

Methods to Reduce Evaporation of Water from Reservoir

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Abstract - Demand for water has been increased nowadays as a result of increase in population and industrial activity. Global warming and increase in concentration of greenhouse gases in atmosphere will affect temperature and rainfall. This change effect on reservoir storage and availability of water resources as resources are limited. Development of water resources should ensure efficient control, conservation and use of available water. The need of water saving is greatest in areas of low runoff and less rainfall. Water losses by evaporation must be minimized for greatest utility of limited supplies. Seepage loss in water course return to stream and aquifers for reuse, evaporation loss signifies water that is lost from available supply. Measurements done showed 95% of rainfall is evaporated which affect the available water storage. Evaporation from reservoirs is important issue frequently, so there is need for more emphasis on minimizing if not preventing the losses due to evaporation. This evaporation can be retarded by either physical, chemical or biological methods among which physical method is most effective. Published research reveals that floating covers is most effective method for evaporation control which reduces about 70% of evaporation. This method could be applied in different arid and semi-arid areas which could help decrease in evaporation rate.

Key Words: Evaporation, global warming, reservoir, floating covers

1. INTRODUCTION

The 21st century is involved with the scarcity of water resources, growth in population, deforestation and limited resources of water. Water is an essential ingredient for human life and any other living organisms. So, it directly affects to human influences, environmental, natural influences (i.e. climate), income, quality and quantity of crops, etc.

To reduce or control the evaporational loss, different methods such as physical, Biological and Chemical are used. Mainly four factors affects the evaporation. It consists of –

- 1) Area of water surface: Larger the area larger the evaporational loss
- 2) The temperature and air above it: Higher the temperature then higher the evaporational loss
- 3) Motion of air above water surface:- Greater motion of air carries more vapour.
- 4) Relative humidity:- Moist air absorbs moisture less readily than dry air.

The amount of water lost from reservoir depends upon many factors including the depth, size of the storage and method used to store. It can be managed by firstly increasing the depth and secondly by applying the most effective method on water storage reservoir.

Also, proper management of resources saves the amount of water. It helps in the growth in economy and narrow the water storage gap.

The use of biological cover such as wind breakers, palm fronds could reduce the evaporation volume and physical method involves floating covers and suspended covers also can lower the rate of evaporation. In addition, chemical barriers plays significant role to decrease evaporation. The Main purpose of this paper is to present result in last 5 years (from 2016 to 2020) from numerical investigation method of evaporation control surface and to find out the most effective method to reduce evaporation loss in Khadakwasla Reservoir Maharashtra. A brief description of three methods are also included in this review.

1.1 EVPORATION AND FACTOR AFFECTING

Evaporation is process in which liquid changes to gas without becoming hot enough to boil.

It occurs when individual liquid particles at exposed surface of liquid absorb enough energy to overcome force of attraction with other liquid particles. If surface particles are moving in right direction they will pull away from liquid and move into air.

Control of evaporation from water bodies has been one of main planks of water conservation. A number of factors affect the evaporation of water from water Temperature-Higher the temperature greater the rate of

evaporation. When temperature of liquid increases, the kinetic energy of individual molecules also increases. Thus energy makes it easier for liquid molecules to overcome the intermolecular forces of attraction and escape into atmosphere as a gas.

Surface area -

Evaporation is a surface phenomenon Evaporation from water bodies directly depends on the extent of its surface exposed to atmosphere. The larger the number of liquid molecules are at the surface the larger the number of molecules that will break away from liquid and become a gas at given point of time, which contribute to an increase in rate of evaporation.

Wind speed-

Greater the movement of air above the water surface, greater is the loss of water. Evaporation increases humidity of the atmosphere that surrounds the liquid. Presence of air circulation can speed up this process and make environment less humid.

Therefore, by decreasing the humidity of liquid surrounding can increase the rate at which liquid evaporated.

Humidity-

Greater the humidity surrounding the water slower is the rate of evaporation.

Atmospheric pressure-

The number of air molecules per unit volume increases with the pressure. Evaporation decrease with increase in pressure.

Quality of water-

Salt content affects the rate of evaporation. Evaporation decreases with increase in the salt content in water. In sea, evaporation is 2-3% less compared to fresh water, when other condition are Method and analysis which is performed in your research work should be written in this section.

