新一代含烷基糖苷基的液碱清洁剂

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摘要：在一些清洗过程中，如食品工业设备清洗，强碱性往往是必要的。目前在高浓度的电解质强碱液体清洗剂中，使用非离子表面活性剂还有一定的困难，特别是以 NaOH 作为碱时，高效协同效应表面活性剂，如烷基葡糖苷，可以应用到高盐含量清洗剂中，高浓度清洗剂可节省包装与运输费。当代技术已发展到一个合理同效应表面活性剂混合物，即烷基葡糖苷与非离子表面活性剂，可应用到强碱液体清洗剂中。

关键词：洗净；烷基糖苷；水溶助长剂；低泡；高碱性
中图分类号：TQ649　　文献标识码：A　　文章编号：1006－7264（2000）S2－0081－05

The New Generation of Alkyl Glucoside Based, Liquid Alkaline Cleaning Systems

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Abstract: In some cleaning applications, e. g. food processing industry, high caustic is required for effective cleaning. Till now, it has been a difficult task to formulate liquid alkaline cleaners with high electrolyte content in combination with efficient nonionic surfactants, and this is particularly true if the electrolyte in use is NaOH. Extremely efficient co－surfactants for formulations with high salt content can be found in the alkyl glucoside range. With alkyl glucosides as co－surfactants, it is also possible to formulate highly concentrated liquid products and hence packaging and transport fees are greatly reduced. The technology has been used to develop well－balance mixtures of alkyl glucosides and nonionic surfactants for use in liquid alkaline and high alkaline systems.

Key words: cleaning, alkyl glucosides, hydrotrope, low foam, high alkaline

In some cleaning applications, e. g. in the food industry, high caustic is required for good cleaning. Up till now it has been difficult to formulate liquid alkaline cleaners with high electrolyte content in combination with efficient nonionic surfactants. It is especially difficult when the electrolyte is NaOH. Extremely efficient co－surfactants for formulations with high salt content can be found in the alkyl glucoside range. With these co－surfactants it is also possible to formulate highly concentrated liquid products and by this save packaging and transportation costs.

This knowledge has been used to develop well－balanced mixtures of alkyl glucoside and nonionic surfactants for use in liquid alkaline and high alkaline systems.

1　Structure－Property Relationship for Some Alkyl Glucosides

In a study, 25 different alkyl glucosides with different chain－lengths, different branching and different degrees of polymerisation have been examined regarding their properties, such as foaming, hydrotropic, wetting, surface tension reduction and cleaning properties. A principal component analysis（PCA）was made on the collected data and these analyses showed a clustering of surfactants into groups due to the structures. To get the best hydrotropic property with the lowest foam, the alkyl glucoside should be based on a short

Received date: 2000－05－08
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—branched hydrophobe.

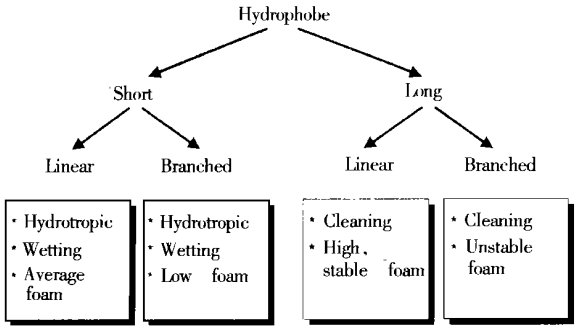

Fig. 1 Alkyl glucosides

2 Alkyl Glucosides as Hydrotropes in High Alkaline Cleaning Products

In order to get a clear and stable liquid cleaning product containing both a nonionic surfactant and a chelating agent or other electrolytes, a hydrotrope is required. Typical hydrotropes are xylene sulphonate, cumene sulphonate, phosphate esters, amphoterics or specific cationic surfactants. Lately alkyl glucosides have been more and more used, not only because they are environmentally friendly but also because of their efficient hydrotropic properties, especially in high electrolyte containing liquid cleaning products.

