ELEMENTIS

A global specialty chemicals company

Application Leaflet

RHEOLATE® 465

Strongly hydrophobic modified alkali swellable (HASE) acrylic thickener for waterborne systems

Key Benefits

- Efficient high- and mid-shear viscosity build
- Alkyd like flow and leveling
- Superior roller spattering resistance

Introduction

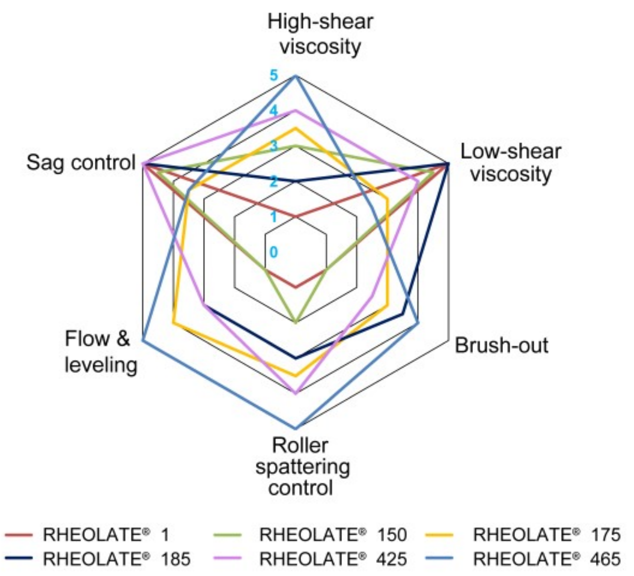
RHEOLATE® 465 is a rheology modifier based on a strongly hydrophobic modified alkali swellable (HASE) acrylic polymer. HASE thickeners excellently combining the properties of ionic- and associative rheology modifiers in one product. Due to its unique polymer structure, RHEOLATE® 465 provides efficient high-and mid-shear viscosity build together with Newtonian flow characteristics. As a result, RHEOLATE® 465 provides well balanced sag and leveling performance resulting in optimized application properties.

RHEOLATE® 465 is specifically suitable for waterborne architectural coatings such as e.g. high PVC architectural systems, exterior and interior paints and can also be used in various industrial coating systems, specifically those which are applied by roller applied and curtain.

Composition	Proprietary HASE (hydrophobically modified alkali swellable emulsion)
Appearance	Milky white liquid
Specific gravity, [g/cm³]	1.07
pH	<5.0
Brookfield viscosity (Brookfield LVT, spindle 1, 60 rpm, 25 °C), [cps]	<20
Non-volatile content, [%]	30.5
Volatile	Deionized water

Key benefits

- Efficient mid- and high-shear viscosity build
- Predominant Newtonian alkyd like flow
- Excellent brush drag and leveling
- Improved moisture resistance compared to other acrylic and cellulosic thickeners
- Superior spatter resistance



Incorporation and levels of use

RHEOLATE® 465 can be added directly to the system. It is most commonly added to the letdown, but a portion can also be incorporated into the millbase, if a higher viscous grind is desired. If only very low-shear mixing conditions are available for incorporation, a pre-dilution with water might be beneficial. This is specifically relevant if RHEOLATE® 465 can only be added at the end of processing, especially in case if highly interactive binders of small particle size are present.

The typical level of use in paints or inks for RHEOLATE® 465 is between 0.3% to 1.0% (as delivered) by weight.

As RHEOLATE® 465 is an alkali swellable thickener, it requires a pH of the systems at least 7.5 for complete activation. Nevertheless, RHEOLATE® 465 is effective over a wider range of pH than other HASE grades.

As in case with all HASE thickeners, RHEOLATE® 465 requires time to activate fully after addition. The equilibration time will vary depending on formulation, but in most cases will be reached after 16 hours.

