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# Multifunctional Surfactants – Essential Ingredients for Efficient Cleaning Products

S. Muresan\*, A. Zuberbuehler

## abstract

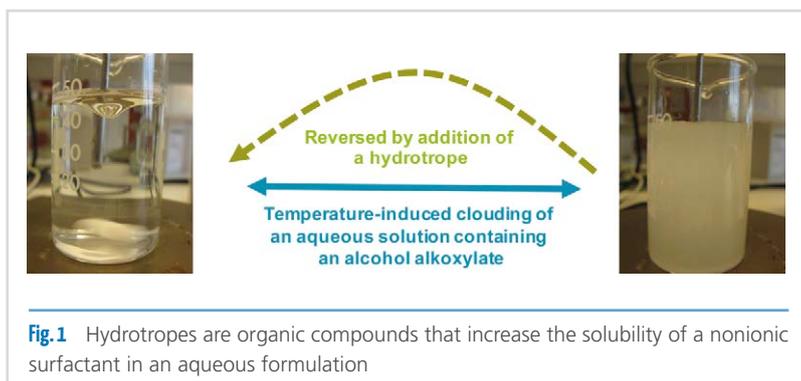
Beyond their solubilizing property, multifunctional hydrotropes or co-surfactants provide additional value to cleaning formulations. The added value of these multifunctional hydrotropes derives from the synergy with primary surfactants due to low application concentrations, foam control, compatibility with high alkalinity/electrolyte content, reduced environmental impact, low environmental and human toxicity. The product portfolio of AkzoNobel Surface Chemistry includes several classes of multifunctional hydrotropes, such as cationic and amphoteric surfactants, alkyl glucosides and alkyl amide ethoxylates.

## Functionality of Hydrotropes

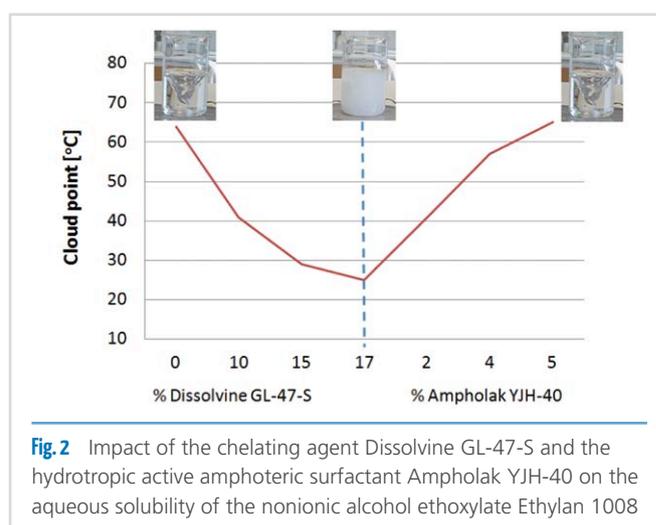
The temperature where water-soluble surfactants become turbid is called cloud point. This is a typical characteristic of nonionic surfactants and the process is reversible. The cloud point increases with increasing the number of EO units (Ethylene Oxide groups) and decreases with increasing the length of the hydrophobic chain and/or with branching.

In the presence of electrolytes (caustics, acids, salts), the solubility of nonionics reduces and the cloud point decreases; the solution destabilizes and becomes turbid. By adding hydrotropes, the cloud point of aqueous solutions of nonionics, and consequently the stability of formulations, is increasing (Fig. 1).

As a typical example of the hydrotropic effect, Fig. 2 shows the influence of an amphoteric co-surfactant – in this case Ampholak YJH-40 (sodium capryl-aminopropionate)– on the cloud point of a solution containing a nonionic surfactant – in this case Ethylan 1008 (C10 alcohol ethoxylate) – and the chelating agent Dissolvine GL-47-S (GLDA-Na<sub>4</sub>, 47%). The initial cloud point of the aqueous solution of 5 wt-% Ethylan 1008 decreases with increasing the amount of the chelating agent. Adding Ampholak YJH-40 to the solution of 5 wt-% Ethylan 1008 and 17 wt-% Dissolvine GL-47-S increases the cloud point.