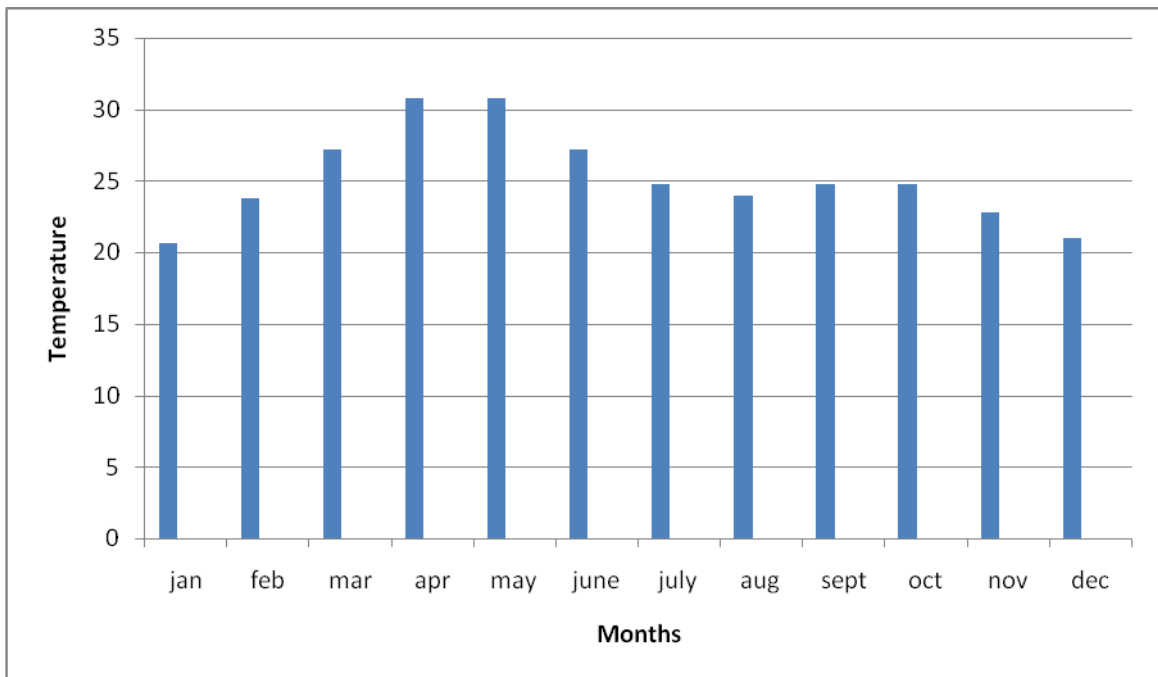
Table 1. Monthly Temperature (c) At Khadakwasla Reservoir During The Period From 2016to 2020

	Jan	Feb	March	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Avg
2016	21	26	29	32	31	28	24	24	25	24	22	21	25.58
2017	21	24	27	30	31	27	25	24	25	25	22	21	25.16
2018	21	23	27	30	31	27	24	24	25	26	24	20	25.16
2019	19	23	27	31	30	28	25	24	24	24	23	22	25
2020	21	23	26	31	31	26	26	24	25	25	23	21	25.16
Avg	20.6	23.8	27.2	30.8	30.8	27.2	24.8	24	24.8	24.8	22.8	21	

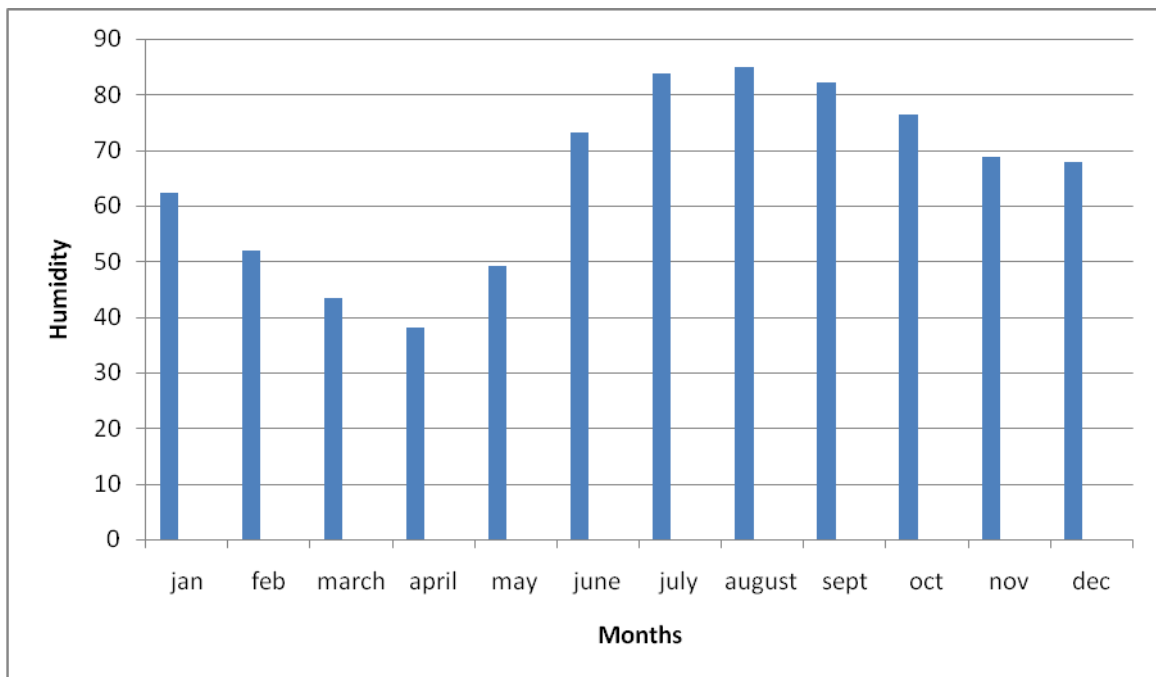
Table 2 Monthly Humidity (%) At Khadakwasla Reservoir During The Period From 2016to 2020

