Technical News Feature

Soaps and Detergents and the Environment[1]

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ABSTRACT

For more than a quarter of a century there has been a constantly growing awareness of, and interest in, the effects of the detergent industry, by the nature and use of its products on the environment. This interest has largely been in terms of the aquatic environment, but also, as with other industries, in terms of other socioecological issues. This paper concentrates on a review of detergents and their components, both organic and inorganic, and their impact on the aquatic environment in different parts of the world. It deals in particular with sodium tripolyphosphate, a major inorganic component in detergents, and presents an up-to-date and critical review of technical, environmental, sociological and legislative aspects of this product on a worldwide basis and a comparison of it with some of its proposed partial substitutes.

The latest statistics produced by Henkel indicate a world production of our products of some 25 m tonnes, as shown in Table I:

TABLE I

World Production of Soaps and Detergents, 1977 (million tonnes)

Western Europe	6.30
Eastern Europe	2.77
North America	6.91
Latin America	2.29
Oceania	0.27
Africa	1.01
Asia	5.48
Total	25.03

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Table II is a breakdown by product type:

TABLE II

World Production of Soaps and Detergents by Type, 1977 (million tonnes)

Soaps	8.05
Soap powders	0.45
Syndets – powder	7.48
Syndets – liquid	4.47
Scouring cleaners	0.61
Other cleaners	1.83
Unclassified	2.14
Total	25.03

Until fairly recently, water resources were considered to be infinitely self-renewing and were widely used for dumping waste materials. Indications of problems arising from such a policy were the ecological hiccoughs of the past 25 years, coinciding with rapid growth in our industry.

Increasing domestic water use, resulting from postwar rehousing programs and a higher standard of living was responsible, especially in Western Europe, for creation of a need for efficient water management, particularly in sewage treatment and the greater re-use of water to ensure our drinking water supplies—quite apart from esthetic reasons.

Our industry was first concerned with liquid and gaseous factory effluents, then technical advances enabled replacement of highly alkaline products by less harmful ones; problems of enzyme incorporation were overcome by improved industrial housekeeping and personnel monitoring.

However, the major environmental impact of our industry has been, is, and will be on water cycles.

During the period 1949-1955, foaming of rivers and sewage works reached major proportions and posed both a nuisance and a public health hazard in many countries. Industry faced up to its responsibilities, developed, tested and made available more readily biodegraded alkyl benzene sulfonate surfactants yielding nonfoaming residues—these products, now in use for 15 or more years, resulted in a great reduction in the foaming of our waters.

Reformulation, using alcohols, either as sulfates or as ethoxylates or their sulfates, has, in many cases, even further reduced the chance of foaming and residue problems.

Two inorganic components of detergents influence the water cycle. Sodium Perborate has been increasingly used over the years and its boron content may cause problems in specific cases. It is used more in Western Europe than in North America and its substitution by percarbonate and the incorporation of activators to give lower temperature bleaching from less perborate will alleviate the situation. The other product is sodium tripolyphosphate (STPP), the subject of much technical and political argument.

After a period of quiet on the environmental front with the solution of the foaming problem, there was a steady growth of the detergent industry but pressures built up regarding other aspects of the environment and the quality of life. A problem highlighted, in particular in the US, Canada, Sweden and Switzerland, was eutrophication, and its link with phosphates was established.

I will not detail the many technical and political discussions as to the cause and possible solution of the problem. However, two factors are important: (a) Water cycles in different geographical regions, countries and even parts of countries vary. For example, in Europe, sewage is generally concentrated, large areas are densely populated and there is widespread re-use of water. In North America, particularly around the Great Lakes, sewage is more dilute and receiving water bodies are larger, and there is little need for the re-use of water; (b) where eutrophication is a problem, there is, by definition, an abundance of all necessary nutrients—the Vollenweider figure of 0.01 ppm of phosphorus is still a general guide to the critical level for algal growth and in many cases is impossible to achieve.

While many discussions have taken place on the contribution of various sources of phosphate to receiving waters, it is worth noting that a human being excretes about 1½ grams of phosphorus per day, a cow 26 grams, a pig 7 grams and even a hen 0.9 grams—not to mention other birds—much of it ending up in surface waters.

