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SURFACTANTS IN FERTILIZERS

Effects of Surface Active Agents on Caking of Stored Mixed Fertilizer

WILLIAM J. TUCKER
G.L.F. Soil Building Laboratory, Ithaca, N. Y.

An investigation was undertaken to determine the effectiveness of surfactants in reducing caking tendency and curing time of mixed fertilizers. No significant reduction in caking tendency was caused by incorporating the surfactants in mixed fertilizer when the fertilizer was bagged within 1 week of manufacture and stored for over 3 weeks. The presence of an anionic surfactant did not reduce caking tendency when fertilizer was cured for 4 weeks prior to bagging. Any benefits from the use of surfactants in mixed fertilizer manufacture are dependent upon many factors, including manufacturing methods, processing equipment, and raw materials, some of which may already contain surfactants.

THE USE OF SURFACE ACTIVE AGENTS in the manufacture of mixed fertilizers has been extensively investigated by the fertilizer industry since the winter of 1952 (*1*). The initial laboratory and plant tests of the effects of surfactants in mixed fertilizers were reported in 1952 by Seymour, before the American Farm Research Association (*2*).

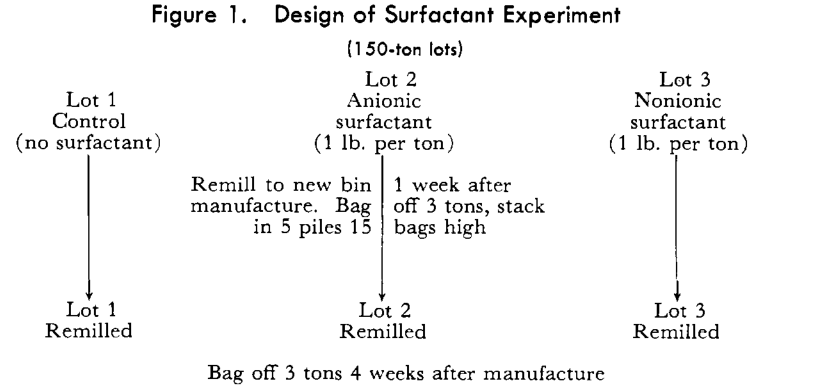
According to Seymour's report, the use of surfactants in fertilizer manufacture should lead to more rapid and complete ammoniation even at low moisture content because of higher initial reaction temperatures, hasten curing reactions, and ultimately improve physical condition of the fertilizer mixture by reducing its caking tendency.