Products tested

Table 1: Formulation of test paints

Raw material	Formulation [%]		Function	Supplier
	Vina-Veova	**VAE**		
	PVC 60%	**PVC 50%**		
Millbase stage				
Deionized water	19.0 - X	14.90 - X		
Add under stirring in the denoted order and grind for 15 minutes at 10 m/s				
Calgon® N New, diluted in at 10%	0.10	0.10	Softener	BK Giulini ICL
Biocide	0.10	0.10	In-can preservation	
NUOSPERSE® FX 504	0.10	0.10	Wetting/Dispersing agent	Elementis
Defoamer	0.40	0.30	—	Elementis
Kronos® 2190	7.50	5.80	Pigment	Kronos International
Calcium carbonate various particle size	32.50	30.90	Extender	Omya
Microtalc IT Extra	2.50	3.40	Extender	Elementis Talc
Socal® P2	5.00	3.85	Extender	Solvay
Sipernat® 820 A	2.00	1.50	Extender	Evonik Industries
Add the below ingredients in the denoted order and mix for further 15 minutes at 15 m/s				
Vinavil 03V	25.00	—	Binder Vina-Veova	Vinavil
Mowilith® LDM 1871	—	32.10	Binder VAE	Celanese
Coalescing agent	1.50	0.80	—	
Defoamer	0.10	0.10	—	Elementis
Add the below ingredients and mix slowly for further 10 minutes				
Deionized water	4.00	9.70	—	
Rheological additive	X	X	—	
Sodium hydroxide w (NaOH) = 0.10	0.20	—	pH adjustment	
Ammonia solution w (NH_3) = 0.25	—	0.20	—	
	100.0	100.0		

X is variable in accordance with individual concentration.

Part 1: RHEOLATE® 465 positioning within the HASE range

In this part of the leaflet, an evaluation of RHEOLATE® 465 in comparison to other acrylic thickeners out of the Elementis' portfolio with respect to the correlation of rheological characteristics and application properties is illustrated.

ASE is an abbreviation for (non-hydrophobically modified) "Alkali Swellable Emulsion"; HASE is an abbreviation for "Hydropho-bically modified Alkali Swellable Emulsion"; PVC is an abbreviation for "Pigment Volume Concentration"

All tested thickeners consist of 30% active substance.

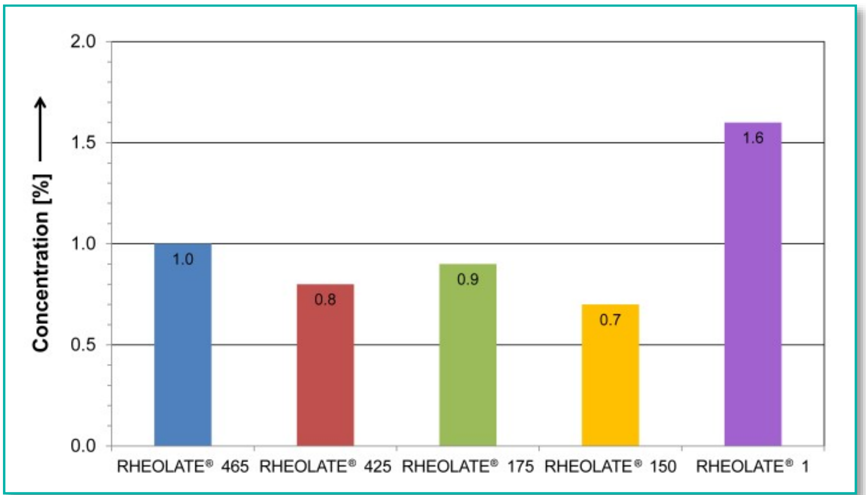
The test system is paint test in Vina-Veova based Paint PVC 60% based on Vinavil 03V (please refer to page 3).

Table 2: Overview tested ASE/HASE thickeners

RHEOLATE® 465	RHEOLATE® 425	RHEOLATE® 175	RHEOLATE® 150	RHEOLATE® 1
HASE	HASE	HASE	HASE	ASE
High-shear rate range	Low- to mid-shear rate range	Mid- to high-shear rate range	Low- to mid-shear rate range	Shear thinning
• Provides alkyd like flow and leveling • Excellent brush drag and improved hiding power • Superior spattering resistance • Mid to high PVC systems	• Balanced flow and leveling • Good allrounder with improved spatter resistance • Balance of sag and leveling • Mid to high PVC systems	• Excellent film build • Good leveling • Excellent spatter resistance • Mid to high PVC paints	• Balanced flow and leveling • To replace cellulose ether • Mid to high PVC paints	• Alternative grade to cellulosic • Gentle structure build • Sag stability • Storage Stability • For low PVC systems

