The Water Resources Research Center has recently completed four years of research in evaporation control on stock tanks and small reservoirs using monolayers. This work has been published in detail in Technical Bulletin 177. A summary of that work, with recent developments, is given here.

Report on Evaporation Control

On Stock Tanks, Reservoirs

Evaporation and seepage losses from stock tanks have long been a source of trouble for ranchers seeking to fully utilize their rangelands. Evaporation can be controlled in various ways but one of the more promising methods that excited water conservationists around the world was the use of monomolecular films formed from long-chain alcohol.

By C. Brent Cluff

This material was first field tested in 1955 in Australia where W. W. Mansfield reported a reduction of evaporation up to 30 percent. Theoretically it requires approximately .02 pounds of alcohol to cover an acre of water. Practically it has been found to require closer to .05 pounds. But even at that rate, one pound of alcohol will cover 20 acres of water surface.

Over a decade has passed since the monolayer was first field tested. As far as the author knows there are no commercial applications of long-chain alcohol for evaporation control at the present time. The biggest detriment to its use is wind. Even a sl[illegible] breeze will blow the monolayer off the pond. When the wind dies down the monolayer will tend to reform, but evaporation is highest when the wind is blowing. This reduces "residual" savings, savings obtained when the wind isn't blowing, to less than 10 percent.

Large Economy Size

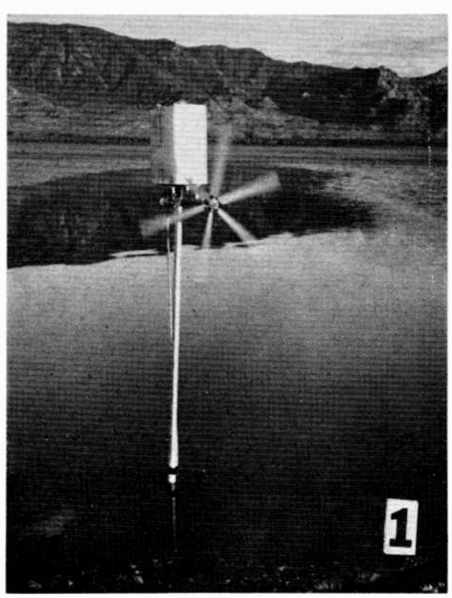
The effect of wind on monolayers suggests that the larger the reservoir the more economical the system of evaporation control becomes. The bigger the lake the longer is the residual time that a given amount of alcohol remains on the water.

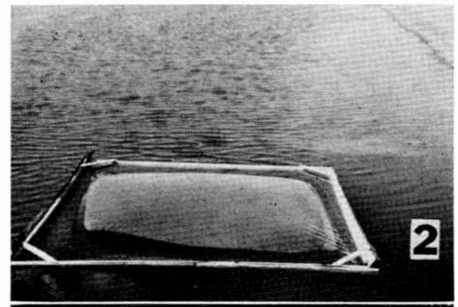
During the last four years an extensive study has been made by the Water Resources Research Center, in cooperation with the U. S. Bureau of Reclamation and the Procter and Gamble Company, to develop some system suitable for small ponds that would apply the material as needed to the upwind shore of the reservoir. Various types of dispensers using alcohol in powder, solution and emulsified form were tried.

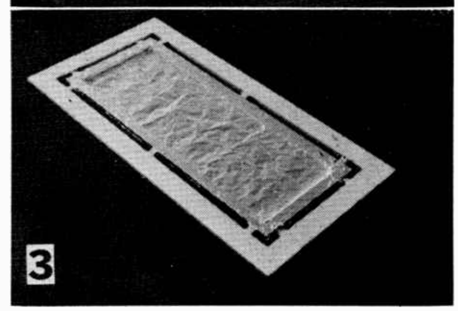
Various types of raft dispensers were tried for both powdered and semi-solid emulsified materials. The raft dispensers were simple in design but failed to supply sufficient material due to plugging. The best system that was developed at The University of Arizona was the wind-activated dispenser, which applied alcohol in a fluid emulsion form. A picture of this dispenser is shown in Figure 1. Note the "sl[illegible]k" on the water's surface, in-[illegible] the presence of a monolayer.

Good — But Not Practical

The wind-activated emulsion dispenser proved to be efficient in applying material as needed to replace that removed by wind. This resulted in savings up to 30 percent in tests on small ponds. The chief disadvantage of this system is that one dispenser would be required for each 30 feet of shoreline. Thus a relatively large number of dispensers would be needed for each stock tank.







For a square pond the cost of preventing water from evaporating, using the wind-activated emulsion dispenser system, was estimated to be more than $3.50 per 1000 gallons for reservoirs less than one acre in size, dropping down to $1.80 per 1000 gallons for a four-acre pond. The cost was not less than $1 per 1000 gallons until the size of the reservoir was increased to greater than 15 acres. These costs include material, maintenance and capital recovery costs for the dispensers.

Because of these findings the WRRC has been exploring other methods of evaporation control for the small reservoirs. As shown in our table, floating rafts used as vapor barriers have considerable economic potential.

Annual cost of vapor barrier per ft.^{2}	*Cost of water saved per thousand gallons*
$.01	**$ .20**
.05	**1.00**
.10	**2.00**

This table was based on the assumption that the vapor barrier would elim-

(Continued on Next Page)

The Water Resources Research Center incorporates the former Institute of Water Utilization of the Agricultural Experiment Station. The author of this article is an assistant hydrologist at the Water Resources Research Center.