2016	56	49	41	36	49	69	85	83	81	73	59	59	61.66
2017	58	47	39	37	50	74	84	84	83	78	70	70	64.5
2018	65	59	47	38	47	75	85	86	78	65	63	63	63.83
2019	61	51	39	37	47	70	85	85	86	84	79	75	66.58
2020	71	59	51	42	53	78	80	87	83	82	73	72	69.25
Avg	62.2	52	43.4	38	49.2	73.2	83.8	85	82.2	76.1	68.8	67.8	

Monthly temperature in (c) from 2016 to 2020



Monthly humidity in (%) from 2016 to 2020



2. METHODS

Wind breakers -

The important factor which affects the rate of evaporation from the surface of water is wind. The effective method to reduce this evaporation losses is by planting trees to the direction of wind. To control the wind speed wind breakers are important. Controlling the evaporation by physical method having high wind speed is done by the wind tunnel walls. change in wind speed can affect erosion of earth, dust storms, evapotranspiration.

Structures like wind breakers saves our energy consumption and control of erosion. It develops the environment, it produces various agricultural products and turbulence also. By changing the wind velocity, air turbulence and directions, the use of wind breaks takes place.

To examine the effect of wind breaks, there are various tests and studies has been conducted on wind velocity. factors such as porosity, height, direction of wind are important for efficiency on wind velocity reduction. The important factor in wind breaks are height. wind break height is depend on the length of the protected area behind the wind breaks.

Another factor which is most effective is porosity and wind breaks describes it's internal structure. empty space to the entire area of windbreaks is the ratio of porosity. Air turbulence is prevented by the porosity. When we use solid windbreaks, wind velocity which is minimum moves towards the windbreaks and it passes the air flow.

In agricultural lands windbreaks has been used. Also windbreaks are used in dust, dispersion of eroded particles and spray drift to nearby habitation. in agriculture, the reduction of wind velocity is effective by using windbreaks. Reduced effect of wind on plants, reduction of pollutants, pathogens and pest reduction, High crop production Performance, these are the advantages of windbreaks application.

There has been various formulae are invented by various scientists to reduce evaporation by use of windbreaks. The one formula invented in zahak. to invent this formula wind velocity, temperature, annual evaporation, humidity are used.

These formula has the lowest error and greatest correlation-

$$E = - 1.452 + (0.464 \times T) + (0.686 \times W) - (0.102 \times M)$$



Wind Breakers

Chemical cover

The reduction of evaporation is also calculated from some chemical methods or by using chemicals such as Hexadecanol and Octadecanol, which are very effective to control the evaporation reduction of water.

There are some formulae are invented to determine the rate of evaporation. The scientist who first developed the evaporation loss by empirical formula is 'Dalton'. Dalton equation is modified by Fitzgerald by modifying coefficient factor for wind velocity and in Western United States these conditions are applicable.

The development in evaporation equation is found by Research Scientists, Boelter, Hickox, Thomas and Ferguson. To determine the effect of application of chemical films which are Hexadecanol and Octadecanol, experiments has been conducted by G.B. Pant University of Agriculture and Technology, Patnagar in UP.

By using wind tunnels of different wind velocities, the reduction of evaporation from free water surface. By using chemical films following equation are suggested with application of hexadecanol.

$$E = (0.0014 + 0.044W) \times (e_s - e_a)$$

Evaporation loss is estimated from land pan evaporimeter. in this floating evaporimeter is used. Floating evaporimeter is made up of GI sheets and these sheets are used. Inside the water body the stored energy has a significant effect on the loss of evaporation. Material which is suitable for manufacturing floating evaporimeter, it is truly reflected.