**Fig. 1** Hydrotropes are organic compounds that increase the solubility of a nonionic surfactant in an aqueous formulation



**Fig. 2** Impact of the chelating agent Dissolvine GL-47-S and the hydrotropic active amphoteric surfactant Ampholak YJH-40 on the aqueous solubility of the nonionic alcohol ethoxylate Ethylan 1008

## Classes of Multifunctional Hydrotropes

The product portfolio of AkzoNobel Surface Chemistry includes several classes of multifunctional hydrotropes. (active content in brackets):

### • Cationic surfactants

Berol R648 NG and Berol R648 PO (quaternary C12-C14 alkyl methyl amine ethoxylate methyl chloride, 60%)

### • Amphoteric surfactants

Ampholak YJH-40 (sodium capryl-aminopropionate, 38-42%)  
 Ampholak XCE (coco iminodiglycinate)  
 Ampholak YCE (sodium cocopropylene-diaminepropionate, 29-30%)

### • Nonionic surfactants (alkyl glucosides)

AG 6202 (C8 alkylglucoside, 65%)  
 AG 6206 (C6 alkylglucoside, 75%)  
 AG 6210 (C8-C10 alkylglucoside, 61%)

### • Nonionic surfactants

Berol SurfBoost AD15 (alkyl amide ethoxylate, 65 %)

Typical hydrotropes, such as cumene (SCS) and xylene sulfonates (SXS), are not surfactants. They are used only for increasing the solubility of surfactants in water, but do not contribute to the cleaning process.

Multifunctional hydrotropes are co-surfactants, which show synergistic effects with primary surfactants. They have high performance at low concentrations, provide foam control, tolerate alkali and electrolytes, minimize impact on the environment and are of low human/aquatic toxicity. These are all examples of additional benefits which, for example, SCS or SXS do not provide.

In line with our sustainability strategy, Planet Possible, Akzo-Nobel Surface Chemistry now also offers Berol R648 PO, an excellent hydrotrope and degreasing booster, effective at very low concentrations. Berol R648 PO has a plant origin provid-

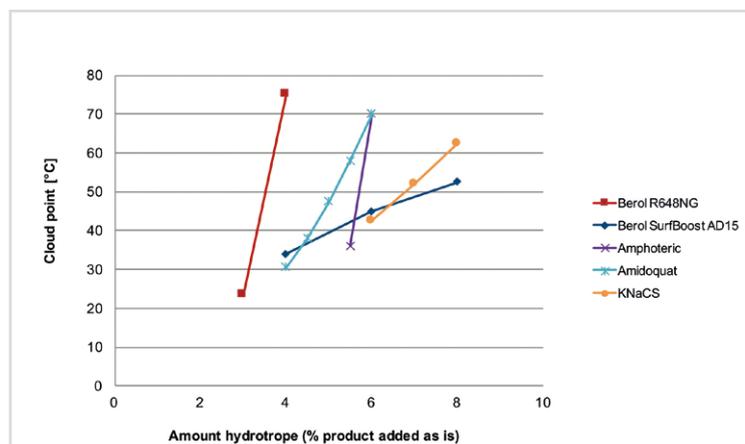
ing a sustainable solution to your customers and it is delivered with an RSPO (Roundtable of Sustainable Palm Oil) Mass Balance certification.

### Increase of Cloud Point

Compared with commodity hydrotropes, such as potassium sodium cumene sulfonate (KNaCS, used as 40 % active solution), co-surfactants feature a significantly better solubilizing property, even in presence of complexing agents (**Fig. 3**).