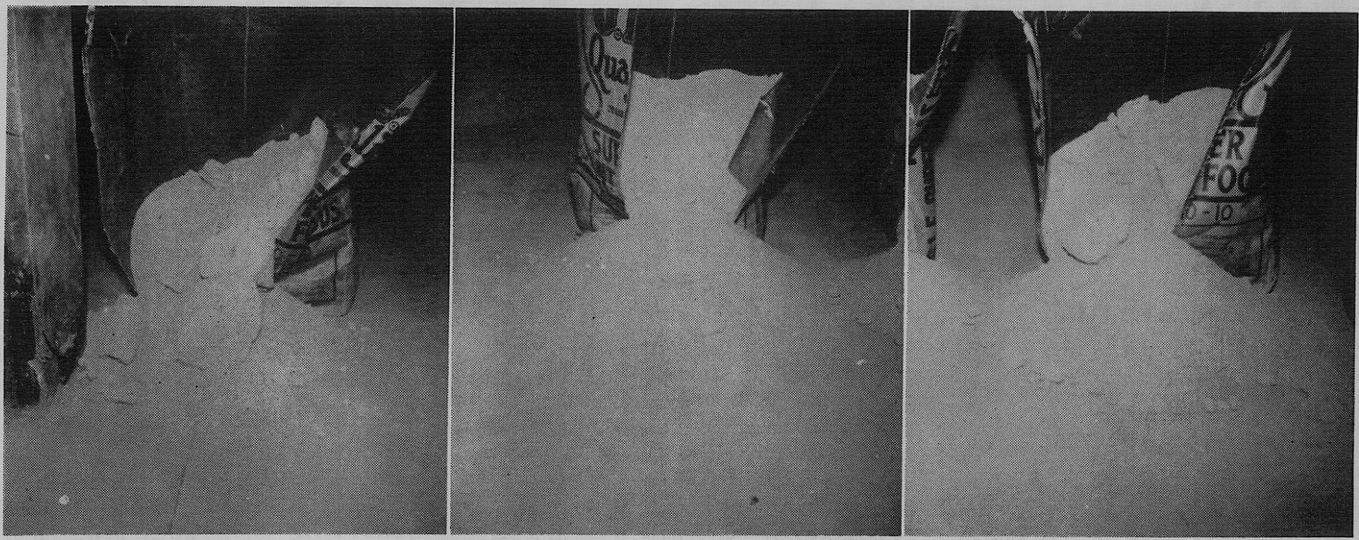
This paper presents the results of a

Table I. 5-10-10 Fertilizer Formula Used in Surfactant Experiment

Material	Amount Used, Lb.
Superphosphate (19.6% available P_2O_5)	1028
Ammonium sulfate (20.5% nitrogen)	172
Potassium chloride (60.5% K_2O)	334
Vermiculite	20
Fertilizer borate	4
Sand (filler)	277
Ammoniating solution (40.3% N)	165
Surfactant	1
Total	2001

Figure 1. Design of Surfactant Experiment





Nonionic | Anionic | Control

Figure 2. Sixth bag in stack for each formulation

Fertilizer 1 week old when bagged, in bag storage 3 weeks

plant scale test of the effectiveness of two different surfactants in a mixed fertilizer manufactured under carefully controlled conditions. Two liquid surfactants were chosen for several reasons: Laboratory tests had shown them to be miscible with and stable in the ammoniating nitrogen solution; it seemed probable that the surfactant could be more thoroughly mixed with the dry materials if it was incorporated in the ammoniating solution; and the surface tension of the ammoniating solution would be reduced before coming into contact with the dry materials.

One of these liquid surfactants was an anionic type. It consisted of an aqueous 38% solution of the sodium sulfate derivative of 2-ethyl-1-hexanol, $C_4H_9CH(C_2H_5)—CH_2SO_4Na$. The other was a nonionic alkyl phenyl polyethylene glycol ether analyzing 95% of active ingredient.

Plant Scale Test of Surfactants in Fertilizer

The batched dry fertilizer materials were mixed in a gravity mixer and conveyed over a weighing belt to a Sackett continuous ammoniator and finally to the curing bin. In the present experiment, the surfactants were introduced into the ammoniating solution line about 6 feet ahead of the ammoniator.

Three 150-ton lots of a 5–10–10 fertilizer were manufactured. The first lot contained no surfactant and served as the control; the second lot contained 1 pound of anionic surfactant per ton of fertilizer; and the third lot contained 1 pound of nonionic surfactant per ton of fertilizer. The same lots of fertilizer materials were used for each of the three lots of fertilizer formulated as shown in Table I.

The three lots of fertilizer were manufactured on successive days. One week after manufacture, the fertilizer in each bin was "remilled"—i.e., removed from its original storage bin, put back through the pulverizing and mixing equipment, and conveyed to a new storage bin. During this remilling process, 3 tons of each material were bagged in 80-pound bags and stored in five separate piles each 15 bags high.

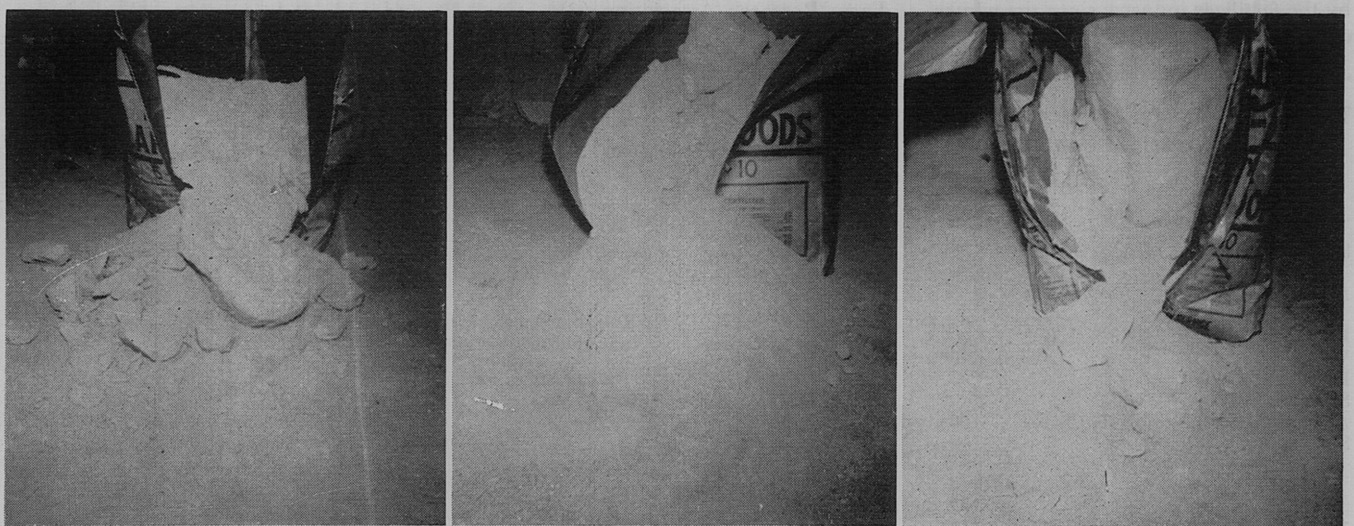
The remaining portion of the fertilizer in each of the new bins was allowed to cure for 3 weeks longer. Then 3 tons of each of the three lots of remilled fertilizer were also bagged and stored in five separate piles, 15 bags high. Figure 1 summarizes design of the experiment.

