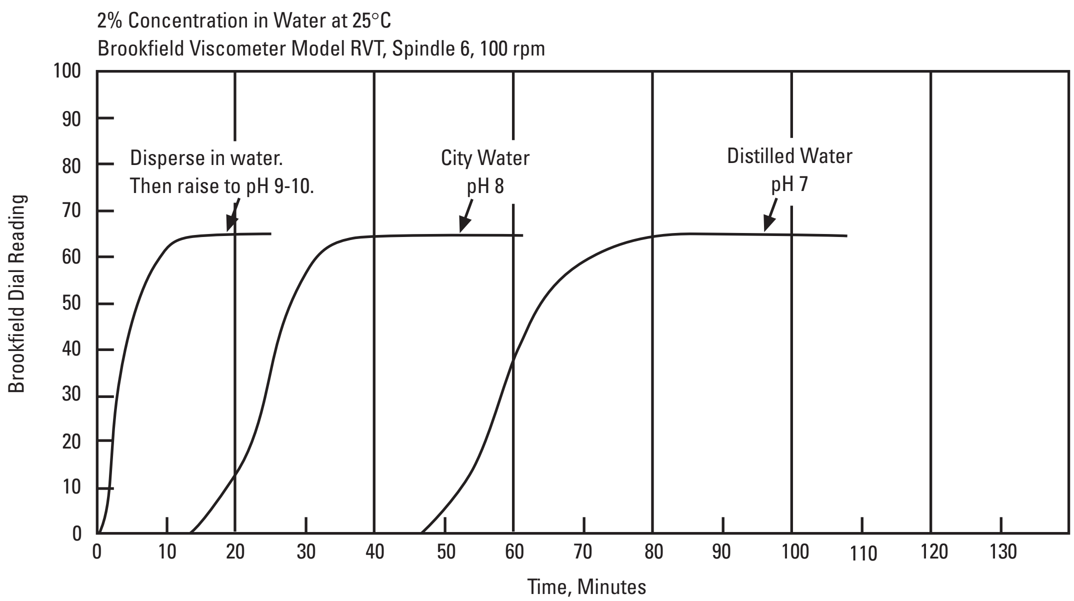
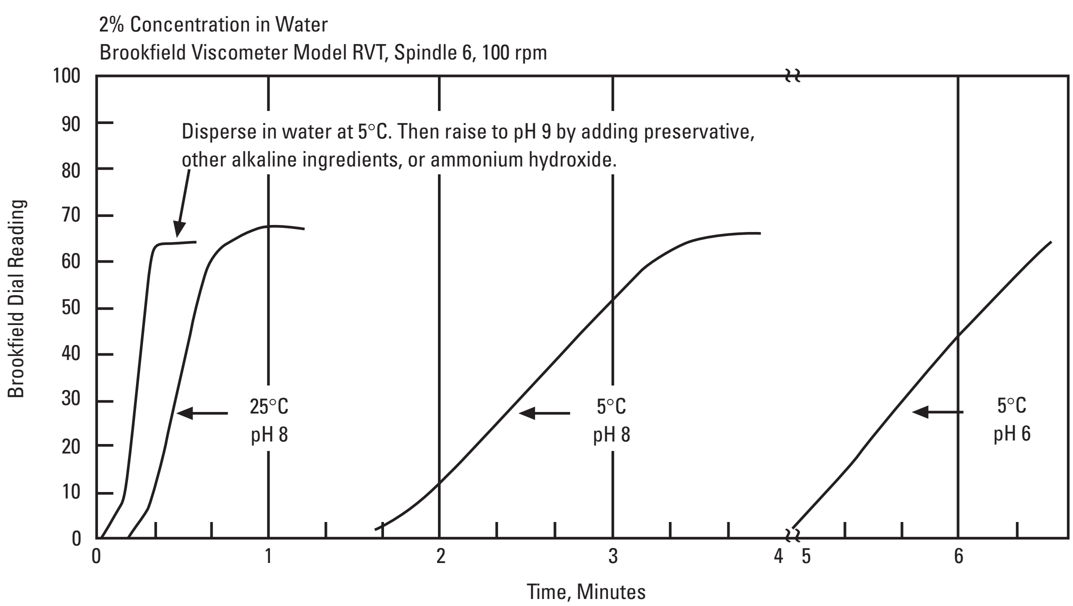
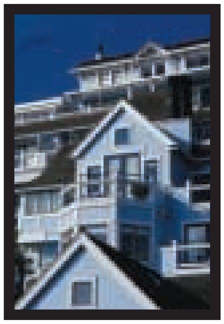
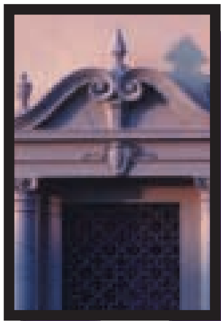


