Study on Evaporation Control in Reservoir

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Abstract- *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 India showed that 95% of the rainfall is evaporated again which effect the available water storage. Many methods were proposed to reduce evaporation from open resurvoirs. These methods can be categorised as physical and chemical methods. Research was done evaluate the efffectiveness of the these methods in evaporation reduction from reservoirs. This project revealed that the physical methods can reduce evaporation effectively without environmental consequences but chemical methods effects water quality and reduce evaporation by 20 to 40% only.*

Keywords- Rainfall , Evaporation Control , Reservoir

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.

The total water resources on earth are estimated to be around 1360 Million cubic km. Out of which only about (33.5 Million cubic km) is fresh water. India possesses only 4% of total average runoff of the rivers of the world although it sustains 16% of the world's population. The per capita availability of water in the country is only 1820 m3 /year, compared to 40855 m3 /year in Brazil, 8902 m3 /year in USA, 2215 m3 /year in China, 2808 m3 /year in Spain, 18162 m3 /year in Australia, 3351 m3 /year in France, 3614 m3 /year in Mexico, and 3393 m3 /year in Japan. The total water resources of India are estimated to be around 1,869 BCM. Due to topographic, hydrological and other constraints, only about 690 BCM of total surface water is considered as utilizable.

A. Importance of Development In This Topic

In the earlier days availability of water was taken for granted. It is now being realized that water, though replenish able, is not an unlimited resource and cannot be produced or added as and when required, by any known technological means. The other important limitation is that the availability of water over the years depends upon the spatial and temporal variation of precipitation. Thus water may be abundant during monsoon season and scarce in non-monsoon season, when most needed. The ingenuity of man, therefore, lies in his ability to modify the pattern of availability of water to suit needs. One of the commonest forms of such modification is storage of water during monsoon season for eventual use in lean season. The traditional methods are big storage in natural or artificial ranks. Lately a large number of storages have been constructed. Due to high temperatures and arid conditions in about one third of the country, the evaporation losses have been found to be substantial. Therefore, it is imperative to minimize evaporation losses in the storages/water bodies.

B. Need of Developing Of Evaporation Control In Reservoir

The need for prevention of enormous evaporation losses assumes greater significance, in view of the predictable scarcity of water; the country will be facing in future. It has been assessed that against the utilizable water resources of the order of 1123 BCM, the requirement by 2025 AD to be met from surface water resources will be around 1093 BCM, thereby surplus by just 30 BCM.

Due to intense agricultural practices, rapid increase in population, industrialization and urbanization etc., scarcity of water is being increasingly felt. The situation becomes grave in the arid and semiarid regions especially during droughts, when general scarcity of water is compounded by high evaporation losses from open water surfaces of lakes and reservoirs. During severe drought conditions of 1987, the water scarcity in Gujarat and some other parts of the country was so severe that even drinking water had to be carried by trains to the affected areas. In the present scenario of utmost strain on the water resources, of the country, it becomes necessary to conserve water by reducing evaporation losses. National Water Policy-2002 under para 19.1 emphasises that evaporation losses should be minimised in Drought-prone areas.

The internet was also browsed to search the information on any new researches or identification of any new technology / chemicals to retard the evaporation rate. The search on internet, resulted in finding some case studies done in this field in other countries, however, the chemicals / technology used is the same as covered in the earlier publication. Some websites are from the manufacturers of WER chemicals such as Hexadecanol or Octadecanol or Acilol claiming to have conducted experiments in other countries towards evaporation control

II. PROBLEM STATEMENT

As per available records, assessment of evaporation losses in the country was first made by L.A. Ramdas and presented in Symposium of Evaporation control in 1966. The assessment was based on the following assumptions.

A. Problem Statement For Experimental Work

- Area of arid, Semi arid and long dry spell regions of India 2,000,000 Sq.Km.
- Estimated water area in this region(1%) 20,000 Sq.Km.
- Estimated area where film application may be feasible 2,000 Sq.Km..
- The evaporation loss from the above area 6,000 MCM

The National Commission on Agriculture (1976) had estimated that the annual evaporation losses from reservoir surfaces will be of the order of 50,000 MCM.

Central Water Commission in their publication “Status Report on Evaporation Control in Reservoirs, 1988” had indicated that on an average there is a loss of about 450 MCM of water every month from an area of 2,000 Sq.Km. Which amounts to an annual loss of 5,400 MCM.

