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Water Conservation through Evaporation Control

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Abstract : *This paper describes in brief the various evaporation Control methods generally used for reducing evaporatian losses from reservoirs, approaches used and measures have been tried at various places for evaporation control.*

1.0 Introduction

Water is the most essential natural resource for life next to air and is likely to become a critical scarce resource in many, regions of the world in the coming decades. This scarce resource cannot be produced or added as and when required by any technological means. The total fresh and sea water content of earth is fixed. Although man has been able to modify to certain extent, the pattern of availability of the fresh water supplies with respect to space and time, the total availability, basically, has remained the same possibly over millions of years [Ref. (1)]. Current estimates indicate that the total volume of water on the earth is 1400 million km^3 of which only about 2.7 percent is fresh water. Further of this fresh water, 77.2 percent is in polar ice caps, 22.4 percent as ground water and soil moisture, 0.35 percent in lakes and swamps, 0.04 percent in atmosphere and less then 0 01 percent in streams [Ref. (2)]. For all practical purposes it is the surface water in the rivers, streams and lakes, amounting to less than half of one percent of available fresh water, that constitutes the basic available supply for man. Therefore. in the tropical and subtropical countries like India, it has become most essential to conserve water by any means like creation of reservoir (surface or underground), and water harvesting works like check dams, bandharas artificial lakes, village ponds and watershed management techniques etc., in whatever quantum possible, for satisfying the demand for irrigation. domestic and industrial water supply and other uses as well. Where sizeable quantum of water is available in the rivers, dams are constructed and reservoirs are formed to store and conserve water for the needs of the society.

2 0 Recent Problems related to Water Use : [Ref. (3)]

2.1 The problem relating to water use has been steadily deteriorating due to (i) increase in population and developmental activities leading to more complex living systems (ii) hydrologic deterioration of the bio-physical setting due to intensification of human activities and extension of the same to new areas and (iii) lack of understanding of the long term perspective relating to inter-relationship between land cycle and water cycle with the promotional role played by the plant and animal complexes. This is manifested by the increasing and persistent water stress conditions not only in traditional arid and semi-arid areas but in humid and sub humid areas also. Water conservation as

well as water harvesting have, therefore become of prime importance and require to be looked into in the context of lesser availability of water per unit area and per capita in the face of increasing demand. To a common man, water harvesting means tapping the waters contributed to the stream or lake through their catchments or areas other than the command areas. In fact water harvesting is not the technique to be restricted to these areas alone but, as a complementary measure, it is as much necessary in command areas and in catchment areas to maintain and control environment below and above the ground surface for optimum and beneficial utilisation of waters. These measures, inter alia, would also include water conservation by way of minimising the loss of surface waters through evaporation and seepage.

3.0 Evaporation and seepage :

3.1 Because of the nature of monsoons, particularly in our country, storage of water at appropriate natural sites has become an indispensable part of the strategy of harnessing it for human use. However, storage over ground necessarily involves, amongst other disadvantages, large quantitative water losses of which the most important are, as already mentioned, evaporation and seepage. The seepage losses depend on geology, stratigraphy and other local features from place to place and are, to a large extent, controllable with the present day seepage control technology. They do not, however, on an aggregate, exceed even about 5% of the total losses. On the other hand, evaporation losses are very high in a tropical country like India because of higher temperatures, larger overall aridity and a large number of sun shine days. Common man may not fully appreciate these losses since these are gradual.

3.1.1. For the large relatively deep reservoirs in Gujarat like Ukai, Kadana, Dharoi, the evaporation losses through their open water surfaces have been roughly assessed as about 20 to 25% of the storage, while for shallow reservoirs and tanks the losses may be as high as 30 to 50% [Ref. (4)]. The annual evaporation from some of the tropical reservoirs in India ranges from 1.8 m to as much as 3 m, in which the summer months contribute as much as 50% of the losses. The need of controlling evaporation is more realized when one looks at the magnitude of losses due to evaporation. According to a study by Meyers, annual evaporation loss from the fresh water areas in 17 western states of USA is 29000 Mm^3 (23.6 Maft) amounting to yearly municipal and industrial requirement of 96 million people as per USA standards. It is estimated that loss of water on evaporation in India by 2000 AD will be of the order of 90000 Mm^3 (72 Maft) as reported by Patel & Buch which is equivalent to the consumptive requirement of the entire population then. This will be almost true everywhere on this globe [Ref (5)]. This makes it clear that evaporation is the prime cause of water loss from all water storages and wet surfaces while it also is the principal beneficial phenomenon in regulating global water balance. Control of evoporation from land based water bodies has, therefore, remained one of the main planks of water conservation strategies. As we know, more arid a region, less is the overall water availability and also greater is the evaporation loss. Thus water conservation by various evaporation control measures has high relevance in this context.

