Home, Institutional and Personal Care Solutions

ACULYN™ Rheology Modifiers

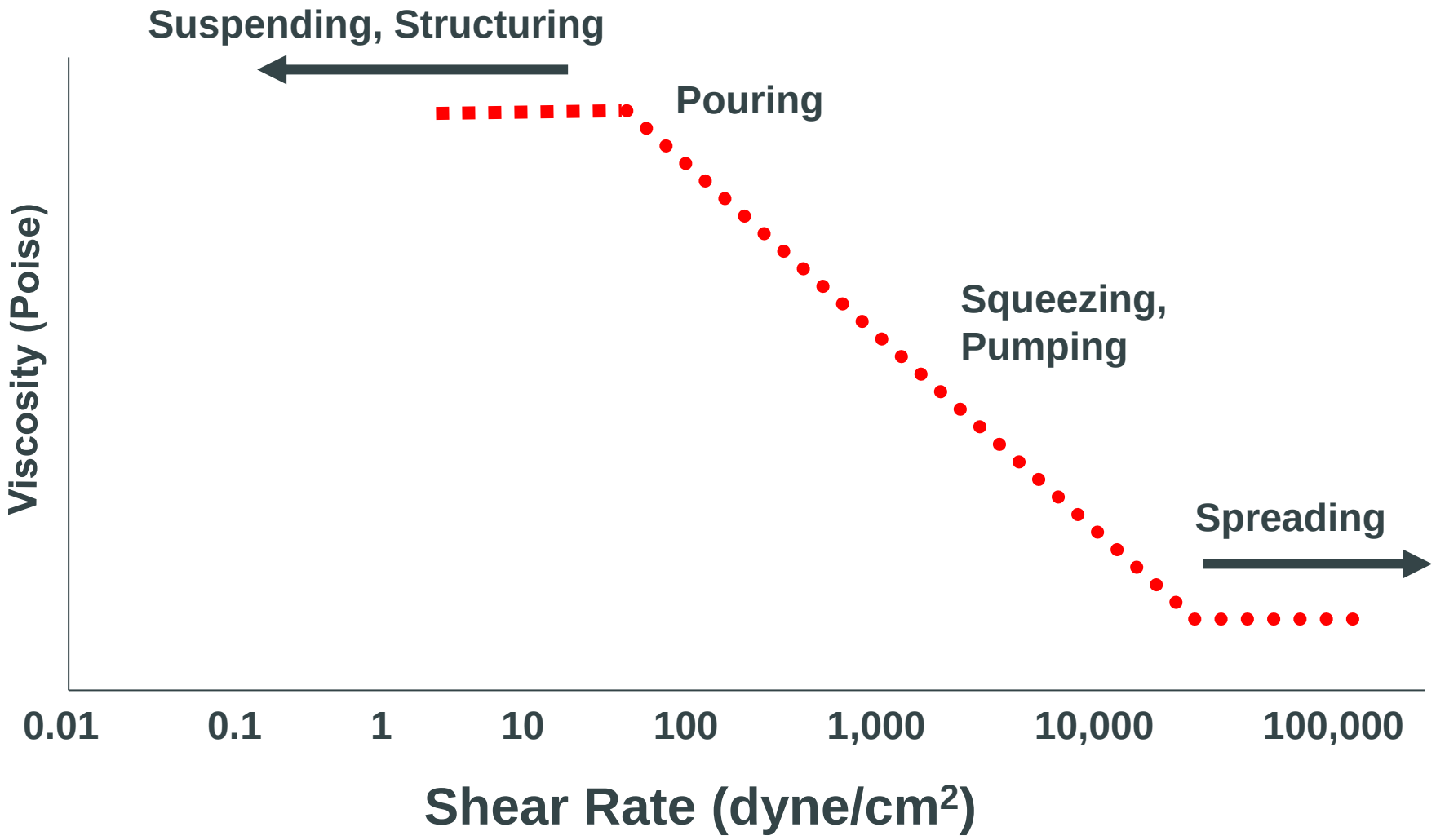
August 2015

Home, Institutional & Personal Care Solutions
Technical Service Manager / Masaki Furuya

ACULYN™ Product Family

	INCI Name	Solid	Preservative
ACULYN™ 33 **ACULYN™ 33A**	Acrylates Copolymer	28%	10ppm CMIT/MIT NO
ACULYN™ 38	Acrylates/Vinyl Neodecanoate Crosspolymer	29%	NO
ACULYN™ 22	Acrylates/Steareth-20 Methacrylate Copolymer	30%	NO
ACULYN™ 28	Acrylates/Beheneth-25 Methacrylate Copolymer	20%	NO
ACULYN™ 88	Acrylates/Steareth-20 Methacrylate Crosspolymer	29%	0.2% Sodium Benzoate
ACULYN™ Excel	Acrylates Copolymer	31%	0.55% Benzoic Acid
ACULYN™ 44	PEG-150/Decyl Alcohol/SMDI Copolymer	35%	NO
ACULYN™ 46N	PEG-150/Stearyl Alcohol/SMDI Copolymer	19%	<0.5% Caprylyl glycol <80ppm MIT
ACULYN™ 60	PEG-150 Distearate	100%	NO

Model Rheology Curve

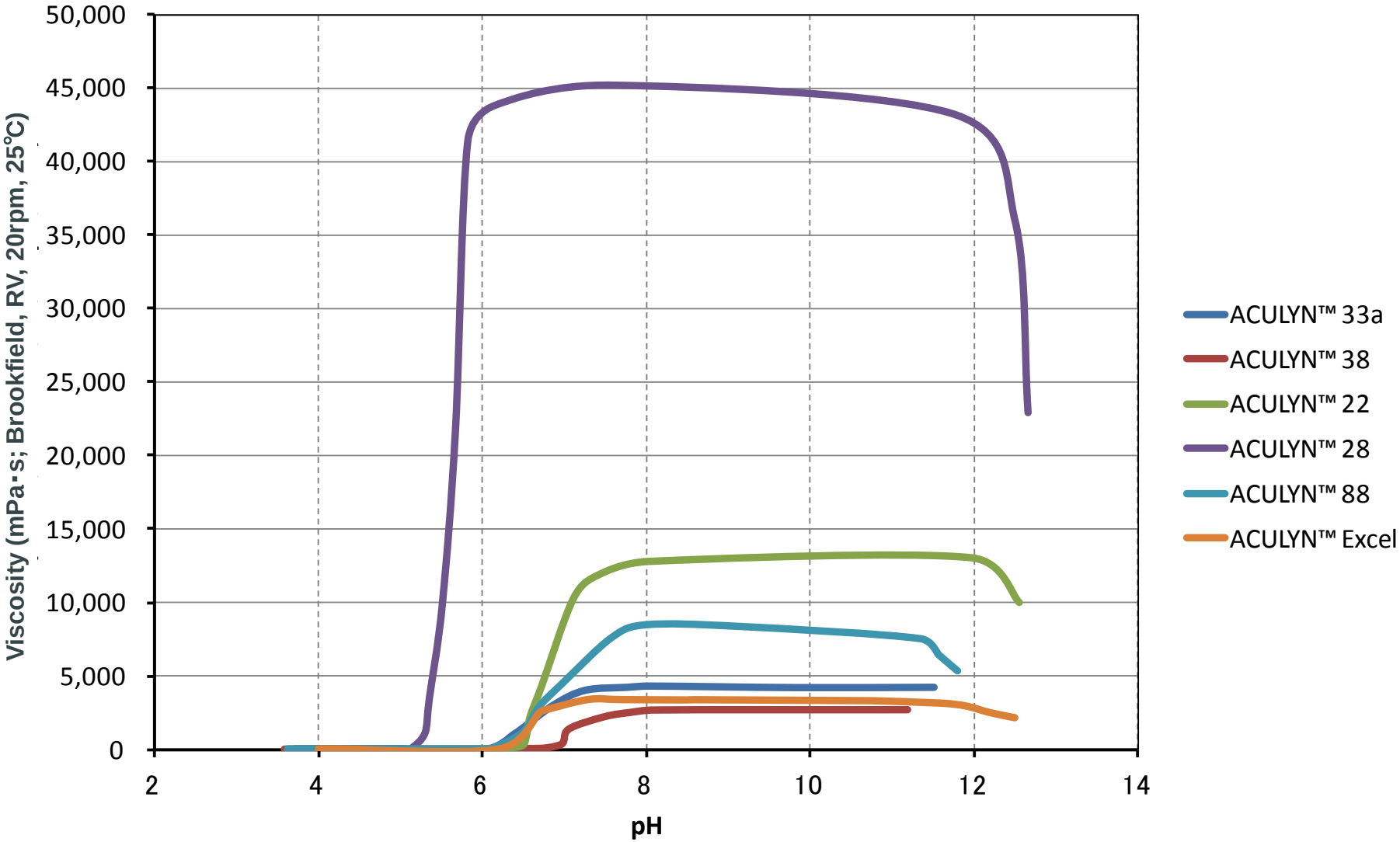


ACULYN™ Rheology Modifiers Selection Guide

	Aculyn™ 22	Aculyn™ 28	Aculyn™ 33A, 33	Aculyn™ 38	Aculyn™ 88	Aculyn™ Excel	Aculyn™ 44	Aculyn™ 46N	Aculyn™ 60
Features/Benefits	Efficient for difficult to thicken surfactant systems.	Our most efficient thickener. Offers wide pH range and excellent clarity.	Superior suspending performance. Thickenes polar solvent system.	Excellent suspending agent for thin pour formulation. Suitable for soap-based system.	Efficient suspension in high viscosity formulation.	Efficient suspension at acidic condition (pH>4) with high clarity.	Compatible with cationic ingredients. Excellent thickener for inorganic sunscreen formulation.	Compatible with cationic ingredients. For rinse-off application only.	Offers "rich" feel to high concentrated surfactant system.
Chemistry	HASE	HASE	ASE	ASE	HASE	HASE	HEUR	HEUR	HNP
Associative	Yes	Yes	No	No	Yes	Yes	Yes	Yes	Yes
Ionicity	Anionic	Anionic	Anionic	Anionic	Anionic	Anionic	Nonionic	Nonionic	Nonionic
Solids, %	30	20	28	29	29	31	35	19	100
Solvent	Water	Water	Water	Water	Water	Water	PG/Water	Water	NA
pH	2.2 – 3.2	3.5 – 4.2	2.1 – 3.5	2.1 – 3.2	3.3 – 4.3	3.0 – 4.0	8-9	6-8	4.5-6.5
Eq *	218	253	218	239	255	254	NA	NA	NA
P.I. **	7.0	7.0	5.0	5.0	4.0	4.0	1.0	6.0	1.0
Rheology	Non stringy	Non stringy	Buttery	Smooth	Non stringy	Non stringy	Stringy, Tacky	Stringy, Tacky	–

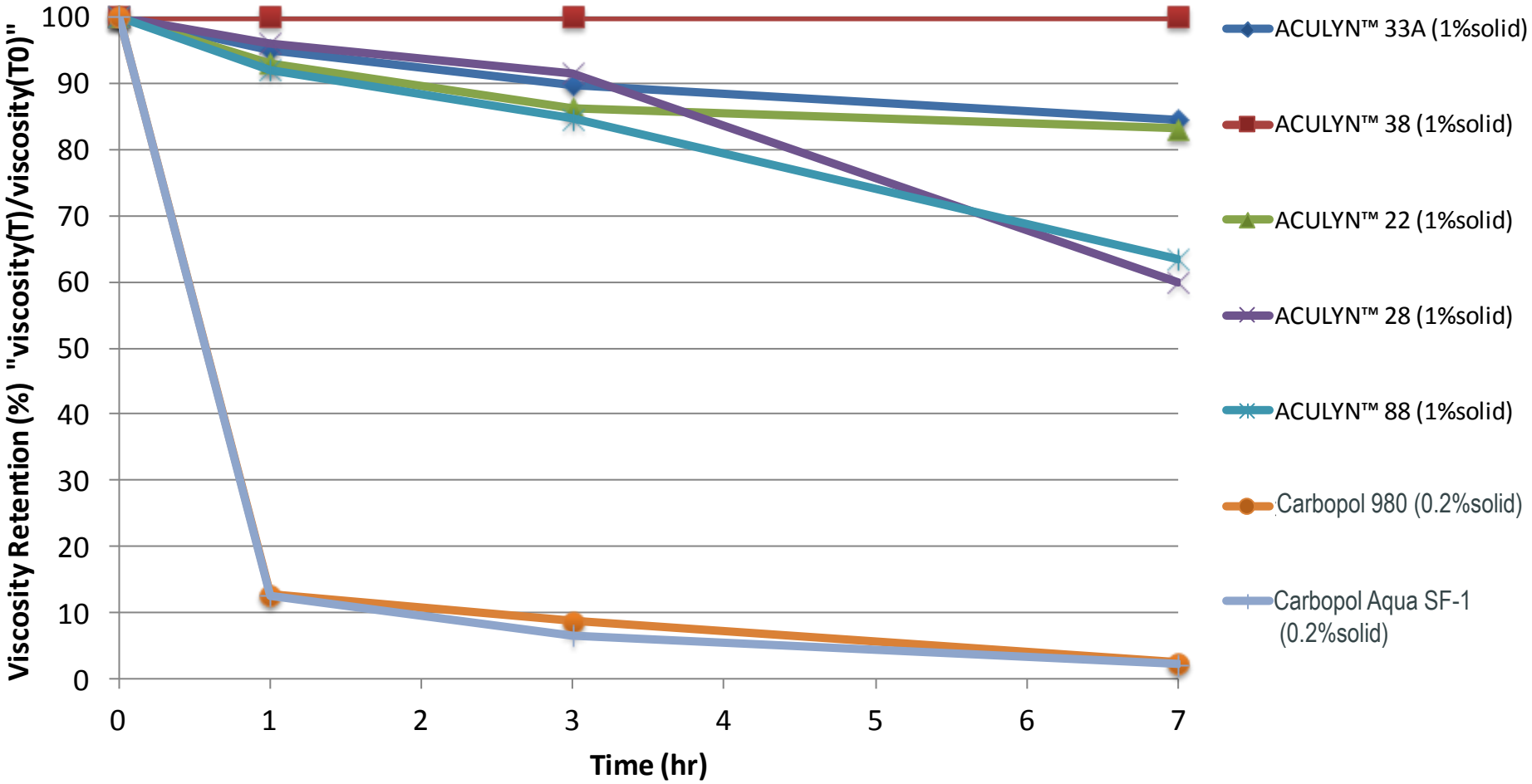
* Eq weight: grams of dry polymer neutralized by 1 equivalent (40g) of NaOH.
** Pseudoplastic Index: Viscosity at 6rpm / Viscosity at 60rpm

Aquous pH / viscosity neutralisation curves (1% solid)



Tolerance to high-shear agitation

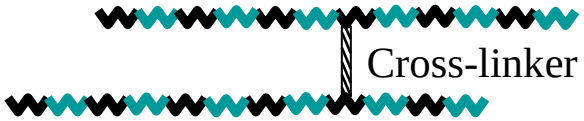
- Viscosity change after high-speed agitation (8,000rpm) with disper blade at 70℃ .



