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# Effect of $MgCl_2$ on the Evaporation Reduction Ability of Cetyl Alcohol

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## Abstract

Water plays a key role in the survival and development of mankind. Today world is heading towards water crises. In order to overcome shortage of water it is necessary to develop some novel techniques of water conservation. Use of chemicals for the retardation of evaporation of water is one such novel technique for the water conservation. Cetyl alcohol is found to be effective in retarding evaporation of water. Here, water evaporation retardation ability of cetyl alcohol is studied in the presence of $MgCl_2$. Magnesium and chloride ions are commonly found as impurities in natural water reservoirs hence this study will be helpful for the assessment of water evaporation retardation ability of cetyl alcohol in natural water reservoirs. Presence of magnesium and chloride ions is found to be supportive in the retardation of evaporation of water moreover it is found that water evaporation retardation ability of cetyl alcohol remains unaffected in the presence of magnesium and chloride ions.

**Keywords**: *Fatty alcohol, Cetyl alcohol, Water, evaporation, retardation*

## 1. Introduction

Water is the most essential compound on the earth for the survival of plants and animals. Nearly 2/3rd portion of the earth is covered with water but only 2.5 percent of total water is potable water. Out of 2.5 percent potable water only 1 percent is accessible for use while remaining 1.5 percent potable water is trapped in snowfields and glaciers in the form of ice [Gleick, 1993]. Day by day demand of potable water is increasing rapidly due to rapid increase in population and industrial growth. This rapid increase in the demand of potable water leads us towards water crises. World economic forum announce that water crises can be the biggest global risk over the next decade [World economic forum, 2015]. In order to meet increasing demand of potable water it is high time to employ some novel techniques for the conservation of water. Retardation of water evaporation by using chemicals is one such novel technique which can be used for the conservation of water.

In 1925, it was found that some compounds can considerably retard evaporation of water by forming mono or multimolecular layer over the water surface. These substances which can suppress evaporation process are known as “Water evaporation retardants”. “Water evaporation retardants” are commonly known as “WER” [Frenkiel, 1965]. In 1927, Langmuir found that cetyl alcohol can considerably retard evaporation of water [Langmuir and Langmuir, 1927]. Cetyl alcohol is a straight chain fatty alcohol. It contains 16 carbon atoms in a straight alkyl chain and $-OH$ group at the terminal carbon. After successful laboratory scale experiments, the first field scale testing of cetyl alcohol as WER was held in Australia around 1950. Field trial reveals that cetyl alcohol can retard evaporation of water up to 30 percent [Mansfield, 1953]. Success of Australian field trial catches worldwide attention and reputed research institutes of many countries like United States of America, Australia, Russia, Israel etc. have started comprehensive research in this area [Barnes et al., 1960, 1962, Robbins & La Mer, 1959, La Mer et al., 1958, 1959, 1962 and 1963]. Most of laboratory scale investigations of cetyl

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alcohol as WER are made by using distilled water [Marcos et al., 2005]. Although estimation of water evaporation retardation ability of cetyl alcohol should be made by using natural water but in that case some errors may arise due to presence of dissolved impurities. Moreover some difficulties also arise in the comparison of results of various experiments. It is valid to use distilled water for the assessment of water evaporation retardation ability of cetyl alcohol at laboratory scale but in actual practice, water in natural reservoirs always contain dissolved impurities. Hence in order to get clear idea about probable effects of dissolved impurities on the effectiveness of cetyl alcohol as WER we have studied the effect of presence of $MgCl_2$ on the water evaporation retardation ability of cetyl alcohol. Magnesium ion and chloride ion are commonly found as impurities in most of natural water reservoirs hence this study will be very useful in this area of research.

## 2. Materials and method.

Distilled water for the experiment was collected by using simple distillation method. Cetyl alcohol solution (2mg/mL) was prepared by dissolving 40 mg Cetyl alcohol (Loba chemie, extra pure) in 20 mL n-Hexane (Merck, 95%). Aqueous solution of Magnesium chloride (15 mg/mL) was prepared by dissolving 1.5 g $MgCl_2$ (Oxford, 99%) in 100 mL Distilled water.