At the time of manufacture and re-

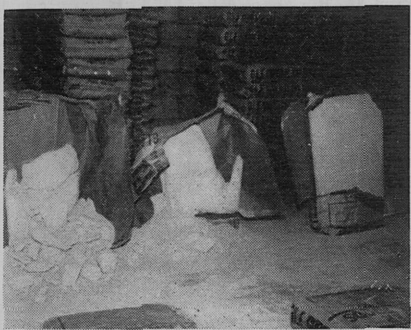
Figure 3. Fourteenth bag in stack for each formulation

Fertilizer 1 week old when bagged, in bag storage 3 weeks

Nonionic | Anionic | Control



Control Anionic Nonionic



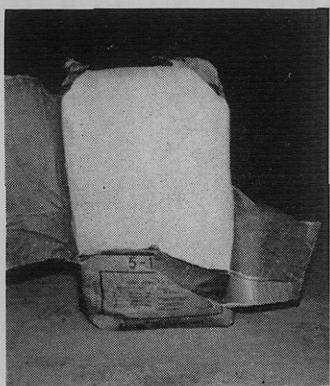


Figure 4. Seventh bag in stack for each formulation

Fertilizer 1 week old when bagged, in bag storage 7 months

milling, temperatures were noted. In order to estimate the degree of caking, the stored bags of fertilizer were subjected to a standard drop test simulating normal handling.

The 15 bags in a single tier, representing each of the three formulations, were laid carefully down on the floor, then were lifted carefully to shoulder height and dropped flat, once. The bags were then lifted on end and slit, allowing the fine material to flow from the slit. Photographs were taken of typical bags of fertilizer in each of the three treatments.

Experimental Results and Related Observations

No significant differences were observed in the reaction temperatures of the three formulations during ammoniation. The temperature increases immediately following ammoniation were 70°, 71°, and 69° F. for Lots 1, 2, and 3, respectively. Further checks on temperature of the fertilizer in the bin were made 1 week and 1 month following manufacture; no significant temperature differences were noted.

Figures 2 and 3 show the beneficial effect of the anionic surfactant on caking tendency when the fertilizer was bagged 1 week after manufacture and stored only 3 weeks.

This beneficial effect disappears when the storage period is extended from 3 weeks to several months (Figure 4).

Figures 5 and 6 show that the surfactant has no effect on caking tendency when the fertilizer, bagged 4 weeks after manufacture, is stored for either a short (Figure 5) or a long time (Figure 6).

If the addition of surfactants had reduced the curing time appreciably, it would seem reasonable to assume that