Structure

Anionics

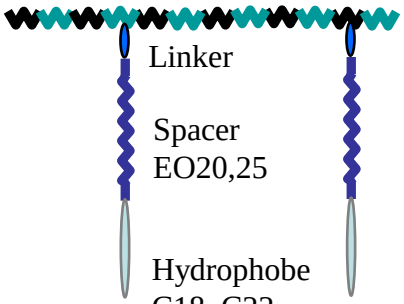
ASE : Alkali Swellable Emulsion



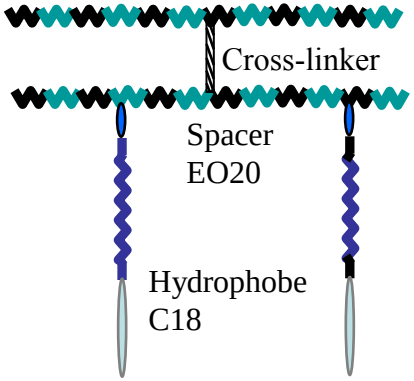
Aculyn 33A
Aculyn 38

HASE : Hydrophobically-modified Alkali Soluble Emulsion

Aculyn 22
Aculyn 28



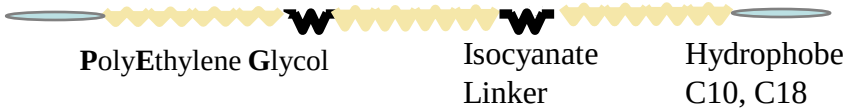
Aculyn 88
Aculyn Excel



Nonionics

HEUR : Hydrophobically-modified Ethoxylated Urethane

Aculyn 44
Aculyn 46



HNP : Hydrophobically-modified Nonionic Polyol

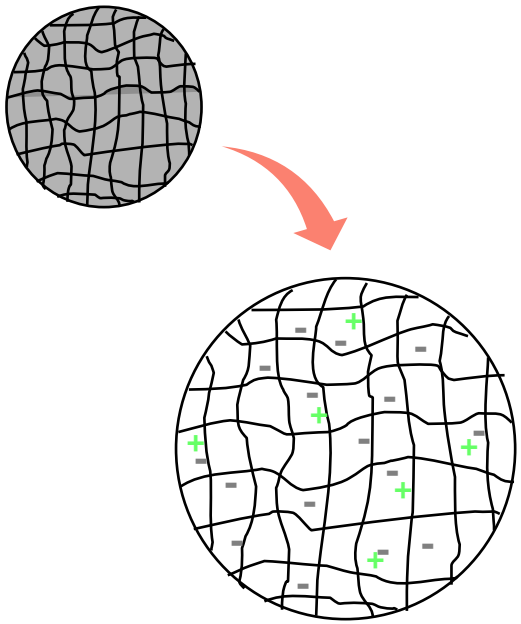
Aculyn 60

Thickening Methanism

Microgel

【 Aculyn™ 33A, 38, 88, Excel 】

Migrogel swells during neutralization to structure the continuous phase of formulations building viscosity and enabling suspension.



Chain Entanglement

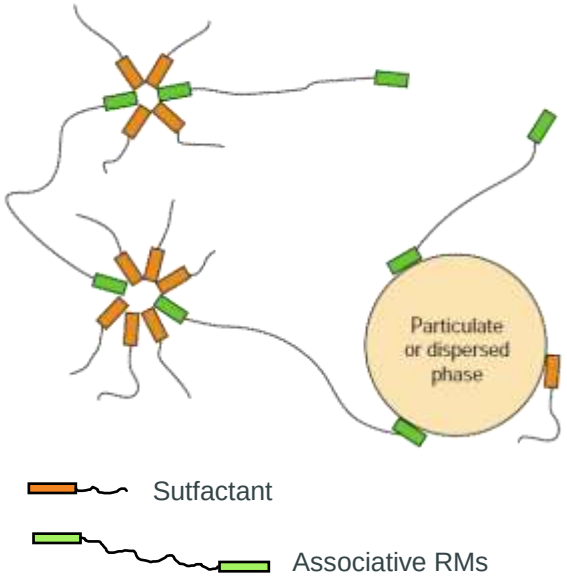
【 Aculyn™ 22, 28 】

When the acid groups are neutralized, they become anionically charged and water-soluble, thus swell due to charge-charge repulsion.

Association

【 Aculyn™ 22, 28, 88, Excel, 44, 46 , 60】

Hydrophobic parts build associations with one another and with other hydrophobes available in the formulasion, such as surfactants, particulates, emulsion droplets and dyes.



I. ASE type: ACULYN™ 33/33A, 38

- Thickening Mechanism
- Suspending Performance

II. HASE type: ACULYN™ 22, 28, 88, Excel

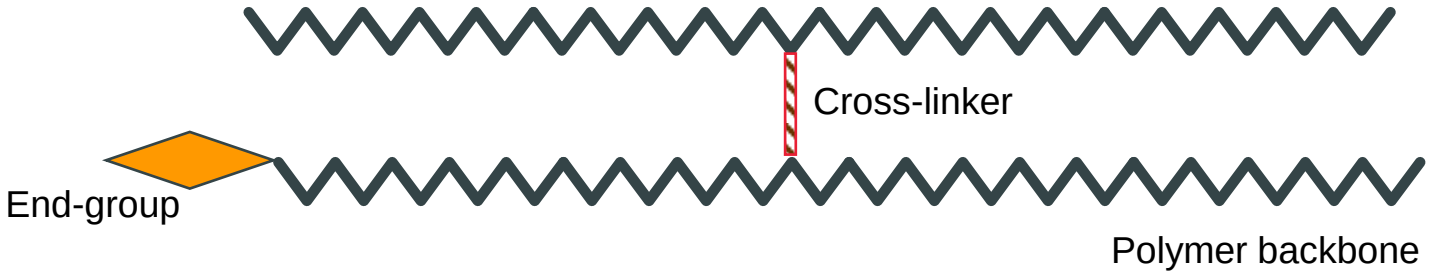
- Thickening Mechanism
- Salt Tolerance
- Associative Thickening
- Surfactant-like Character
  - as Polymeric Emulsifiers
  - Enhance water-resistance
  - Tailored Texture

III. HEUR, HNP type: ACULYN™ 44, 46N, 60

- Thickening Mechanism
- Associative Thickening

ASE: ACULYN™ 33/33A, 38

ASE: Alkali Soluble (Swellable) Emulsion



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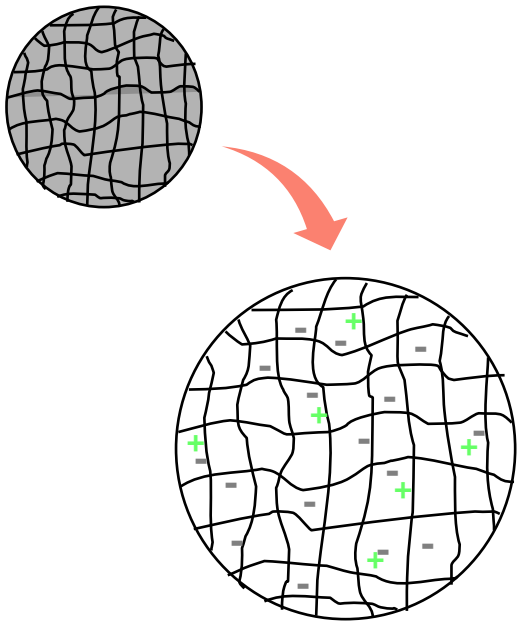

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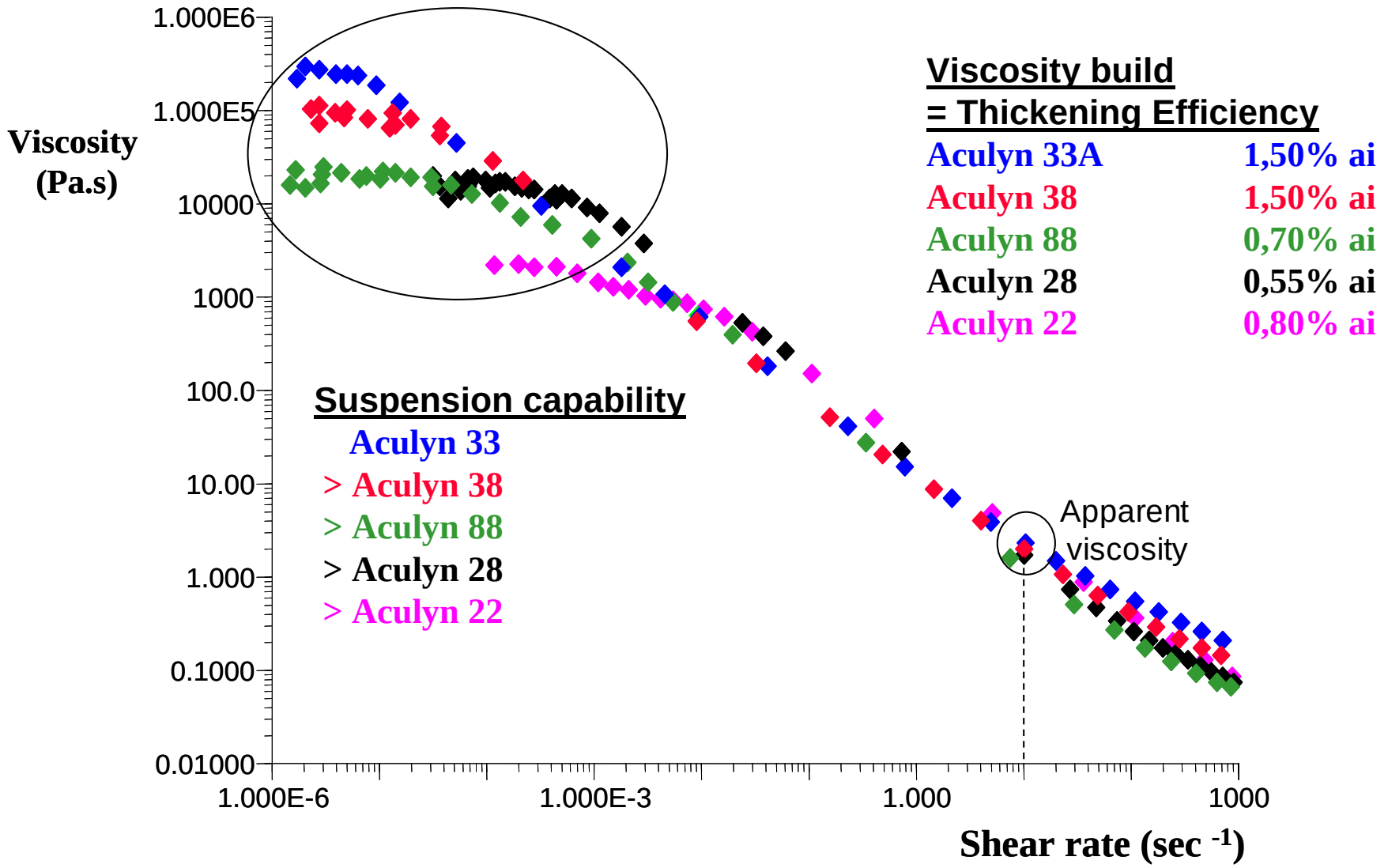
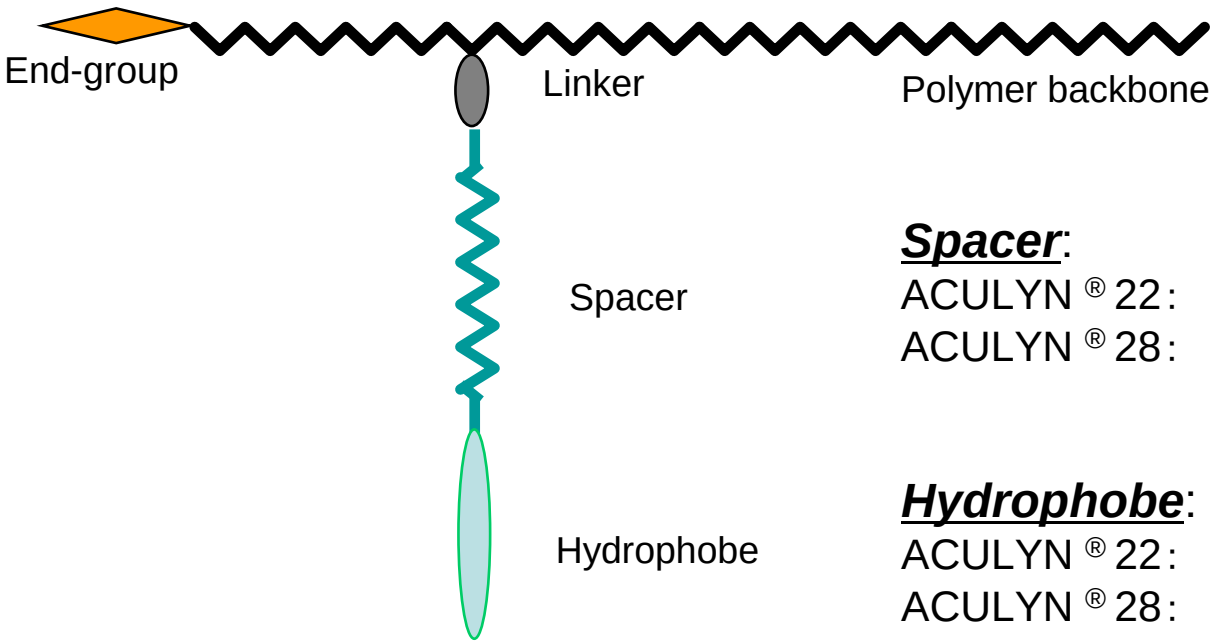
Suspending Performance



HASE: ACULYN™ 22, 28

HASE: Hydrophobically-modified Alkali Soluble Emulsions



Spacer:

ACULYN ® 22 : EO = 20

ACULYN ® 28 : EO = 25

Hydrophobe:

ACULYN ® 22 : C chain = 18

ACULYN ® 28 : C chain = 22

Thickening Methanism

Microgel

【Aculyn™ 33A, 38, 88, Excel】

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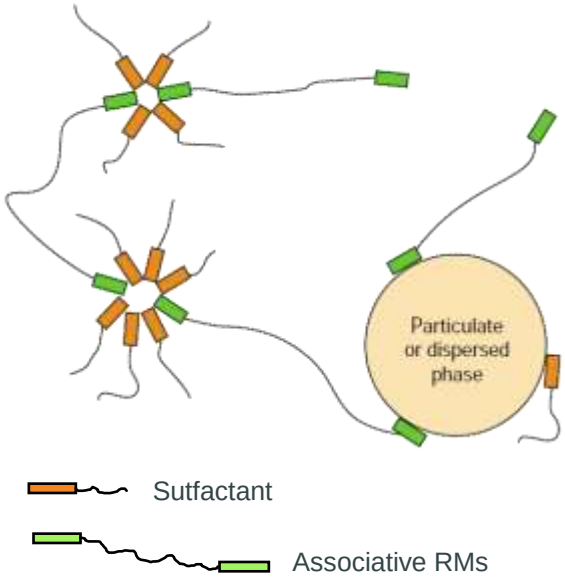
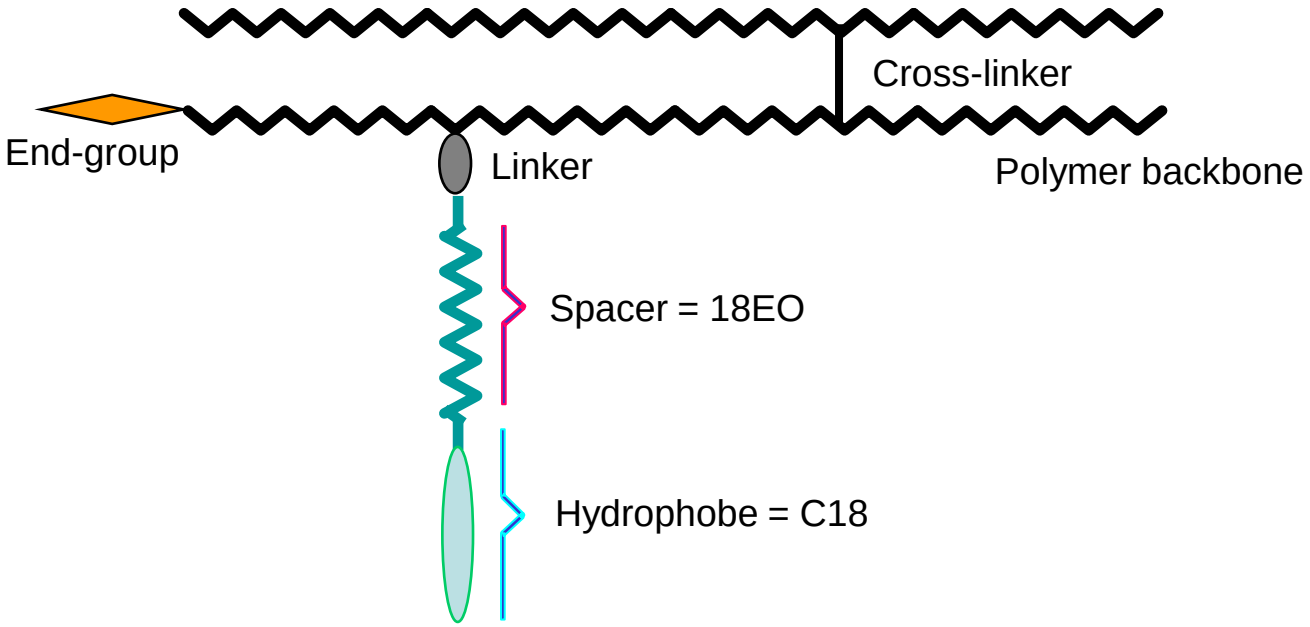


