Floating Sheets of Foam Rubber for Reducing Stock Tank Evaporation

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Highlight: *Foam rubber sheet stock, 48 inches wide and 3/16 inch thick, was lap jointed, using a contact cement, to fabricate three floating covers. Their performance was evaluated on 24-and 30-foot diameter water-storage tanks. Generally, field performance was satisfactory. Minor problems observed included: pecking by birds, temporary clogging of bailing holes, and separation of the cover from an ice surface. None of these problems are expected to cause cover failure. The estimated cost of saving potentially evaporated water in a 4-foot per year evaporation zone ranges from $1.80 to $2.00 per 1,000 gallons. Such a cost may be justifiable when compared to costs of alternate means of producing or saving an equal amount of water.*

The average annual evaporation in the 17 western states (Fig. 1) ranges from 24 to 84 inches (The Water Encyclopedia, 1970) and is several times greater than the annual precipitation in many areas. Livestock water for the drier parts of this area is collected by small water-harvesting systems (Cluff, 1967; Lauritzen and Thayer, 1966; Lauritzen, 1967; Myers, Frasier, and Griggs, 1967) or from seep areas and must be stored for use at a later date. In open storage, much of this water evaporates.

Much investigation has been conducted on controlling evaporation from open water surfaces. Studies have included evaluations of monomolecular layers (Reidhead, 1960; Magin and Randall, 1960), water dyed different colors or water in different colored evaporation pans (Young, 1947; Bloch and Weiss, 1959; Keyes and Gunaji, 1967; Yu and Brutsaert, 1967), various shading materials, and various types of barriers between the water surface and the atmosphere (Genet and Rohmer, 1961; Crow and Manges, 1965; Rojitsky and Kraus, 1966; Cluff, 1967; Myers and Frasier, 1970). All systems have reduced evaporation somewhat, but advantages have been marginal.

Floating foam rubber sheets offer a means of suppressing evaporation. Low-density synthetic sheeting materials have recently been evaluated as floating evaporation barriers between the water surface and the atmosphere. Evaporation reduction on insulated evaporation tanks in Arizona (Cooley, 1970) was essentially equal to the percent of water surface area covered by light-colored floating sheets. Studies in Utah showed that sheets of

Fig. 1. *Mean annual lake evaporation (inches) in the 17 western states (The Water Encyclopedia, 1970). Values for period 1946–1955.*

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The report is a contribution of the Western Region, Agr. Res. Serv., U.S. Dep. Agr., in cooperation with the Utah Agricultural Experiment Station, Utah State University.

Manuscript received January 10, 1973.

black, low-density, closed-cell synthetic rubber sheeting reduced evaporation by about 75% when 95% of the water surface was covered. Tanks in the Utah tests were not insulated. Results from both studies indicate that floating covers can effectively reduce evaporation.

The information reported here deals with construction techniques and procedures along with a field evaluation of the practicality of using floating covers on tanks.

Material Description and Floating Cover Fabrication

The floating cover material being studied at Utah State University is a low-density (7-8 lb/ft^3), closed-cell synthetic rubber sheeting available in roll-stock form up to 5 ft wide and from 1/8 inch to 1/2 inch thick.[1] This synthetic rubber is highly resistant to outdoor weathering. A cover, 1/4-inch thick, large enough to fit a 30-ft diameter tank, weighs approximately 115 lb. The roll-stock can be fabricated into a continuous cover by lap jointing, using a contact cement. Lap widths of 2 inches appear to be satisfactory.

Three floating covers for field studies were fabricated by the Agricultural Research Service in Utah (Fig. 2). Two covers were 30 ft in diameter; the third was 23 ft. Fabrication, indoors on a concrete floor, took 5 to 6 man-hours for the larger covers. The 30-ft covers could be transported to the field in the trunk of a sedan.

All three covers were fabricated from roll-stock 48 inches wide and 3/16 inch thick. Foam rubber rod-stock was bonded around the edge of the covers on the water side to stiffen it and prevent wind from getting underneath.

Holes 1/2 inch in diameter were cut approximately on 4-foot centers to allow the covers to self-bail precipitation or snowmelt collected on top. The self-bailing holes also help in installing the covers since the cover can be submerged, forcing all entrapped air from underneath the cover. Once all water is off the surface, the cover rides directly on the water surface without air pockets, thereby minimizing the chance for wind to lift the cover.

Performance

The 23-ft-diameter floating cover was installed on a tank 24 ft in diameter at Logan, Utah, in September 1971. The two 30-ft diameter covers were installed in southern Utah in November 1971 on tanks belonging to the Bureau of Land Management (Fig. 3). One tank is southwest of St. George, Utah, and the other is northwest of Cedar City, Utah. The tank at Logan is in a moderate temperature, canyon wind area with ice present during the winter. The St. George location is in a high temperature area where little if any ice forms during the year. The tank near Cedar City is in a moderate temperature area, and ice is present during the winter.

