A Review on Study on Evaporation Control of Reservoirs: A Case Study of Katraj Lake

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***Abstract*—The water is the most vital, primary, elementary and basic requirement of the human. Contribution of the water in the development of India is very much crucial and key role is always played by the water in socio-economic development of India. The water that is lost to the air from the surface of the pond is called evaporation. The amount of water lost by evaporation depends largely on local climate conditions. High air temperatures, low humidity, strong winds and sunshine will increase evaporation. Low air temperatures, high humidity, rainfall and cloud cover will decrease evaporation. Evaporation will also depend on the water surface area. The larger the pond, the more water will evaporate from its surface. As our country is agrarian country and the water is the prime need to increase the yield of agriculture product. This project revealed that the physical methods can reduce evaporation effectively without environmental consequences methods of Evaporation Control. For the effective method of Evaporation Control, katraj lake Reservoir will take for the analysis.**

***Index Terms*—Evaporation, Reservoir, Evaporation Control, temperatures, vapour pressure.**

I. INTRODUCTION

Water is one of the nature's precious gifts, which sustains life on earth. Civilizations over the world have prospered or perished depending upon the availability of this vital resource. Water has been worshiped for life nourishing properties in all the scriptures. Vedas have unequivocally eulogized water in all its virtuous properties. We the human creatures of the world are living because we are having a set of sustainable elements on the earth such as the water, the air, the land, etc. These all-natural elements are useful for our survival on the planet earth. Out of these basic elements, the most common liquid which is widely available on our planet is the water. The water is the most vital, primary, elementary and basic requirement of the human. Contribution of the water in the development of India is very much crucial and key role is always played by the water in socio-economic development of India. As our country is agrarian country and the water is the prime need to increase the yield of agriculture product. Our gross domestic production, all over demands, the bullishness of each and every sector, very much depends on the availability of the water and the Gross Domestic production is higher in the year in which availability of the water is sufficient. It is also found that for the efficient development, the optimum use of the water is very much important.

A. Evaporation Loss

When the molecules of the water situated at the surface are changed its state from liquid into vapour and escaped from the water body. Hence the quantity of the water is decreased, called as the loss of the evaporation. This process occurs even below boiling temperature of the water. During this process, the heat energy is absorbed by molecules of the water and it converts into the kinetic energy, as the cohesive forces prevailing between the water molecules are not so high and the water molecules now possess the kinetic energy, the result of which the molecules of the water eject themselves from the surface and start upward motion towards the atmosphere The amount of the energy used by the unit of mass of water to convert its state from liquid into vapour at a constant temperature is called the latent heat or the evaporation and it is about 585 calories per gram. Whenever the energy from the

outside is not obtainable, the heat energy which is obtained from the water bodies itself is used for the evaporation and because of this the temperature of the water is reduced. The water molecules in the state of vapour continuously leaving the water surface and accumulate the above surface hence, the pressure of the surface increases. This pressure is called as the vapour pressure.

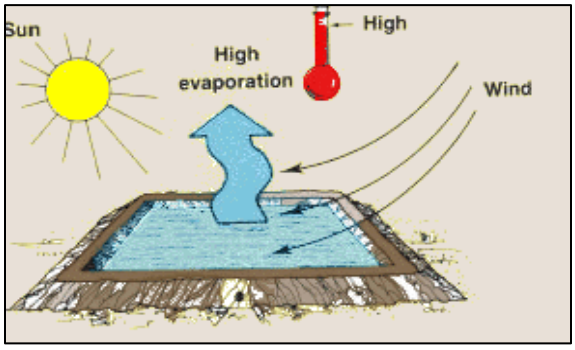

Fig 1 High Evaporation Loss

II. STATE OF DEVELOPMENT

A lot of research works have been done on the evaporation, the water conservation, the water augmentation and water supply in the past. The research works conducted in the past showed that the need of estimation of the available quantity of the water for the effective management of the water resources, for the improvement of the water supply, for the water utilize administration and for the reduction of the water losses from the resources. Good quality literatures are available on the same area and an extensive review works have been undertaken on the same literature in this chapter.