Eutrophication is not considered to be a problem, nor are there any pressures against STPP in the United King-

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dom, Ireland, Sweden, France, Spain, Portugal, Denmark, Austria, Belgium and many other major countries.

In the United Kingdom, many of our rivers can contain 5 ppm of phosphorus—even a two-order of magnitude reduction would not approach the Vollenweider figure, a point acknowledged by the United Kingdom Government's Standing Technical Committee on Detergents. With such water, it is no surprise that when impounded in reservoirs, algal blooms can occur. The Metropolitan Water Board, now the Thames Water Authority, responsible for sewage treatment and for the manufacture and supply of drinking water for Greater London, has treated such waters for many decades. Using good water management practices and good reservoir design, it has found it necessary to curtail supplies on only four occasions during this century on account of algae.

Algae are a problem in the Norfolk Broads, and in Lough Neagh in Northern Ireland. Phosphate removal at sewage works in the affected areas is the approach being taken for domestic inputs in these places.

The position of the Standing Technical Committee on Detergents is that there is no need in the United Kingdom to consider the curtailment of the use of phosphate in detergents. There is no completely satisfactory substitute for it, nor is one necessary in the United Kingdom. Furthermore, any potential substitute would need to be extensively tested under United Kingdom conditions to satisfy our authorities as to its safety and noninterference with sewage works' efficiency or drinking water preparation.

In Sweden, the eutrophication problem was debated in the mid 1960s and it was decided to construct sewage works with phosphate removal facilities and to identify and reduce phosphorus inputs from nonpoint sources. Dr. Bouveng, the Swedish environmental expert, commented at the World Conference on Soaps and Detergents in Montreux in 1977: "The matter of detergent phosphate as the main culprit was brought forward in the more popular part of the discussion of remedial measures. The Swedish authorities concluded, however, that there were clear disadvantages in making the detergent phosphate a major issue, the principal one being a risk that a number of communities would then feel justified to postpone expenditure on extended sewage treatment."

In Sweden, sewage treatment plants now cover almost 100% of the urban population, 80% having phosphate removal facilities. Some of the lakes have been dredged and anoxic waters aerated. There is now no euthrophication problem in Sweden.

The maximal level of STPP voluntarily accepted in this soft water country is 7.5% P (30% STPP). Voluntary limits for detergent phosphate levels of 5.5% P (22% STPP) are agreed upon in Norway and 6.5% P (26% STPP) in Finland, both soft water countries.

In Germany, problems have arisen, particularly with Lake Constance and some smaller lakes and reservoirs. Construction of sewage works with phosphorus removal facilities in the affected areas was agreed upon and around 150 plants are now operational; by the end of 1980, over 200 will be on stream, many of them in areas unaffected by eutrophication because of improved sewage works operation resulting from this process.

Voluntary dosage recommendations permit the use on average of a maximum 37% STPP in German detergents and after many discussions, the expected German government phosphate order restricting the level of phosphates in detergents has still not been promulgated.

In Holland, the Ministry of the Environment has been pressing for the replacement of detergent phosphates and giving priority to the installation of phosphate removal at sewage works in the one-third of the country most affected by eutrophication. At present there is no legislation in Holland.

In Switzerland, over 200 sewage works, with phosphate removal, now discharge effluents conforming to a 1 mg P/liter limit. Some eutrophication problems still occur and discussion on improving effluent quality, and further limits to detergent phosphates from the current approximately 25% STPP average level for heavy duty detergents, is proceeding.

In North Italy, four of the provinces of Emilia Romagna, a major source of effluents going by way of the River Po into the coastal Adriatic Sea, have agreed on an experimental voluntary 5% P limit—20% STPP—in detergents. The Region intends to submit a proposal for national legislation along these lines. Sewage works are being constructed, for example in Bologna, but a major problem in the coastal Adriatic is pollution from large resorts with a dramatic increase in human sewage at holiday periods; and from uncontrolled discharges from intensive animal breeding units in the Po Valley. These have led to sporadic algal blooms.

In France, the government, having surveyed its rivers, takes a relaxed attitude towards such eutrophication as exists and no detergent phosphate reduction has been called for.

In Spain, river and reservoir water qualities have been monitored with no indications of any activity against detergent phosphates.