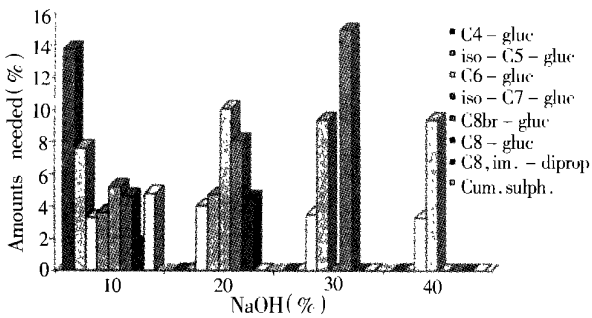

Fig. 2 Hydrotrope efficiency

In some applications it is important to dissolve efficient nonionic surfactants into a high concentration of sodium hydroxide, and this is extremely difficult. Different alkyl glucosides based on C_4 to C_8 linear and branched hydrophobe, have been compared with two conventional hydrotropes, sodium cumene sulphonate and octyl imino dipropionate. The hydrotropic efficiency has been tested in formulations with 5 % nonionic surfactant C_{10} $(EO)_4$ in 10, 20, 30 and 40 % sodium hydroxide solutions.

The result shows an unexpected high hydrotropic efficiency for hexyl glucoside. Hexyl glycoside is the only one that functions in 30 % and 40 % NaOH at reasonable amounts needed to get a clear and stable formulation.

3 Cloud Points

The cloud point of the nonionic surfactant is one of the most important parameters when choosing the right nonionic surfactant for different applications. For an alkyl ethoxylate the cloud point can easily be defined, but for an alkyl glucoside it is almost impossible to find any cloud point in water. The cloud point of the glucoside is extremely sensitive to the concentration. This phenomenon influences the solubility and gives the alkyl glucoside this extremely good solubility in high electrolyte solutions.

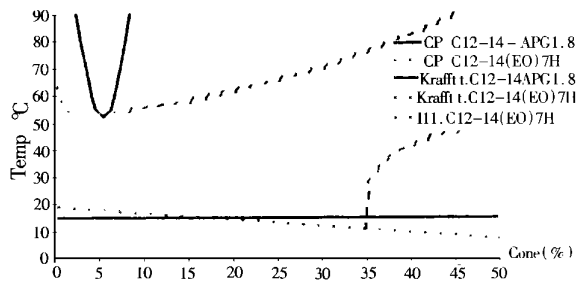

Fig. 3 Phase diagrams of C_{12-14}APG1.8 and C_{12-14} (EO) 7 from Balzer (ref.)

What happens when mixing an alkyl ethoxylate with a low cloud point <0 ℃, with an alkyl glucoside with a cloud point >100 ℃? Mixing these two types gives a clouding behaviour similar to what is shown for the glucoside. This makes it possible to dissolve a nonionic surfactant, with a low cloud point, into a high concentration of electrolyte such as NTA or NaOH.

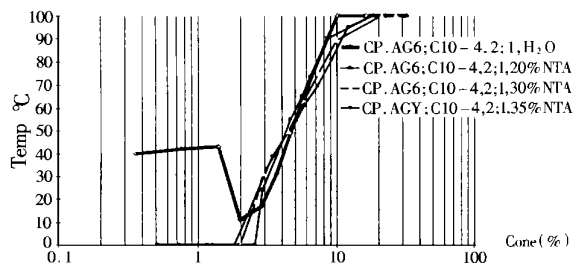

Fig. 4 Cloud point C_6—glucoside and C_{10} (EO) 4, NTA

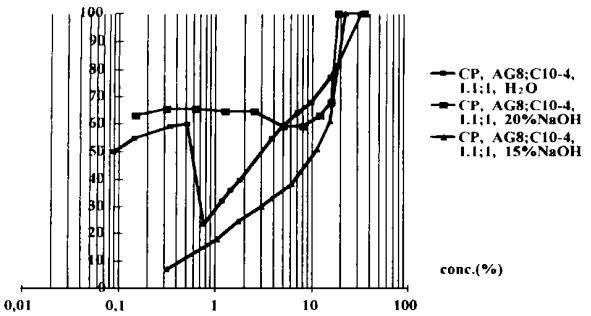

Fig. 5　Cloud point C_8—glucoside and C_{10} (EO) 4 in 20 and 15% NaOH

4　Berol LFG 61 and Berol DGR 81 are a New Generation of Surfactants for Making High Alkaline and/or High Concentrated Liquid Cleaning Products

Berol LFG 61 and Berol DGR 81 are the new generation of environmentally adapted, well—balanced mixtures of short chain alkyl glucoside and alkyl ethoxylates that provide these performance advantages:

— They are soluble and stable in ＞40% NaOH
— They have good wetting and cleaning properties
— They are soluble in high electrolytes
— They are soluble in weak acids

5　Wetting

The surface tension of a NaOH solution is very high, so in a high alkaline cleaner it is very important to get into solution a surfactant with a good wetting property. The contact angle has been measured with a goniometer, one minute after application of a droplet on a hydrophobic surface.