### Improvement of Cleaning Performance

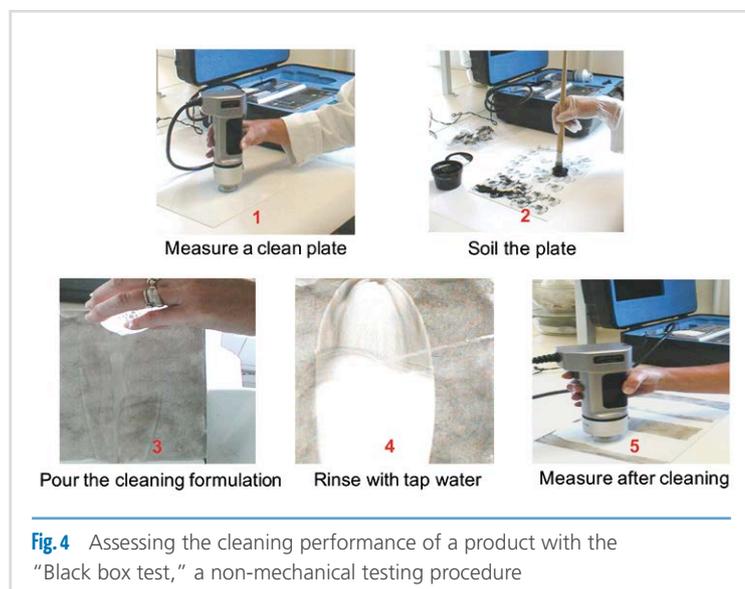
Improved cleaning effectiveness of nonionic alcohol ethoxylates through the addition of co-surfactants can be demonstrated with the so-called “black box test” developed by AkzoNobel. The AkzoNobel test kit is used to evaluate the degreasing effect (non-mechanical efficacy) of a test formulation. The test soil used is petroleum-based grease. The soil is spread on a plate and then the cleaning solution is poured from above onto the vertically positioned plate, and rinsed with tap water. The cleaning performance can be assessed visually or quantified with a portable spectrophotometer. The individual working steps are shown in **Fig. 4**.



**Fig. 3** The increase of cloud point of a nonionic surfactant solution containing a chelating agent by hydrotropes. Base formulation: 5 wt-% Berol 260 (C9-C11-alcohol ethoxylate), 8 wt-% Dissolvine GL-47-S, and X wt-% hydrotrope

### I&I Hard Surface Cleaning Formulations

**Fig. 5** shows the impact of cleaning efficiency using Berol R648 NG in a cleaning solution at low in-use concentration. Formulations contain 5 wt-% of Berol 260, 8 wt-% of Dissolvine GL-47-S and X wt-% hydrotrope to reach a cloud point > 70°C. At a dilution of 1:80 (0.06 wt-% nonionic and 0.05 wt-% com-



**Fig. 4** Assessing the cleaning performance of a product with the “Black box test,” a non-mechanical testing procedure



**Fig. 5** Improved non-mechanical removal of soil with a cleaning solution of nonionic and complexing agent by the addition of the co-surfactant Berol R648 NG. Dilution 1:80, Black box test with diesel engine soil on coated metallic plate

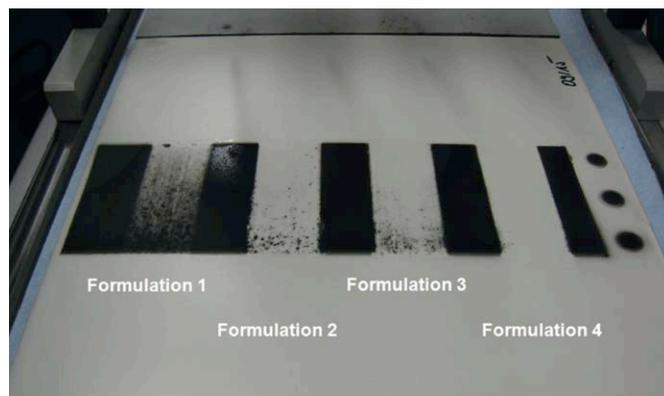
plexing agent), a clean surface is reached only with Berol R648 NG.