Figure 1: Loading levels

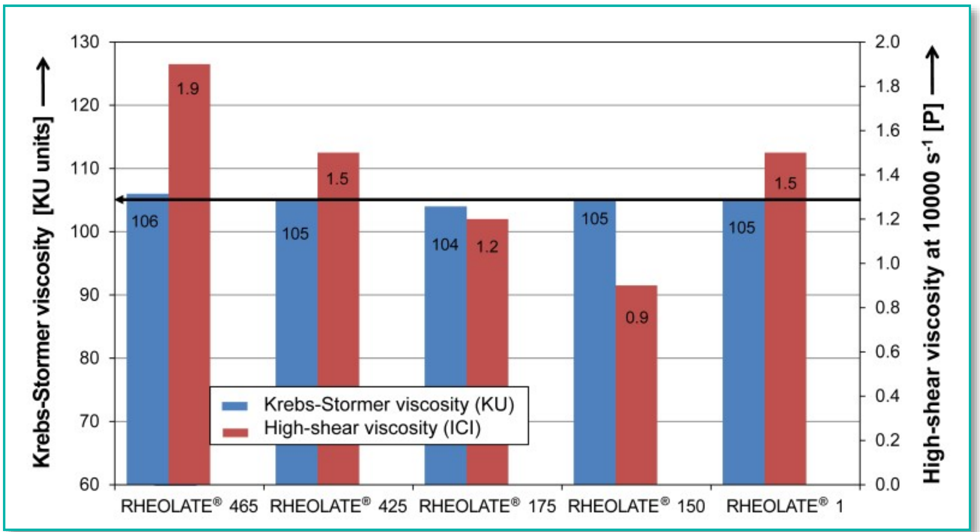
The figure 1 shows in the graph are required to achieve a Krebs-Stormer (KU) viscosity of 105 units (±2) with the relevant rheology modifier.



All HASE based thickeners require remarkably lower loading levels than the ASE based RHEOLATE® 1 to achieve 105 KU. Within the HASE range, RHEOLATE® 465 needs a slightly higher quantity.

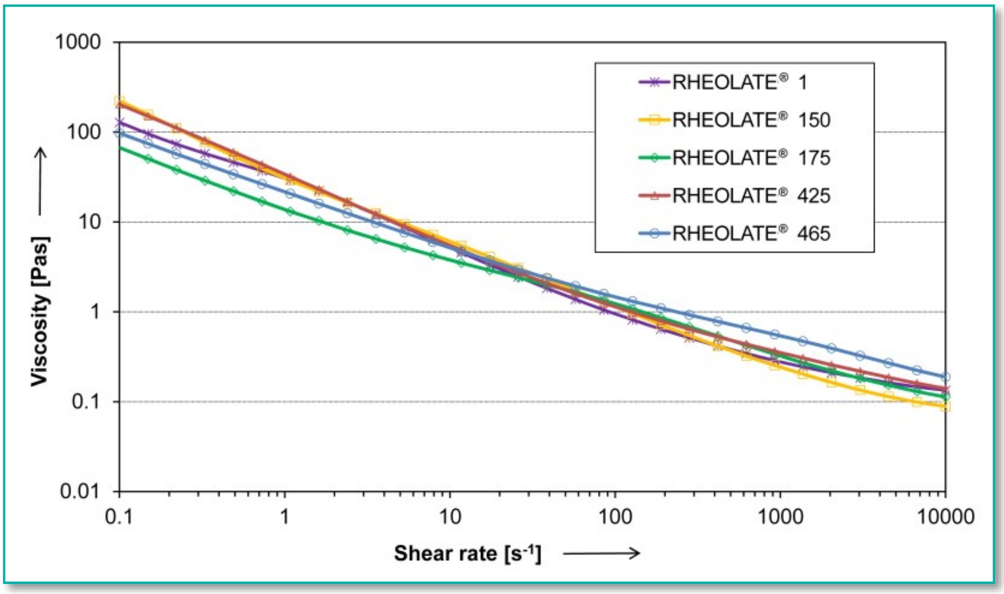
Figure 2: Comparison of high- and mid-shear viscosity

A comparison was made of high-shear/ICI viscosity at equal Krebs-Stormer viscosities of 105 units. The loading levels required are equal to the figure 1.



RHEOLATE® 465 provides the highest viscosity at high-shear rates of all tested thickeners at equal mid-shear/ KU viscosity values.

Figure 3: Flow curves



RHEOLATE® 465 provides the most Newtonian flow out of the tested range of rheology modifiers. Especially at high-shear rates RHEOLATE® 465 yields the highest viscosity values which confirms the ICI values. The use of RHEOLATE® 175 results in a comparable Newtonian flow, however, at higher shear rates the viscosity remains on a lower level than with RHEOLATE® 465. All other thickeners display noticeably stronger shear thinning flow.