To carry out evaporation reduction experiment plastic beakers (Height-17.7 cm, Diameter - 11.8 cm) are used. Beakers were labeled as Beaker -1 to Beaker - 5. These beakers were filled with $MgCl_2$ solution, distilled water and cetyl alcohol solution as below,

Beaker-1: 1000 g Distilled water + 1 mL Cetyl alcohol solution.

Beaker-2: 10 mL $MgCl_2$ solution + 990 g distilled water + 1 mL Cetyl alcohol solution.

Beaker-3: 20 mL $MgCl_2$ solution + 980 g distilled water + 1 mL Cetyl alcohol solution.

Beaker-4: 30 mL $MgCl_2$ solution + 970 g distilled water + 1 mL Cetyl alcohol solution.

Beaker-5: 1000 g Distilled water

Initially Magnesium chloride solution was added by using screw type burette followed by required amount of distilled water so that total weight of water became 1000 g. 1 ml cetyl alcohol solution in each beaker was added by using screw type burette. All the beakers are exposed to the same atmospheric conditions in a specially designed experiment chamber and weight loss was measured at an interval of 24 hours.

## 3. Results and discussion

Table 1 **Weight of water**

| Hours | Weight of water (g) | | | | |
|---|---|---|---|---|---|
| | **Beaker-1** | **Beaker-2** | **Beaker-3** | **Beaker-4** | **Beaker-5** |
| **0** | 1000 | 1000 | 1000 | 1000 | 1000 |
| **24** | 975 | 977 | 979 | 982 | 938 |
| **48** | 942 | 947 | 951 | 957 | 875 |
| **72** | 900 | 909 | 915 | 924 | 810 |

Table 2 **Weight loss**

| Hours | Weight loss per day (g) | | | | |
|---|---|---|---|---|---|
| | **Beaker-1** | **Beaker-2** | **Beaker-3** | **Beaker-4** | **Beaker-5** |
| **0** | 0 | 0 | 0 | 0 | 0 |
| **24** | 25 | 23 | 21 | 18 | 62 |
| **48** | 33 | 30 | 28 | 25 | 63 |
| **72** | 42 | 38 | 36 | 33 | 65 |

Table 3 **% Evaporation**

| Hours | % Evaporation per day | | | | |
|---|---|---|---|---|---|
| | **Beaker-1** | **Beaker-2** | **Beaker-3** | **Beaker-4** | **Beaker-5** |
| **0** | 0 | 0 | 0 | 0 | 0 |
| **24** | 40.32 | 37.1 | 33.87 | 29.03 | 100 |
| **48** | 52.38 | 47.62 | 44.44 | 39.68 | 100 |
| **72** | 64.62 | 58.46 | 55.38 | 50.77 | 100 |

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Table 4 : **%Evaporation reduction**

| Hours | % Evaporation reduction per day | | | | |
|---|---|---|---|---|---|
| | Beaker-1 | Beaker-2 | Beaker-3 | Beaker-4 | Beaker-5 |
| 0 | 0 | 0 | 0 | 0 | 0 |
| 24 | 59.68 | 62.9 | 66.13 | 70.97 | 0 |
| 48 | 47.62 | 52.38 | 55.56 | 60.32 | 0 |
| 72 | 35.38 | 41.54 | 44.62 | 49.23 | 0 |