Figure 5. Fourteenth bag in stack for each formulation

Fertilizer 4 weeks old when bagged, in bag storage 3 weeks

Nonionic Anionic Control

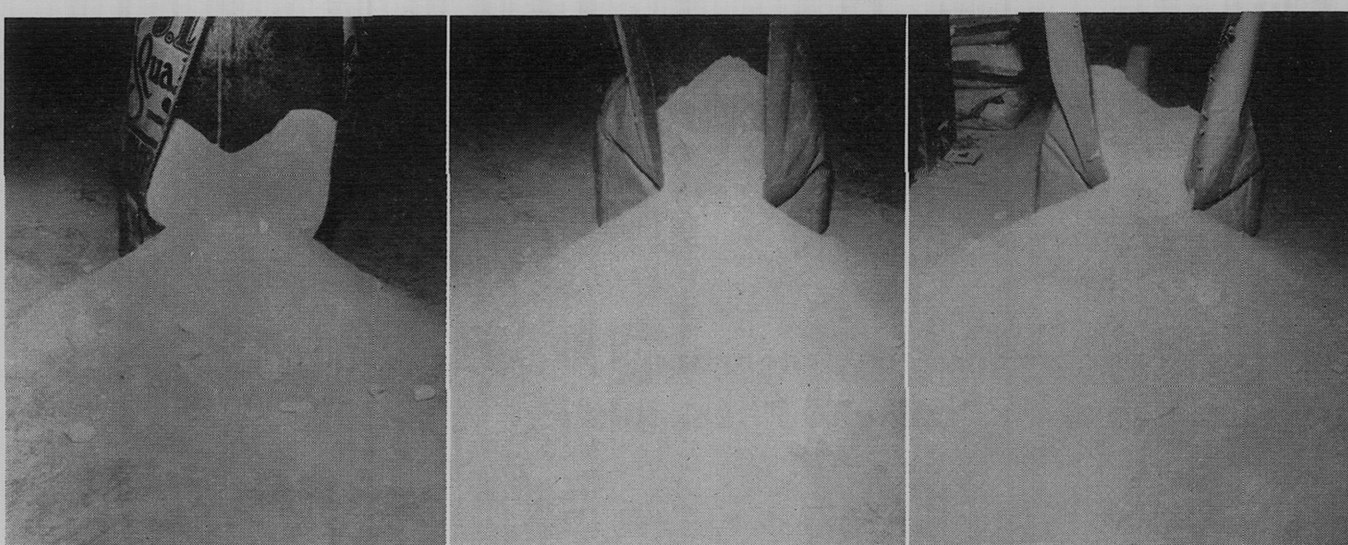
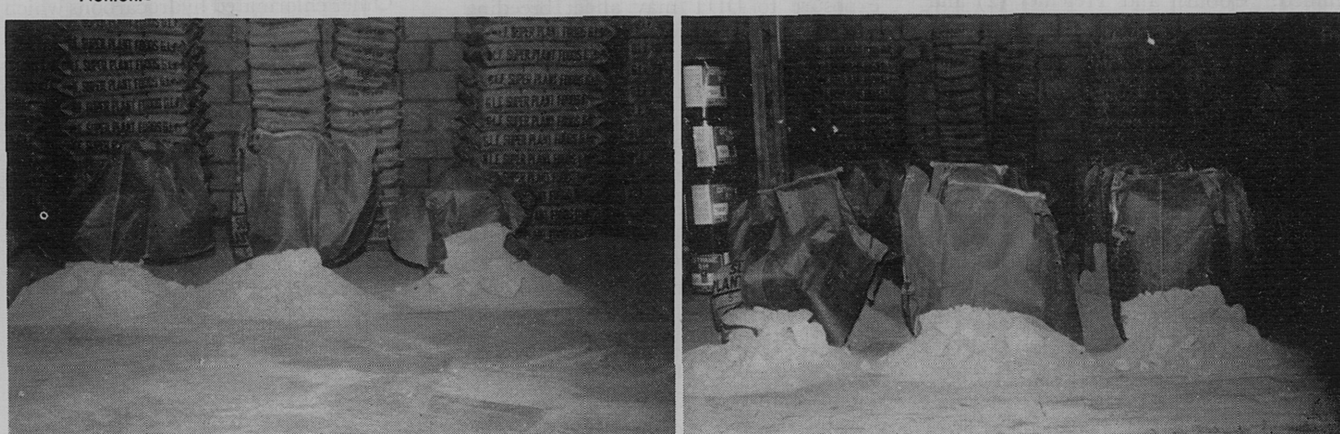


Figure 6. Seventh and tenth bags in stack for each formulation

Fertilizer 4 weeks old when bagged, in bag storage 7 months

Nonionic Anionic Control Nonionic Anionic Control



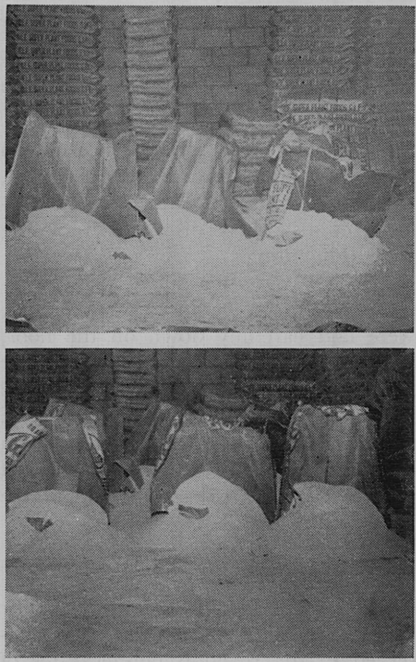
the caking tendency of the fertilizer bagged after 4 weeks would not differ much from that bagged after 1 week. A comparison of Figure 5 with Figures 2 and 3, however, shows the marked beneficial effect of the additional 3-week curing period prior to bagging. This same effect can be seen by comparing Figure 6 with Figure 4 and by noting Figure 7.