Table 3: Application results

Rheological additive	Sag resistance	Leveling	Brush-out	Roller Spatter	Color acceptance +1% Tinting Paste (Colortrend violet 23)	
	[μm]	0-poor 10-excellent	0-poor 5-excellent	0-poor 5-excellent	Stability [ΔKU]	Rub out [ΔE]
RHEOLATE® 1	>1000	0	0	0 - 1	+3	0.64
RHEOLATE® 150	>1000	0	0	0 - 1	+6	1.36
RHEOLATE® 175	700	1	2 - 3	0 - 1	+2	0.90
RHEOLATE® 425	>1000	0	2	2	+2	0.66
RHEOLATE® 465	**700**	**4**	**3**	**4**	**±0**	**0.65**

RHEOLATE® 465 provides excellent leveling and roller spattering characteristics in comparison to the other tested grades. Also the color acceptance of the paints formulated with RHEOLATE® 465 is the best of the tested range. Especially the viscosity stability on tinting is excellent as no change in the Krebs-Stromer values was noticed. Sag resistance is on an acceptable level and in line with the other "Newtonian" grade RHEOLATE® 175. Sag and leveling control test panels results can be found below.

Figure 4: Sag stability

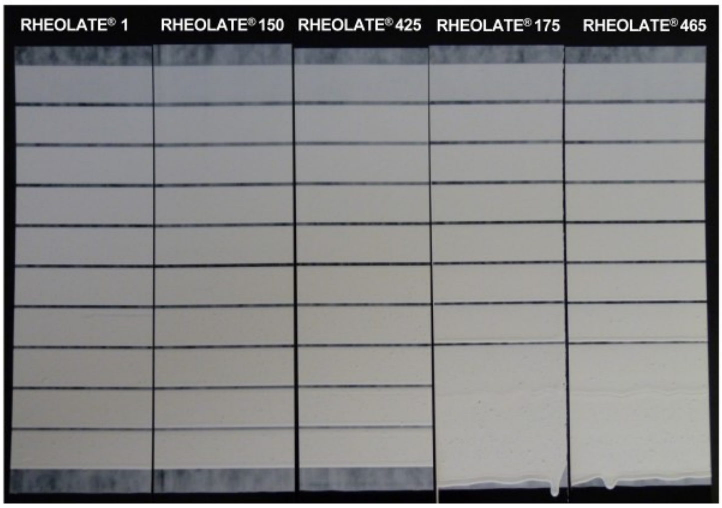


Figure 5: Leveling (applied with a blade 418)

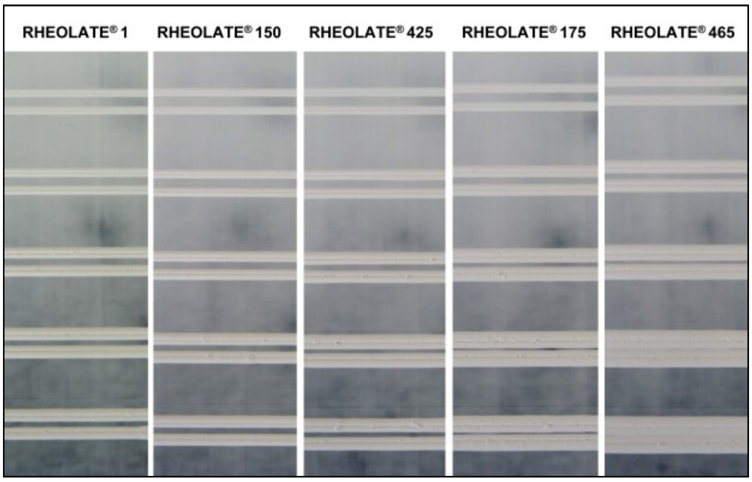
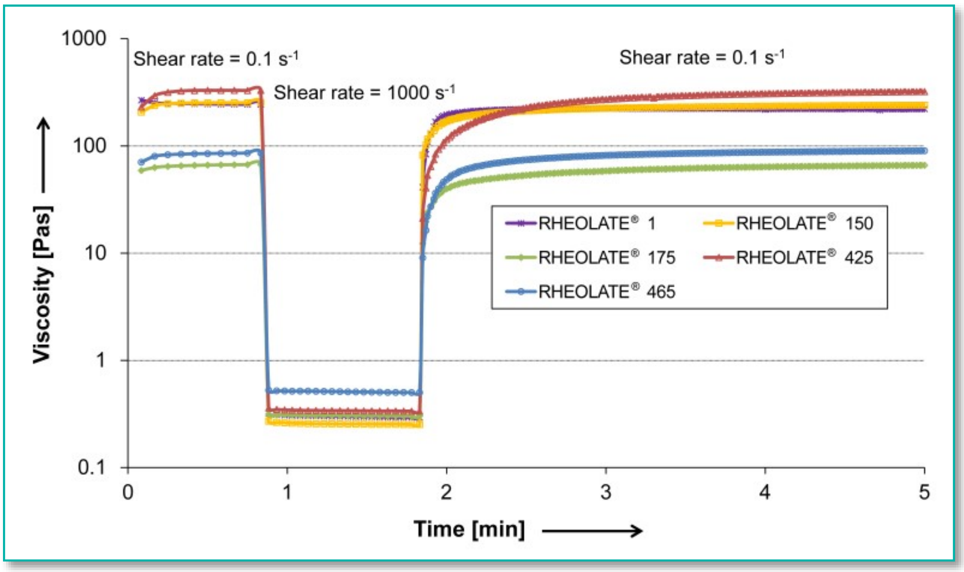


