EVALUATING THE EVAPORATION WATER LOSS FROM THE OMAR MUKTAR OPEN WATER RESERVOIR

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ABSTRACT

Water is the most precious natural resource in the world, especially in Middle East. Evaporation losses from storage facilities can potentially be large, particularly in Open Water Reservoirs. In the Great-Man-Made-River-Project there are many of this type of reservoir, such as the Omar Muktar Open Reservoir, which is located in Slouge area to the west of Benghazi City in Libya. This reservoir is chosen as the application area for this investigation work. Over 20% of the total Omar Muktar Open Reservoir's water storage capacity, ($4.7x10^6$ m^3), is lost due to the evaporation phenomena during the year of 2004.

Management of water by reducing the evaporation rates will optimize the amount of water that may perhaps support the ever-growing domestic, agricultural, and industrial demands. Sustainable management of evaporation by using the monolayer technique, the aim is to reduce the amount of evaporation on open bodies of water, is reviewed in this study. A field experiment was conducted in this study beside the Omar Muktar reservoir to test the effect of the monolayer in reducing the evaporation loss. The results of this conducted experiment were analyzed. Finally, assessment work for decision making was done to evaluate the usage of the monolayer technique to reduce the evaporation in comparison to the cost of the local water that are lost by evaporation.

INTRODUCTION

By creating The Great Man Made River, the Libyan people have generated a new water resource in a dry environment. The one area of Nature that has remained unconquered in this accomplishment is that of the evaporation phenomena. This research will examine a ready product, WaterSavr™, in reducing the evaporation process in attempt to support the ever-growing domestic, agricultural, and industrial demands.

Precipitation, percolation, runoff, and evaporation are stages in the cycle of water, which is without beginning or end. Evaporation and precipitation are the principal driving forces in the water cycle. Solar radiation is the source of needed energy. Evaporation raises the storage requirements of reservoirs and lowers the yield of lakes and ponds. Swamps and other wet surfaces, too, return much water to the atmosphere. Rates of evaporation from open water surfaces vary with the temperature or vapor pressure of the water and the air in contact with it, and furthermore, with wind speed, barometric pressure, and water quality. Because these factors are by no means independent, individual effects are not clear cut. In general, evaporation and gas transfer have much in common.

Natural evaporation takes place by the exchange of water molecules between air and a free water surface. This water surface could be a lake or a river, in our case the water surface is an open water reservoir.

Evaporation from open or "free" water has been well studied. Open water in this context refers to reservoirs, specifically the Omar Muktar Open Reservoir. There are at least four causes that might influence open or free water evaporation rates:

(1) *Barometric Pressure*. Free water evaporation increases with decreasing pressure, but the effect is usually balanced by the cooler temperature in storms and at higher elevations, where there are lower pressures.
(2) *Dissolved Matter*. Dissolved matter decreases the vapor pressure of water, consequently decreasing evaporation.
(3) *Shape, Site, and Situation of Evaporating Body*. Ponds, and lakes bounded by hills might decrease wind. Size and particularly length along the major axis of the wind give more near-surface velocity and surface roughness (waves).
(4) *Relative Depth of Evaporating Body*. Shallower lakes maintain more energy close to the surface and thus have higher evaporation than a deeper lake.

OBJECTIVE

There are several techniques that are aimed to reduce the loss of water from open reservoirs due to the evaporation phenomena, such as: (1) WaterSavr™ – monolayer (Nylex), (2) E-VapCap – floating cover (Evaporation Control Systems), (3) NetPro shade cloth – suspended cover (NetPro), (4) Polyacrylamide – PAM chemical (CIBA Specialty Chemicals), and finally (5) Raftex – modular covers (F Cubed Aust. Pty Ltd). WaterSavr™ is known to be effective from several experiments around the world.