Thermal conductivity which is equivalent to water and also it should be non-leaky, a material have to achieve the Objectives. 0.556 W/m°C is the thermal conductivity of water. for iron it is 0.75 and for brick it is 0.60 and 0.78 for window glass and for plastic it is 0.02. In this values of plastic and concrete are less and brick is very heavy and le

also So, perspex sheet is a new material which is non- brittle and workable is used. Sliding arrangements follows the water surface and it could be fixed at desired location, this is the main advantage of this pan.



Chemical Cover

Floating covers -

To reduce evaporation from the water surface, an impermeable barrier which floats on the surface of water are used.

For making these continuous covers, materials like polystyrene, foam, and wax are used. For these floating covers the most acceptable and durable material is polystyrene plastic. From open water reservoir 95% of reduction of evaporation from floating sheets such as E-vap cap has shown.

Fixed or floating covers by covering surface of water retards the evaporation loss. The energy input from the atmosphere reflects by these floating covers, so reduction in evaporation is obtained. These cover functions as they prevents the transfer of water vapour to outer atmosphere and also traps the air.

Floating covers or may or sphere are used for large storage of water. Covering the water surface with floating covers, for large water surface are prohibitive. The danger of floats being lost over the spillway or from some outlet occurs in case of reservoir having the flood outlets. So, for large water bodies these floating covers has the limited utility.

Reduction of evaporation to 80% from floating spheres of polystyrol in small experiments has performed by Genet and Robber. The advantages like reflecting solar energy and influencing evaporation for white sphere has been studied.

From floating bodies such as vegetable oil, wax, wheat husk, wooden blocks, paddy husk, thermocol bodies, saw dust, the experiments had done and These experiments are performed for period of 15 days only.

46% of having of water is done by evapo-retardant like mustard oil is the most effective. From remaining other water bodies the effective was found to be thermocol, wax, paddy straw, saw dust and wooden blocks are in the order of effectiveness for saving water.

The accuracy of evaporation loss is obtained by their utility and economics. Also by observing other experiments under varying size and varying conditions of water bodies.

To assess the effectiveness of the floating covers the annual evaporation according to different levels of coverage was calculated by the expression :

$$E = (1-x) \cdot E_{base} + x \cdot E_{cover}$$



COMPARATIVE STUDY

Wind Breaks

Wind breaks are the structures which are used to control wind speed. It's changes can affect the phenomena such as evapotranspiration, earth erosion. Change in velocity and direction of wind or air influences the evaporation rate of certain distances.

There has been various formulae are invented by various scientists to reduce evaporation by use of windbreaks. The

one formula invented in zahak. to invent this formula wind velocity, temperature, annual evaporation, humidity are used. These formula has the lowest error and greatest correlation,

$$E = -1.452 + (0.464 \times T) + (0.686 \times W) - (0.102 \times M)$$

Where,

E= Evaporation (mm)

T= temperature (centigrade)

W= wind speed (m/s)

and M = relative moisture.

Chemical method

Using chemicals such as Hexadecanol and Octadecanol, which are effective way to control the evaporation reduction of water.

There are some formulae are invented to reduce the evaporation rate. By using chemical films following equation is suggested with the application of hexadecanol ,

$$E = (0.0014 + 0.044W) \times (e_s - e_a)$$

Where,

E= Evaporation rate (mm/hr)

W= wind velocity (km/hr)

e_s and e_a are the the saturation and actual vapour pressure respectively in millibars.

Using this method 3.5 to 4% of evaporation rate can be reduced.

Floating Cover

Impermeable barriers which float on the surface of water are used to reduce the evaporation from water surface. Materials like polystyrene, foam, and wax are used for making these continuous cover.

The formula to reduce evaporation using floating covers are as follows

$$E = (1-x) E_{base} + X \cdot E_{cover}$$

Where,

E= Daily evaporation rate

x= fraction of covered area (ranging from 0-1)

E_{base} =daily evaporation without using cover

E_{cover} =daily evaporation with 100% coverage.

Using this method 25 to 26% of evaporation rate can be reduced.

3. CONCLUSIONS

With the help of chemical method that is by using Bycetyl Alcohol, Stearyl Alcohol evaporation of water can be Reduced upto 20% to 40% . It has low initial cost and high maintenance.

With the help of wind breakers that by Planting trees evaporation rate can be reduced upto 15% to 25%.This method is suitable for small size reservoir, and not for large reservoir.

When designing new water storage evaporation control technique such as deeper storage wind breakers should be included in the design if siable height level of evaporation reduction be required then physical reduction method should be Applied.

Physical method is economical and Ecofriendly to human and environment Publish research shows that floating covers have great potential in reducing evaporation and improve the water quality.

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