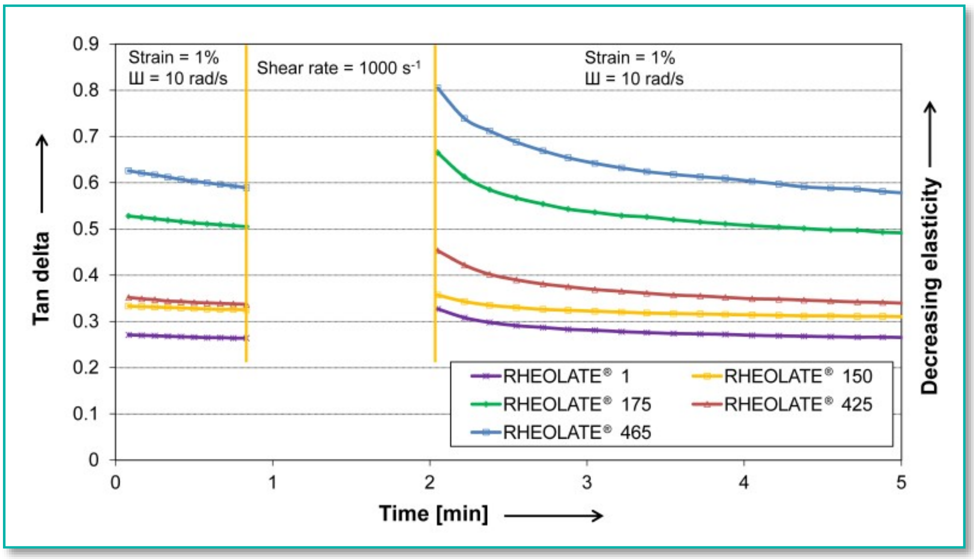
Figure 6: Viscosity recovery



RHEOLATE® 465 and RHEOLATE® 175 show the lowest viscosities at low-shear. The viscosity with RHEOLATE® 465 at high-shear was the highest of the tested rheology modifiers. This confirms the findings in the previously shown rheograms. RHEOLATE® 1 and RHEOLATE® 150 display higher low-shear viscosity values combined with fast recovery. RHEOLATE® 425 shows similar high viscosities at low-shear rates, however, with a slower recovery rate. This data support the previously shown sag and leveling results: a fast recovery yields high sag resistance but a poorer leveling.

Figure 7: Structure recovery

The figure 7 shows the plotted damping factors/tan delta values are indications for the viscoelasticity of the tested systems. Tan delta values of below 1 are typical for systems with dominating elastic characteristics. A damping factor of above 1 indicates dominating fluid properties. Consequently, increased elastic properties are predicting improved sag stability. A decreasing elasticity typically demonstrates good leveling and flow as well as brush drag and good material transfer visible as good hiding power.



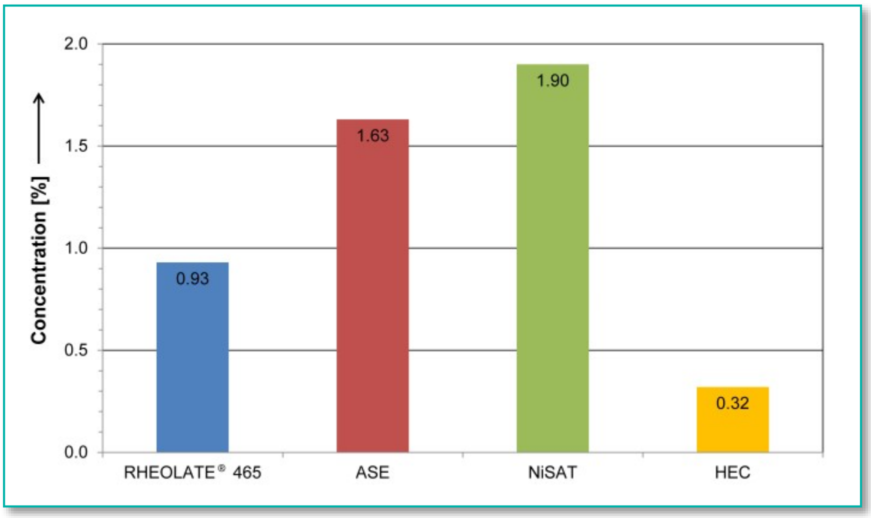
RHEOLATE® 465 provides the highest tan delta values before and after shear. This indicates the lowest elasticity of the paint before and after high-shear. These data support the previously displayed good leveling results.