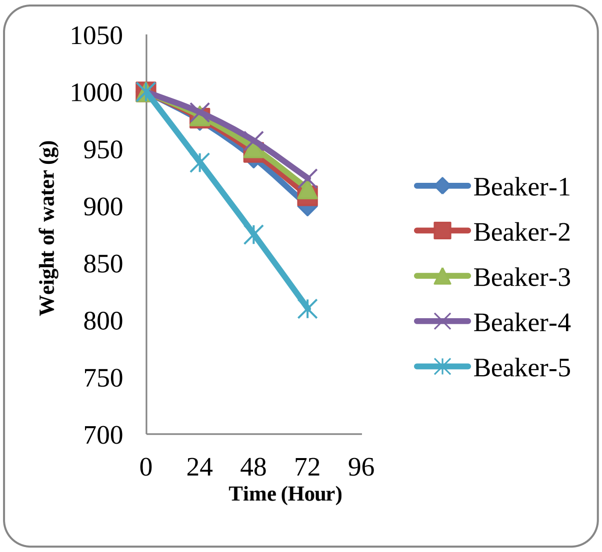


Fig. 1- **Weight of water Vs Time**

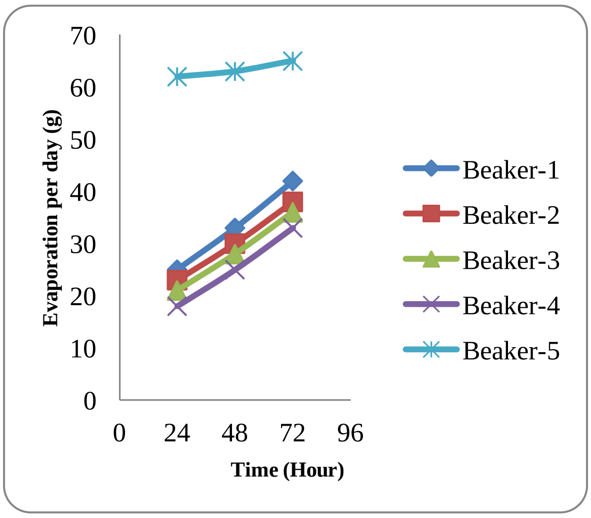


Fig. 2- **Evaporation Vs Time**

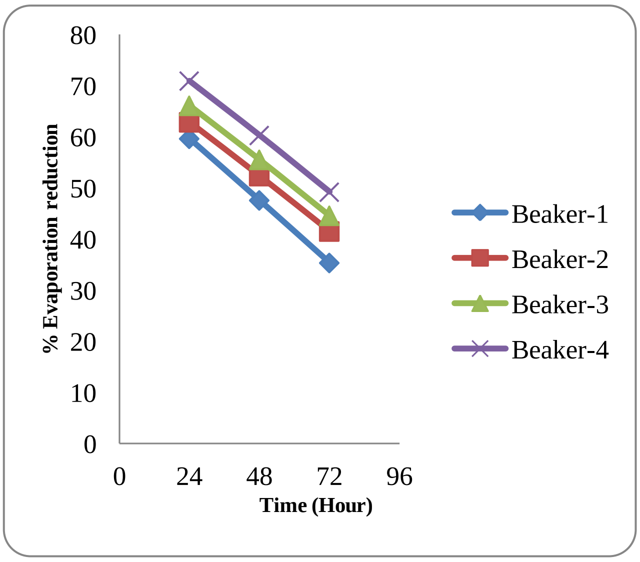


Fig. 3-**% Evaporation reduction Vs Time**

It is apparent from table – 2 & 3 and figure – 1, 2 & 3 that presence of $MgCl_2$ also retards evaporation of water. The reason behind this phenomenon is that water is a polar molecule. In $H_2O$, Hydrogen atom is partially positively charged and oxygen atom is partially negatively charged. Energy required by water molecule to escape from surface of water increases due to electrostatic force of attraction between polar water molecule and $Mg^{2+}$ and $Cl^{-}$ions, as a result of that rate of evaporation decreases in the presence of these ions.

In Figure – 1 , a straight line is observed for the beaker -5. This straight line indicates that rate of water evaporation in beaker -5, which contains only distilled water remains nearly same throughout the experiment. Moreover it can be concluded from this result that atmospheric conditions i.e. temperature, wind velocity and humidity remains identical during experiment period.