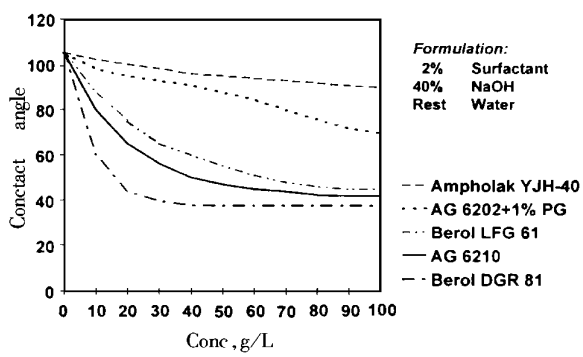

Fig. 6　Wetting on Parafilm

Berol DGR 81 gives very good wetting at 20 g/L in a high alkaline cleaner containing only 2 % surfactant. Berol LFG 61 needs a higher concentration, as the cmc is higher. AG 6210 ($C_{8\sim10}$— glucoside) also gives good wetting, but AG 6202 (C_8— glucoside) and Ampholak YJH— 40 (C_8— imino dipropionate) have rather poor wetting property. (Ampholak YJH—40 is not soluble in 40 % NaOH, only in the diluted solution)

6　Foaming

In many applications low foam is required. It is especially difficult to find surfactants with low foam and good cleaning that also are soluble in high electrolytes. Berol LFG 61 is very low foaming even at high concentrations and the foam collapses immediately. Berol DGR 81 is also low foaming but only at low concentrations or at higher temperatures. The $C_{8\sim10}$—glucoside (AG 6210) that has a good wetting, is high foaming.

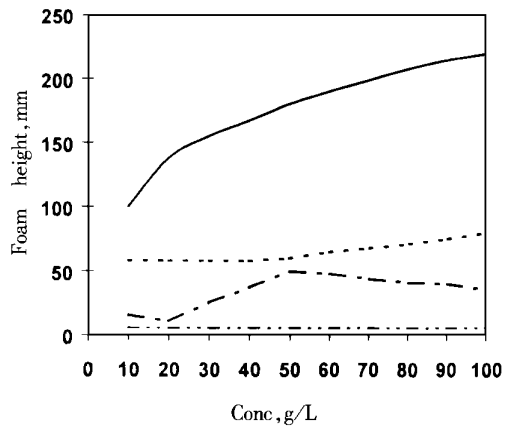

Fig. 7(***a***)　Foaming, 20 ℃

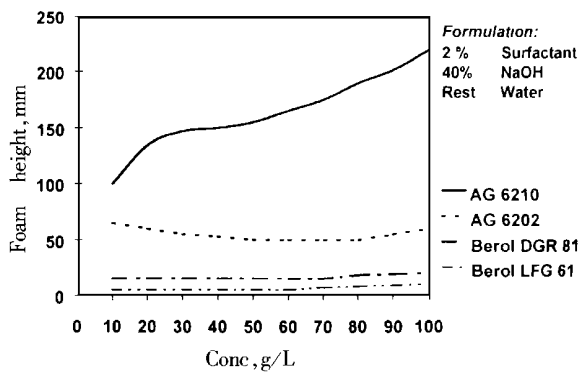

Fig. 7(***b***)　Foaming, 40 ℃

7 De—foaming

In some applications, such as CIP (cleaning in place) it is not enough to have a low foaming product, it also has to be de—foaming. In breweries, dairies and machine dishwashing, high alkaline cleaning products are used, and here it is important not only to clean but also to eliminate the protein foam. In a foaming test, Albumin has been added as a foaming aid and without any surfactant present, only NaOH, a stable foam was formed. When doing the same foaming test, but also adding Berol LFG 61, almost no foam was formed. Berol LFG 61 has de—foaming properties on protein foam.