Part 2: RHEOLATE® 465 vs. alternative thickener technologies

In this part of the leaflet, RHEOLATE® 465 is being evaluated in comparison to further thickener technologies such as hydroxyethyl cellulose grade (HEC), a type of alkali-swellable emulsion (ASE) as well as a very Newtonian associative thickener grade (NiSAT).
The test system is a Vinyl ethylene/acetate (VAE) based PVC 50% paint based on Mowilith LDM 1871.

Figure 8: Loading levels

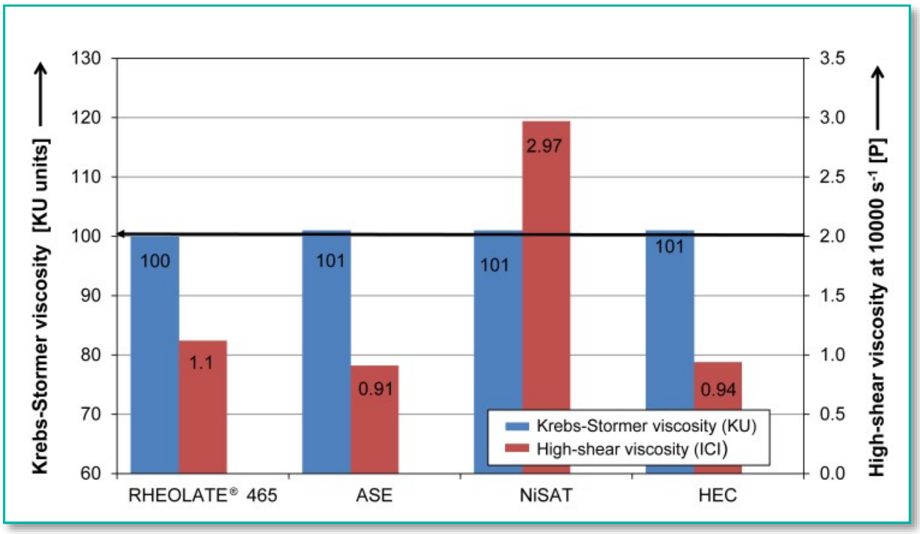
The loading levels shown in figure 8 are required to achieve a Krebs-Strormer (KU) viscosity of 100 units (±2) with the particular thickener.



RHEOLATE® 465 requires significantly lower quantities than the ASE and the NiSAT grade in a VAE based PVC 50% paint. HEC requires a lower loading level due to higher active content to achieve the needed Krebs-Stormer viscosity.

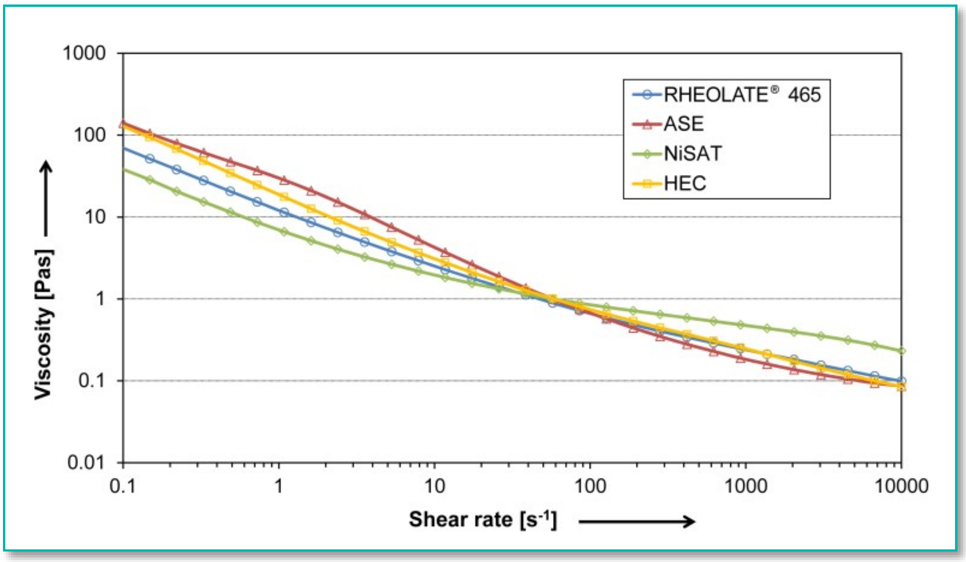
The figure 9 shows the high-shear/ICI viscosities at equal Krebs-Stormer viscosities of 100 units. The loading levels required are identical to the figure 8.