Mostafa A. Benzaghta et. al. (2009) The future effects of climate change on water resources in the world will depend on trends in both climatic and non-climatic factors. Evaluating these impacts is challenging because water availability, quality and stream flow are sensitive to changes in temperature and precipitation. Other important factors include increased demand for water caused by population growth, changes in the economy, development of new technologies, changes in watershed characteristics and water management decisions. Global warming and the increasing concentration of greenhouse gases in the atmosphere will affect temperature and rainfall. This change has direct effect on reservoirs storage and availability of water resources. For example, measurements done in Australia showed that 95% of the rainfall is evaporated again which effect the available water storage. Many methods were proposed to reduce evaporation from open reservoirs. These methods can be categorised as physical and chemical methods. Research was done evaluate the effectiveness of the methods in evaporation reduction from reservoirs. Published research revealed that the physical methods can reduce evaporation effetely without environmental consequences but chemical methods effects water quality and reduce evaporation by 20 to 40% only.

Yara Waheeb Wessef et. al. (2019) Many methods have been tested and developed all over the world to save water from evaporation process. This paper presents a state of-art review of published research work in the last 14 years (from 2014 to 2018) in which it was focused on the physical, chemical and biological methods of evaporation reduction from water surfaces. The main characteristics, as well as the advantages and disadvantages of each method are indicated. Among these used techniques for reducing evaporation are physical methods that use floating or suspended covers and can save a large percentage of water (between 70 and 95%). The use of thermal mixing by compressed air seems to be very important for evaporation suppression on deep reservoirs (greater than +18 m). Moreover, currently chemicals are widely used to reduce water evaporation, such as Water Savr, and can save relatively a small percentage of water (between 20 - 40%). Biological methods such as floating plants, wind breakers and palm fronds can provide a significant decrease in the volume of evaporation but they have some restrictions on their uses.

Abdelmajeed, M. A. et. al. (2009) Gasoline is a volatile organic compound (VOCs) which consists of different hydrocarbons with different boiling points in the range of 30-200oC. The light compounds that have boiling point of less than 40oC constitute about 10%. Khartoum, Sudan is characterized with an average of 10 hrs. of sunshine and solar radiation of 3.05-7.62 kWh/m2/day and average temperature of 32 to 40oC. Under these conditions high evaporation rate is expected from storage tanks. The objective of this study is to evaluate the evaporation loss of gasoline from internal floating roof storage tank. The case study is based on metrological and operation

data for the year 2008. The result revealed that the total evaporation loss is 0.5%. This is significantly higher than that set by the ministry of energy [i.e.0.25%]. The results should be of concern to the petroleum industries and government. The reduction of evaporation loss of gasoline will give attractive economic returns as well as reducing air pollution and hazards.

Qian-Qian Xia et. al. (2022) Reservoirs play a vital role in agricultural irrigation, food security, and ecological protection in arid and semi–arid areas where water resources are scarce. In the Tarim Basin (TB) in north-western China, a large number of reservoirs have been built or are being built, resulting in significant evaporation losses. However, information about the distribution, area and evaporation rate of the reservoirs in TB is limited. To contribute, we present an inventory of reservoirs and calculate their monthly surface area and evaporation rate during the study period of 1990–2019, using the Terra Climate dataset, Google Earth Engine (GEE) platform, Landtrendr algorithm, Penman method, and Landsat images. The results suggest: (1) The inventory of 167 reservoirs in TB consists of 142 existing reservoirs (built before 1990), 5 new reservoirs (mountain reservoirs, built during 1990–2019), and 20 dried–up reservoirs (plain reservoirs that went extinct during 1990–2019). (2) The reservoir types in TB are mainly plain reservoirs with an altitude of less than 1500 m and an area of less than 10 km2 , accounting for about 88% of the total number of reservoirs. (3) The surface area of the reservoirs increased at a significant rate ($p < 0.05$) of 12.45 km2/y from 401 km2 in 1990 to 766 km2 in 2019. (4) The evaporation rate of the reservoirs increased at a slight trend of 0.004 mm/d/a and varied from 2.57 mm/d in 1990 to 2.39 mm/d in 2019. Lastly, (5) The evaporation losses of reservoirs in TB significantly increased ($p < 0.05$) from 4.72 × 108 m3 to 4.92 × 108 m3 due to the significant increase in reservoir surface area ($p < 0.05$) and the slight increase in evaporation rate from 1990 to 2019. This study provides essentials of the reservoir inventory, surface area, and evaporation rate with considerable baseline inferences for TB that may be beneficial for long–term investigations and assist in local water resources decision support and sustainable management in arid regions.

