Builders for Synthetic Detergents

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COMPOUNDS which assist the soaps in their detergent property have come to be called 'Builders'. Such builders have been added to the Synthetic detergents almost from the days of their introduction in industry. In fact, the use of synthetic detergents without builders is very rare except in some cases of non-ionic detergents, in textile industry. A hundred per cent pure synthetic detergent has been found to be inefficient in practice.

The commonly used builders can be classified as below:—

1. Alkali Salts—
   - (*a*) *Cabonates* (Soda ash, modified soda. Sodium Sesquicarbonate).
   - (*b*) *Silicate* (meta-, Sesqui—and Ortho-)
   - (*c*) *Phosphates* (Tri Sodium Orthophosphate, Sodium hexametaphosphate, tetrasodium pyrophosphate, Sodium tri-polyphosphate, Sodium tetraphosphate).
   - (*d*) *Borates* (Sodium tetraborate).
2. Alkali hydroxides (Sodium hydroxide).
3. Neutral inorganic salts (Sodium sulphate, Sodium Chloride).
4. Colloidal additives (Bentonite, Water glass, Carboxy methylcellulose, proteins, amino acids, modified celluloses, water-soluble Cellulose ethers, peptides).
5. Solvents (pine oil, petroleum fractions, chlorinated solvents).
6. Sequestering agents (Sodium Salts of polyamino carboxylic acids).
7. Whitening Agents.
8. Foam Extenders (Alkylol amides of fatty acids).

The effect of each class of builders on the synthetic detergents is discussed here.

Alkaline builders exert their effect by virtue of their alkalinity. Soaps in aqueous solution tend to hydrolyse and form acid soaps that are adsorbed on the fabric. The fabrics thus get soiled rather than cleaned. Prevention of hydrolysis is the most important function of alkaline builders. In actual practice, at use concentrations, the various builders provide the following pH ranges:—

Hydroxide ..	.. 12.8
Carbonates ..	.. 10.1-11.2
Silicates ..	.. 12.0-12.6
Phosphates ..	.. 7.6-11.7
Borates ..	.. 9.2

Investigations by Snell[1,2] indicate the importance of control of hydrolysis of soap by pH adjustments.

The water-softening effect of these builders is also indirectly responsible for increasing the efficiency of detergents. They prevent the deposition of insoluble calcium and magnesium soaps. The builders, in effect, tie down the calcium and magnesium ions. This is particularly

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true of sodium hexametaphosphate which is sold under the trade name of calgon. In aqueous solutions, there is formed a sodium ion and a complex anion containing sodium. The anion then reacts with calcium or magnesium ion from hard water by exchange of the sodium for calcium or magnesium ion and thus effectively removes calcium or magnesium ion from solution. Miles and Ross[3] who have compared various builders consider water-softening as the most important action of builders where soap is used as a detergent.

The builders are not generally regarded as surface active—that is they do not reduce surface tension at the solution-air interface. On the contrary, the aqueous solutions of most of the builders have surface tensions higher than that of water, indicating negative adsorption.[4] This arises from more intense fields of attractive forces surrounding their ions, than the water molecules, resulting in a tendency to draw the ions into the body of the solution. The opposite effect occurs with organic detergents. Inspite of this in actual practice, builders in combination reduce the surface tension more than the surface active agent alone. The effect of builders in reducing interfacial tension between detergent solutions and oily matter in the soils is of considerable importance in cleaning.[5] This facilitates removal of oily soil by emulsification. This effect is particularly pronounced in the case of phosphate and silicate builders.

Builders may also affect the action of detergent systems by ion-exchange with soil components and modification of electrical charge on soil and substrate. Sanders and Lambert[6] have shown that with synthetic detergents and cotton fabric, the above mentioned factors are involved more in the building mechanism than changes in the surface activity of the detergent.