HASE: ACULYN™ 88



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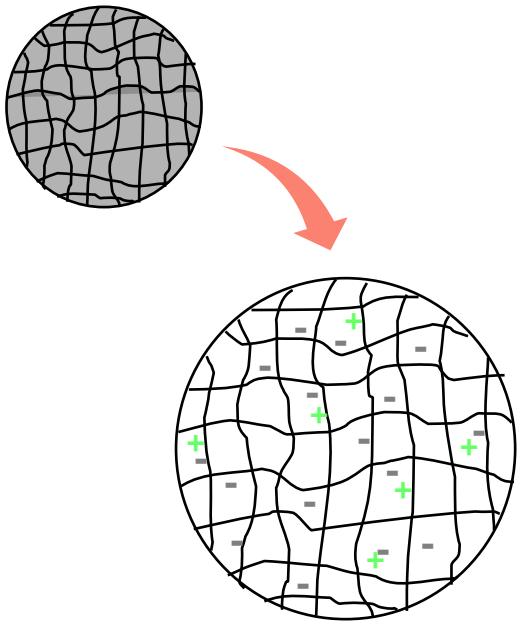

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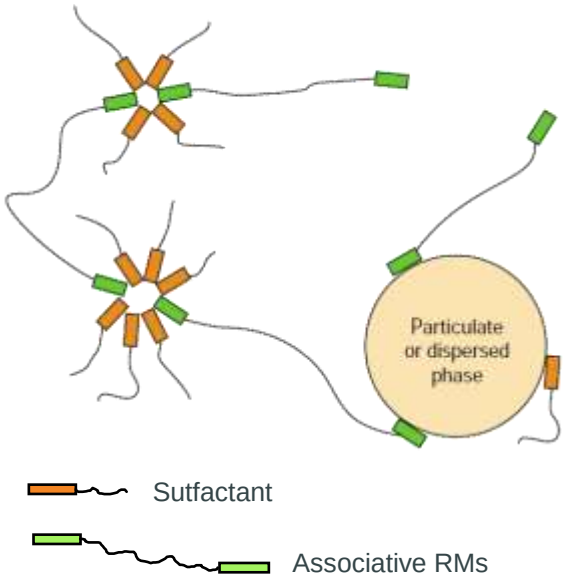
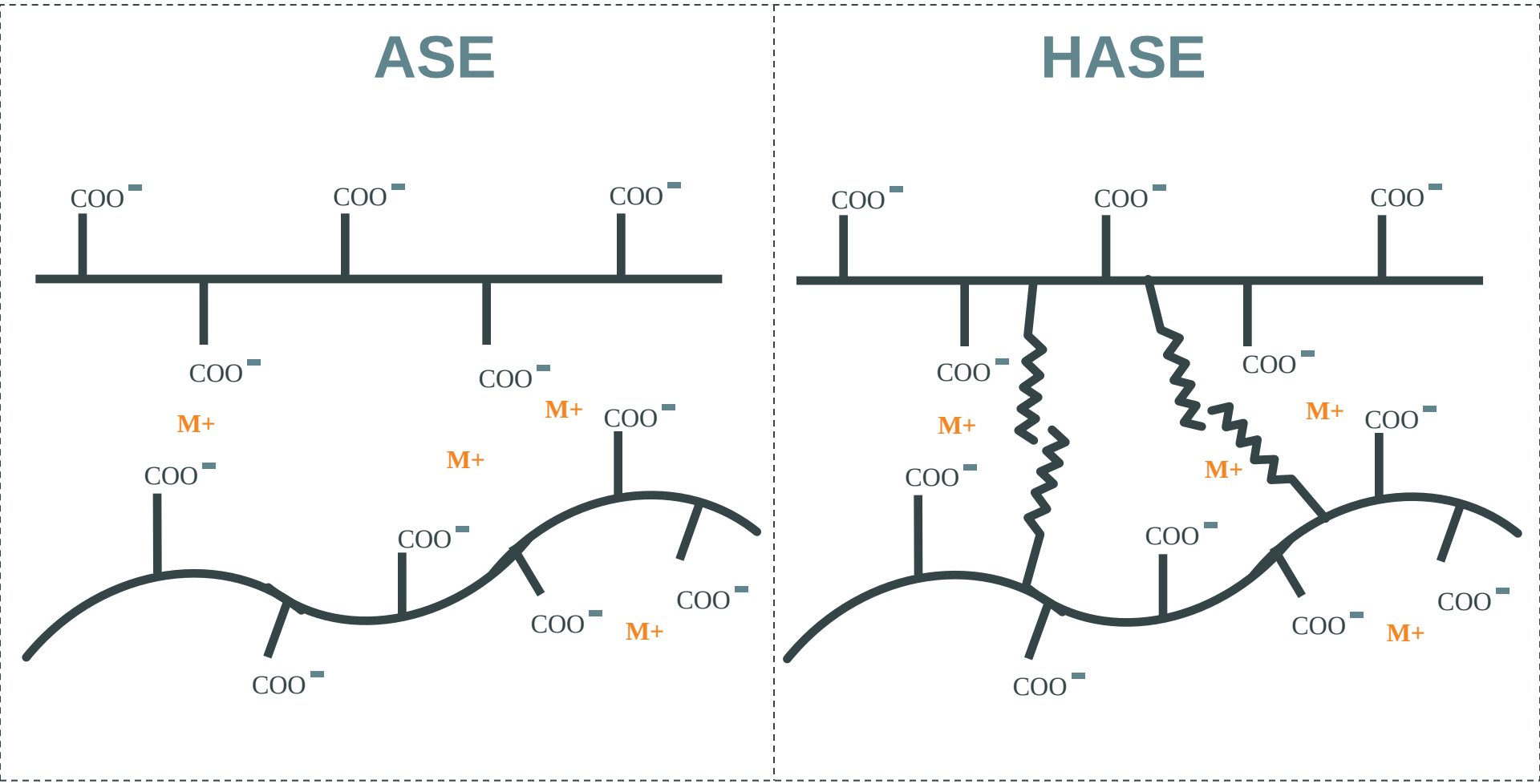


Functionality/Technical Attributes

The effect of electrolytes on ASE & HASE



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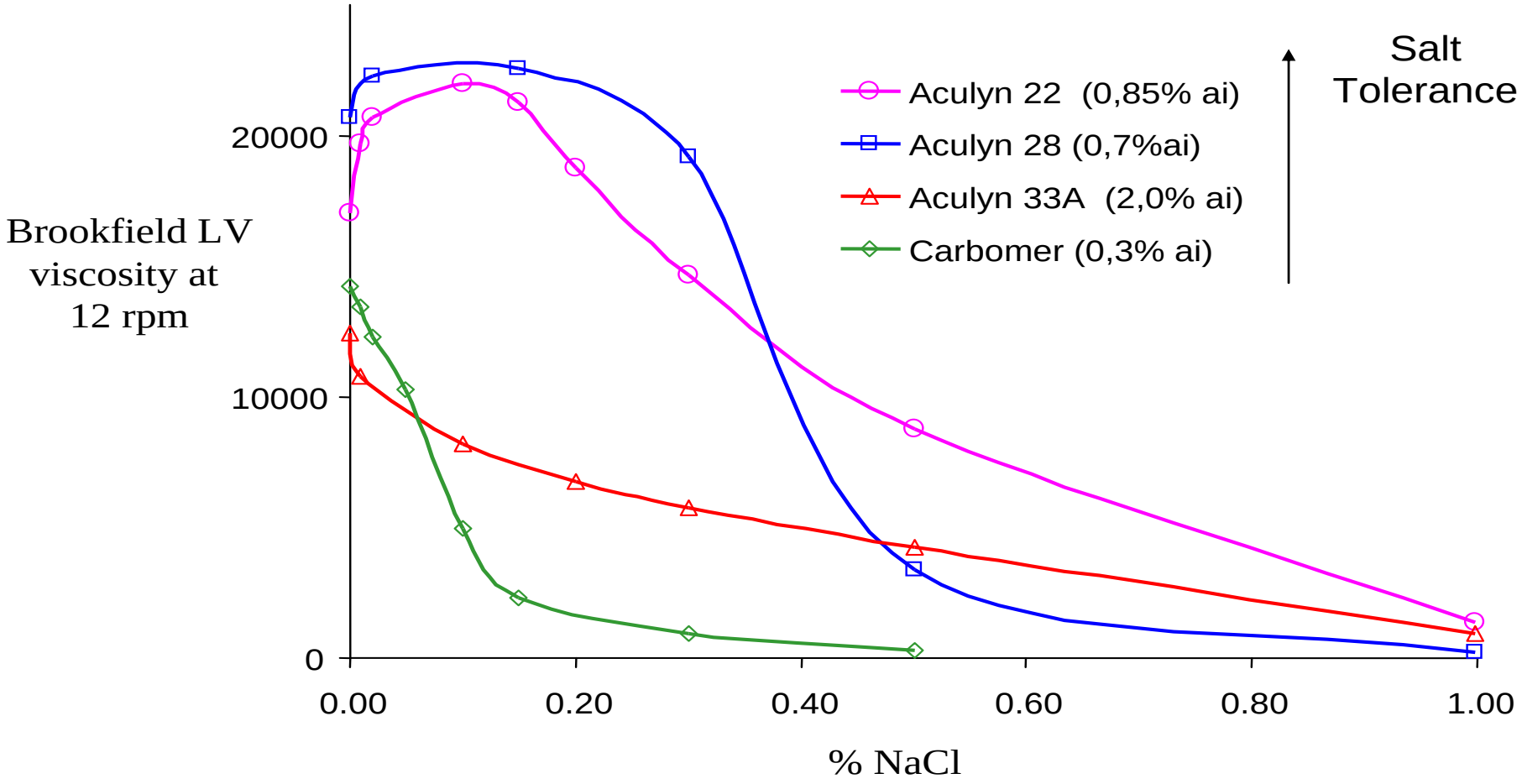