Mrs. M. S. Joshi et. al. (2021) 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.

Azolla Fern et. al. (2018) In these projects is deals with control the evaporation of water in lakes and ponds using azolla fern. The project is done by experimental using chemistry and environmental laboratory. Using the instruments of Chinese glass bowl and heat the water to find out the evaporation. These projects execute in Roever Engineering College. We make pond to find the evaporation of these project deals with control the evaporation of lakes and ponds. The pond size is 2m length ,2.5m breadth and 0.3m depth, then provided with the half level of water 500 liters only. The lake to be provided the azolla to control the evaporation of water and erosion of banks, in this project execute in model protocol. Azolla is a branched free floating aquatic fern and is it is one of the foods for animals like goat, cow, fish etc. Evaporation refers to water losses from the surface of a water body to the atmosphere. Evaporation occurs when the number of moving molecules that break from the water surface and escape into the air as vapor is larger than the number

that re-enters the water surface from the air and become entrapped in the liquid. Evaporation increases with high wind speed, high temperatures and low humidity. A sizable quantity of water is lost every year by evaporation from storage reservoirs and evaporation of water from large water bodies influences the hydrological cycle. Among the hydrological cycle, evaporation is perhaps the most difficult to estimate due to complex interactions among the components of land-plant-atmosphere system.

Hany F. Abd-Elhamid et. al. (2021) The shortage of water is a major obstruction to the social and economic development of many countries, including Egypt. Therefore, there is an urgent need to properly manage water resources to achieve optimum water use. One way of saving available water resources is to reduce evaporation that leads to the loss of a large amount of water from reservoirs and open lakes. This paper aims to use a floating photovoltaic system (FPVS) to cover a lake's water surface to reduce evaporation and also for energy production. This methodology was applied to Lake Nasser as one of the largest lakes in the world where much evaporation happens due to its large area, arid environments, and the shallow depths of some parts of the lake. The estimated evaporation from the lake was 12.0 × 109 m3/year. The results show that covering 25%, 50%, 75%, and 100% of the lake can save about 2.1, 4.2, 6.3, 7.0, and 8.4 × 109 m3/year and produce energy of 2.85 × 109 , 5.67 × 109 , 8.54 × 109 , and 11.38 × 109 MWh/year, respectively. Covering areas of shallow water depth was more efficient and economical. The results show that covering 15% of the lake's area (depths from 0.0 to 3.0 m) can save 2.66 × 109 m3/year and produce 1.7 MWh/year. Covering 25% of the lake's area (depths from 0.0 to 7.0) can save 3.5 × 109 m3/year and produce 2.854 MWh/year. Using an FPVS to cover parts of Lake Nasser could help manage water resources and energy production for Egypt to overcome the likely shortage of water resources due to population growth. This system could be applied in different locations of the world which could help in increasing water resources and energy production, especially in arid and semi-arid regions.

Ahmad Danboos et. al. (2018) Lakes and reservoirs behind dams are important elements for sustaining ecological balance. They play vital functions at various times and for different purposes, such as supplying water for irrigation, hydropower, and mitigating disastrous environmental effects and impacts, as well as ensuring flood mitigation, insurance during periods of drought, etc. However, these artificial lakes and reservoirs evaporate more rapidly than did the natural surface water flow before the dam was built because dams generally increase the surface area of the body of water. Thus, more of the water surface is exposed to air and direct sunlight, increasing evaporation. This "lost" water is referred to as having been consumed because it is removed from the system. In some cases, this water consumption can be quite substantial. The present trend of global warming speeds up the shrinkage of the water area relative to the land area. This is especially true for lakes and reservoirs, and the environment around them undergoes changes that have degraded the lives of the inhabitants and impacted their economic activities. Many of the world's lakes and reservoirs are facing the threat of shrinkage. The present study reviews the evidence that demonstrates the high evaporation rates at the Al Haditha Reservoir during the past few decades, with the consequent degradation of its environment that accompanies the changes in the area covered.