3 2. The major factors influencing the evaporation of water from open water surfaces are :

a) Water surface area
b) Vapour pressure
c) Temperature
d) Wind
e) Atmospheric pressure and
f) Quality of water

3.3 Scientific researchers and engineers have been trying to evolve methods for reducing losses due to evaporation as a part of the drive for water conservation. Obviously the basic

natural and climato - meteorological factors related to evaporatron cannot be controlled under normal conditions at a reasonable cost. As a result efforts have to be channelised in the direction of managing suppression or inhibition of evaporation from water surfaces by appropriate physical or chemical means.

4.0 Evaporation Control Methods :

4.1 The methods generally used or being tried for reducing reservoir evaporation losses are :

i) Wind breakers
ii) Covering the water surface externally
iii) Reduction of exposed water surface by way of compartmentalisation of reservoirs
iv) Underground storage of water
v) Integrated operation of reservoirs
vi) Treatment with chemical water Evapo Retardants (WER)
vii) Use of agricultural practices like mulching, avoiding flooding of fields etc.
viii) Developing crops with low evapotranspiration requirement

4.2 These can be subdivided in two groups/ categories viz.

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

Short term measures can be adopted during drought and scarcity conditions especially for crisis management. The measures that may be categorised under this group are application of chemical retardants, covering the water surface through use of plastic floating material, floating spheres of polysteryls etc. for protection against rise in temperature and effects of air currents. Rest of the methods mentioned above can be classified as long term measures.

4.3 Although evaporation losses in the country are quite substantial, the evaporation retardant methods cannot practicably and economically be applied 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 affected areas under specified wind speed and temperature conditions of the water bodies. Again these efforts are usually limited to small water bodies.

4.4 Control of losses through evaporation can be done through three types of approaches viz., (a) suitable planning of physical dimensions of water bodies to reduce the effect of evaporation causing parameters, (b) preventing direct contact of these parameters with the water bodies, (c) resorting to alternative ways for water storage.

4.4.1 In the first category we try to have the smallest practicable surface area per unit of volume stored. Thus deep basins are preferably selected. In the case of artificially constructed ponds and tanks also, we attempt to keep as large a depth as practicable by excavating deep and having high peripheral embankments. Such banks can also serve as wind retarders. The storages can also be planned to have two or three compartments or sub storages so that they can be filled up in stages one after the other depending on the quantum of inflows. If necessary towards the summer, water from sub-storages can be pooled up into one compartment only by resorting to pumping. Of course such an exercise has to be supported by economic analysis of various available alternatives. In the second category, direct exposure of water surface is avoided through coverage with chemical films, polyethylene and such other membranes, roofing over small tanks, etc. Also afforestation all round is done to keep the temperature down with higher humidity and to provide a barrier to high wind velocities. Mulching is done around the plant roots and, wherever possible, crops with low foliage are preferred to restrict evapotranspiration. The third approach comprises storing of water in the soil and ground aquifers. This is done by allowing the water to seep and also by Inducing the recharge to the sub soil. Various methods of natural and

artificial recharge are now available whereby surplus water, particularly during the rainy season, is transferred below the ground. Flooding pervious soil areas, constructing spreading channels and natural recharge tubewells connected to lower aquifers, adopting soil and water conservation measures in the water-sheds and command areas, constructing chech dams, underground barriers in river beds etc. are some other measures by which large quantities of surface water can be transferred to underground storage thus restricting evaporation losses to a very great extent.

4.4.2 Thus following measures have been tried at various places for evaporation control.

a) To construct carry over storage reservoirs at the highest available altitudes.

b) To select narrow spread of the reservoir i e. to select the site where deep water pockets can be created.

c) To minimise exposed water surface through integrated reservoir management.

d) To redues surface area by creating smaller compartmenfs of stored water.