Figure 3
Typical Effect of Temperature and pH on Hydration Time and Dissolving Rate of CELLOSIZE HEC







- Don't add anything that will raise the pH of the water until the thickener particles have been wetted out. Two or three minutes of mixing will typically wet the particles. Raising the pH thereafter will markedly increase the rate of solution.
- Add an effective preservative at the earliest convenient point in the process.
- With higher viscosity grades, do not attempt to prepare solutions at concentrations much above 2.5 to 3 percent, by weight. The final viscosity will make the solution difficult to handle.

CELLOSIZE HEC QP-type shows a delayed viscosity build when added to water. The time required for thickening to begin is called "hydration time." It is this property that facilitates dispersions in water without troublesome lump formation. Dissolution time is the time required to reach maximum viscosity. In the laboratory, hydration time is determined in a pH 7.2 buffer at 25°C. In plant applications, the hydration time may differ from that of the laboratory because the pH and temperature of the water may differ. These effects are shown in Figures 2 and 3. The effect of pH on the hydration time of CELLOSIZE HEC ER-types is shown in Figures 4 and 5.

Figure 4
Hydration/Dissolution Behavior of CELLOSIZE HEC ER-15M

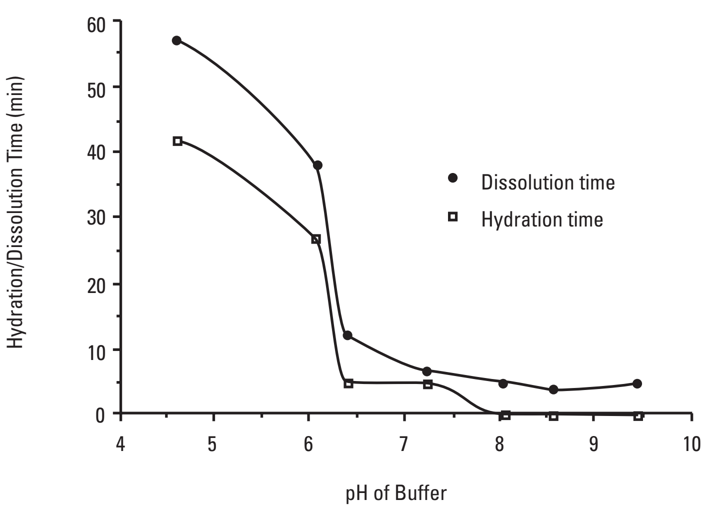
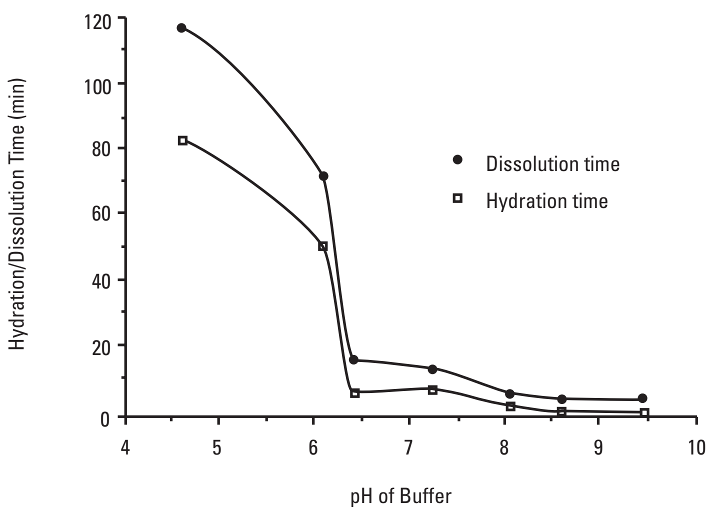
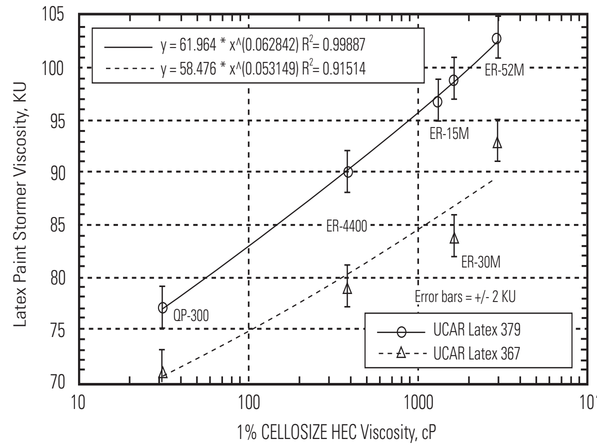


