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# Evaluation of Chemical Composition and Particle Size Gradation of Evaporation-Reducing, Monolayer-Forming Materials

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**Summary Report to**
**The Proctor and Gamble Company**

Prepared by
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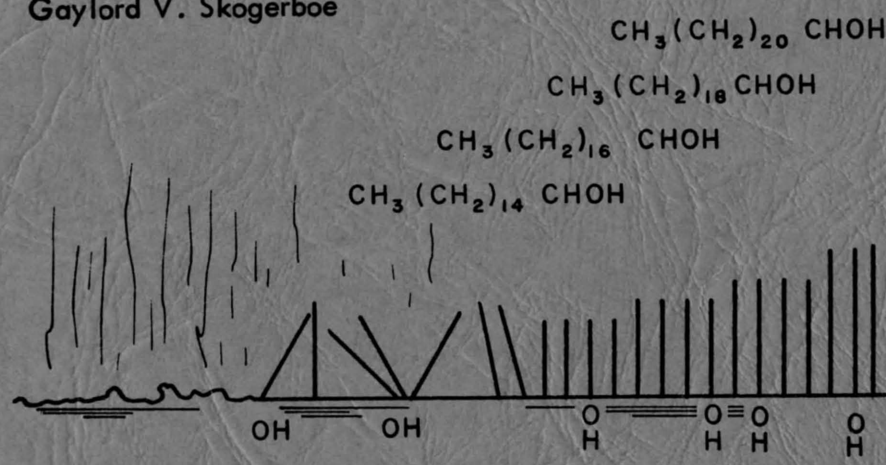




**Utah Water Research Laboratory**
**College of Engineering**
**Utah State University**
**Logan, Utah**

August 1965

Report PR-WG28-1

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## Materials

Initial field testing began shortly after the arrival of materials in August, 1964. The field experiments were designed to evaluate the effects of the long-chain alcohol $C_{20}$ and particle size gradation on the effectiveness of evaporation retardants when applied by aerial techniques. The materials which were tested at Utah Lake are listed below.

Table 1. Chemical composition of test materials.

| | Formula A | Formula B |
|---|---|---|
| $C_{12}$ alcohol | 0.7% | 0.7% |
| $C_{14}$ alcohol | 2.0% | 1.5% |
| $C_{16}$ alcohol | 25.5% | 17.9% |
| $C_{18}$ alcohol | 69.7% | 52.0% |
| $C_{20}$ alcohol | --- | 26.9% |
| Miscellaneous | 2.1% | 1.0% |

Table 2. Average particle size of test materials.

| Formula | Batch | Average Particle Size in microns |
|---|---|---|
| A | 1 | 650 |
| A | 2 | 100 |
| A | 3 | 75 |
| B | 1 | 750 |
| B | 2 | 270 |
| B | 3 | 75 |

In addition to the above materials furnished by The Proctor and Gamble Company, a material which has been used previously as an index was incorporated into the experimental design at Utah Lake. The average particle size of the index material is 105 microns and its chemical composition is $C_{14}$ - 2%, $C_{16}$ - 30%, $C_{18}$ - 60%, and $C_{20}$ - 8%.

## Utah Lake Tests

Index material. The performance of the index material was as expected. The film started to show two minutes after application and had spread to a width of 700 feet in an hour. After nine hours, the film still had a good appearance but wave action had distorted the film strip width so that the width varied from 300-700 feet. The indicator oils showed that the film pressure remained in excess of 35 dynes per centimeter (dynes/cm) throughout the day.

<u>Formula A materials</u>. No visible film appeared on the water surface after application of the three A-materials, until after eight hours when a few very small circular patches of film appeared. Because of the negative results, additional strips of A-material were placed on the water surface but no film appeared. In an additional effort to obtain a visible film with the A-materials, two small bays on Utah Lake were selected wherein material was applied over each bay 4-5 times. The total application in these bays was approximately 0.8-1.0 pounds per acre (lb/ac), but still no positive results were obtained.

<u>Formula B materials</u>. A film began to appear for each of the three B-materials within three minutes after application. The variation of the average film strip widths with time for each of the materials is listed below.

Table 3. Rate of spread of B-materials.

| Formula | Batch | Average Particle Size in microns | Time Since Application in hours | Strip Width in feet |
|---|---|---|---|---|
| B | 1 | 750 | 1 1/2 | 150 |
| | | | 2 | 200 |
| | | | 8 | 300 |
| B | 2 | 270 | 1/2 | 200 |
| | | | 1 | 300 |
| | | | 1 1/2 | 400 |
| | | | 3 | 500 |
| | | | 7 1/2 | 500 |
| B | 3 | 75 | 1/3 | 150 |
| | | | 1/2 | 250 |
| | | | 1 | 400 |
| | | | 3 | 550 |

The film pressure for the B-materials remained between 29-35 dynes/cm throughout the day with the exception of a few readings in excess of 35 dynes/cm. The application rate, which was computed on an assumed strip width of 500 feet, was 0.20 lb/ac. The temperature of the water surface was, for the most part, 61° F.