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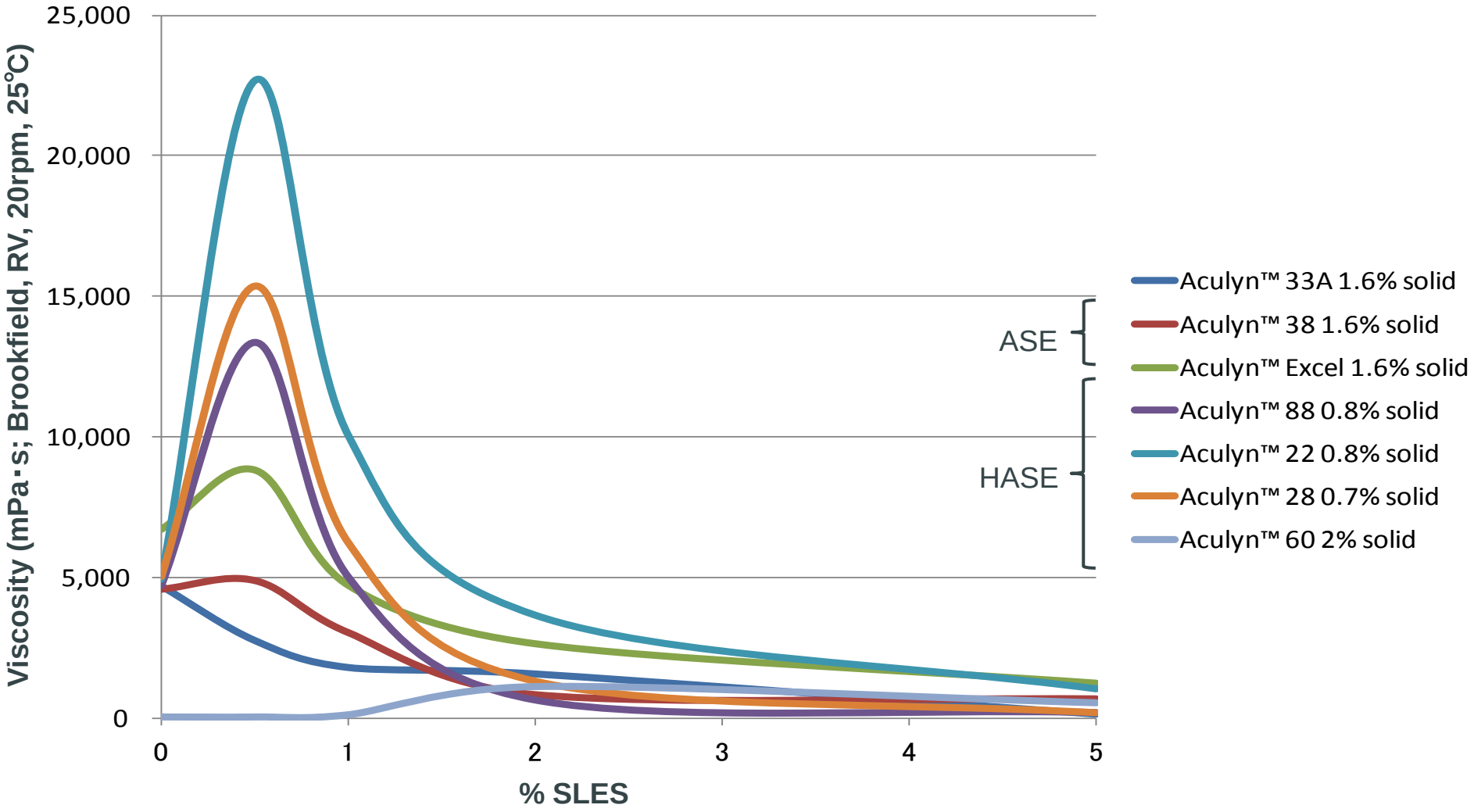
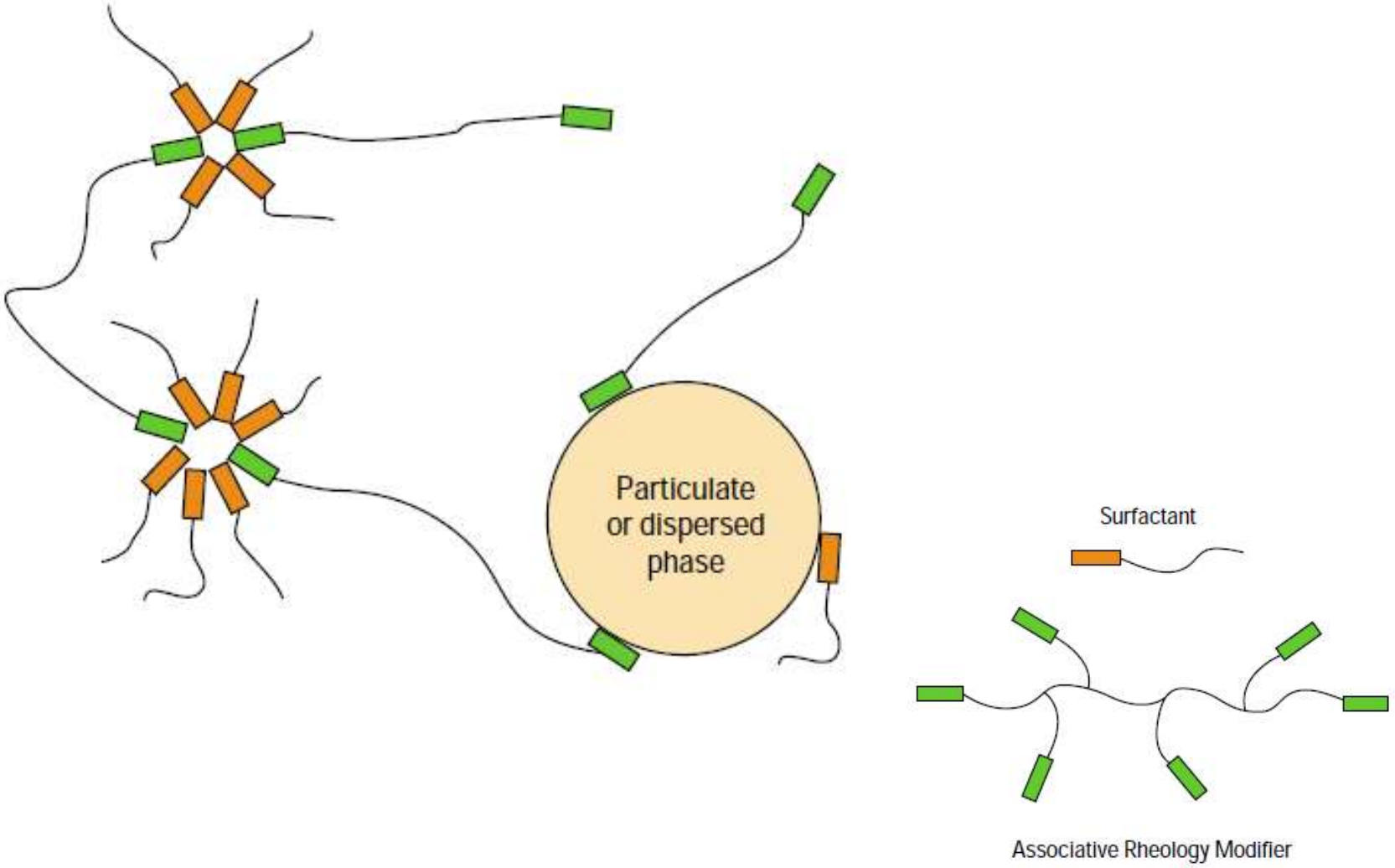
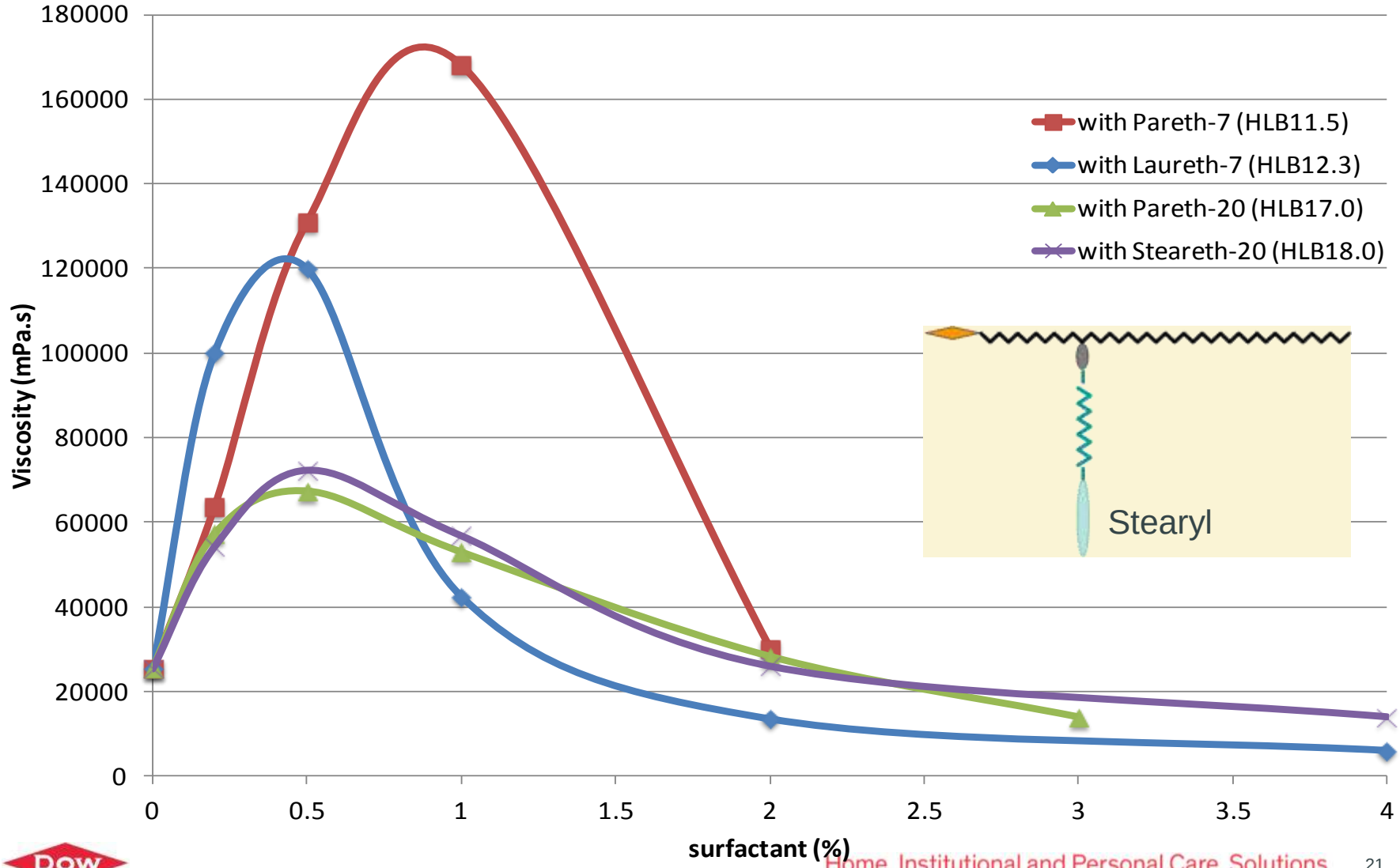


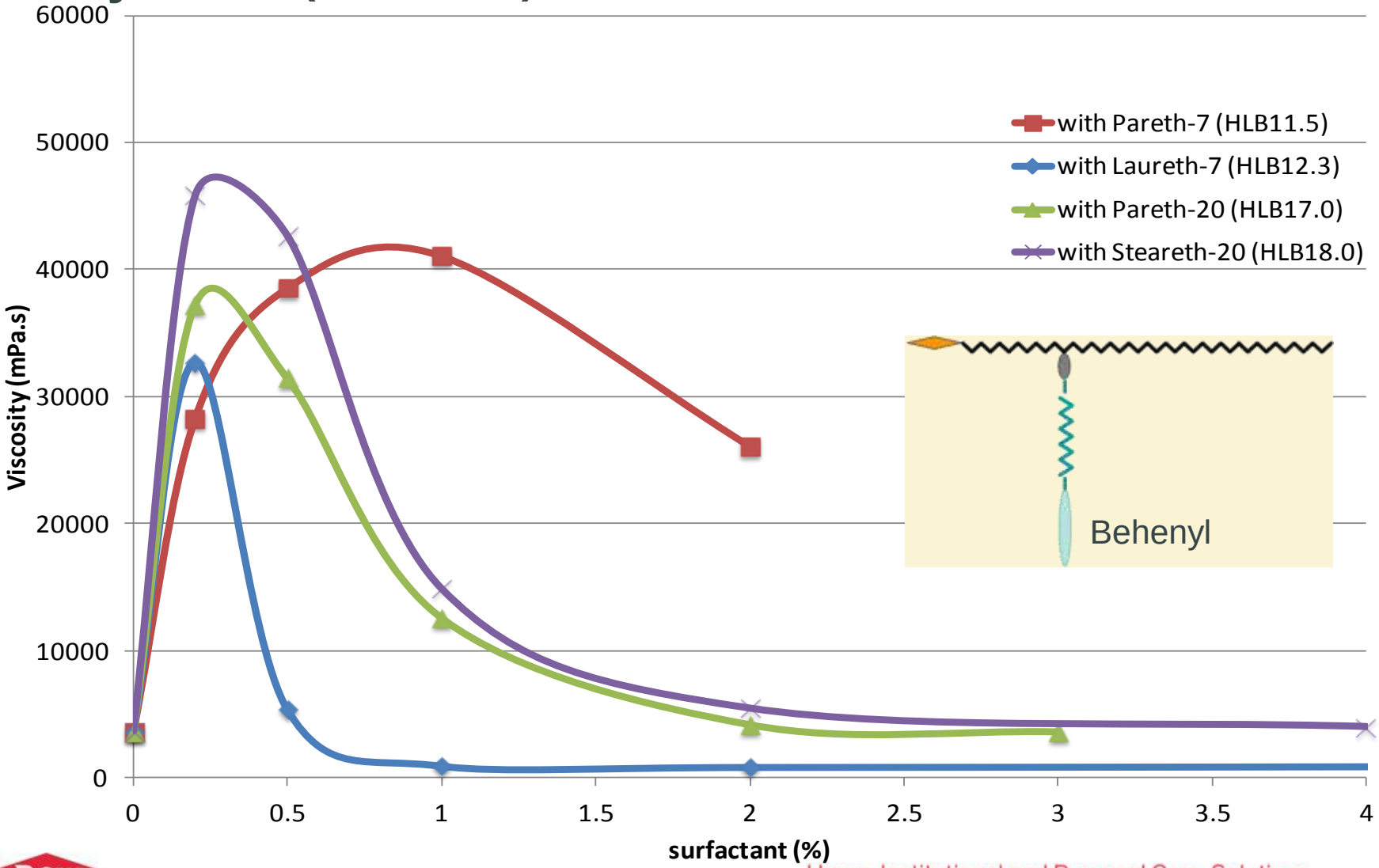
Associative Thickening



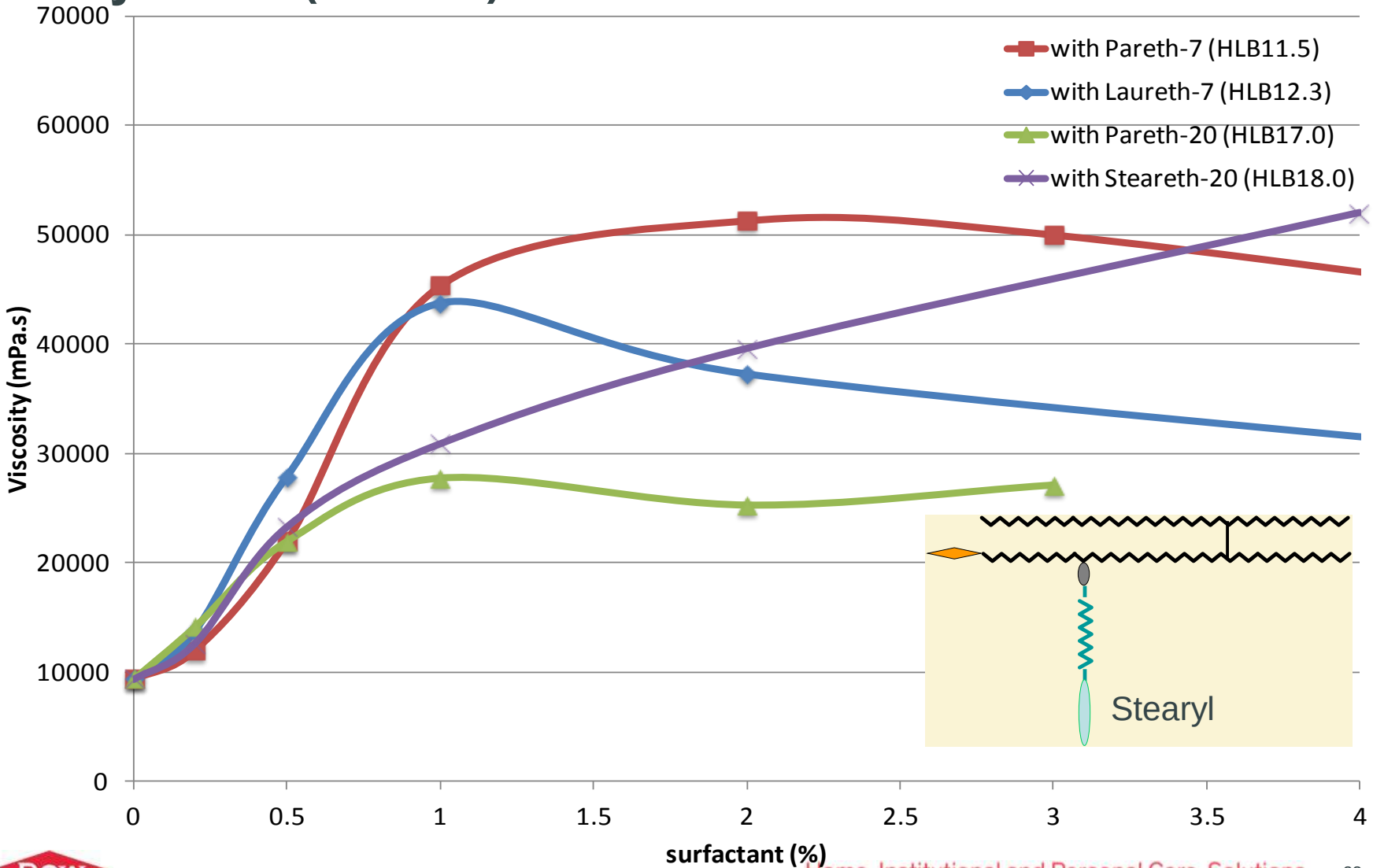
Example of Associative Thickening:
Aculyn™ 22 (1% solid) with Nonionic Surfactants