Another factor which must be considered is the action of builders in preventing redeposition of the soil. Perhaps inorganic builders effect redeposition through modification of electrical forces between soil and fabric (substrate) and in some cases by protective colloid action. Inorganic builders that have polyvalent ions, for example, polyphosphates and silicates, are superior to others.[7]

The neutral inorganic salts, particularly, sodium sulphate, are extensively used. The presence of sodium sulphate in practically all anionic detergents is due to sodium hydroxide required to neutralise the excess sulphuric acid used in sulphonation, particularly, the alkyl sulphates and alkylarylsulphonates. Harris[5] states that in the case of dodecylbenzene sodium sulphate, with certain reservations, the neutral salts improve foaming, wetting and detergency properties. The effect appears to involve micelle formation by coagulation of colloids by oppositely charged ions. These neutral inorganic salts also improve the detergency of soaps. But if large amounts are used, the effect is reversed, probably due to an actual salting out of the soap, preceded by the formation of large micelles.

Colloidal Additives

The colloidal additives that are used as builders form true colloidal dispersions in the bath. The oldest is 'bentonite' and various other colloidal clays. Their main function is to adsorb the soil, as it is removed, and prevent it from redeposition on the fabric. Bentonite is also well known for its emulsifying power. However, the most important of this class of builders in respect of cotton detergency, is sodium carboxy methylcellulose, commonly known as CMC. A review of its development and appliction in Germany, where it was first introduced and known as Tylose HBR is described by Hollabaugh[8] *et al.* The effectiveness of CMC in improving the overall detergency is, to a great extent, due to its ability to prevent redeposition of solid.[9,10,11] Although as stated previously, the effectiveness of CMC is due to its prevention of soil redeposition it also improves soil removal properties. The soil removal caused by the alkaline builders is further improved by CMC. Recently, a study by Stupel[12] on the builder action of CMC using Fluorescence Microscopy, showed that in laundering process, CMC is not adsorbed by the fibre, but becomes visible by being attached to the soil. At high concentration in acid media, CMC is brought on to the fibre.

Other products having the same general functions but of considerably less commercial importance are water-soluble cellulose ethers,sodium starch glycollate, methyl ethyl and hydroxyl ethyl cellulose and various proteins and protein derivatives. The peptides and amino acids act by reducing the surface tension of the surface active agent. Lecithin has been claimed to improve the emulsifying and foaming properties of soaps.

Solvents:

Solvents, such as pine oil, petroleum fractions and chlorinated solvents, are used, particularly, when the soil to be removed is extraordinarily heavy and is greasy in nature. They probably function by dissolving the greasy soil, thus rendering it fluid and easy to be removed by emulsification in aqueous phase of the bath. The solvent is usualy added to a concentrated stock solution of the detergent, in which it forms a stable emulsion. The solvent remains emulsified in the diluted bath.

Sequestering Agents:

Sequestration is defined as the formation of soluble complexes of metal ions in presence of chemical agents that would normally produce precipitates in aqueous solutions.[13]. . This, when applied to synthetic detergents, means the solubilization in water of precipitates of metal ions. So, the compounds, capable of binding metal ions so that they no longer exhibit their normal reactions in the presence of precipitating agents, are known as sequestering agents or sequestrants.

Commercially available sequestering agents are generally classified as organic or inorganic. The condensed polyphosphates are the most widely used of inorganic sequestering agents. They have been already referred to above. Of the organic seauestering agents, two groups are of economic importance. They are the amino-polycarboxylic acids, such as ethylenediaminetetra-acetic acid, EDTA, and the hydroxy carboxylic acids such as gluconic acid, citric acid, and tartaric acid. Lignin, because of its phenolic hydroxylic group, has been suggested in dissolved form as a sequestering agent for calcium and magnesium ions in systems containing soaps.

Whitening Agents:

These are extensively used in products intended for household laundering. They are stilbene derivatives substantive to fabrics. They function by absorbing ultraviolet light and emitting in the blue region of the spectrum. This masks the yellowish tone of the fabrics resulting in a brighter and whiter appearance. They are very largely used for cottons and woollens. Special types have been produced for use on synthetic fibres.

Foam extenders:

Foam extenders are used because of their effect in extending the capacity of the solution to solubilise grease without loss of foaming. For this, alkylolamides of fatty acids are extensively used.

From the above it will be seen that a variety of products have been used up to build synthetic detergents. The manufacture of better products, eventually, depends on the better understanding of the fundamentals of detergency process.

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