551·508·7 : 551·573

Some experiments with the U. S. A. Standard Evaporimeter

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1. Introduction

The U.S.A. Standard Evaporimeter is in regular use at a number of selected Agricultural Farms in the Indian States and in the Observatories of the India Meteorological Department. The evaporimeter consists of a cylindrical reservoir 48″ in diameter and 10″ high supported on a wooden frame 4″ high. The level of the water in the reservoir is maintained at about 2″ from the rim so that the height of the level of water is nearly 12″ above ground. The evaporimeter is of 20 SWG copper sheet. The evaporation is measured by accurately determining with the hook-gauge the change in the level of water in the reservoir after any given interval of time. The hook gauge is placed on a still well provided with levelling screws.

This instrument is fairly in wide use at many stations in India for measurement of evaporation. To ensure the comparability of observations recorded at different stations, care is taken as far as possible to keep to the standard of specifications prescribed for the instrument and also to maintain similar conditions of exposure at all stations. But, it was noticed that some conditions of exposure such as the colour of the paint on the evaporimeter, the depth of water level in the tank etc, could not be maintained identical at all the places at all times. It was, therefore, considered desirable to investigate the extent of the effects of such uncontrollable variations in the conditions of exposure. In the series of experiments designed for such a purpose some more factors of variation such as the height of the tank above the ground, size of tank etc have also been included for testing. The series of experiments were conducted in the Central Agricultural Meteorological Observatory at Poona and the results of the observations are summarised below.

It may also be mentioned here that in an observatory there is a contribution to the loss of water from an open tank evaporimeter by birds etc. In the series of experiments discussed here such losses have been avoided by suitable watch and maintenance conditions.

2. Colour of paint on the evaporimeter

When the evaporimeters are supplied to the observatories, they are painted white outside and are either painted white or tinned inside. It may happen in course of time that the paint may wear away or become discoloured. To study the effect of colour of paint on evaporation, observations were taken with 6 USA type evaporimeters and they were painted as follows—

- A—Tinned inside, white paint outside
- B—Painted white, both inside and outside
- C—No paint inside, white outside
- D—No paint both inside and outside
- E—Painted black inside and outside
- F—No paint inside, painted black outside

Taking the mean evaporation of the Standard A as unit, the ratios of the other means are given in Table 1.

From Tables 1 and 2 it will be seen that the effect of the colour of the paint on the evaporation is not negligible. While the temperature of the water in the tank in the morning

TABLE 1

Inside	A Tin	B White	C No paint	D No paint	E Black	F No paint
Outside	White	Do.	White	Do.	Do.	Black
1953						
Jan	1	0·92	1·01	1·15	1·15	1·17
Feb	1	0·94	1·00	1·13	1·12	1·14
Mar	1	0·92	0·99	1·07	1·08	1·08
Apr	1	1·02	1·09	1·18	1·19	1·20
May	1	0·90	1·02	1·05	1·10	1·08

TABLE 2

Temperature of water (°F) in the evaporimeter on a few days in June 1953

Date	A	B	C	D	E	F
			At 0900 IST			
JUNE						
6	69·5	69·2	69·0	69·7	69·6	69·6
7	69·3	69·0	68·9	69·3	69·2	69·5
8	69·8	69·7	69·3	69·8	69·7	69·7
9	69·8	69·8	69·1	69·5	69·2	69·5
10	71·1	71·0	70·5	70·5	70·6	70·6
11	74·6	74·4	74·0	74·2	74·1	74·2
			At 1400 IST			
6	80·1	80·3	80·4	84·8	84·9	84·8
7	80·1	80·3	80·4	85·0	84·9	84·8
8	80·3	80·3	80·5	85·9	86·0	85·9
9	81·0	80·6	80·7	87·0	87·1	86·9
10	83·1	83·0	82·9	88·4	88·6	88·6
11	83·9	83·7	83·7	89·3	89·5	89·5

TABLE 3

Mean daily evaporation with water level at 5, 3 and 2 inches below rim

Month	5"	3"	2"
1955			
Apr	0·464	0·468	0·496
May	0·415	0·441	0·449
Jun	0·342	0·371	0·372
Jul	0·175	0·187	0·193
Aug	0·132	0·142	0·154
Sep	0·147	0·148	0·167
Oct	0·167	0·179	0·181
Nov	0·179	0·185	0·185
Dec	0·168	0·179	0·176
1956			
Jan	0·196	0·207	0·209
Feb	0·263	0·274	0·289
Mar	0·392	0·409	0·406

TABLE 4

Season	Water level	
	5" below rim	3" below rim
April—June	0·93	0·97
July—October	0·91	0·98
November—March	0·94	0·99

is almost the same, they differ among themselves by nearly 5°F in the afternoon.