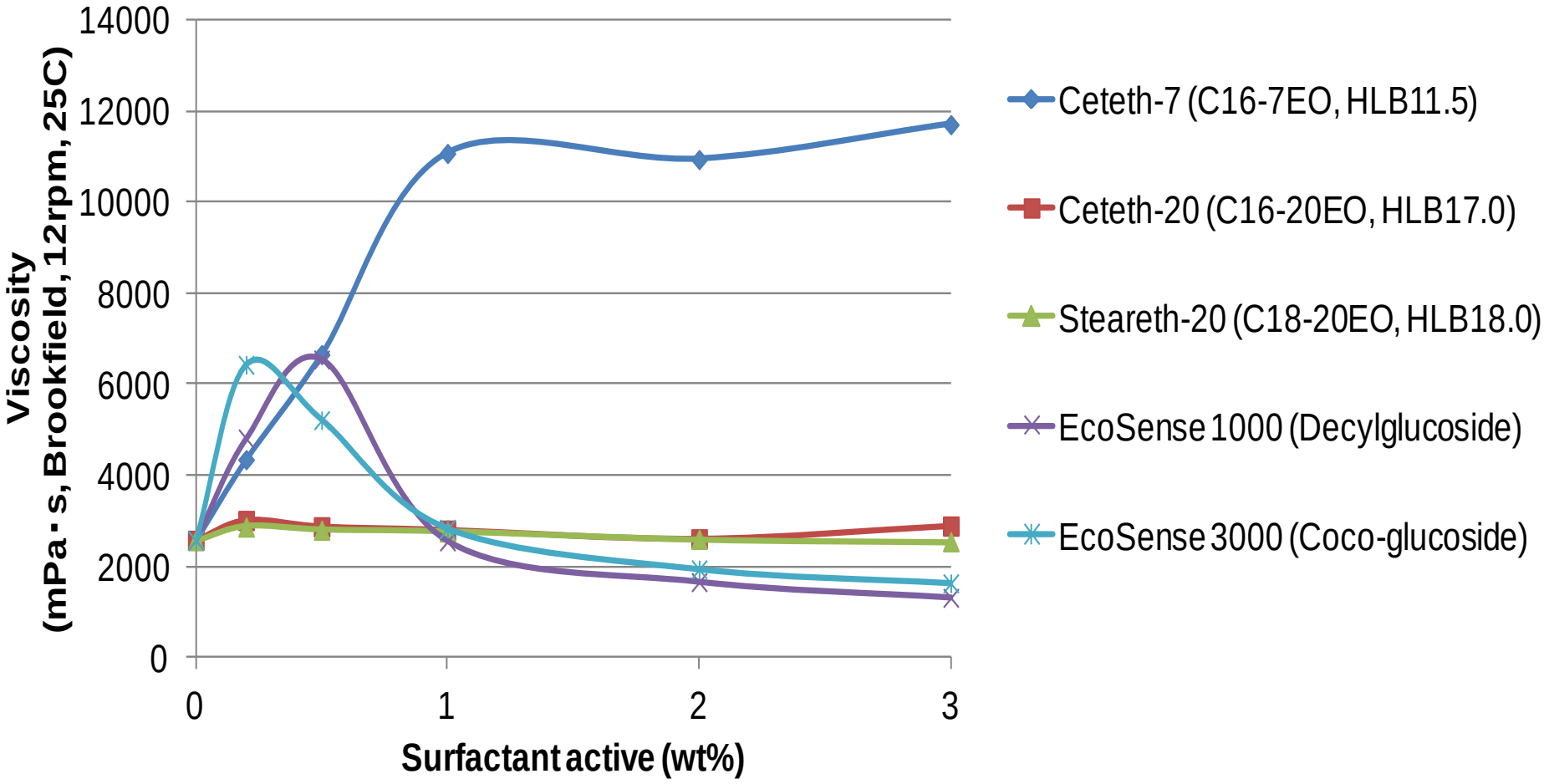
Example of Associative Thickening:
Aculyn™ 28 (0.5% solid) with Nonionic Surfactants



Example of Associative Thickening:
Aculyn™ 88 (1% solid) with Nonionic Surfactants

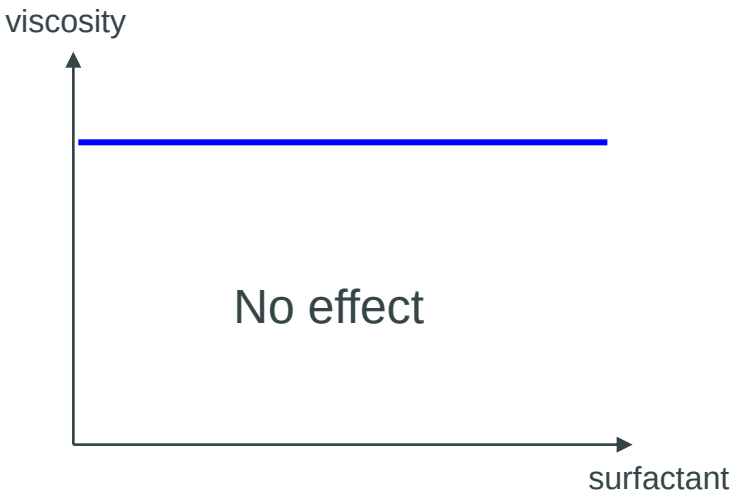
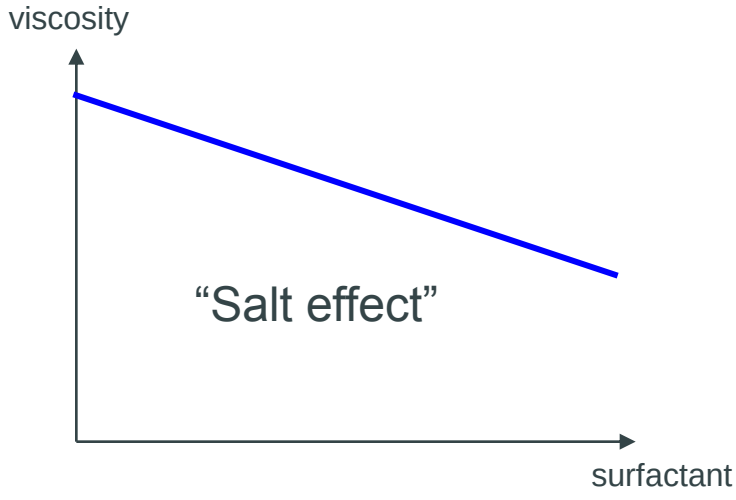
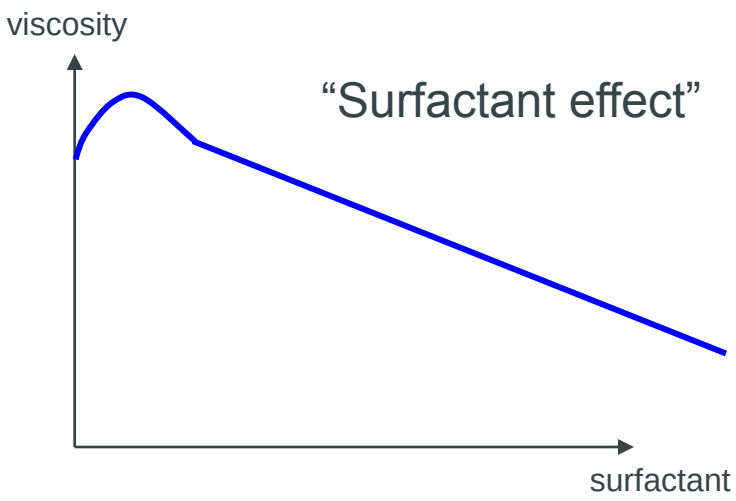
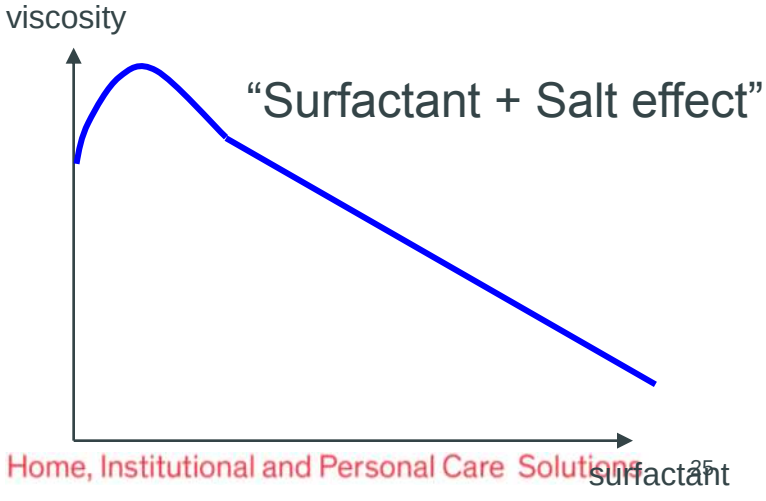


Example of Associative Thickening:
Aculyn™ Excel (1%solid) with Nonionic Surfactants

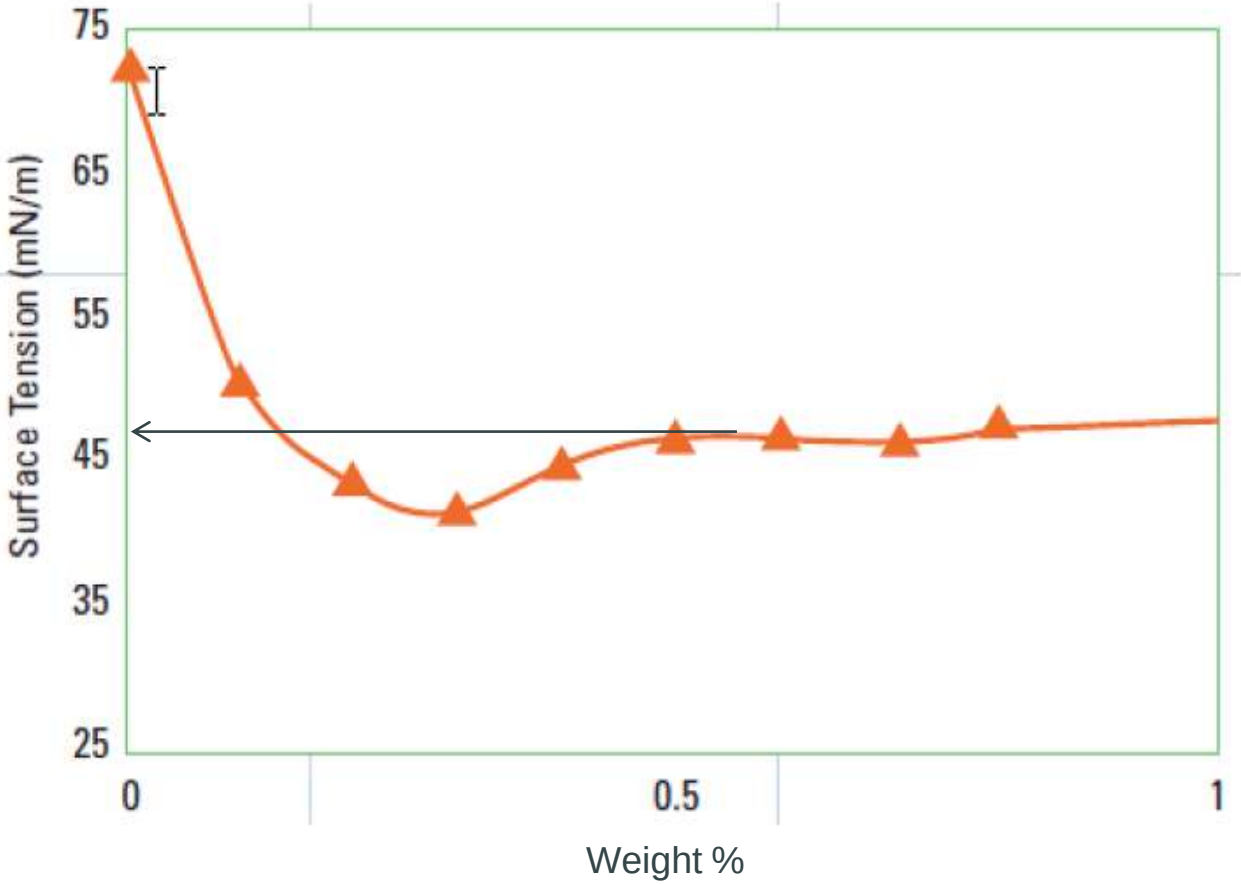


Functionality/Technical Attributes

Behaviour with typical surfactants (pH 7.5)

	NONIONIC	ANIONIC
ASE		
HASE		

HASE ACULYN™ - Surfactant-like Character

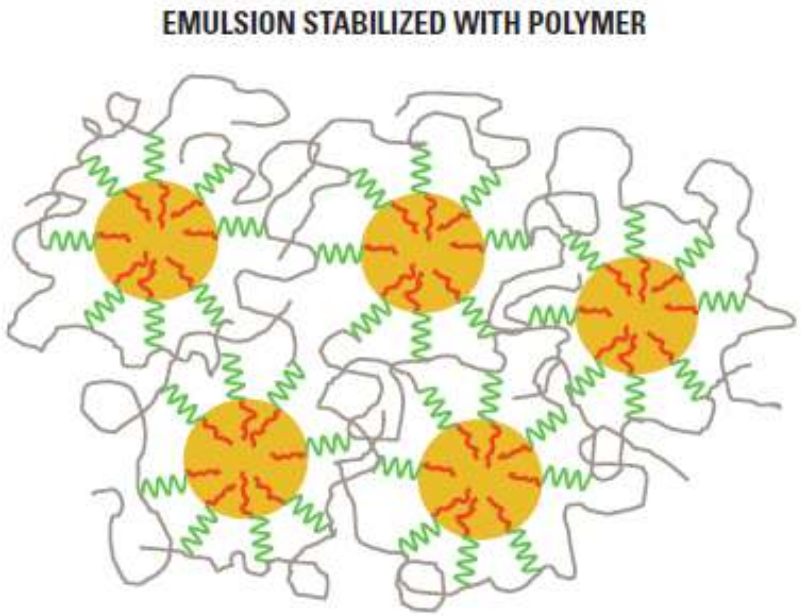


Surface tension of typical surfactants

INCI	ST(mN/m)
Water	72
SLE(3)S	35-38
Laureth-9	29
Decylgclucoside	29

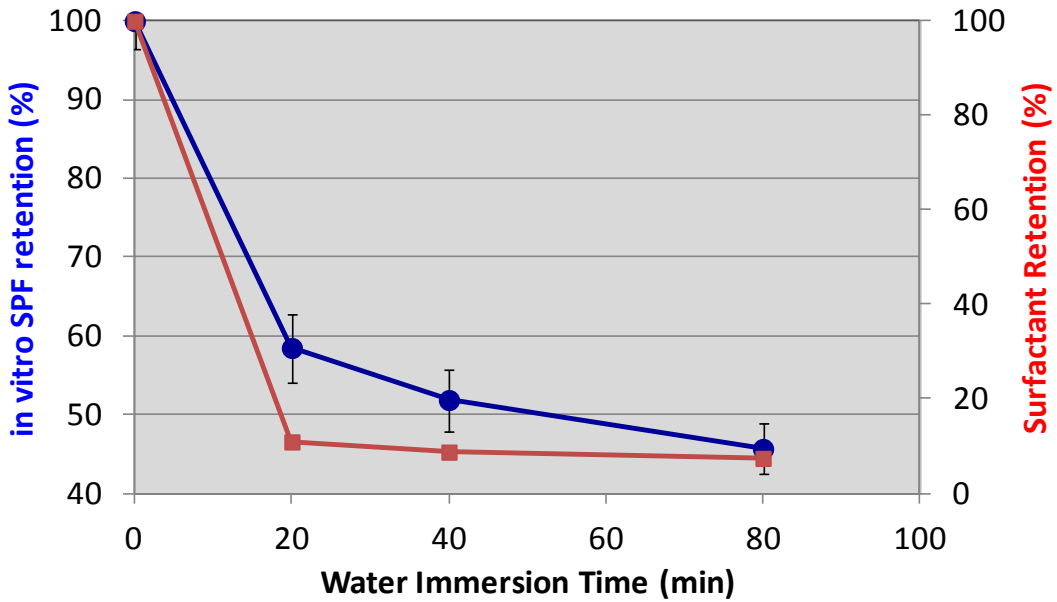
HASE ACULYN™ as Polymeric Emulsifier

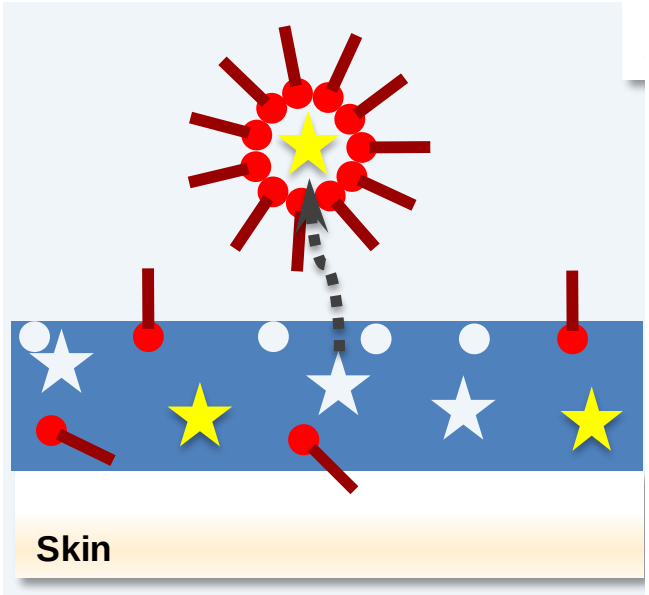
- Work as primary emulsifier without HLB-limitation
- Efficient emulsion stabilization with lower concentration
- Foaming and foam stabilization
- Enhance suspension stability of oils and particulates
- Offer both emulsification and rheological benefits
  (thickening, shear thinning property, …)
- Reduce potential risk of irritation caused by emulsifier
- Enhance water-registance