This study will focus on using WaterSavr™ as a technique to reduce the evaporation in open reservoir in the Great Man-Made River project. The data that were recorded to estimate the water losses due evaporation from the Omar Muktar Open Reservoir which is one of the major open reservoirs in GMRA project, was chosen as an application area in this study to evaluate the benefits of using WaterSavr™ as a technique to reduce the evaporation. Omar Muktar Open Reservoir is located in Slouge area to the west of Benghazi City in Libya with a surface Area is 700,000 square meters, Figure 1. A small scale field experiment, which involved the use of WaterSavr™ product, was conducted in this study for this evaluation process. The location of Sloque agricultural project, which is adjacent to the Omar Muktar Open Reservoir, was chosen for this filed experiment.

Figure 1: Omar Muktar Reservoir

METHODOLOGY

An evaporation retardant product, WaterSavr™, was used which is a new surface water evaporation control product, Figure 2.

Figure 2: WaterSavr™ against reservoir 50

According to its manufacture, WaterSavr™ is a patented hydrated lime powder with hydroxyl alkanes that can be applied to the surface of the water. Ionic repulsion causes the hydroxyl alkanes to self-spread, resulting in a mono-molecular film on the surface of the water. With a concentration of 83.3% by weight, its primary constituent is calcium hydroxide, also known as lime or slaked lime. Two hydroxyl alkanes, stearly alcohol and cetyl alcohol, are present at concentrations of 4.6% each.

Two identical agricultural open water reinforced concrete reservoirs, which are located in two adjacent farms numbers 50 and 51 in Sloque agricultural project, were used in the testing procedure of the WaterSavr™ product, see Figures 3 and 4.

Figure 3: Reservoirs 50 & 51 in a row

Figure 4: Reservoir 50

Each reservoir has the following characteristics: a volume of 275 m^3, with a surface area of 10 m in diameter, and depth of 3.5 m. The following table locates the exact position of the two reservoirs; they are labeled with respect to the farm number that they are located on.

Table 1: Exact positions of the two reservoirs

Reservoir Number	Elevation (m)	GPS Coordination
50	65	N 31° 47.972, E 20°-13.369
51	66	N 31° 47.972, E 20° 13.26

These reservoirs are expected to be exposed to identical climate conditions of temperature, humidity, and light due to short distance between these two tanks. The only difference was the addition of WaterSavr™ to one these reservoirs (reservoir no. 50), see Figure 5.

The water levels in both reservoirs (no. 50 and 51) were daily measured to estimate the water losses due to the evaporation phenomena. Figure 7 shows a comparison between the daily measured data.

Figure 5: Application of WaterSavr™ to the reservoir no. 50.

RESULTS ANALYSIS AND RECOMMENDATIONS

1. Although the two tanks were filled with water at the same time and with same water quality, it is visibly clear that the treated tank no. 50 has an intense growth of algae, see Figure 7. Even though there are reports, McGuire Environmental Consultants' WaterSavr™ Evaluation 2004, that state that algae won't be a problem. This may be related to the biodegraded organic (Stearyl alcohol and cetyl alcohol) components in the WaterSavr™, one of the outcomes of the biodegradation is CO_2. As we know, that CO_2 is needed by algae for photosynthesis during daylight. According to this observation, it is recommended that more studies are needed to expose the effect of using the WaterSavr™ in the algae growth in arid and hot weather.

Figure 6: Growth of algae is not visible in tank 51

Figure 7: Algae are clearly visible in tank 50

2. During the 46 days, an average of 229 mm of water has evaporated from reservoir 50 (treated with WaterSavr™), and an average 274 mm of water has evaporated from reservoir 51 (untreated with WaterSavr™), Figure 8. In comparison between the two reservoirs, a 16.42% of water was saved in the reservoir treated with the evaporation retardant product, WaterSavr™.