Figure 9: Comparison of high- and mid-shear viscosity



At equal KU values, RHEOLATE® 465 provides slightly higher ICI viscosities than HEC and ASE based thickeners. However, the NiSAT based rheology modifier gives by far the highest high-shear viscosity values.

Figure 10: Flow curves



RHEOLATE® 465 results in less shear thinning behavior than ASE and HEC. The NiSAT thickener provides the most Newtonian flow characteristics of all tested thickeners.

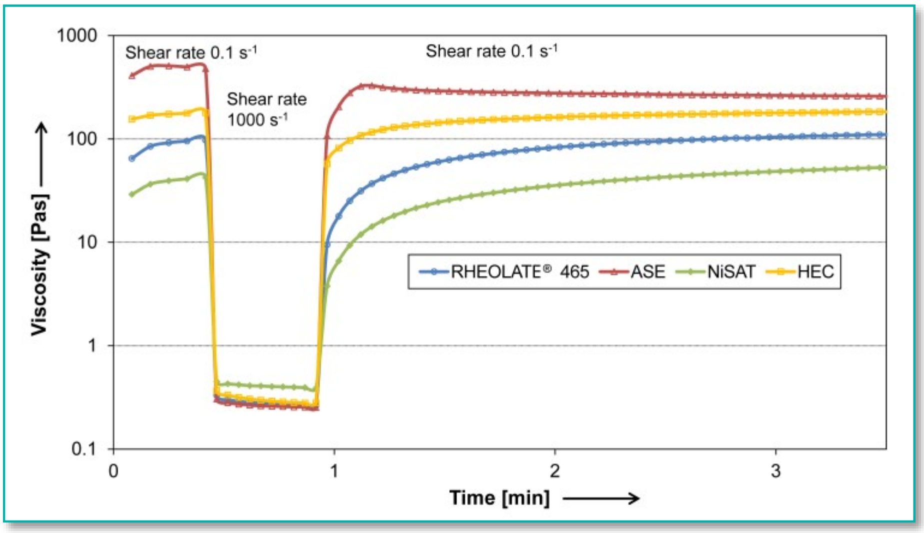
Table 4: Application results

Rheological additive	Sag resistance [µm]	Leveling 0-poor 10-excellent	Brush-out 0-poor 5-excellent	Roller Spatter 0-poor 5-excellent
RHEOLATE® 465	**800**	**3**	**4**	**3 - 4**
ASE	>1000	0	1	0 - 1
NiSAT	700	4	5	5
HEC	800*	0	1	3

* Sample demonstrated severe slumping

RHEOLATE® 465 provides comparable sag stability to the NiSAT and the HEC thickener. The NiSAT based paint did not reach equal layer thickness without flowing off. The paint containing HEC demonstrates severe slumping. RHEOLATE® 465 clearly outperforms ASE and HEC in terms of leveling and roller spattering characteristics. For these properties only the NiSAT performs slightly better than RHEOLATE® 465.