Percentage evaporation reduction in figure – 3 is found to be decrease with time it is because of decomposition or loss of cetyl alcohol. All the four lines in figure -3 are parallel to each other it indicate that although % evaporation reduction due to cetyl alcohol decreases with the time but % evaporation reduction due to presence of $MgCl_2$ remains almost constant throughout the experiment.

Here, it is apparent that presence of $Mg^{2+}$ and $Cl^{-}$ions also contributes in the evaporation retardation moreover it does not affect evaporation retardation ability of cetyl alcohol. Water in the most of natural water reservoirs are found to be contaminated by $Mg^{2+}$ and $Cl^{-}$ions hence these results are very encouraging.

Average evaporation reduction by cetyl alcohol in the presence of $Mg^{2+}$ and $Cl^{-}$ions is found to be 52.27 % to 60.17 % it shows that cetyl alcohol can be effectively work as WER even in hard water. Presence of $Mg^{2+}$ and $Cl^{-}$ions helps in the suppression of evaporation of water.

## 4. Conclusions

Presence of $Mg^{2+}$ and $Cl^{-}$ions is found to be supportive in the retardation of the evaporation of water. Moreover no negative effect on the efficiency of cetyl alcohol is observed. It can be concluded that cetyl alcohol can be used as WER even if water contains $Mg^{2+}$ and $Cl^{-}$ions.

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## References

[1] Barnes, G. T.; La Mer, V. K. Evaporation resistant measurement for investigating the molecular architecture of monolayer films, 3rd Int. Congr. Of surface activity, cologne, vol. 2, p. 192-5, 1960.

[2] Barnes, G. T.; La Mer, V. K., The evaporation resistance of monolayers of long chain acids and alcohols and their mixtures, In: La Mer, V. K. (ed.). Retardation of evaporation by monolayers: transport process, p. 9-33, New York and London, academic press, 1962.

[3] Barnes, G. T.; La Mer, V. K. The laboratory investigation and evaluation of monolayers for retarding the evaporation of water, In: La Mer, V. K. (Ed.). Retardation of evaporation by monolayers: transport process, p. 35-9. New York and London, Academic press, 1962.

[4] Gleick, P.H., Water in Crisis: A Guide to the World's Freshwater Resources, Oxford University Press, P. 13, ed. (1993).

[5] J.Frenkiel, Evaporation reduction, UNESCO, 1965.

[6] La Mer, V. K.; Robbins, M. L. The effect of the spreading solvent on the properties of monolayers, J. phys. Chem., vol. 62, no. 10, p. 1291-5, 1958.

[7] La Mer, V. K. Barnes, G. T., The effects of spreading technique and purity of sample on the evaporation resistance of monolayers, Proc. Nat. Acad. Sci., vol. 45, no. 8, p. 1247-80, 1959.

[8] La Mer, V. K.; Aylmore, L. A. G, Evaporation resistance as a sensitive measure of the purity and molecular structure of monolayers. Proc. Nat. Acad. Sci., Vol.48, no.3, p.316-24, 1962.

[9] La Mer, V. K.; Aylmore, L. A. G.; Healy, T.W., The ideal surface behavior of mixed monolayers of long-chain n-paraffinic alcohols. J. phys. Chem., vol. 67, no. 12, p. 2793-5, 1963.

[10] Langmuir, I.; Langmuir, D. B., The effect of monomolecular films on the evaporation of ether solutions, J. phys. Chem., vol. 31, no. 11, p. 1719-31, 1927.

[11] Mansfield, W.W., The effect of surface films on the evaporation of water, Nature, Vol.172, no. 4389, p.1101, 1953.

[12] Marcos, G.; Mauricio, S. B.; Mario, J. P., Reduction of evaporation of natural water samples by monomolecular films, J. Braz. Chem. Soc., Vol.16, 2005.

[13] Robbins, M. L.; La Mer, V. K., The effect of the spreading solvent on the properties of monolayers, J. coll. Sci., vol. 15, no. 2, p. 123-54, 1959.

[14] "Water crises are a top global risk", World Economic Forum, 16 January 2015