I&I hard surface cleaning formulations presented in **Tab. 1** were tested with the IKW test method and the Sheen scrubber.

The test results in **Fig. 6** show an excellent cleaning performance of Berol R648 NG compared with the typical hydrotrope KNaCS.

## Household Hard Surface Cleaning Formulations

Perfect removal of soil is obtained without mechanical cleaning by adding Berol SurfBoost AD15 into a cleaning formulation containing 5 wt-% of Berol 260 and 8 wt-% of Dissolvine GL-47-S. The pH of the formulation is adjusted to 10 with citric acid.



**Fig. 6** Cleaning efficiency of I&I hard surface cleaners described in Table 1 assessed with the IKW test method using the Sheen scrubber. The unique chemistry of Berol R648 NG enables superior cleaning performance at low concentrations (Formulations 2-4)

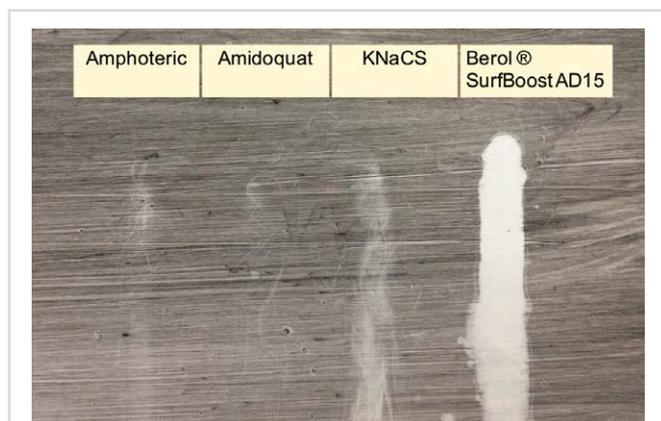
Ingredients	Content (wt-%)			
	Formula 1	Formula 2	Formula 3	Formula 4
Berol 260 (C9-C11 alcohol ethoxylate)	5.0	5.0	5.0	4.0
Berol R648 NG (quaternary C12-C14 alkyl methyl amine ethoxylate methyl chloride)	-	4.5	4.5	4.0
Ethylan 1005 (C10 alcohol ethoxylate)	-	-	-	0.5
Na-Cumensulfonat, 40 %	6.5	-	-	-
Dissolvine GL-47-S (GLDA-Na <sub>4</sub> )	5.0	5.0	5.0	5.0
Alcoguard 4160 (sulfonated multipolymer)	1.0	1.0	1.0	1.0
PnP (solvent)	-	-	3.0	-
Water	ad 100	ad 100	ad 100	ad 100

**Tab. 1** I&I hard surface cleaning formulations. Labelling

**Books**

Mihaela Saller  
 Tel: +49 8281 79940-20  
 Fax: +49 8281 79940-50  
 ✉ bookshop@sofw.com  
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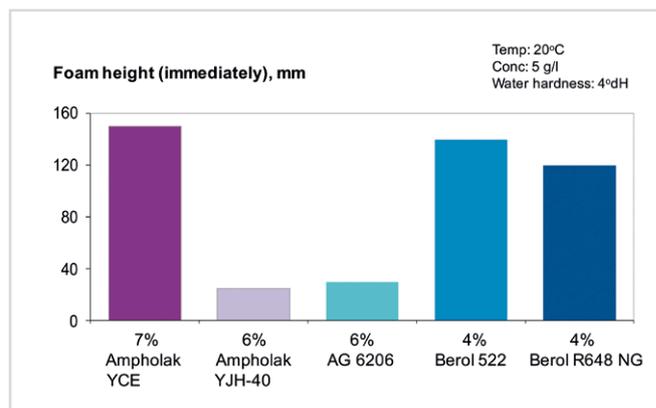
**Fig. 7** Improving the cleaning efficacy of a household cleaner without mechanical impact by addition of the co-surfactant Berol SurfBoost AD15 (Formulation: 5 wt-% Berol 260, 3.6 wt-% Hydrotrope, 8 wt-% Dissolvine GL-47-S, balance water, pH 10 adjusted with citric acid).

