DETERGENTS AND WATER

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One of the blessings of civilization is the appreciation of cleanliness and to most people this means soap and water, or in today's world more correctly detergent and water. For out of the turmoil of supply and demand associated with World War II, there came a cheap, efficient cleaner or detergent perfected almost simultaneously in the research laboratories of Germany and America and derived from an abundant raw material, petroleum.

This new detergent--Alkylbenzene Sulfonate or ABS--could be readily made from petroleum in almost any desired quantity at stable, economically attractive prices. In addition, it was more efficient than soap. It didn't form precipitates with hard water leading to the familiar ring in the bathtub. It didn't form curds in slightly acidic water. In fact, it could be used in almost any kind of water to give a solution having the same acidity (pH) as the water itself. Soap always is alkaline. This meant that detergents could be made neutral, a most desirable property which permitted their use for washing fibers like wool without causing shrinking. Also, these neutral cleaners were shown to be easier on the hands.

Finally, ABS was found to be more soluble in water than soap, and washing and rinsing processes could be carried out at lower temperatures with equal or better results.

With all these favorable features, it is hardly any wonder that within a few years after their introduction synthetic detergents largely replaced soap in the cleaning compounds sold, not only in the United States, but all over the world.

The problems of making specific products having not only utilitarian but advertising appeal were quickly solved and I am sure most of you wonder at the myriad of solutions that became evident with each season's fare of "detergent operas."

Detergents do well the job they were designed to do--Clean. But, cleaning is only the first part of the cycle involved in this wonderful product of civilization. If the subject or surroundings are to show the benefits of the operation, the grime removed and the detergent and water used have to be discarded--which is no problem if you happen to have some bottomless pit like the Pacific Ocean as the sump--and if you don't have to use the water and detergent over again.

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Speaking for the detergent industry, I can happily say that we can spare the detergent, but speaking for most of mankind, I can't say that we can spare the water.

Obviously, this is why we have waste disposal systems designed to decompose or remove the contaminants in waste water, hopefully to the point where that water is sufficiently pure to permit its reuse as is or with reasonable dilution with fresh water. Activated sludge plants, trickling filters, septic tanks and cesspools are of course typical systems for carrying out this process with varying degrees of efficiency.

Soon after detergents were introduced it became apparent that something different was happening in the country's waste disposal plants. Foam, that universal indicator for a surface active material, began to appear in the sewage plants themselves, in the effluent, and occasionally in some of the receiving rivers and streams. All the problems associated with sewage plant operation and water pollution were immediately placed on the culprit--synthetic detergent or ABS.

The soap and detergent industry recognized the problem and in the early 1950's formed a technical committee to study the subject and advise appropriate action.

This committee systematically looked at all the aspects of the problem and after several years of research carried out in member laboratories and at the best sanitary engineering and toxicology laboratories in the country, including M.I.T., the University of California, the University of Wisconsin, Johns Hopkins, Hazelton Laboratories, and the Philadelphia Academy of Natural Sciences came up with the following observations:

1. ABS does not interfere with the normal operation of a waste disposal system. Other organics in the system are readily decomposed in the presence of ABS.

2. ABS may cause foam in an activated sludge plant, but this foam can be controlled by the use of defoamers or water sprays.

3. Depending on the system, from 40 to 80 percent of the ABS entering the system is removed during processing.

4. Although some ABS gets through waste disposal plants, it is not building up in the country's water supplies. Continued monitoring of the Ohio and Mississippi rivers for several years showed no increase in the ABS level which was first measured at 0.16 parts per million in 1959 and has not increased since.

5. ABS can not be tasted in concentrations below 16 ppm which is of course well in excess of any concentration which might be found in water normally used for human consumption, and certainly well above the level of 0.5 ppm of ABS suggested by the U. S. Public Health Service as the upper limit for potable water.