The evaporimeters painted white outside and those that are unpainted or painted black outside form into two distinct groups, the latter being warmer than the former at 1400 IST by nearly 5° F. The white painted instruments rise in temperature by nearly 10°F while the black painted ones rise by nearly 15°F. The colour of the paint inside has no appreciable effect on the temperature of the water. The difference in temperature is, therefore, entirely due to difference in the absorption of solar radiation, black colour absorbing very much more than white. During night, the black painted instruments radiate more than the white painted ones, and the temperature of the water is almost the same in all the tanks by 0900 IST. The other factors remaining the same, the colour of the paint outside will have a controlling effect on the daily evaporation. It is, therefore, necessary to get the evaporimeter painted periodically outside, particularly when it shows signs of deterioration in colour. It is necessary to remove the old paint, as otherwise the coat of paint will become thicker and thereby affect the heat absorbed by the water from the sides of the tank.

3. The depth of water level in the evaporimeter

According to the standard instructions, the level of water in the evaporimeter should be about 2 inches below the rim of the tank. Water should be added to the tank as soon as the level falls below 2″ from the rim. To determine the variation in the evaporation when the level of water in the tank is not maintained at a standard value, observations were recorded in three USA evaporimeters with water levels at not more than 2″, 3″ to 4″, and 5″ to 6″ below the rim of the tank. The results are given in Table 3.

The ratio of the evaporation from tanks with water level 5″ and 3″ below rim to that from the standard in different seasons is given in Table 4.

This brings out clearly the effect of the sides of the vessel in the flow of wind over the water surface and the importance of maintaining the water level the same in all the instruments so that the evaporation data may be comparable.

4. Elevation of the evaporimeter above ground

The evaporation recorded with the standard USA evaporimeter indicates the evaporating power of the air layers 1 foot above ground. There can be some difference of opinion as to whether the tank should be sunk in the ground or should be installed with the water level at a height of 12 inches above ground. It has been felt by some that if the water surface is flush with the ground, conditions of exposure will depart less from natural.

In some countries like Britain, evaporimeter tanks are sunk in the ground with the water level with the ground; in many other countries, the USA type evaporimeters are exposed with the water level 12″ above the ground level. It is felt that it will be useful to examine the difference in the evaporation recorded with the two methods of exposure under the conditions prevailing in India.

If the tank is installed above the ground, leakage can be detected much easier; dirt does not splash and flow into the water from the surrounding surface; changes in grass length in the surrounding area will have smaller influence on air movement over the tank. Heat transfer through the tank, although greater than for a sunken tank, can be allowed for if desired, if air and water temperatures, humidities and winds are available. Such allowances for a sunken tank will not be practicable and will require information on soil temperatures and soil moisture.

Experiments were conducted at Poona by Ramdas (1952), the results of which should provide a basis for converting "the evaporation from the water surface one foot above ground in a USA standard evaporimeter" with values corresponding to "a water surface flush with the ground" and to convert this

TABLE 5

Mean daily evaporation (inches) from evaporation tank

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Water in level with ground (A)	0·195	0·255	0·311	0·376	0·420	0·295	0·175	0·154	0·197	0·202	0·205	0·186
Water level 12" above ground (B)	0·232	0·309	0·399	0·469	0·517	0·332	0·199	0·171	0·214	0·219	0·225	0·205
Ratio A/B	0·840	0·825	0·779	0·802	0·812	0·889	0·879	0·901	0·921	0·918	0·916	0·907

again into "the evaporation from an extended wet soil or water surface". The evaporation E recorded in an instrument with standard exposure (with water surface 1 foot above the ground) was compared with that from another similar instrument E_0 sunk into the ground with the water level flush with the ground.