III. EXPERIMENTAL WORK

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.

A. Factors Affecting Evaporation

Evaporation is a process by which a liquid changes into vapour form. Water molecules are in constant motion and some have the energy to break through water surface and escape into air as vapour. Evaporation in general is a beneficial phenomenon in regulating global water balance through the hydrological cycle and it is the same phenomenon contributing to massive losses from water bodies. Control of evaporation from land based water bodies, has thus remained one of the main planks of water conservation strategies. This assumes greater significance in arid regions, where water scarcities are already a common problem.

A number of factors affect the evaporation of water from open water surface, of which the major are:

- **Water Surface Area** : Evaporation is a surface phenomenon and the quantity lost through evaporation from water stored, therefore, depends directly on the extent of its surface exposed to the atmosphere.
- **Temperature** : The temperature of water and the air above it affect the rate of evaporation. The rate of emission of molecules from liquid water is a function of temperature. The higher the temperature, greater is the rate of evaporation.
- **Vapour Pressure Difference** :The rate at which molecules leave the surface depends on the vapour pressure of the liquid. Similarly, the rate at which molecules enter the water depends on the vapour pressure of the air. The rate of evaporation therefore depends on the difference between saturation vapour pressure at the water temperature and at the dew point of the air. Higher the difference, more the evaporation.

B. Methods to reduce Evaporation

Although evaporation losses in the country are quite substantial, the evaporation retardant methods perhaps cannot be employed to all open surface water bodies, irrespective of their size and shape. In view of this, water conservation management by control of evaporation has so far been limited generally to drought prone and scarcity areas under specified wind speed and temperature conditions of the water bodies.
The methods of evaporation control can be grouped under two broad categories:

(i) Short term measures and
(ii) Long term measures.

A number of approaches have either been applied or considered by Engineers and Scientists in their attempt to reduce evaporation losses from surface of water bodies. Since the basic meteorological factors affecting evaporation cannot be controlled under normal conditions, efforts have so far been restricted to managing the suppression or inhibition of evaporation from water surfaces by physical or chemical means. The methods generally used or being tried are broadly listed below:

i) Wind breakers
ii) Covering the water surface
iii) Reduction of exposed water surface
iv) Underground storage of water
v) Integrated operation of reservoirs
vi) Treatment with chemical Water Evapo Retardants (WER)

- **Wind Breakers**

Wind is one of the most important factors which affect rate of evaporation loss from water surface. The greater the movement of air over the water surface, greater is the evaporation loss. Planting of trees normal to windward direction is found to be an effective measure for checking of evaporation loss. Plants (trees, shrubs or grass) should be grown around the rim of tanks in a row or rows to act as wind breaker. These wind breakers are found to influence the temperature, atmospheric humidity, soil moisture, evaporation and transpiration of the area protected.

Plants to act as wind breakers are usually arranged in rows, with tallest plants in the middle and the smallest along the end rows, so that more or less conical formation is formed.

Trees grown as wind breakers are constantly subjected to usual stress of wind, temperature, moisture, evaporation, insects and diseases. Thus, plants selected as wind breakers should be capable of resisting these stresses. The list of vegetation recommended by Indian Council for Agricultural Research, New Delhi (Technical Bulletin No. 22) for planting as wind breakers in different regions of India is given . The spacing between plants varies from place to place, depending upon the climate and type of soil.

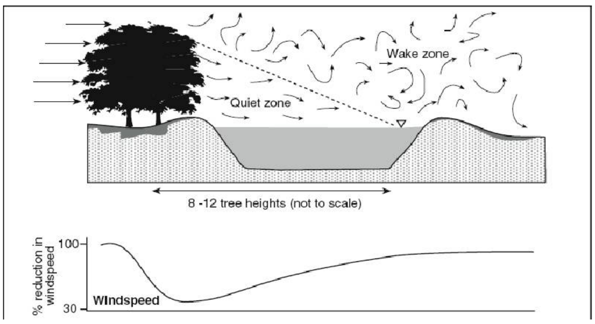

Fig 1 Wind Breakers

- **Covering the Water Surface**

By Covering the surface of water bodies with fixed or floating covers considerably retards evaporation loss. These covers reflect energy inputs from atmosphere, as a result of which evaporation loss is reduced. The covers literally trap the air and prevent transfer of water vapour to outer atmosphere.
Fixed covers are suitable only for relatively small storages. For large storages, floating covers or mat or spheres may be useful and effective. However, for large water surfaces the cost of covering the surface with floats is prohibitive. Further in case of reservoirs with flood outlets, there is also the danger of floats being lost over spillway or through outlets. The floating covers are thus of limited utility to larger water bodies.