(e) To cover the water surface in a reservoir with fixed floating bodies.

(f) To provide wind breakers like provision of curtain of tees.

(g) To store water in ground water reservoirs.
(h) Use of evaporation retardants to form surface film

(i) To reduce energy that causes evaporation using the techniques like (1) changing the water colour, (2) wlnd barriers, (3) shading the water surface, (4) floating reflecting covers etc [Ref. (6)].

4.5 During his visit to India in early nineteen seventies, Dr. Roger Revelle, renowned oceanographer and hydrologist, had suggested that large quantities of surplus surface waters of the Ganga-Yamuna Doab can be advantageously stored underground within the large alluvial tracts. This can prevent substantial evaporation losses and the water can be retrieved for use as per necessity. The augmentation tubewells, adopted in Haryana and Punjab are, to some extent, examples of this principle. Vivekanand Training and Research Institute in Gujarant has successfully implemented in Kutch the scheme of recharge tubewells for conveying monsoon stream flows down to the lower aquifers. Many reservoirs like Dharoi, Kadana in Gujarat are required to store water for City water supplies. These are often required to be released into the rivers during the latter part of summer. Till then the reservoirs continue losing water through evaporation. It may be worthwhile trying an alternative approach of releasing water during winter for storage in the sandy river beds near the cities. If necessary under ground barriers may be constructed in the river beds close to the water supply intake works. These river bed storages can be used during the summer season when water shortages are experienced. Because of such advance releases the surface storage reservoir areas will remain smaller during summer when the evaporation depths are otherwise maximum [Ref. (7)].

5 0 Conclusion.

Losses on account of evaporation from water surface have attained such sizeable dimensions that they cannot be overlooked any more by a good water manager. The ever-increasing demand for pure water which is bound to increase with growth in population should be a matter of concern for Government and other institutions responsible for planning for long future needs. Ways and means to reduce evaporation losses have to dominate in the field of overall water planning and management Chemical treatment with fatty long chained alcohols for producing a film maintaining requisite pressure is now more or less an accepted made of treatment for chronic and emergent conditions. The method is found to be economical for water supplies in frequently drought affected arid and semi arid zones even though the initial cost may be high. This is often

because of high alternative costs of transporting water from great distances. It should be the endeavour of research workers and manufacturers to bring down the cost of such chemical compounds or to develop cheaper compounds so that the conservation of water through applicaton of such treatment, may prove economical even for using the storages of such conserved waters for irrigating lands for agriculture production. Greater attention will also have to be paid to evolving easier and more cost effective methods of transferring surface water to the ground for strage and subsequent use. This. again, will be related to the availability of adequate energy at economical costs. Research will have, therefore, to be intensified in identifying and developing local and cheap energy sources for the purpose. It may not also be out of place here to mention that while making economic considerations in respect of evaporation loss control measures an overall view should be taken. Only the saving in water may not just be compared with expenditures but apart from cost economics there is a deeper human vaiue associated with the availability of water and this value can never be measured in term of money.

References

1) Water Resources of India 1988, C.W.C. Publication No. 30/88 Chapter No. 1

2) Mistry J. F. 1988 "Optimisation of Water Resources Development in River Basins" Important Aspects of River Valley Projects, Vol. I.P. 184.

3. Das D. C. 1988 "Water Harvesting for Water Consarvation in Catchment and Command area". Proceeding of the National Seminar on Water Conservtion and Management in Drought, P. II/WCM/1, 2

4) Water Management Foum, Gujarat, 1988 "Water Conservation by Evaporation Control-Retardants and their Applications"

5) Patel V.B. and Buch D. T. 1989 "Evaporation Control as a Water Conservation Measures". Proceeding of the National Seminar on New Perspective in Water Management, National Academy of Engineering.

6) Dave K. M. 1989 "Evaporation Control Need and Measures" Proceeding of the International Workshop on Evaporation from Open Water Surfaces, Vol. I

7) Purohit M.U. 1989 "Assessment of Evaporation Losses - Direct Methods - Indirect Methods". Proceedings of the International Workshop on Evaporation from Open Water Surfaces, Vol. II. Pages 265-269.