**Fig. 7** shows the cleaning results in comparison with different co-surfactants against KNaCS at a dilution of 1:10 on ceramic tiles with “kitchen soil” consisting of 20 % Lambert soil, 50 % corn oil and 30 % water.

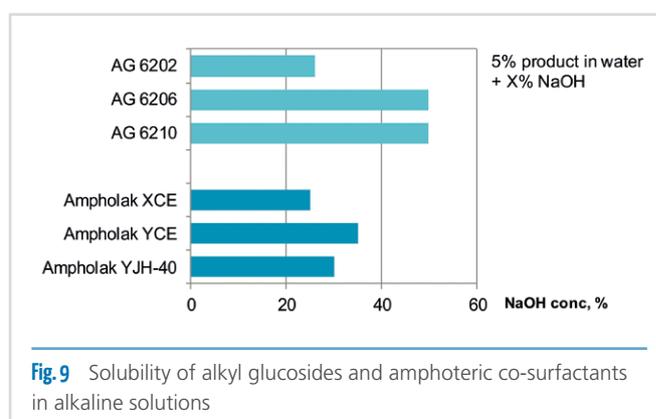
In **Tab. 2**, two non-classified formulations are listed for household cleaners providing an excellent soil and fat removal.

## Foaming Properties of Co-surfactants

The impact of different co-surfactants on the foam profile of a cleaning solution containing a low-foaming nonionic and electrolytes like TKPP and metasilicate is shown in **Fig. 8**. Different co-surfactants have been used, namely Ampholak YCE, Ampholak YJH-40, AG 6202 and Berol R648 NG. Ampholak YJH-40 and AG 6202 give low foaming properties when combined with the low foaming nonionic surfactant Berol 260 (C9-C11 alcohol ethoxylate). If extremely low foam is required, Berol 840 (C8 alcohol ethoxylate) can be used instead of Berol 260.



**Fig. 8** Foaming of a cleaning solution containing a low-foaming nonionic (Berol 260), TKPP and metasilicate by addition of co-surfactants. Formulation: 5 wt-% Berol 260, 6 wt-% TKPP, 4 wt-% metasilicate and the corresponding wt-% co-surfactant for setting the cloud point to 40 °C



**Fig. 9** Solubility of alkyl glucosides and amphoteric co-surfactants in alkaline solutions

## Solubility of Hydrotropes in Alkaline Solutions

Alkyl glucosides and amphoteric hydrotropes can be successfully used in concentrated salt and alkali formulations. **Fig. 9** shows the high solubility of sodium hydroxide in 5 wt-% alkyl glucosides and amphoterics.

Ingredients	Content (wt-%)	
	Formula 1	Formula 2
Berol 260 (C9-C11 alcohol ethoxylate)	1.0	-
Berol 185 (alcohol alkoxyate)	-	3.0
Berol SurfBoost AD15 (alkyl amide ethoxylate)	2.0	1.0
Dissolvine GL-47-S (GLDA-Na <sub>4</sub> )	0.5	-
Citric acid	-	0.5
Water	ad 100	ad 100
pH value	ca. 11	ca. 8

**Tab. 2** Household hard surface cleaning formulations. Not classified

\*contact

Sorel Muresan, PhD | corresponding author  
sorel.muresan@akzonobel.com  
Adrian Zuberbuehler

AkzoNobel Surface Chemistry AB  
Hamnvägen 2 | 44485 Stenungsund  
Sweden