Genet and Rohner had reported that floating spheres of a polystyrol reduced evaporation to 80% in small experimental tanks. The white spheres have the added advantage of reflecting solar energy and thus influencing evaporation.


Fig 2 Covering the Water Surface

- **Underground Storage**

This is a radically different approach for control of evaporation losses, which comprises storage of water in underground cavities or aquifers. This can certainly be done with great advantage in specific cases, where aquifers for such storages are available and do not entail higher lateral dispersion losses. Sub-surface dams can also be constructed in such schemes to prepare limited aquifers and thereby raise the level of storage, reducing subsequent pumping. Sub-surface dams or underground check dams have been constructed in Maharashtra, Andhra Pradesh, Gujarat and some other States across streams or rivulets in water deficient areas to hold groundwater and recharge the adjoining limited aquifers. They can be of masonry on rolled imperious fill depending on the rocky or alluvial strata. Problems of water supply by raising of groundwater, thus have been mitigated for many settlements. One outstanding application of this method was 35 recharge of the aquifer adjoining Talaji rivulet near the town of Talaja in

Bhavnagar District of Gujarat where significant water level rise was registered, after the limited monsoon. The main advantage of this method is that loss of valuable lands and forest areas due to surface submergence can be altogether avoided. The method has a great future all over India in view of the environmental advantage.

Fig 3 Underground Storage

IV. CONCLUSION

A. Guidelines For Use Of Chemical WERs

The following guidelines are suggested for using WERs in arid, drought prone or water deficit areas. These are broad guidelines only and may be varied depending on the site conditions or according to the manufacturer's specification for WER and equipment used.

- **Application in Emulsion Form :** The doze of emulsion per day may be 500g/hectare of open water surface for initial 15 days. It can then be reduced to 250g/hectare/day in the subsequent periods of application. The required quantity of emulsion may be diluted with water 20 to 25 times by volume for ease of application. Mixing of emulsion with water may be done either manually or mechanically. The later, however, gives more homogeneous mix. The diluted mix is then filtered to separate out lumps or impurities which could block the dripping line. Application of the solution is done by dripping from storage drums fitted on floating rafts or on shore dispensers.
- **Application in Powder Form** : The suggested dose for application of WER in powder form is approximately 75g/hectare of water surface per day. As the powder is supplied in lump form, it is required to be pulverized into a fine powder form by using a manual or mechanical pulveriser. The powder can be dispersed on water surface from boat by means of manually operated dusters

V. SUGGESTED AREAS OF FURTHER RESEARCH

Research and development efforts are needed in the following areas to improve the evaporation control in water bodies.

- R&D efforts are needed to develop a chemical WER, which should give a more compact monolayer with strong cohesive forces, properties of self spreading and reuniting to maintain the monolayer in resilient state on the water surface for wind velocities higher that 15-20 km per hour. However, the use of chemical WER is presently limited to small and medium tanks, because in large reservoirs wind has a detrimental effect on WER film.
- The monolayer formed should be durable, so that the frequency of application can be reduced from 24 hours to 3-7 days to make it more acceptable and cost effective.
- There is a need to bring down the cost of chemical WERs presently available. This can be achieved by developing new process technology for mass production of chemical WER.
- Little research has been done in India in the field of evaporation control by methods other than chemical retardation. Research efforts are needed to develop effective and economically viable materials for evaporation control, such as floating covers etc. Also there is need to develop/ identify plants for use as wind breakers, which are effective and at the same time have lower rate of evapotranspiration.

A. Future research

Economic analyses have suggested that chemical covers may represent the best option for evaporation control on large agricultural water storages. Future research is planned commencing in June 2006 with the support of the CRC for Irrigation Futures. The research will focus upon developing computer based monitoring technology which will rely upon real time computerized infrared visualization of the chemical coverage on the water surface. This will lead to the development of computerized delivery systems to optimize application across large storages.

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