Summary and Conclusions

Drop tests made on the bagged fertilizer indicated no reduction in the caking tendency of the fertilizer in the presence of either of the two surfactants on prolonged storage for several months.

When the fertilizer was bagged 1 week after manufacture and stored for 3 weeks, the anionic surfactant reduced noticeably the caking tendency of the bagged fertilizer stacked in the conventional manner. The beneficial effect of the anionic surfactant noted during this short storage period was not evident in the same bagged fertilizer several months later, nor in the fertilizer bagged 4 weeks after manufacture and stored for either a short or a long time. The effect of the additional 3-week curing was to obliterate the beneficial effect of the anionic surfactant.

This suggests that no reduction in caking tendency in bagged fertilizer can be expected from incorporating these surfactants into mixed fertilizers, if the fertilizer is to be bagged within 1 week of manufacture and stored for more than 3 weeks. Nor can any reduction in the caking tendency be expected from the presence of an anionic surfactant if the fertilizer has been cured for 4 weeks prior to bagging.



Nonionic Anionic Control

Figure 7. Thirteenth bag in stack for each formulation

Top. Fertilizer bagged 1 week after manufacture
Bottom. Fertilizer bagged 4 weeks after manufacture
Each bag was dropped five times flat and once on each end before slitting—considerably more handling than in standard drop test. Fertilizer in storage 7 months

Acknowledgment

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PESTICIDE TOXICITY

Effects of Chlorinated Hydrocarbon Insecticides upon Quail and Pheasants

JAMES B. DeWITT
Fish and Wildlife Service, U. S. Department of the Interior, Laurel, Md.

EFFECTS UPON WILDLIFE of the insecticidal use of chlorinated hydrocarbons have not been fully determined. Coburn and Treichler (*2*) and Dahlen and Haugen (*3*) have published data on the acute oral toxicities to avian species of some of these compounds, and studies have been made on the immediate effects resulting from use of DDT for control of agricultural and forest insect pests. Hotchkiss and Pough (*6*) found that the use of 1 pound of DDT per acre had no apparent effect upon bird numbers, but that an experimental application at the rate of 5 pounds per acre resulted in marked reductions in avian populations. Similar findings were made by Robbins and Stewart (*10*), and Robbins, Springer, and Webster (*9*) found a 26% decrease in breeding birds following five annual applications at the rate of 2 pounds per acre.

These results suggest that prolonged exposure to DDT may affect breeding potential of birds even when no immediate effects are apparent. Under conditions of sublethal intake, DDT accumulates in various organs and body tissues (*7*), and DeWitt, Derby, and Mangan (*4*) showed that nonbreeding adult quail succumbed to DDT poisoning when concentration of the toxicant in muscle tissue exceeded 30 to 35 γ per gram. Coburn and Treichler (*2*) and Mangan (*8*) reared young quail on diets containing 0.01% DDT, and Mangan found that no ill effects were apparent under conditions of relatively low storage in tissues. However, the experiments were terminated at the end of 9 or 10 weeks, and no data are available on effects of more prolonged exposure.

Other chlorinated hydrocarbons which are being, or may be, used under conditions offering possible hazards to wildlife include aldrin (1,2,3,4,10,10-hexachloro - 1,4,4a,5,8,8a - hexahydro-1,4,5,8 - dimethanonaphthalene), dieldrin (1,2,3,4,10,10 - hexachloro-6,7 - epoxy - 1,4,4a,5,6,7,8,8a - octahydro - 1,4 - endo, exo - 5,8 - dimethanonaphthalene), endrin (1,2,3,4,10,10-hexachloro - 6,7 - epoxy - 1,4,4a,5,6,7,8,-8a - octahydro - 1,4 - endo, endo - 5,8-dimethanonaphthalene), and strobane (mixed polychlorinated terpenes). Strobane may be considered relatively nontoxic (*11*), but Eden (*5*), Arant (*1*), and Sherman and Rosenberg (*12, 13*)