Incidentally, the USPHS set this limit for aesthetic rather than health reasons. Water which contains more than 0.5 ppm of ABS along with other impurities may foam slightly.

6. ABS in concentrations up to 50 ppm does not impart an odor to water nor accentuate other already present odors which might be characterized as fishy, sulfidy, or chlorine-like.

7. ABS in concentrations 1000 times those which might be associated with food were found not to be harmful to either rats or beagle dogs. In the dog toxicity tests the beagles were fed about 1/4 pound of ABS over a two-year period with no harmful results. If the same ratio of detergent to body weight were applied to man and all the detergent were put in his drinking water, the man would consume about two pounds of detergent in the form of a 250 ppm water solution in the same two-year period. This is about one-half the concentration recommended for washing clothes.

8. Below 5 ppm ABS is not harmful to fish, snails or diatoms. In Santee, California, fish thrive in an artificial lake supplied with reclaimed water containing 5-7 ppm ABS.

These findings seemed to present a fairly reasonable case that ABS was not really a noxious contaminant of water. However, it does cause foam and public officials don't like the threat of foam in their drinking water and something had to be done about it.

Several approaches were suggested without too much success. These included:

(A) Replacement of the ABS with a low foaming detergent. Unfortunately, the low foamers in the washing machine give more foam than ABS upon equivalent dilution in waste waters.

(B) Redesign the waste disposal plants. Some success was achieved here but it was soon realized that anything but a simple modification to an existing plant would be too costly to be acceptable.

(C) Remove the ABS by foaming. This is successfully being done at the Whittier Narrows Water Reclamation Project

outside Los Angeles, California, where water is being recharged to the ground at less than 2.0 ppm ABS and with lower than normal organic impurities. This method may offer good possibilities for removing all organic impurities from water. In this instance the problems associated with disposal of the foam containing the impurities may be substantial.

(D) Change the chemistry of the ABS so that it will be biodegradable. This approach makes the most sense and is being actively pursued by the soap and detergent industry. Research on the mechanisms of biological degradation in a waste disposal plant showed that ABS which is a highly branched organic molecule is not readily broken down by living organisms whereas similar chemicals with so-called straight chain or linear structures are more readily decomposed. Newer materials having these structures as well as the same desirable detergent properties have been synthesized from petroleum and will be offered to the consuming public possibly within the next year and certainly before December 1965, the date promised by the industry for complete conversion to the new "biodegradable product" called Linear Alkylate Sulfonate (LAS) to differentiate it from ABS.

In coming up with this new material the various members of the industry have individually spent years of independent research on the problem while working together and with the Department of Health, Education and Welfare on appropriate laboratory test methods to be used to identify acceptably degradable products. In addition, cooperative data have been obtained on the extent of biodegradability which might be expected in typical activated sludge plants and septic tanks. Whereas, in controlled field tests ABS shows an average of 50 percent disappearance, in typical installations LAS shows better than 90 percent.

In addition to our work in the United States, we have followed closely the experiments in England and Germany. Perhaps you are familiar with the highly publicized field trials of "soft ABS" at Luton England. Here, with the use of a product probably not as good as that which we expect to produce in the United States, significantly improved but not perfect control of foaming of the effluent from the town sewage works was obtained.

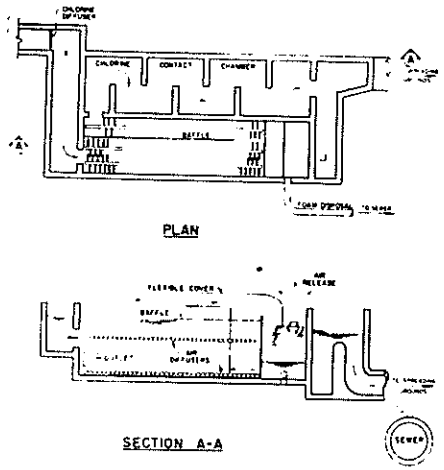
The Germans have legislated soft ABS into being. We hope we can avoid this in America as legislative controls may be a detriment to progress in an industry which has never hesitated to spend money for research on better products.