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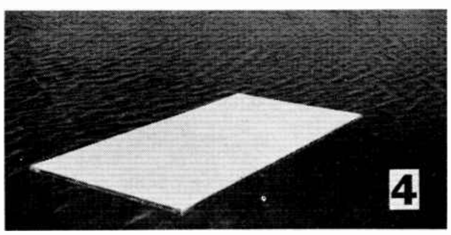
inate the estimated annual evaporation of 50 gallons per foot.[2] Various vapor barrier materials are available at an annual cost of approximately one cent per foot.[2]

The least expensive material is four-mil polyethylene with a useful life of approximately a year and a capital cost of approximately one cent per foot.[2] A longer lasting material such as butyl rubber would require a higher capital investment of approximately 20 cents per foot, but would have an estimated life of 20 years or more. Even the butyl rubber then would be less expensive than the monolayer on small reservoirs.

Various Rafts Tried

In order to utilize vapor barriers on all sizes and shapes of small ponds various types of floating rafts have been tried during the past year at the WRRC. Polyethylene, because of its low cost, was first tried. The polyethylene was attached first to a narrow styrofoam frame two inches high. This frame was not strong enough to withstand the shearing force of the wind on the rafts. Wood was next used as a frame material, using the same design. This raft is shown in Figure 2 partially flooded with water. It was found that the frame had to be higher than three inches to eliminate flooding of the raft with waves. The



higher the frame, the more wind the rafts catch. This requires the use of a stronger and, therefore, more expensive frame.

To reduce the height of the raft a "moat raft," as shown in Figure 3, has been tried. This raft has a connected two-piece frame made of styrofoam that has an inner open area of water that traps the waves and prevents them from flooding the vapor barrier. The low profile of this design reduces the amount of shearing stress that the frame must withstand. This design has been quite successful in preventing flooding by waves in winds up to 20 miles per hour and with modification of the frame it should be successful at higher wind speeds. Using four-mil, aluminum-coated polyethylene this raft should last at least two years with an initial capital cost of approximately four cents per foot.

A 4 x 8 foot styrofoam raft 5/8″ thick, painted white, is currently being field tested. The white paint protects the styrofoam from weathering and increases reflection of heat energy. This raft is shown in Figure 4. On a pan test this type of raft caused approximately a 100 percent reduction in evaporation over the area covered. A unique feature of this raft is a suction lip to protect the edge of the raft and prevent its being blown away by wind. Additional work is needed to simplify construction of the suction lip but, if this work is successful, it would cost approximately 15 cents per foot and last five years or longer if properly maintained.

Recently it was announced that the government of West South Africa has ordered the covering of all its reservoirs with floating concrete rafts to reduce evaporation loss. This floating concrete is made from cement, sand and polystyrene. Government engineers estimated that the protective concrete covering cut evaporation by 80 percent in full scale tests. This type of covering would cost more than the lightweight rafts listed above but it should be more durable. Floating concrete then is another means of evaporation control to be considered.

More research is needed but it is apparent that through the use of floating rafts evaporation can be controlled for a cost less than the cost of most domestic water supplies.

There Also is Seepage

Evaporation control, however, is not all of the problem. As stated in the opening sentence, seepage control is also needed. On our present large capacity stock ponds with our present technology seepage control is relatively expensive.

Perhaps the most economical answer to a dependable stock water supply, where ground water is not readily available, is through a water harvest system for collecting and storing precipitation. Since stock seldom use more than 100,000 gallons annually at any conventional range storage tank, if seepage and evaporation are both eliminated, the stock tank could be made small.

The size requirement is further reduced if sediment-free water, obtained from a water-proofed catchment is used to fill the pond. Its period of useful life would not be limited, as is the case for a conventional stock tank that is filled with sediment-laden flood water.

A water harvest system that will furnish a firm water supply of 100,000 gallons annually has been installed at the Water Resources Field Laboratory in Tucson. This system will be discussed in more detail in part II of this series, appearing in the next issue of Progressive Agriculture.

Underground Asphalt Layer Tested to Save Water, Boost Yields

A new concept aimed at water conservation and increased crop yields is being tried at the UA's Yuma Branch Experiment Station, a cooperative research project in which the Experiment Station is working with American Oil Company scientists.

In trials this past winter on the Yuma mesa sand, a thin layer of asphalt was spread two feet below the surface of the sandy soil, making an asphalt barrier designed to reduce loss of irrigation water by preventing excessively deep — and uneconomic — infiltration.

Company officials, who first tried this principle in cooperation with soil scientists at Michigan State University, hope this asphalt sub-surface dam will have two beneficial effects — reducing the farmer's cost for irrigation water and also conserving that vital resource.

From the Michigan tests came enthusiastic belief that the underground barriers would permit cultivation of millions of acres of land not now suited to agriculture, because such land is too porous to hold the water which it receives. These same tests brought increased yields — in one Michigan test 100 percent increase in cucumber yields — and quality of the vegetables from the barrier plot was higher than those from the control plots nearby.

Yuma is chosen for western tests for a few obvious reasons, such as the sandy mesa soil, the highly refined winter vegetable industry of the area, and a test of salt retention.

It will be many months before any confirmed answers will be ready.