The floating covers have shown no material degradation during the first year. All lap joints and the rod-stock bonded around the edge have maintained a satisfactory bond. The strength of the lap joints over long periods of time is a concern and is being studied in laboratory tests. The only strength loss encountered in the laboratory has been in joint laps of 1 inch and less.

Minor field problems observed include some pecking by birds around the bailing holes on the cover near Cedar City, dust

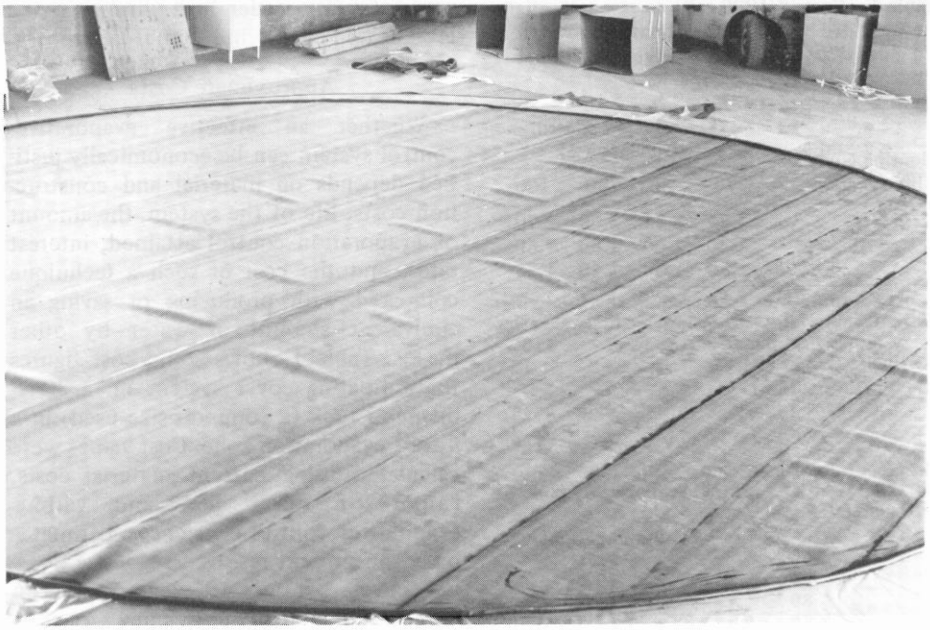

Fig. 2. *Thirty-foot diameter floating cover fabricated from 48-inch wide, low-density, closed cell rubber sheet stock.*

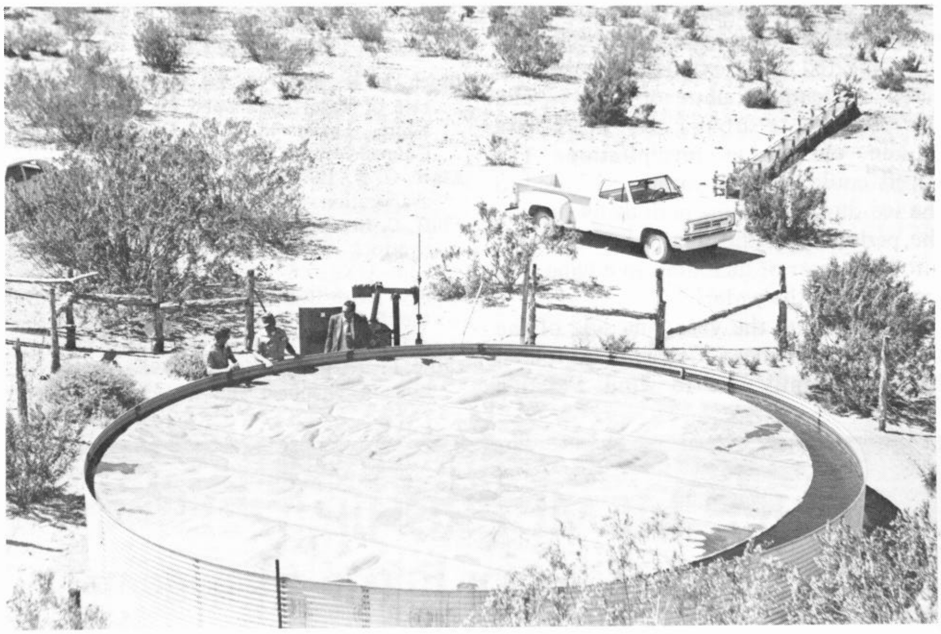

Fig. 3. *Thirty-foot diameter floating cover on water-storage tank near St. George, Utah. The cover should be fabricated to fit the tank more closely than this one does.*

[1]Material available from Inmont Corporation, St. Louis, Missouri. Listing of the company name is for the readers' use only and does not imply endorsement of the products or the company by the U.S. Department of Agriculture.