Figure 5
Hydration/Dissolution Behavior of CELLOSIZE HEC ER 52-M

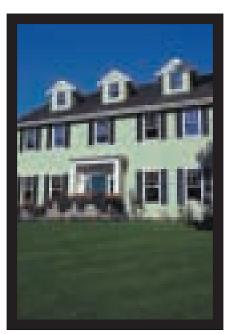


The Effect of CELLOSIZE HEC Solution Viscosity on Latex Paint Stormer Viscosity

Figure 6
Effect of CELLOSIZE HEC Solution Viscosity on Latex Paint Stormer Viscosity (UCAR Emulsion Systems Interior Vinyl-Acrylic Flat, PVC = 60.5%)



Both the QP and ER grades of CELLOSIZE hydroxyethyl cellulose (HEC) are used extensively as thickeners for latex paints because of their formulating robustness, inertness to surfactants and colorants, and reproducible thickening efficiency. The effect of CELLOSIZE HEC solution viscosity (viscosity grade) on the Stormer viscosity of latex paint was determined by preparing in the laboratory a series of three prototypical paint formulations using identical raw materials and varying only the grade of CELLOSIZE HEC used in the paint. The data from these experiments were plotted, and the data were fit to a power law regression with a high degree of correlation. The specific grades of CELLOSIZE HEC used in each paint formulation are annotated on the graphs. These data clearly suggest that viscosity variation within a grade of CELLOSIZE HEC does not significantly impact Stormer viscosity, and emphasize the robust and reproducible thickening character of CELLOSIZE HEC. To affect a significant change in the Stormer viscosity requires switching to a different grade of CELLOSIZE HEC.



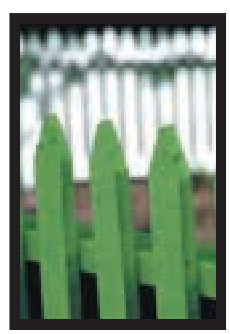


Figure 7
Effect of CELLOSIZE HEC Solution Viscosity on Latex Paint Stormer Viscosity (Rohm & Haas Exterior All-Acrylic Flat, T-64-4, PVC = 40.0%)

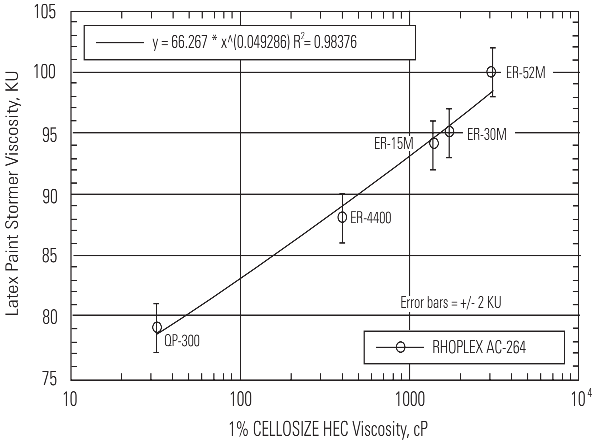
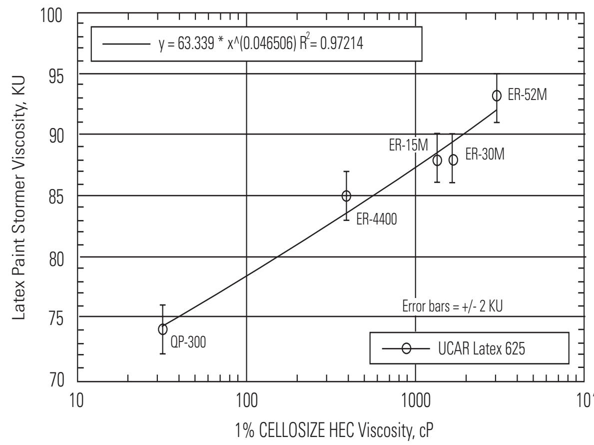


Figure 8
Effect of CELLOSIZE HEC Solution Viscosity on Latex Paint Stormer Viscosity (UCAR Emulsion Systems Exterior All-Acrylic Flat, E-2437, PVC = 44.7%)



Entrained Air

Large amounts of air bubbles in paints can cause high viscosity readings. This phenomenon is often referred to as "false body." After escape of the air bubbles on standing, viscosities are often lower.