In Japan, Shiga Prefecture—about 1 million people—contains Lake Biwa which supplies some 13 million people with water. Detergents represent a minor contribution to phosphate loading but as part of a campaign, the local authorities propose introduction of zero phosphate legislation in that prefecture from July 1, 1980, together with some expenditure on sewage treatment facilities.

In Venezuela, STPP contents of detergents are to be regulated from 20% P_2O_5 in 1980 (35% STPP) to 10% P_2O_5 in 1895 (17.3% STPP), because of eutrophication of Lake Valencia. Many products in Venezuela, however, already contain low STPP levels.

The North American situation is familiar to most people.

In Canada, we have a mandatory 2.2% P (9% STPP) maximum, and the installation and operation of sewage works with phosphate removal in the Great Lakes catchment area. Nitrilotriacetic acid is permitted and used up to around 15%.

In the United States, we have zero phosphate legislation in the Great Lakes States and sewage works with phosphate removal operating, or under construction. I have seen no evidence of improvement in eutrophication in the United States resulting from zero phosphate legislation. The rest of the United States is virtually unaffected, several States operating to an 8.7% P (35% STPP) limit.

Many substitutes for STPP have been proposed but only two—nitrilotriacetic acid and zeolites—remain as possibilities. To those seeking a quick reaction to the eutrophication problem, the use of these products appears attractive. However, on examination, this is not the case. STPP possesses many valuable properties, being: nontoxic and harmless to human beings; cheap and available in many countries; a good sequestering agent for calcium and magnesium ions; a suspending agent for removed soil; an emulsifying agent for oily and greasy soil; a buffer at an ideal pH for detergency; readily soluble; noncorrosive or abrasive.

Nitrilotriacetic acid, used in combination with STPP, produces products with reasonable performance levels. Its use is permitted in Canada and it is used to a limited extent in Sweden where, however, the detergent makers have, over the years, preferred to use STPP.

In Canada, a relatively small tonnage user, and where effluents are discharged into large bodies of water, with limited re-use for the preparation of drinking water, it can be considered as being an egg-cupful in an ocean. Problems which might arise from variable biodegradability and resultant heavy metal chelation are over-weighed by massive dilution.

In the United Kingdom, Germany and Italy, receiving waters are generally small, subject to wide variations in flow, and often re-used several times for the preparation of drinking water. Laboratory work in the United Kingdom demonstrated that nitrilotriacetic acid possesses chelation properties such that when biodegration is incomplete, it can extract heavy metals from sewage sludges with consequent risk to human health when the water is subsequently used for drinking purposes. In these countries, much more consideration would be necessary before widespread use of this material could be approved.

In the United Kingdom, the Government's Standing Technical Committee on Detergents recommended in its 12th Report in 1971 against the use of nitrilotriacetic acid without extensive testing, and has not changed its position.

Zeolites are insoluble, so their particle size needs careful control to minimize ash build-up on fibers with consequent loss in strength and fiber damage. They are not claimed to be as effective in their performance as STPP, nor are they claimed to be complete replacements for it—a point substantiated in our laboratories using European detergent formulations and washing conditions. Their effects on sewage works operations have not as yet been evaluated on a major scale.

I hope this resumé of an emotive subject, complicated by political and technical considerations, will be of interest.

STPP is an essential and vital building block for good quality, low-priced household detergents which the housewife can use economically. There is no fully tested and completely satisfactory replacement available.

Detergent phosphate contribution to phosphate loadings is highly variable from place to place.

Improved and cheaper methods of sewage purification have been developed and the means to effect phosphate removal at sewage works is now widely practiced in many countries.

In my view, governments must face up to their responsibilities in respect of human health and sanitation, for which adequate sewage treatment facilities and water management are essential. The housewife should not, for political purposes, be deprived of products she has grown to accept as necessary in improving her living standard. It is my belief that: (a) problems arising from eutrophication and their association with detergent phosphates are always local and are never national; (b) they cannot be resolved by simplistic legislative controls over one of many phosphorus inputs; (c) it is essential to prove under long-term and specific water cycle parameters the safety and acceptability to sewage works' operation and drinking water preparation practices of any proposed substitutes. I would ask those authorities concerned to give consideration to these factors.

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