Table 1. Cost ($/1000 gal)[1] to save potentially evaporated water using a floating cover from a 30-ft-diameter water-storage tank in a 4-ft per year-evaporation zone.

Floating cover life (years)	Evaporation control efficiency (%)			
	70	80	90	100
5	3.85	3.35	3.00	2.70
10	2.30	2.00	1.80	1.60
15	1.80	1.60	1.40	1.25

[1] Cost computations are based on the following:
Initial material cost (¼ inch thick sheeting $0.23/ft², includes trim loss) $187
Estimate freight charge 15
Labor (fabrication) (2 men, 3 hrs. @ $4/hr) 24
Total $226

Interest rate of 8 percent.
Water saved at various evaporation control efficiencies:

Efficiency	Thousand gallons/year
100%	21.1
90	19.0
80	16.9
70	14.8

accumulation that plugged some of the bailing holes on the cover near St. George, and separation of the cover from an ice surface at Logan. Bird pecking is not expected to be extensive enough to cause mechanical failure of a cover, and the dust crusts around the holes have broken up during precipitation. The covers could be mechanically anchored to the ice during freezing periods by turning the perimeter of the floating cover down into the water or including an edging that extends into the water.

Once during the year, one side of the floating cover near Cedar City folded back, apparently due to wind. Floating cover stability under high winds is being investigated in a wind-tunnel laboratory.

Approximate Costs

Whether an effective evaporative-control system can be economically justified depends on material and construction costs, life of the system, the amount of evaporation control attained, interest rates, and the cost of such a technique compared with producing or saving an equivalent amount of water by other means. Table 1 shows some cost figures for a floating cover system on a 30-ft-diameter tank (a common size used) in a 4-foot evaporation zone. Cost values were calculated using current material costs, range of cover life, and various evaporation-control efficiences. Estimates based on present research suggest a floating cover life of 10 years, with an evaporation-control efficiency ranging somewhere between 80 and 90%. The cost to save potentially evaporated water under these conditions ranges from about $1.80 to $2.00 per 1,000 gallons.

Literature Cited

Bloch, M. R., and T. Weiss. 1959. Evaporation rate of water from open surfaces coloured white. Letter to the editor. Bull. Res. Council Israel, 8A, 188-189.

Cluff, C. B. 1967. Rafts: New way to control evaporation. Crops Soils Mag., 20(2):7-9.

Cluff, C. Brent. 1967. Water harvesting plan for livestock or home. Progressive Agr. in Arizona XIX (3):6-8.

Cooley, Keith R. 1970. Energy relationships in the design of floating covers for evaporation reduction. Water Resources Res. 6:717-727.

Crow, F. R., and H. Manages, 1967. A comparison of chemical and non-chemical techniques for suppressing evaporation from small reservoirs. Trans. Amer. Soc. Agr. Eng. 10(2):172-174. Chicago, Illinois.

Genet, E., and R. Rohmer. 1961. Reduction de l'evaporation par le recouvrement de la surface de l'eau a l'aide de parles de plastique. L'Eau, 48:348-352.

Keyes, C. G., Jr., and N. N. Gunaji. 1967. Effect of dye on solar evaporation of brine. Int. Union of Geodesy and Geophys. Gen. Assembly, Int. Assoc. Sci. Hydrol. (Bern), Pub. 78, 338-347.

Lauritzen, C. W. 1967. Raintraps of steel. Utah Sci. 28:79-81.

Lauritzen, C. W., and Arnold A. Thayer. 1966. Raintraps for intercepting and storing water for livestock. U. S. Dep. Agr., Agr. Inform. Bull. No. 307. 10 p.

Magin, G. B., and L. E. Randall. 1960. Review of literature on evaporation suppression. U. S. Geol. Surv. Prof. Paper 272-C, 53-69.

Myers, L. E., and G. W. Frasier. 1970. Evaporation reduction with floating granular materials. J. Irrigation Drainage Div., Amer. Soc. Civil Eng. (IR 4), 425-436.

Myers, Lloyd E., Gary W. Frasier, and John R. Griggs. 1967. Sprayed asphalt pavements for water harvesting. J. Irrigation and Drainage Div., Proc. Amer. Soc. Civil Eng. (IR 3), 79-97.

Reidhead, R. D., Jr. 1960. Evaporation and evaporation suppression bibliography, in Evaporation Control, M.S. thesis, Michigan State Univ., East Lansing.

Rojitsky, J., and Y. Kraus. 1966. Reduction of evaporation from water surface by reflective layers. In Service Prelim. Res. Progress Rep. Water Planning for Israel, Tel-Aviv, Israel, 1-21.

The Water Encyclopedia. 1970. The Maple Press Company, 91.

Young, A. A. 1947. Some recent evaporation investigations. Trans. Amer. Geophys. Union, 28:279-284.

Yu, S. L. and W. Brutsaert. 1967. Evaporation from very shallow pans. J. Appl. Meteorology 6:265-271.