Surfactant and Water Demand

Paints made with insufficient surfactant to satisfy the dispersion demand of all the pigments and extenders can give abnormal viscosity behavior. Extenders of fine particle size can require extra surfactant to stabilize paint viscosity. Alternatively, the extender may have to be replaced by one that works better. There are also differences in the surfactant level of latexes and compensation for that factor must be made in the paint formula.

Some inorganic co-thickeners have a high water demand and can cause abnormal viscosity behavior, depending on the way the co-thickener has been added. Some users presoak the co-thickener or add it early to the pigment grind to satisfy water demand during the grind stage before the paint is canned.

Occasionally, a pigment grind will partially absorb the thickener or latex and form an agglomerate. The cause may be insufficient surfactant, or addition of thickener or latex too soon after addition of extenders with high water demand.

Effect of pH

In attempting to compare various cellulosic derivatives for their relative resistance to enzyme degradation, factors such as pH, temperature, and enzyme concentration should be taken into consideration because they will affect enzyme activity. Cellulase enzymes, for example, are most active in the 5.5 to 6.0 pH range. Particular care should be exercised when running accelerated tests by

inoculating HEC solutions with relatively high concentrations of enzyme. For example, small differences in pH in the 6.5 to 7.5 range will influence enzyme activity and apparent resistance of the HEC to enzyme attack. It is recommended that such tests be run under carefully controlled conditions by dissolving the HEC in a buffer solution to negate any effect of pH differences on enzyme activity.

In paint formulations, the pH is normally adjusted to the range most suited to the particular binder being used. Pure acrylics will frequently be formulated around a pH of 9 or above, while vinyl-acrylic copolymers are usually in the 7 to 8 pH range.

Residual Catalyst in Latex

Residual oxidizing catalyst in latexes can degrade cellulosic thickeners, causing a progressive loss in viscosity. The severity and duration of the viscosity drop depends on the amount of catalyst left in the latex. When the catalyst is exhausted, the viscosity drop ceases. Some commercial latexes may contain as much as 250 ppm residual persulfate catalyst, enough to cause significant viscosity loss.

Natural Thickeners and Gums

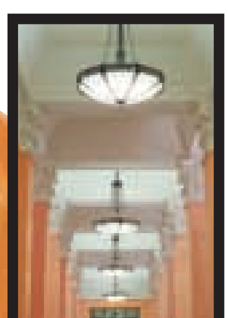
Some gum thickeners derived directly from natural products have been found to cause viscosity loss when used in combination with cellulosic thickeners. For example, gum arabic from two different sources was found to cause rapid viscosity reduction of solutions of cellulosic thickener. This apparently resulted from the presence of enzymes in the natural products. There was no evidence of bacterial growth in the solutions. Heating the solutions to 75°C stopped the viscosity loss.

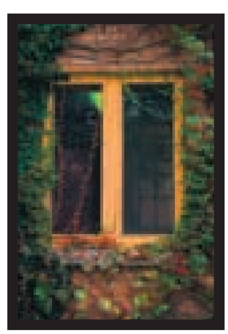
Thickener Addition Procedure

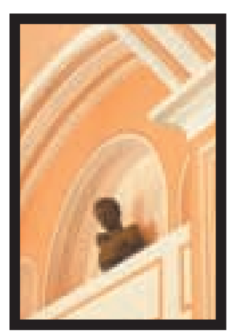
When the thickener is added early during preparation of the pigment grind, ample time is available for complete solution and equilibration of the thickener in the system. When the thickener is added at the end of the grind or to finished paint, sufficient time may not be available for a stable viscosity to be reached. An inadequate thickener addition procedure can result in the development of small thickener lumps or gels and failure to develop full viscosity.

Latex Addition to Hot Grind

Heat is generated during the rapid agitation of pigment grinds. Depending on the paint formulation and the time of grinding, temperatures may exceed 60°C. When added to pigment grinds at such temperatures, some latexes can be partially coagulated and produce an abnormal viscosity response.







Handling

and Storage

CELLOSIZE HEC is a water-soluble solid that is normally supplied as a powder in multi-ply paper bags. Moisture and heat can cause CELLOSIZE HEC to form lumps, so bags should be stored in a dry location at a temperature of less than 40°C (104°F). CELLOSIZE HEC can be handled in common materials of construction such as steel, aluminum, and stainless steel, and it is compatible with most common gasketing materials.

Good housekeeping should be used when handling CELLOSIZE HEC powder to reduce the risk of slipping hazards if spilled CELLOSIZE HEC on walking/working surfaces becomes wet. If CELLOSIZE HEC powder is spilled, as much as possible should be swept or vacuumed up before it becomes wet. Washing with water, solvents, or most cleaning products will probably not be effective and may increase the slipping hazard. High pressure water blasting can be used to remove buildup of material.