Enhance Water-Resistance (e.g. sunscreen)

UV actives drain through re-emulsfication





When emulsified by ACULYN™, formulators can

- Reduce or eliminate emulsifier
- Expect interactions with particles and actives

Enhance Water-resistance

Example of Emulsifier-free Emulstion

Components	% w/w	Function
Propylene glycol	5.0	Humectant
D-Panthenol	2.0	Vitamin
ACULYN™ 22	2.5	Primary emulsifier
ACULYN™ 33A	2.7	Rheology modifier
10% Sodium hydroxide	2.0	Neutralizer
Isopropyl palmitate	10.0	Emollient
Tocopheryl acetate	1.0	Vitamin
Tocopherol	0.01	Anti-oxidant
Ethylhexyl methoxy cinnamate	5.0	UV-B filter
Mineral oil	3.99	Base oil
Fragrance	0.2	
NEOLONE™ 950 (MIT)	0.78	Preservative
Methylparaben	0.11	Preservative
NEOLONE™ PH-100 (Phenoxyethanol)	0.37	Preservative
Water	64.34	

Key for polymeric emulsification

I. Dissolve ACULYN™ in water-phase. Add ½ of neutralizer then heat.

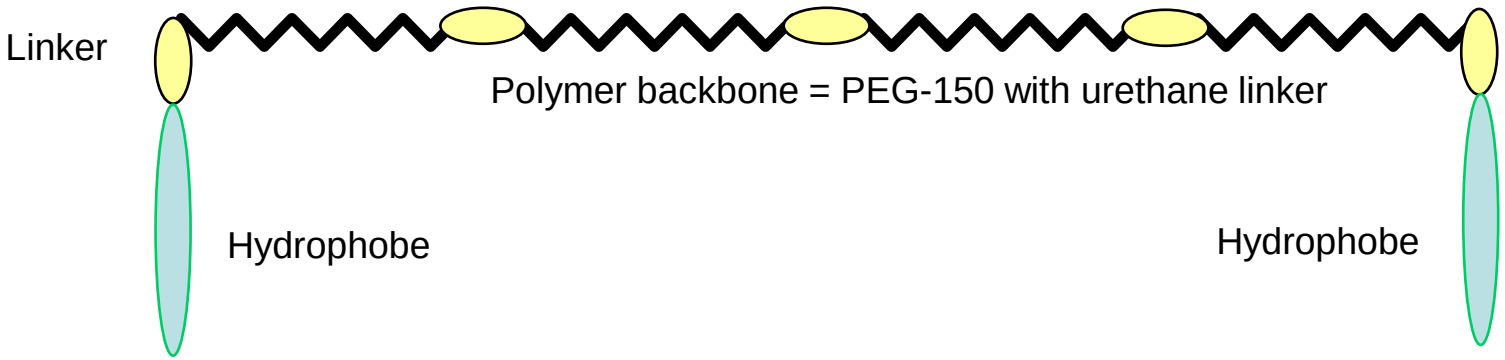
II. Add heated oil-phase into water-phase.

III. Keep agitation and cool to <50℃.

IV. Add rest ½ of neutralizer

V. Agitate until cool to room temperature.

HEUR: ACULYN™ 44, 46N

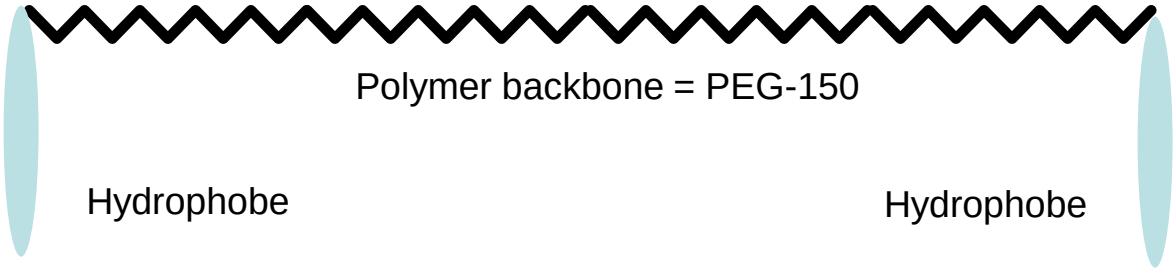


Hydrophobe:

Aculyn 44: C chain = 10

Aculyn 46N: C chain = 18

HMP: ACULYN™ 60



Hydrophobe:
ACULYN® 60: C chain = 18

Thickening Methanism

Microgel

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Chain Entanglement

【Aculyn™ 22, 28】

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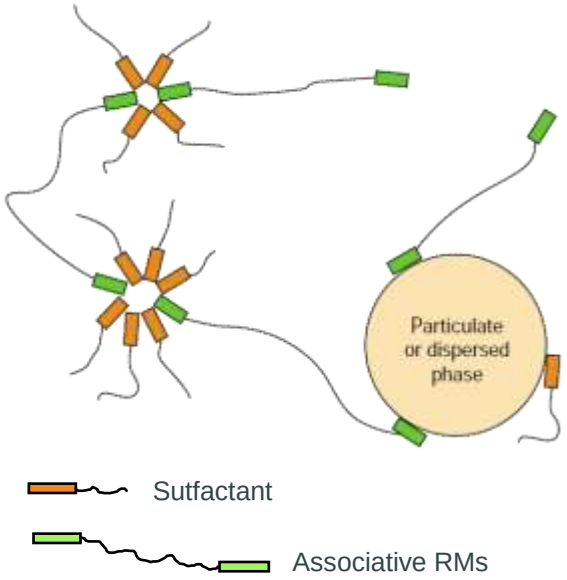
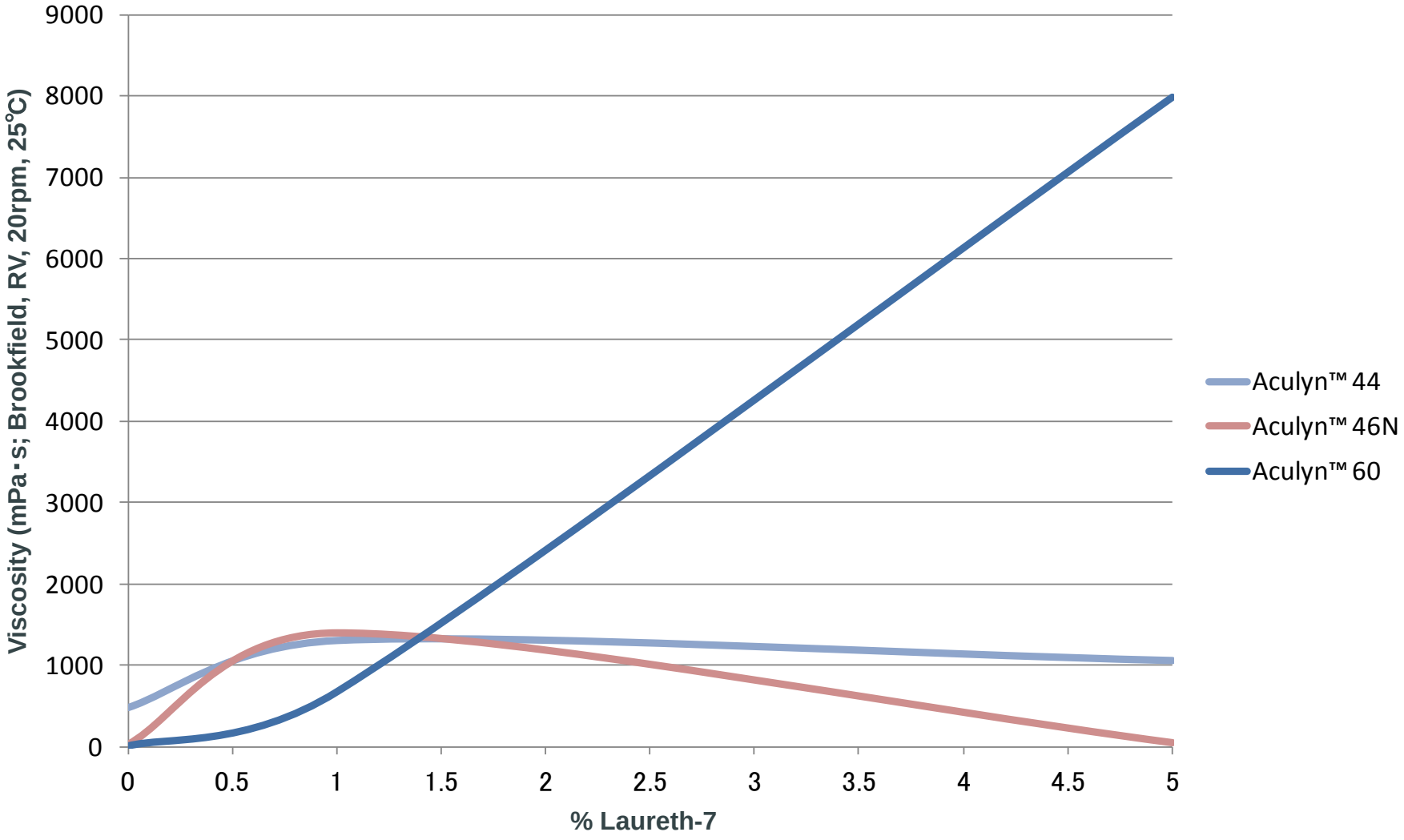


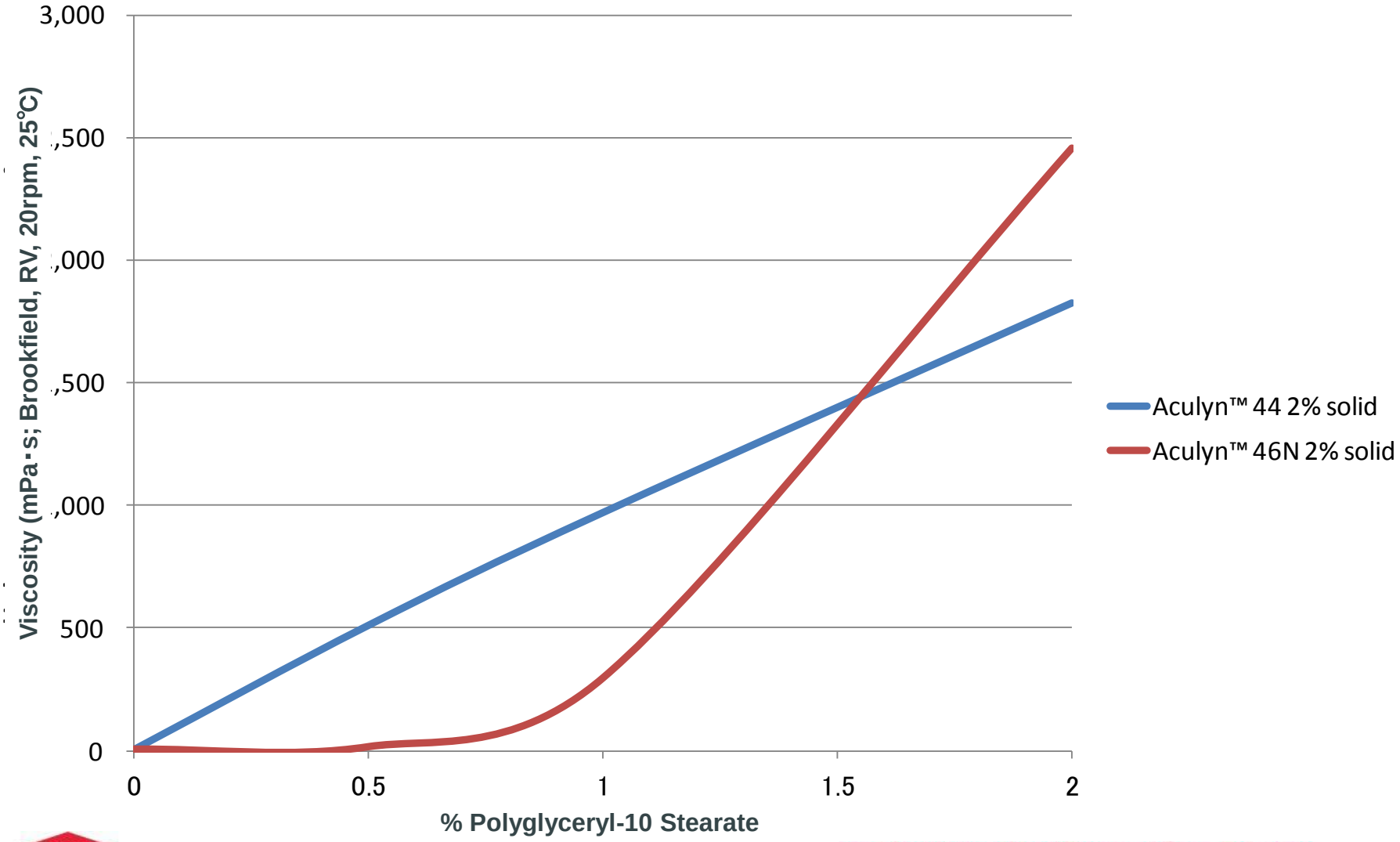
Surfactant Synergies: Associative Thickening:

2% solid of nonionic ACULYN™ with Laureth-7



Surfactant Synergies: Associative Thickening:

2% solid of nonionic ACULYN™ with hydrophilic emulsifier



Cationic Hair Conditioner with Aculyn™ 46N

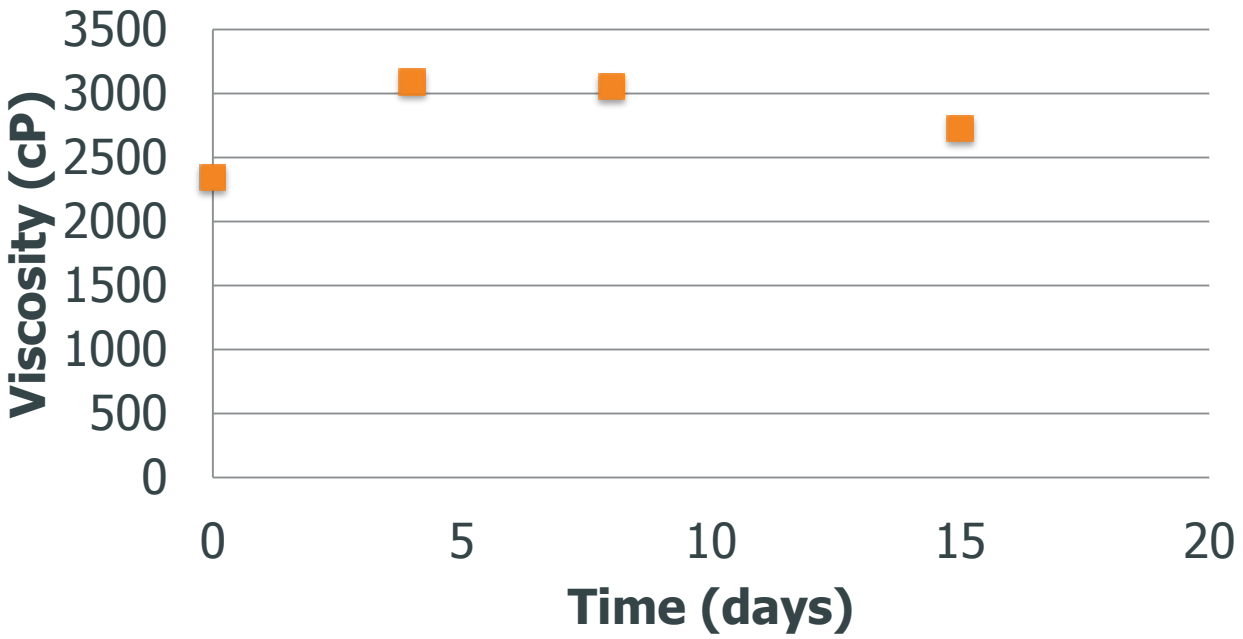
Phase	Trade Name	% Wt.	CTFA / INCI Name	Supplier
A	Deionized Water	85.20	Water	
A	Dehyquart A-CA	2.00	Cetrimonium chloride	Cognis
A	**Aculyn™ 46N**	**3.30**	**PEG 150/ Stearyl Alcohol/SMDI Copolymer**	**Dow Chemical**
A	Citric acid (10% w/w)	2.00	Citric acid, monohydrate	J.T. Baker
A	Tealan	0.30	Triethanolamine	Rita
B	Lanette 16	2.50	Cetyl Alcohol	Cognis
B	Paraffin	0.50	Paraffinium Perliquidum	Merck
B	Tween 40	1.00	Sorbitan monopalmitate + 20 EO	Uniqema
D	Abil 0SW5	2.50	Dimethiconol	Degussa
D	Ethyl Panthenol	0.50	Panthenyl Ethyl Ether	Roche
D	Hair Vital Extra	0.10	Fragrance	Bells & Fragrances
D	**Kathon™ CG**	**0.10**	**Methylchloroisothiazolinone,Methylisothiazolinone**	**Dow Chemical**
D	DI Water	q.s	Water	

Product Characteristics :
Creamy white viscous liquid, pH 4.5-5.0, 3500-4500 cps Brookfield LV Spindle 4 60 rpm

Processing Instructions:
1. Mix Dehyquart A-CA with deionized water with speed of 200 rpm. Add in Aculyn™ 46 first, followed by citric acid. Adjust the pH to pH 4.5-5 using Tealan. Heat the mixture to a temperature of 70^0C. This will be phase A.
2. In a separate beaker, add in Lanette 16, paraffin, followed by Tween 40. Heat to 70^0C. This will be phase B.
3. Add phase A to phase B and stir at a speed of 500 rpm. Maintain the temperature at 65° C- 70^0C and stir for 3 minutes. (Add in 20% of water at temperature of 60° C while stirring to account for water loss). This will be phase C.
4. Remove from heat and continue stirring at speed of 400 rpm to allow mixture to cool to temperature of 40° C. Add in Abil OSW5, Ethyl Panthenol, Fragrance and Kathon™ CG step by step. This will be phase D.
5. Top up with deionized water to 100% and mix well.

Results:

	Aculyn 46N		
Lot #	A007C3T003	A007C3K016	A007C3K017
Viscosity, initial, (LV 4/60rpm)	1813	1386	1600
Viscosity, 2 weeks equilibrated (LV 4/60 rpm)	2859	2759	2619
pH	4.6	4.5	4.7



Home, Institutional and Personal Care Solutions

NEW!

ACULYN™ Excel

ACULYN™ Excel, high-performing suspending agent

ACULYN™ Excel Rheology Modifier is differentiated from industry benchmarks as it is:

1. **Able to suspend both beads and bubbles**
2. **Has a broader surfactants versatility**
3. **Demonstrates excellent performance** to Acrylates Crosspolymer-4 at all pH including low pH values
4. **Exhibits similar performance to the industry benchmark** (Acrylates Copolymer) at higher pH values – thus enabling brand owners who are covering different pH values to select a more versatile suspension aid.

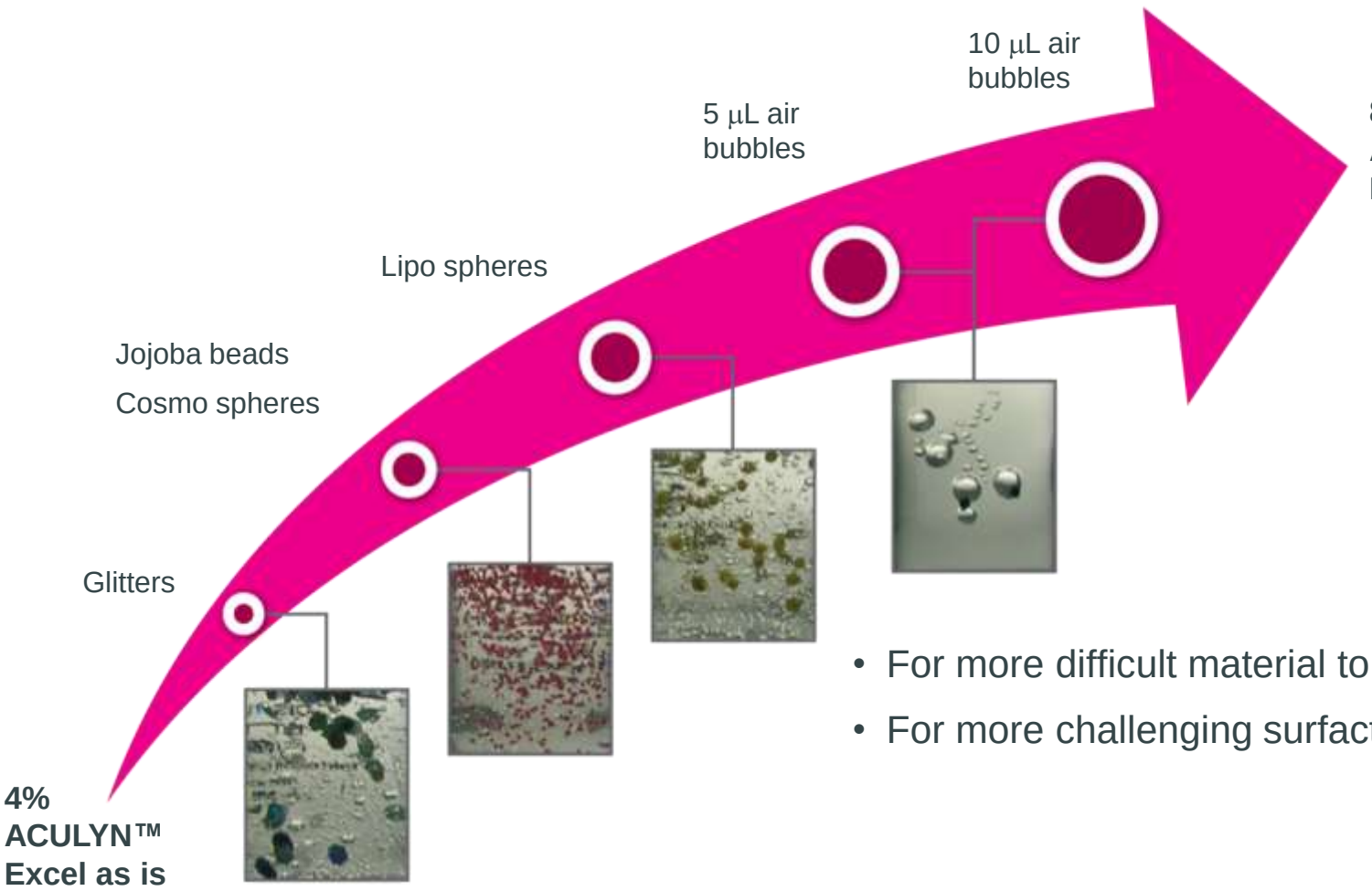
Believe

1. ACULYN™ Excel can suspend both beads and bubbles with excellent clarity

ACULYN™ Excel suspension aid offers clarity at low pH values

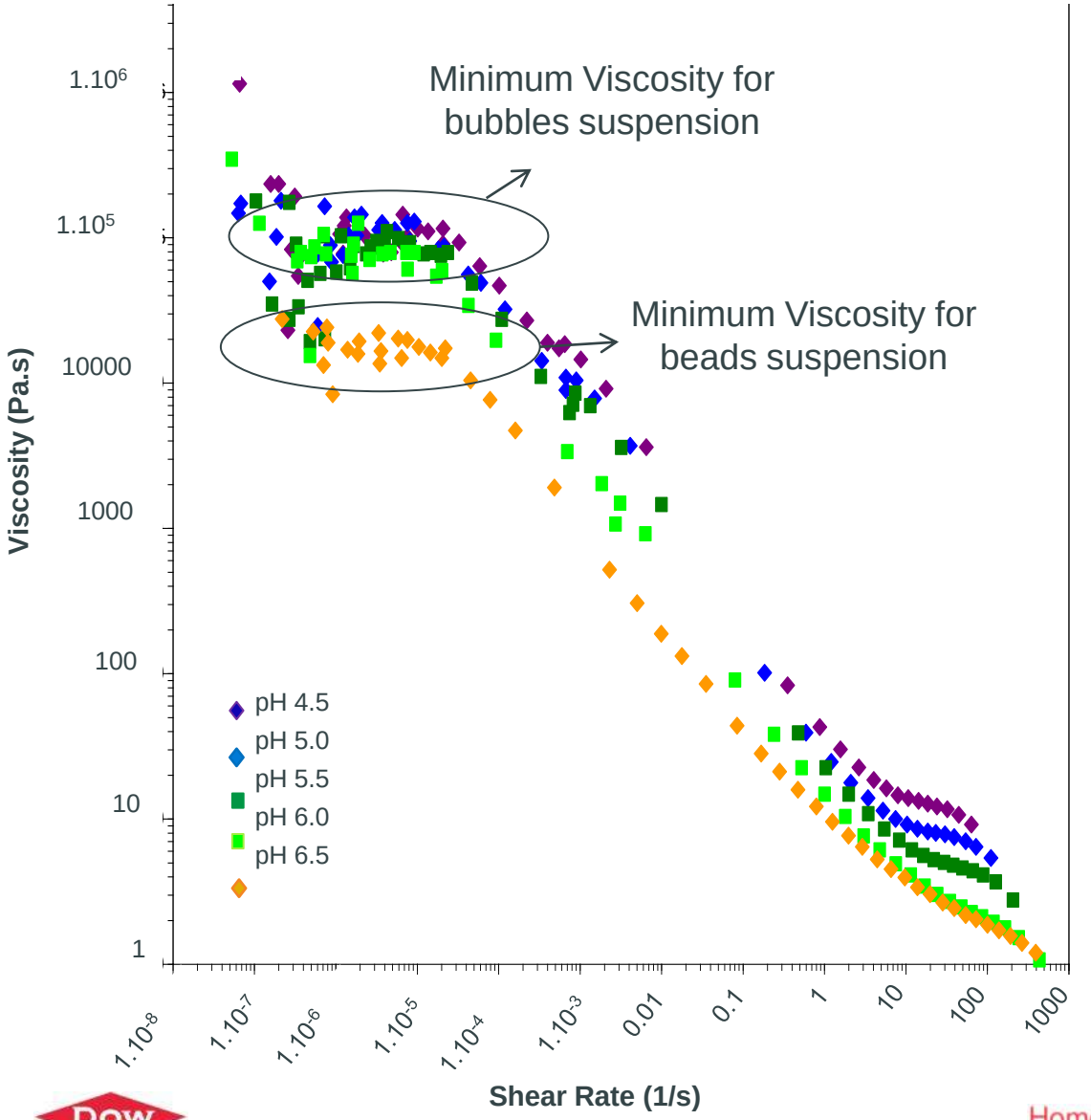
At pH 5.0, 12% surfactant (SLES-CAPB)

ACULYN™ Excel offers truly efficient suspension at low pH values in clear systems



- For more difficult material to suspend
- For more challenging surfactant systems

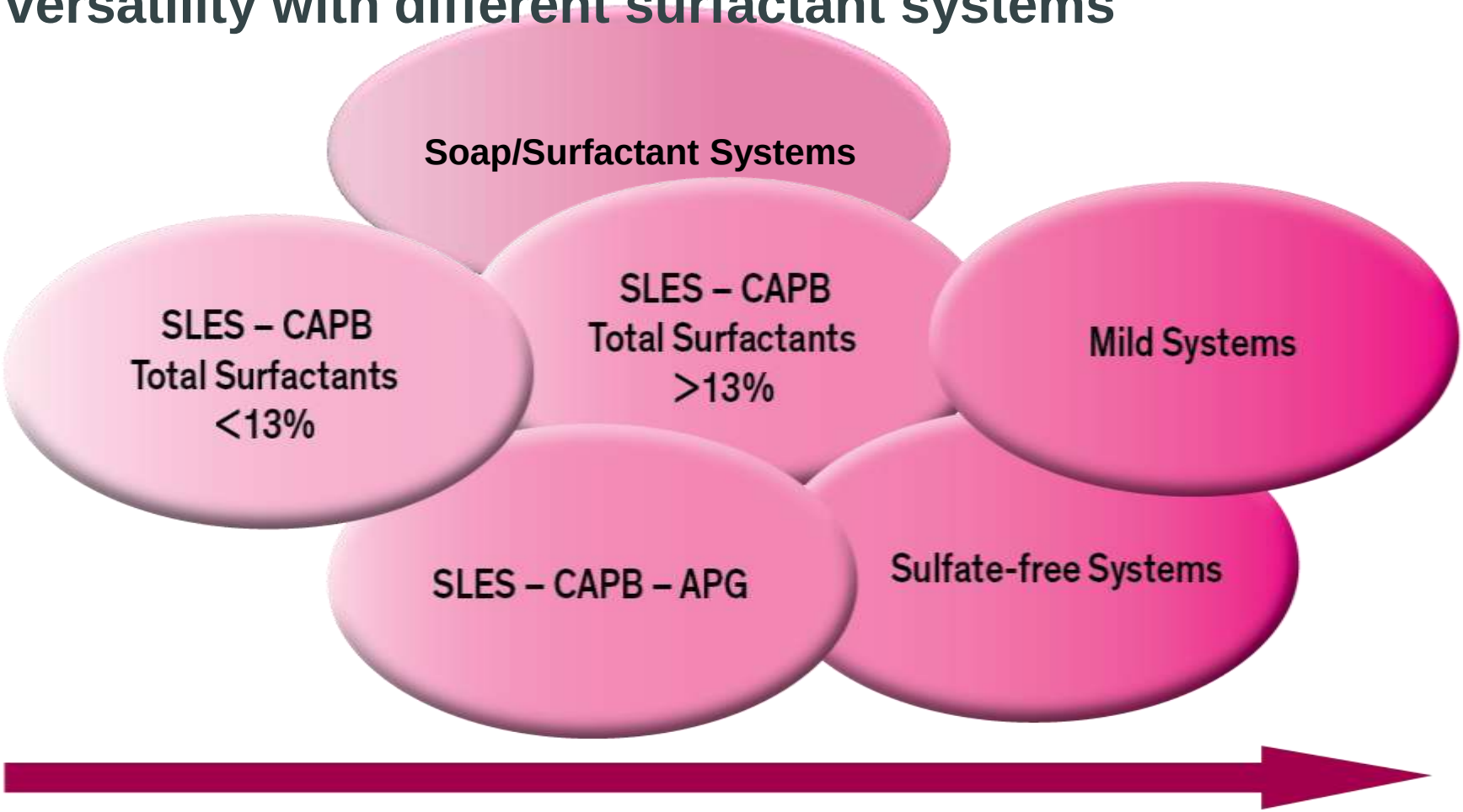
ACULYN™ Excel suspension vs pH



- Good to very good suspension properties whatever the pH
- Efficient through pH 3 to 11