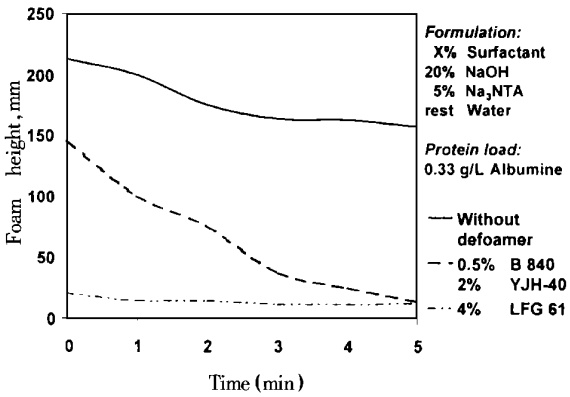

Fig. 8 Defoaming of protein foam, 20℃

8 Cleaning

8.1 Degreasing, mineral oil

In industrial cleaning, very often the dirt contains of mineral oil/grease and particles. To emulsify mineral oil the pH is not important, but to have good dispersing of the particles the pH should be ~11. Traditionally, a high alkaline cleaner is used only by tradition. It is only when the oil/grease is charred and impossible to emulsify that high caustic is necessary to boost performance.

A degreasing test is done where real dirt from an engine is applied on a white plate, the cleaning solution is just poured over the plate without any mechanical force and then the plate is rinsed with water. The cleaning is measured by reading the whiteness of the plate.

Berol DGR 81 (Alkylglucocide/nonionic mix) is almost as good as Berol 226 (Cationic/nonionic mix optimized for degreasing), which is the best surfactant for waterbased degreasing.

Berol LFG 61 also has good degreasing property, but the concentration has to be much higher to reach the same performance as for Berol DGR 81.

A formulation with Berol 260 ($C_{9\sim11}$—EO_4) and Ampholak YJH—40 (C_8 imino dipropionate), as the hydrotrope, was also tested. Berol DGR 81 has a better degreasing property than this, normally very good formulation.

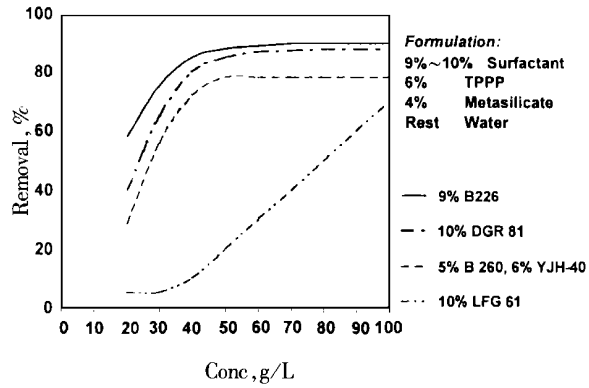

Fig. 9 Lack box text, 20℃

Very often low foam is required for waterbased degreasing in the metal working industry. It is possible to get very good degreasing with low foam using Berol LFG 61 or Berol DGR 81.

8.2 Degreasing, vegetable fat and charred fat

To remove saponifiable fat a high alkaline cleaner is used, as this is a cheap way to clean. Soap is formed from the fat, which then can be rinsed away. An addition of a good wetting and emulsifying surfactant, which is soluble in high caustic, such as Berol DGR 81, will of course increase the cleaning result.

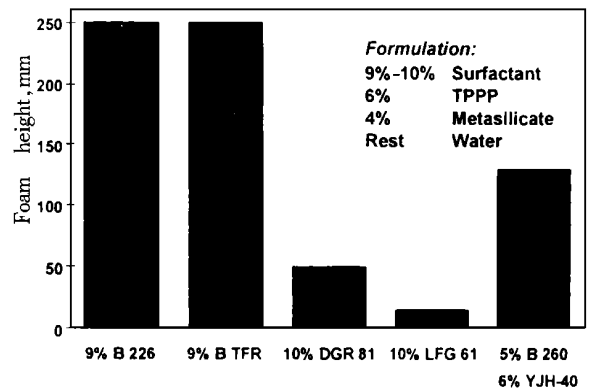

Fig. 10 Foaming, 20℃ (Conc: 50g/L)

To remove charred fat from ovens and grills, a high alkaline cleaner is used. Charred fat cannot be emulsified, it has to be softened by the caustic. It is important to have a good wetting agent to help the caustic penetrate into the fat. Berol DGR 81 is also very suitable for this application.