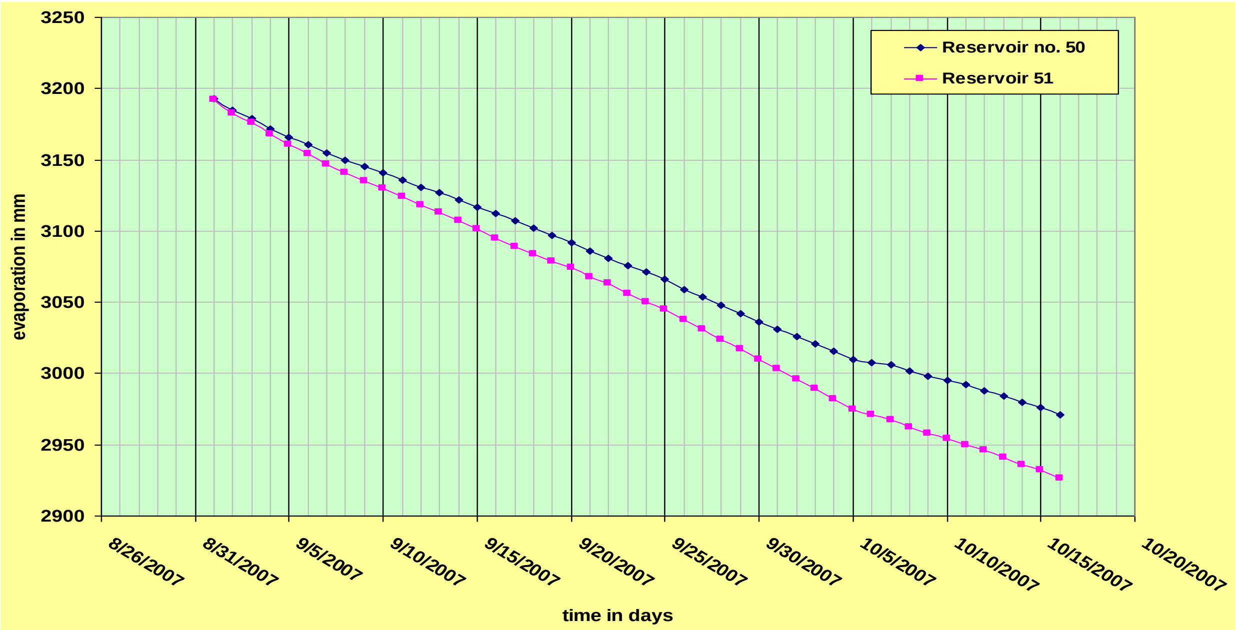

Figure 8: Evaporation loss records during 46 days:
Navy blue line: Treated reservoir with WaterSavr™ (reservoir 50)
Pink line: Untreated reservoir with WaterSavr™ (reservoir 51)

3. The result of the experiment, as presented in the Figure 7, shows that a 16.42% of water was saved in the reservoir no. 50 with the evaporation retardant product, WaterSavr™. To improve the saving amount, it is suggested in this study that the amount of WaterSavr™ (0.981 gram/19.63 m^2) should be doubled to reduce the cuts in the fine mono-molecular film due to the wind effect, which creates voids in the surface of water allowing the surface to be without protection.

4. According to GMRA, in year 2004, the evaporation loss from the Omar Muktar Reservoir is (928,195 m^3). Table 2 shows the Evaporation rates during year 2004. Using the experiment results the expected water saving with using WaterSavr™ will be only 152,409 m^3 in the Omar Muktar Evaporation Loss in m^3 during year 2004. According to this finding the amount of annual saving with using the WaterSavr™ is not encouraged. For this reason, we suggest more studies should be done to improve this technique.

Table 2: The Omar Muktar Evaporation Loss in m^3 during year 2004, Source GMRA, 2005

Month	Reservoir Evaporation Loss M^3 Omar Muktar
January	10428
February	13296
March	22311
April	36502
May	97276
June	147900
July	149353
August	153559
September	158015
October	65111
November	42858
December	31586
Total	**928586**

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