2. **ACULYN™ Excel** has a broader surfactants versatility

ACULYN™ Excel suspension aid exhibits good versatility with different surfactant systems

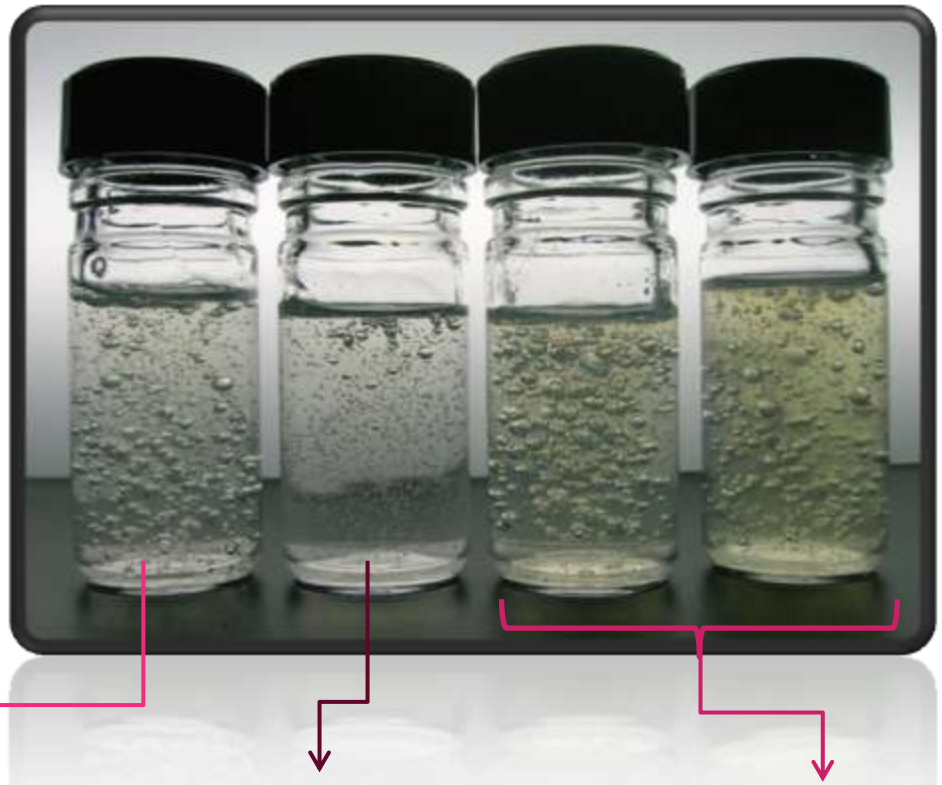


ACULYN™ Excel use levels (4.0–8.0% as is) will depend on both suspended agent and surfactant systems.

3. ACULYN™ Excel demonstrates excellent suspending performance at all pH including low pH values

ACULYN™ Excel retains both suspension performance and clarity at pH 5 with formulation ageing

At pH 5.0, 15% surfactant (SLES-CAPB), 2.2% solids polymer



* aged >6 months at 50°C

ACULYN™ Excel still exhibits suspension and clarity after ageing.

Acrylates Crosspolymer-4 is still clear, but bubbles' suspension disappeared upon ageing.

Suspension is still good, but yellowing is observed upon ageing.

ACULYN™ Excel suspension aid exhibits performance over a wide pH range

ACULYN™ Excel NTU: 15.7	« Acrylates Copolymer » 1 NTU: 6.6	Acrylates Crosspolymer -4 NTU: 6.6	« Acrylates Copolymer » 2 NTU: 4.7

Suspension is also achieved with good clarity at **pH 6.5** with ACULYN™ Excel.

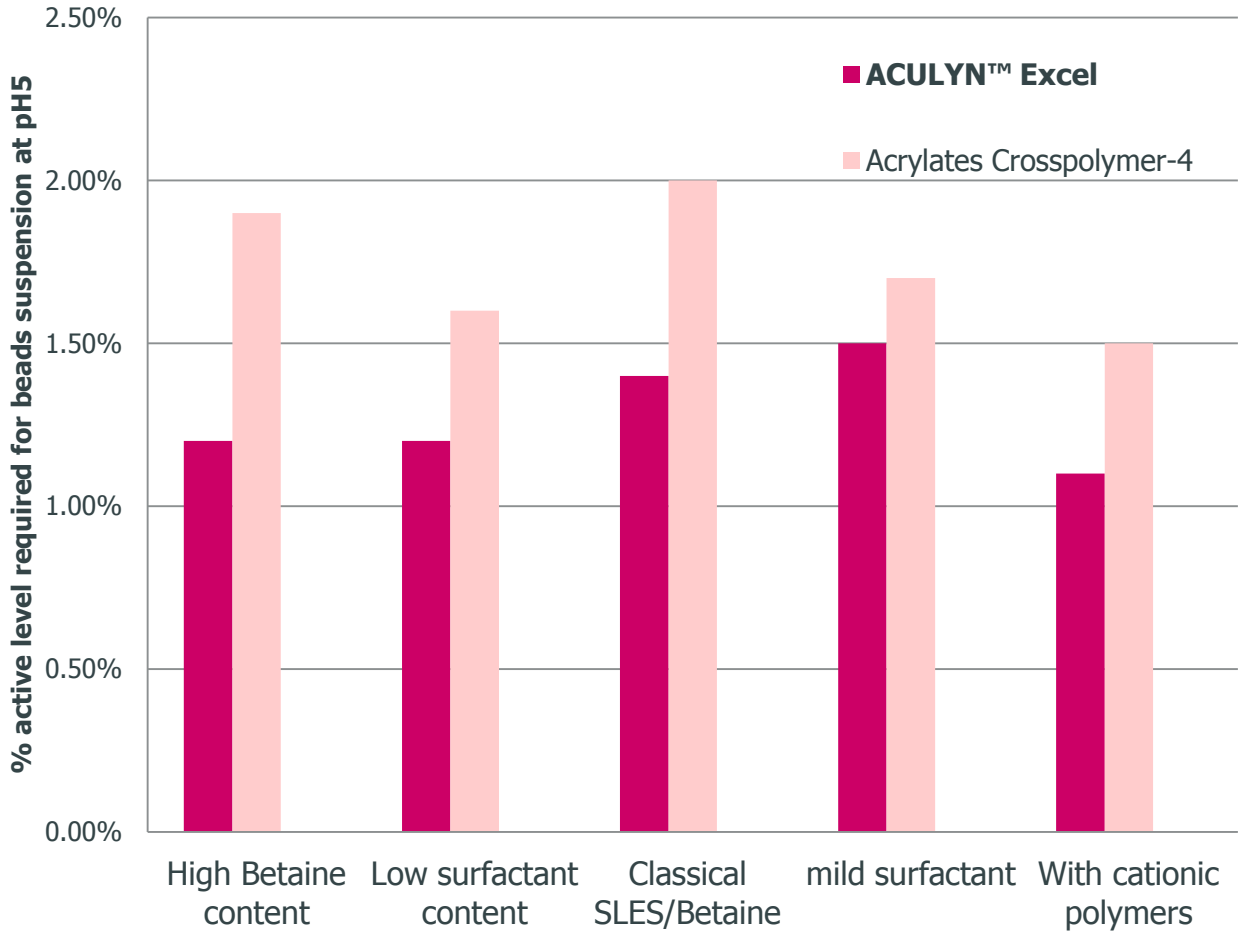
No suspension at **pH 6.5** for these two polymers.

ACULYN™ Excel is an excellent choice for formulators who want to use a suspension aid over a wide range of pH, including the low pH values while delivering clear formulations.

* aged >6 months at 50°C

At pH 6.5, 15% surfactant (SLES-CAPB), 2.2% solid polymer

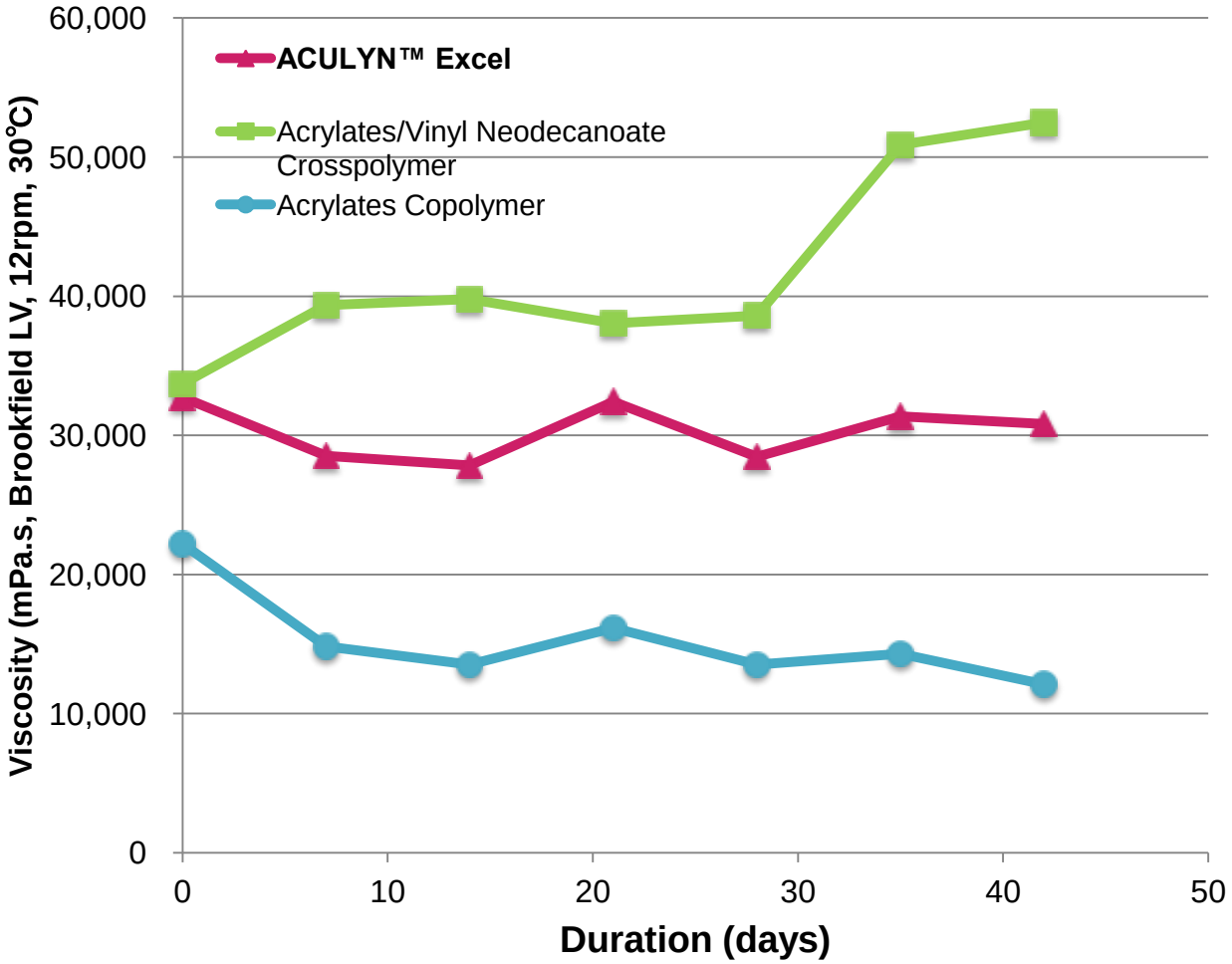
ACULYN™ Excel Rheology Modifier is an affordable solution versus other suspension aids at low pH



ACULYN™ Excel consistently beats the competitive grade in terms of suspension efficiency (lower use levels required) in various surfactant systems.

- **4. ACULYN™ Excel** exhibits similar or superior performance at higher pH values

Performance in Soap/Surfactant System (Viscosity)

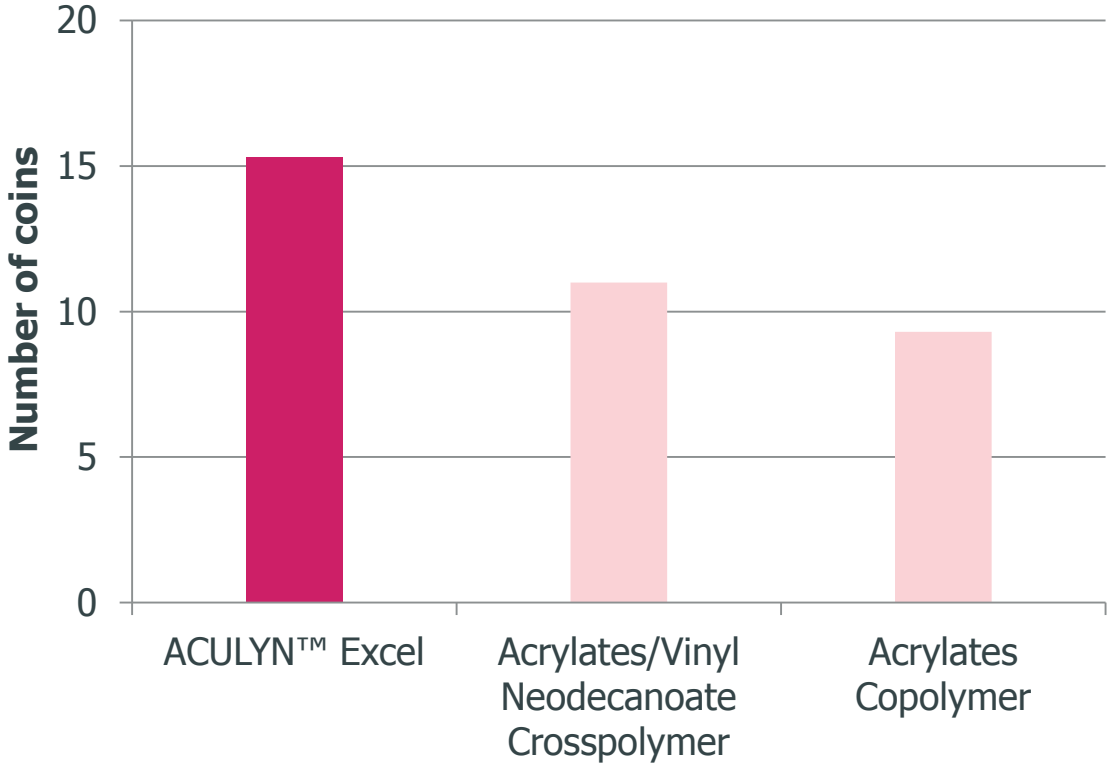


ACULYN™ Excel demonstrates superior stability in terms of formulation viscosity in soap/surfactant system. (pH 8.3)

* aged at 30℃

At pH8.3. 1.8% solid Polymer, 15% Soap, 4% Potassium Laureth-5 Carboxylate, 2% Decyl Glucoside,

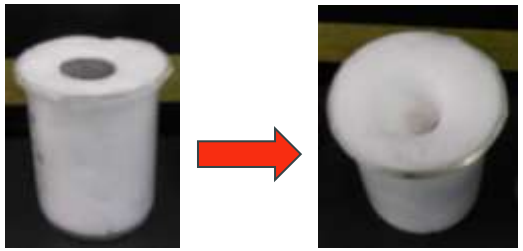
Performance in Soap/Surfactant System (Foaming)



ACULYN™ Excel - containing soap/surfactant formulation generates denser foam enabling milder cleansing.

Test Protocol:

1) Generate foam with 5g of formulated solution and 10g of water by rubbing hands.
2) Fill 100ml beaker with generated foam.
3) Put JPY1 coin (ca. 1g aluminum plate) gently one by one until coins start to fall



Thank You