While the Europeans have been concerned chiefly with large municipal-type disposal plants, we have extended our studies to find out what happens in that almost exclusive American system--the septic

TABLE I

DEGRADATION & REMOVAL IN SEPTIC TANKS (%)

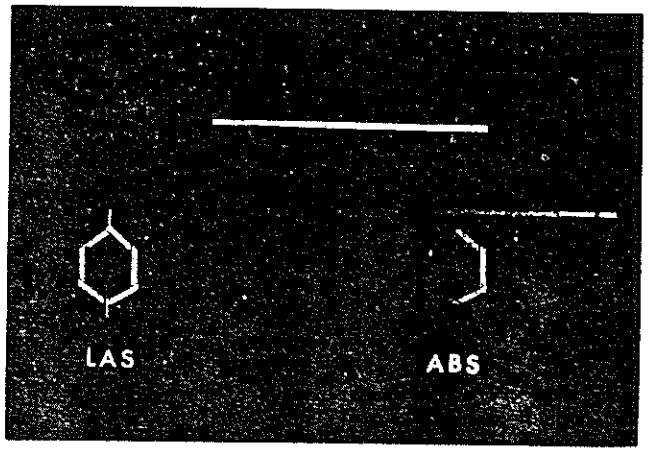
DET.	ALONE		+ FIELD	
	DEG.	REM.	DEG.	REM.
PP	3.8	16.3	60.5	78+
SC	S 0	9.6	87.3	97-
ALC	21-	60.8	54.3	99.6

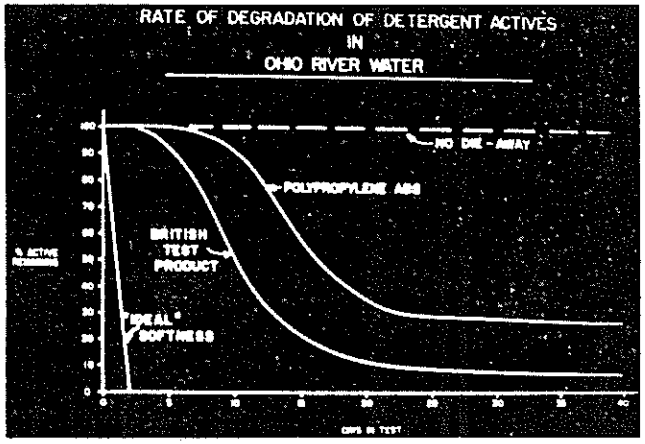


WHITTIER NARROWS WATER RECLAMATION PLANT

FOAM FRACTIONATION PROCESS

FOR REMOVAL OF ALKYL BENZENE SULFONATE (ABS) DETERGENTS





tank. This work was done at the University of California and points out that these new biodegradable materials only disappear satisfactorily in an aerobic system. A septic tank with a properly designed tile field is aerobic.

In an anaerobic system which is typical of a cesspool or septic tank operation discharging directly into the ground water without an intervening tile field, little if any degradation of LAS, ABS or other organics is found to occur. Such a system can not be considered an adequate waste disposal operation. In fact, we in the detergent industry see no easy or cheap answers to sloppy or inadequate waste disposal systems. ABS has been a very effective indicator of contamination in such systems and whereas we have seen that it in itself was not harmful, the same can not be said for the other contaminants which may have accompanied it. The foam on contaminated water raised the flag of caution. Who is going to question the same water when the indicator is gone?

We in the detergent industry feel that in changing our products at a great capital expense to the producers, but at no extra cost to the consuming public we have done our part in helping to keep the Nation's water clean. We hope in turn the public will also recognize its responsibility and provide the necessary and proper waste disposal facilities to insure that waste water capable of purification can be properly reclaimed. After all, detergents need clean water too.