Figure 11: Viscosity recovery

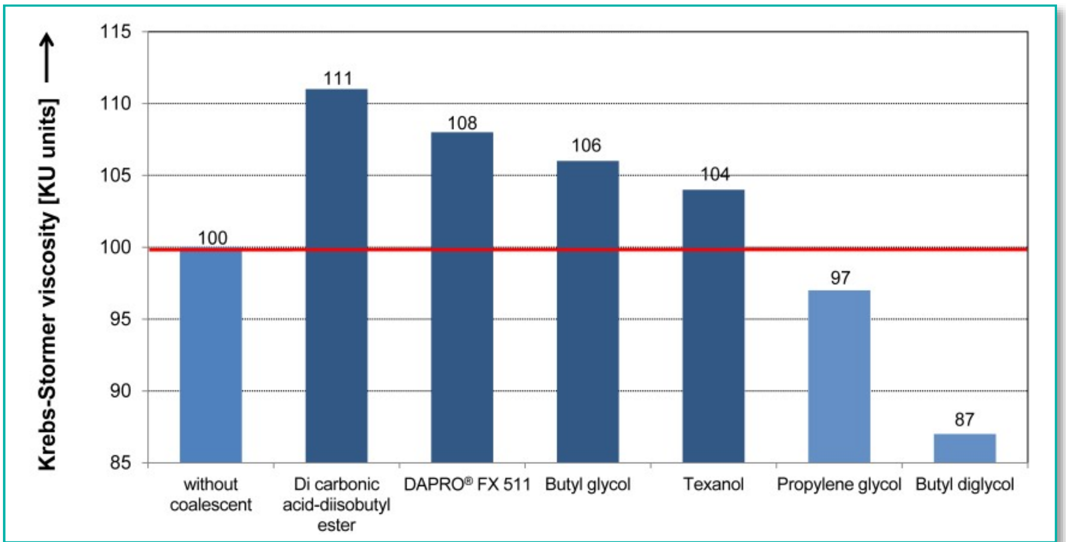


The ASE based paint shows the highest viscosity at low-shear combined with a very quick recovery after high-shear. Paints based on RHEOLATE® 465, and especially based on NiSAT, yield remarkedly lower viscosities at low-shear. In comparison to the ASE, both demonstrate a somewhat more gradual viscosity recovery behavior. The paint formulated with HEC shows intermediate recovery behavior.

These rheological data support the application properties in the table 4. Typically, a higher viscosity at low-shear combined with a quick viscosity recovery indicates improved sag resistance. A low-shear viscosity with slightly slower viscosity recovery acts beneficial for flow and leveling.

Part 3: Coalescent influence on RHEOLATE® 465

Figure 12: Package viscosity



DAPRO® FX 511 is based on a propylene glycol ester

The type of solvent/coalescing agent used in the relevant formulation is strongly affecting the package viscosity provided by RHEOLATE® 465.

Generally, it can be seen that with tendencially reducing the polarity of the co-solvent formulated results in a viscosity increase. Increasing subsequently the polarity of the solvent, mid-shear viscosities are reduced.

Conclusion

RHEOLATE® 465 provides the most Newtonian flow characteristics and the highest efficiency within in the tested range of acrylic thickeners. Consequently, RHEOLATE® 465 performs excellently with respect to

- the balance of sag and leveling
- efficient viscosity build over various shear rate range, with a special focus on Newtonicity
- sag stability
- color acceptance and viscosity stability after tinting

RHEOLATE® 465 clearly outperforms Hydroxyethyl cellulose (HEC) and non-hydrophobically modified alkali swellable emulsions (ASE) in terms of levelling and roller spatter resistance. These characteristics can only be matched by a non-ionic synthetic associative thickener (NiSAT), but the required loading level with RHEOLATE® 465 is much lower.

The in-can viscosities of systems equipped with RHEOLATE® 465 is strongly influenced by the used coalescing agent/co-solvent. Therefore, a predictable viscosity adjustment can be supported by the choice of the coalescing agent. This consequently enhances the production latitude with respect to viscosity control.

Appendix

Test methods

- The rheological data (rheograms, viscosity and structure recovery) were determined using an Anton-Paar MCR 301 rheometer, equipped with measuring geometry PP 50, at a gap width of 1 mm, at a temperature of 23 °C. The individual measuring parameters are shown in the relevant graphs.
- Mid-shear/KU (Krebs-Stormer) and high-shear/ICI (at 10000 s^{-1}) viscosity was measured in accordance with the Elementis standard methods of testing, 24 hours after manufacturing the paints.
- Leveling was determined using test blade 419 and after brush application. The characteristics were judged visually on a scale from 0 to 10 (in case of blade testing) and 1 to 5 (in case of brush-out testing). The higher the mentioned number indicates better performance.
- Sag was tested using a test blade with applicable ayer thicknesses of 100 - 1000 μm. The displayed values indicate the maximum applicable layer thickness without runners.
- To test the roller spattering performance, 50 g of the individual paint were rolled on a vertical wall in 10 cycles. The spatters were collected on a black leneta chart positioned underneats. The number of spatters were judged visually on a scale from 1 to 5. The higher the mentioned number indicates better performance.
- Color acceptance and viscosity stability determined after the addition of 1% Croma Trend Violet 23. The tinted paints were applied at 150 μm on a leneta chart after 10 minutes mixing in the Scandex shaker. The rub-out tests are being performed 2 min after application. After drying the ΔE value was determined using the Datacolor Microflash 100. Viscosity stability was measured using the KU viscosmeter.

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