Sanket S. Jadhav et. al. (2018) many methods exist for either measuring or estimating evaporative losses from free water surfaces. Evaporation pans provide one of the simplest, inexpensive, and most widely used methods of estimating evaporative losses. The use of pan data involves the application of a coefficient to measured pan readings to estimate evaporation from a larger water body. Pan evaporation is considered an indication of atmospheric evaporative power. Global warming and the increasing concentration of greenhouse gases in the atmosphere will affect temperature and rainfall. This rise in temperature ultimately results in evaporation losses from storage reservoirs. As water is limited resource and its conservation and management is important, so that there are different method to reduce evaporation from open reservoirs. These methods are mainly categorized as physical and chemical methods. Water losses by evaporation from storage reservoirs must be minimized for greatest utility of limited supplies. Hence in this paper we have focused on evaporation losses from the open reservoir and carried out test on artificial

reservoir using low density polypropylene balls as floating cover to predict how much percentage of evaporation losses can be reduce from open reservoirs. From analysis 80-82% evaporation losses can be reduced to actual losses from water bodies.

Abrar Ali et. al. (2016) While the countries developed its economic, the sources of water are running down which may generate a shortage of water for the coming generations, so the government decide that, this water's problem will effect for a long time period and will be a trouble for the country's development, if no solution take place for fix this problem. Based on lack of water sources, Oman's government determine a critical plan for saving the water sources, also government search about the evaporation factors and try to control those factor. The control strategy contains a radical solution to minimize the effectiveness of water shortage problem. Water is the basis of the life, by the continuous of the water the life will continue. Previously the water pools have no benefit from it and people leave it as it is without any exploitation. But development of thin film surface coating for reduction of water evaporation research work start trade on those water pools for expand them uses and protect this water from losses specially by evaporation, that a physical process which usually occurs on water bodies, both natural and man-made. Thin film surface coating is determined as the best way to store the water pools by applying Polystyrene polymer and Tetra hydro furan solvent as a film on the surface of the water, thin layer will be formed and cover the water from evaporation. This research work is divided into two sections as a theoretical and experimental part, where the theoretical part include search about the evaporation factors on water surface and the methods for reducing the rate of evaporation, while the experimental part expresses on finding the suitable methodology that can be follow in the research work. When the testing part is carried out, the evaporation rate is compared between the two trays which with the thin film and the tray under natural conditions to get the final result and discuss whether the research work is suitable for water shortage problem and how it will be helpful in the future. The found out of this research work, thin film is the best solution to protect the water for a time and get benefit from the water pools while need for it without any losses and this research work determine as a modern way that depend on availability sources

Cluff, C. Brent et. al. A summary of the leading methods of evaporation control is presented. Eight categories of evaporation control were discussed. The three leading categories of evaporation control discussed were the monolayer, the reduction of the surface- area -to volume method and floating vapor barriers. These methods are less expensive and appear to have a wider range of application than de-stratification, wind barriers, shading the water and floating reflective barriers. The other method of evaporation control discussed was the use of sand or rock -filled reservoirs. This method was found to be effective but limited to smaller size reservoirs. The use of fatty alcohol to form monolayers will work on larger reservoirs using either the airplane or a pipeline carrying the alcohol in slurry or an emulsified form. An airplane was used to distribute alcohol on the 12,000-hectare Vaal Dam in Africa during an extreme drought. The estimated cost was $0.021 /m6. The method is less cost -effective on smaller reservoirs due to rapid removal of the material by the wind. The reduction of surface -to-volume ratio can be accomplished through the use of proper site selection or if in flat terrain through the use of the compartmented reservoir. The concept of the compartmented reservoir can be used on existing reservoirs but more easily on new ones since it involves the use of construction equipment. The proper use of the compartmented reservoir concept should result in a lower unit cost of water saved than any other presently known evaporation control method.

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III. CONCLUSION

The water is the most important element on earth that plays many vital roles in the life cycle of all living being. The importance of water and its optimum use are generally known and accepted practices. It is also very well known to save water in as much quantity possible has become the need of the hour. As our country is agrarian country and the water is the prime need to increase the yield of agriculture product. Among the hydrological cycle, evaporation is perhaps the most difficult to estimate due to complex interactions among the components of land-plant-atmosphere system. Using an FPVS to cover parts of Lake Nasser could help manage water resources and energy production for Egypt to overcome the likely shortage of water resources due to population growth. This system could be applied in different locations of the world which could help in increasing water resources and energy production, especially in arid and semi-arid regions Reservoir during the past few decades, with the consequent degradation of its environment that accompanies the changes in the area covered Published research reveals that floating cover 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. This work needs to reveal that the physical methods can reduce evaporation effectively without environmental consequences methods of Evaporation Control.

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