Tests at Salmon Creek Reservoir

Additional testing of the A-materials was conducted at Salmon Creek Reservoir near Twin Falls, Idaho, during September and October of 1964 and June of 1965. The primary purpose of the fall tests was to evaluate the A-materials on a reservoir containing good quality water. The quality of water in Utah Lake is poor and very turbid. The results of testing at Salmon Creek Reservoir were much the same as at Utah Lake with the exception that the A-1 material did form a film strip having a width of approximately 30 feet within a few minutes after application. The film did not spread and after an hour it began to break up and soon disappeared. The winds during this time varied from 0-5 miles per hour (mph).

During the fall of 1964, The Proctor and Gamble Company forwarded additional quantities of the A-3 material. Some of the material was prepared from the same batch of alcohol used in preparing the materials for testing at Utah Lake, while other quantities of A-3 material were prepared from a new batch of alcohol. The A-3 materials from the two separate batches were to be evaluated to ascertain any differences between the two batches which might account for the negative results at Utah Lake.

The A-3 material prepared from the original batch of alcohol gave results identical with previous tests. The A-3 material prepared from the new batch of alcohol did form a narrow film strip. Four additional flights were made over the same path and the strip did become wider, but was not comparable at all with the index material. The total application rate for the strip was in excess of 1 lb/ac.

Laboratory Tests

Tests were conducted with the A-3 and B-3 materials by the Institute of Water Utilization (IWU) Research Center, Arizona Agricultural Experiment Station, University of Arizona during October, November, and December of 1964. The tests were conducted in the laboratory and small outdoor ponds. The results of the tests are reported by C. Brent Cluff, Assistant Hydrologist, IWU, in a quarterly progress report to The Proctor and Gamble Company dated March 5, 1965. The portions of the progress report describing the tests with the A-3 and B-3 materials has been extracted and is reported below.

During October through December, tests were made to determine the difference between a powdered material containing large percentages of hexadecanol and octadecanol (A-3) as compared to a powdered material containing large percentages of docosanol and eicosanol (B-3). These materials were tested on the spreading rate flume in the laboratory, on the evaporation pans, and on both East and West Ponds.

The spreading rate tests made using the A-3 and B-3 materials as sent direct from Cincinnati, and that from Utah indicates that the materials have essentially the same spreading rate with the possible exception that the spreading rate of the A-3 material sent from Utah diminished at a greater rate as the material spread down the flume. The application rate was approximately 1 lb/ac.

Two pan tests were made during October to test the relative effectiveness of the A-3 and B-3 materials. In P & G Pan Test No. 1, a treatment of 0.8 lbs/ac was made initially, followed by a 1.6 pound per acre application 36 hours later. There was virtually no savings with the A-3 material, whereas the longer chain material did form an effective film which lasted about 48 hours after the final treatment. The B-3 material sent from Cincinnati was about twice as effective as the B-3 material sent from Utah. In P & G Pan Test No. 2, a larger application of 3.2 pounds per acre was applied. In the second pan test, there was no significant difference between the B-3 material as sent direct from Cincinnati and that sent from Utah.

One extended pond test was made during the quarter utilizing the three 53 x 78 foot ponds at the IWU Research Center. The East Pond was treated with 2 ounces of B-3 powder every other night while the West Pond was treated with an identical amount of A-3 powder. This application is approximately 1.0 lbs/ac per day depending on the water level in the ponds. The B-3 material was more effective with a savings of 19.4 percent as compared to 15.4 percent for the A-3 material during the application period. The average wind speed for the period was 1.6 mph. During the residual period extending to the end of December, the percentage savings using the B-3 material increased to 21.5 percent (total savings were less) whereas the percentage savings using the A-3 material decreased to 10.8 percent. The average wind speed decreased slightly to 1.4 mph.

The series of tests made during this period to show the relative effectiveness of the A-3 and B-3 powders indicated that the B-3 material was by far the better material on the pan tests and seemed to last longer and was more effective on the pond tests. The spreading rate tests were not too conclusive but did indicate that the spreading rate for the B-3 material was as good, if not a little better, than the shorter chain material. The application rates in the pond tests when accumulated were large, thereby, tending to hide the effect of a difference in spreading rates of the two materials. The pan tests did show that when used in single applications of 0.8, 1.6, and 3.2 lbs/ac, the A-3 material was ineffective as an evaporation suppressant.

## Conclusions

The testing did substantiate to quite a degree that the longer-chain alcohols ($C_{20}$ and/or $C_{22}$) could be incorporated in an evaporation retardant which would be applied from the air. Also, the tests showed that the material with the smaller particle sizes spread faster than materials with large particles, which was as expected.