In some of these cleaning applications, a high foaming product is required. Adding a high foaming amphoteric such as Ampholak XCE will increase the foam for Berol DGR 81.

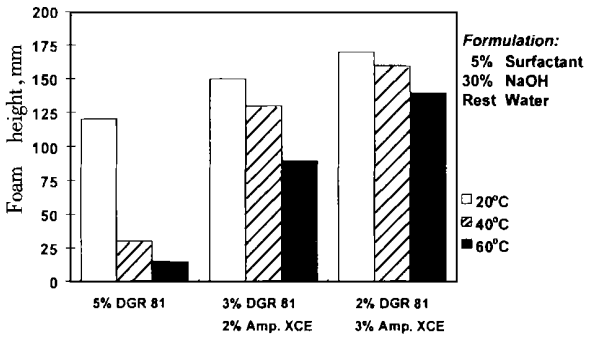

Fig. 11　High foaming caustic formulation (Conc: 50g/L)

9　Pigment Removal and Dispersing

To remove particles and to keep them dispersed in the solution so they do not redeposit onto the surface is important in all cleaning applications. Alkyl glucosides have been found to have very good pigment dispersing property.

In vehicle cleaning, the dirt contains a lot of particles, not only from the road but also from pollution from the air. These particles are extremely small and very difficult to remove in touchless/brushless machines, which have become more and more common today. These small particles that are left after rinsing with high pressure are called the "traffic film". A test was made in a high—pressure machine on dirt collected on plates that were placed on the roof of a car for 6 weeks. Berol DGR 81 was found to be even a little better than Berol TFR (cationic/nonionic mix), which is an optimized blend of nonionic and cationic surfactants, specially developed as a good dispersing agent in this application.

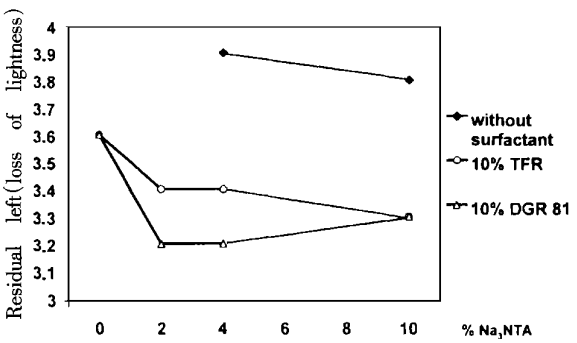

Fig. 12　High pressure cleaning with different amounts of Na_3NTA

10　Formulations

The solubility of Berol LFG 61 and Berol DGR 81 is special. The solubility of these surfactant blends increases when the concentration of electrolytes increases. To get a clear formulation there is a minimum concentration of these surfactants needed to get a clear formulation. This minimum concentration decreases when the electrolytes are added.

Table 1　Formulations　%

LFG61 min	DGR81 min	NaOH	Na—gluconate	Na_3TNA
2	—	40	3	—
3	—	20	5	—
—	2	30	—	—
—	10	—	—	10

This very strange behaviour leads to that a clear cleaning formulation will become cloudy on dilution, (see also point 3). This cloudiness of the diluted cleaner, usually does not lead to a separation. The cleaning property will be at optimum as we are close to the cloud point. Other interesting properties that have been found are that due to this cloudiness, there is low friction (lubrication effect) with manual cleaning and an increased "shine" on the cleaned surface can be recognised.

11　Environmental Data

The aquatic toxicity is very low for the alkyl glucosides, and the biodegradation very fast. Based on this data, these products are considered "readily biodegradable" by OECD standards. Berol LFG 61 and Berol DGR 81 are environmentally adapted for the future.

Table 2　Ecological Data

	Biodegradation	Aquatic toxicity, mg/L Fish	Daphnia	Algea
Berol DGR81				
alkylglucoside	＞70	420	490	＞100
alcohol ethoxylate	＞60	1～10	1～10	1～10
Berol LFG61				
alkylglucoside	＞70	420	490	＞100
alcohol ethoxylate	＞60	＞10	1～10	1～10
AG6202	＞90	＞300	＞100	＞100
AG6210	＞60	＞10	＞10	