Reducing Evaporation from Small Reservoirs

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WATER STORED in reservoirs and ponds is subject to evaporation losses. Water is a precious commodity, and its value increases many times during summer periods of low rainfall and high use. In many instances, municipalities, ranchers, and farmers can ill afford any losses from the quantity stored during times of plenty.

The problem of evaporation is particularly acute in arid climates. For example, in August, 1957, the city of Dallas, Texas, lost eight billion gallons of water through evaporation—60 per cent more than the total quantity used by its citizens during that month. On the other hand, evaporation is not confined to hot, dry climates. At Wind River, Washington, the average temperature during July is only 63.4°F., yet evaporation from a standard Weather Bureau pan amounts to 6.63 inches (Steele, 1952); this is equivalent to a daily loss of more than 4,000 gallons from a one-acre pond.[1]

Because water is so precious, it is important that evaporation losses be restricted or eliminated. This can be accomplished by storing water in underground reservoirs, in closed containers, or in deep pools with small surface areas. Another method that appears to have great prospects is the use of chemicals that spread over the evaporating surface.

Hexadecanol—an Evaporation Retardant

Basic laboratory research on the use of chemical films to prevent evaporation was started several decades ago. Certain chemicals appear to be exceptionally effective because of their structure, and hexadecanol (cetyl alcohol) appears to be one of the most promising. Each molecule of hexadecanol is a long chain of carbon atoms whose ends behave differently toward water; one end of the chain is attracted to water, whereas the other end is repelled. As a result, when hexadecanol is scattered over a surface of water, its molecules align themselves vertically, side to side, and form a thin film over the surface.

In 1953, and again in 1955, Mansfield reported on experimental work done with hexadecanol in Australia. He reported that hexadecanol success-

[1] Pan evaporation is customarily converted to lake evaporation by multiplying by the coefficient 0.70 (Wisler and Brater, 1956).

fully reduced evaporation both in the laboratory and on a lake, and losses from a two-acre lake were reduced by 30 per cent. Later, the Australian government (Anonymous, 1956) issued a leaflet describing the use of the Mansfield process for reducing evaporation. In this process, beads of hexadecanol are placed within a fiberglass raft or wooden float having bronze or aluminum gauze windows. The beads filter through the gauze to form a continuous chemical film over the water surface. Whenever the film becomes discontinuous, more beads filter out. The procedure is effective on quiet water areas up to two acres in size.

The success of these field trials induced the Southwest Research Institute (Beadle and Cruse, 1957) to pursue further research on the use of hexadecanol as an evaporation retardant. In one of their large-scale tests, reductions in evaporation up to 18 per cent were achieved on a four-acre lake. Laboratory investigations have also been conducted in Illinois (Roberts, 1957), and there too hexadecanol effectively reduced evaporation by 50 per cent during the warmest summer days.

The question of the toxicity of hexadecanol is of course of paramount importance. But research in Oklahoma (Timblin *et al.,* 1957) on a six-acre lake indicated that hexadecanol does not adversely affect water quality, including taste, odor, and color. Moreover, research (Berger, 1958) has shown that the chemical is not toxic to humans or fish. Hexadecanol oxidizes to palmitic acid, a common food element and a component of normal fat.

An Experiment in Oregon

In the summer of 1957, the Pacific Northwest Forest and Range Experiment Station instituted an experiment near Portland, Oregon, to evaluate the effectiveness of hexadecanol in reducing evaporation. The experiment was conducted from May through September at the Portland Waterworks, some 40 miles east of the city. Here summer temperatures are not high: the average temperature is 67.6° F. during the daytime and 54.4° F. at night. The average daily temperature is 61° F.

In this experiment, two standard Weather Bureau pans (four feet in diameter, 10 inches deep) were placed side by side, and one was treated with hexadecanol. The powdered chemical was applied six times at irregular intervals, varying from seven to 36 days. The applications were made after heavy rainstorms or when additional water was added to the pan to restore its original level.

Results

The results of the experiment definitely show that hexadecanol will reduce evaporation from a body of water. For the period studied (May through September), the effect of the treatment was to reduce evaporation by 42 per cent:

	Evaporation (Inches per day)
Untreated pan	0.1663
Treated pan	.0964

The ratio of losses from the treated to the untreated pans averaged 0.580, with a standard error of only 0.012.

In this experiment, since evaporation data were obtained both in the morning and in the evening, it was possible to compare evaporation losses from the treated and untreated pans for both day and night periods. During the daytime (8 A.M. to 6 P.M.) the loss ratio was 0.445 $\pm$0.014, and at night (6 P.M. to 8 A.M.) the ratio was 0.812 $\pm$ 0.017. In other words, during the day hexadecanol reduced evaporation by 55.5 per cent, but at night the reduction was only 18.8 per cent.

Discussion

No doubt exists that hexadecanol reduces evaporation. But a question that requires an answer is whether the savings are quantitatively significant. Can a substantial amount of water be saved by using the chemical?

Assume a summer water shortage in the vicinity of Portland, Oregon. Average daily evaporation from a pan amounts to 0.166 inches. The loss from a reservoir would be 70 per cent[2] of this figure, or 0.116 inches. On a one-acre reservoir this depth of evaporation is equivalent to 3,150 gallons. The use of hexadecanol would reduce this loss to 1,827 gallons a day, thereby effecting a daily saving of 1,323 gallons, or approximately 10,000 gallons a week.

This experiment was not conducted to determine the economics of applying hexadecanol. However, Beadle and Cruse (1957) estimate that with an application rate of 2.2 pounds of hexadecanol per acre, the cost of saving 1,000 gallons of water is only ½ cent. In Portland, the price of 1,000 gallons of water is 18.7 cents. It is evident that apart from the need for conserving water supplies during times of shortage, this particular water-conserving measure is economically feasible. During times of water shortage, farmers, ranchers, and municipalities in the Pacific Northwest would benefit greatly from the water savings effected by the use of hexadecanol.

[2] See footnote 1.

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Erratum

On pp. 41-42, vol. 33, no. 1 (February, 1959), for column heading, Table 2, *Conductivity of Saturation Extract, μmhos per cm,* read *Conductivity of Saturation Extract, mmhos per cm.*