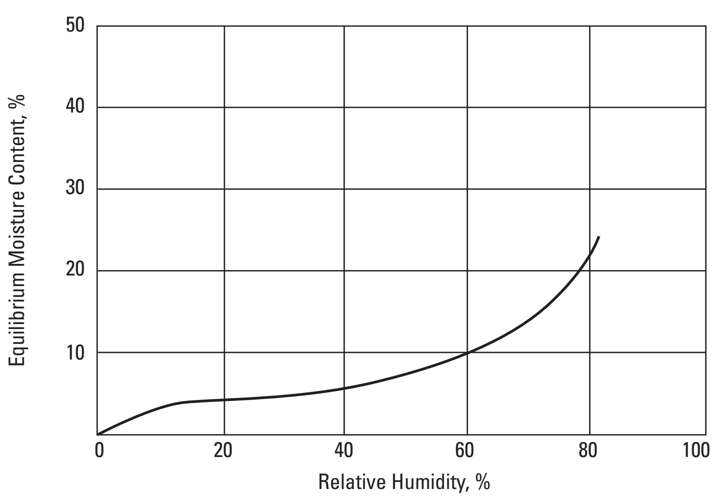
Hygroscopicity

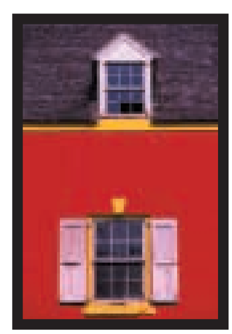
CELLOSIZE ER HEC and conventional CELLOSIZE HEC are hygroscopic and will absorb moisture. There may be a loss of moisture in dry weather and a gain in humid weather.

The moisture level of all grades of CELLOSIZE HEC, as packaged, does not exceed five percent by weight. However, storage in loosely covered containers will change the moisture content to an equilibrium value determined by the relative humidity of the environment. The effect of relative humidity and the equilibrium moisture content of CELLOSIZE HEC and HEC ER is shown below.

Under humid conditions, sufficient water can be absorbed to reduce appreciably the thickening effect that would be expected from a given weight of CELLOSIZE HEC. To obtain the desired viscosity, compensate for the weight change in moisture. Avoid exposure to the atmosphere.

Figure 9
Relative Humidity vs Equilibrium Moisture Content at 25°C



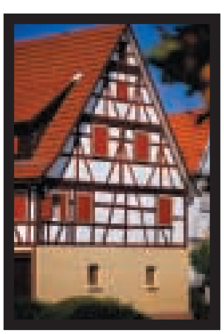


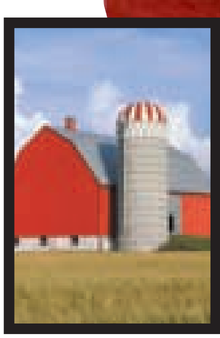
Explosibility of Dusts

Dusts of CELLOSIZE HEC, like those of many organic compounds, are explosive if mixed with air or other oxidants in critical proportions and in the presence of an ignition source. These dusts represent a hazard similar to that of other cellulosic derivatives and of many widely-used organic solids. With K_{ST} values in the range of 30 and 81 bar m/s, CELLOSIZE HEC is identified as a Class I dust. With K_{ST} values $_3$200 bar m/s, CELLOSIZE ER HEC is identified as a Class I dust. Explosion-venting design may be accomplished by utilization of NFPA-68 guidelines. Though measured minimum ignition energy levels are greater than 300 mJ, care should be taken to prevent ignition from common causes, such as cutting and welding, stray electric current, and hot surface temperatures. To minimize the potential for electrostatic discharge problems, avoid conveying through electrically nonconductive piping. Also, normal good housekeeping procedures should be practiced to control the explosibility of dust. At the Dow CELLOSIZE HEC production facilities, CELLOSIZE HEC dust is conveyed in air in grounded equipment with explosion venting on receivers and dust collectors. In the presence of flammable gases, liquids, or vapors, CELLOSIZE ER HEC should be handled in inert nitrogen-blanketed equipment.

Product Safety

When considering the use of any Dow products in a particular application, you should review our latest Material Safety Data Sheets and ensure that the use you intend can be accomplished safely. For Material Safety Data Sheets and other product safety information, contact Dow at the numbers on the back cover of this brochure. Before handling any other products mentioned in the text, you should obtain available product safety information and take necessary steps to ensure safety of use.





For more information, complete literature, and product samples, you can reach a Dow representative at the following numbers:

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