These experiments were continued and the mean daily evaporation in each month in the sunken tank and in the standard tanks are given in Table 5. These are based on the data for the period January 1952 to December 1955.

From Table 5 it is observed that taking the year as a whole, the mean evaporation from the sunken tank E_0 is 0·866 of that in the standard tank E. Ramdas (1952) obtained a reduction factor of 0·845 ,*i.e.*,

$$E_0 = 0{\cdot}845\ E$$

As the factor to convert the evaporation readings for a standard tank to that from a tank with water flush with the ground forms a basis for further estimation of the evaporation from an extended area, a detailed examination of the collected data is necessary. Observations of evaporation have been recorded at Poona at 0700 L.T. (0735 IST), 0800 IST, 1400 L.T. (1435 IST) and 1700 IST. Table 6(a) gives the mean daily evaporation from 0800 IST to 1700 IST and Table 6(b) that from 1700 IST to 0800 IST in the two instruments. The former gives the value during the bright hours of the day while the latter refer to the dark hours. The evaporation during the whole day and those from 0800-1700 IST and from 1700-0800 IST are also shown in Fig. 1.

The evaporation is intimately related to the temperature of the water. Tables 7(a) and 7(b) give the mean temperatures in the two evaporimeters during different hours of the day, *viz.*, 0735, 0800, 1435 and 1700 IST. Table 7(c) gives the mean difference in the temperature of the water in the two tanks during these hours.

It is observed from Table 6(a) that the mean evaporation of water in the sunken tank during the period 0800-1700 IST is 0·77 of that from the standard instrument. However, during the period 1700-0800 IST (Table 6b) the factor is 0·891 from January to April and nearly 1 in the other months. The temperature of the water in the standard tank is less than that in the sunken one by nearly 3-6°F in the morning; they are almost the same in the afternoon except from February to April when the standard tank is slightly warmer by nearly 2°F. It may, therefore, be roughly assumed that the mean temperature of the water in the standard tank is cooler than that in the sunken one during night; it is almost the same in both for major part of the period 0800-1700 IST. Assuming that the saturation deficit of the air over both the tanks is nearly the same, from 0800-1700 IST, the reduced evaporation from the sunken tank during this period is the result of lower wind speeds due to friction near the ground. But during night from 1700-0800 IST, the temperature of the sunken tank is generally

TABLE 6

Mean daily evaporation (inches)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
(a) From 0800—1700 IST													
Water in level with ground (A)	·083	·116	·145	·173	·210	·139	·091	·078	·094	·094	·098	·087	
Standard evaporimeter (B)	·112	·147	·196	·242	·282	·182	·120	·097	·126	·115	·122	·107	
Ratio A/B	·741	·789	·740	·715	·745	·764	·758	·804	·746	·817	·803	·813	·770
(b) From 1700—0800 IST													
Water in level with ground (A)	·113	·147	·173	·203	·213	·157	·099	·087	·108	·106	·108	·100	
Standard evaporimeter (B)	·123	·166	·197	·220	·221	·151	·093	·087	·099	·101	·102	·100	
Ratio A/B	·919	·885	·878	·883	·964	1·04	1·06	1·00	1·09	1·05	1·06	1·00	·986

TABLE 7

Temperature of water (°F)

Hrs (IST)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
(a) Evaporimeter in level with the ground (G)												
0735	64	65	69	72	74	75	75	73	74	73	64	64
0800	62	65	67	73	74	74	75	74	74	74	66	63
1435	73	77	81	86	88	85	83	81	85	86	77	75
1700	79	83	86	88	89	87	84	85	87	87	82	79
Range	15	18	17	16	15	12	9	12	13	14	16	15
(b) Standard Evaporimeter (S)												
0735	58	61	64	68	71	71	71	71	69	69	59	58
0800	56	60	63	69	72	73	72	71	71	69	59	58
1425	72	77	82	87	88	85	83	82	84	85	77	74
1700	79	85	88	90	90	87	84	83	86	87	83	80
Range	21	24	24	22	19	16	13	12	17	18	24	22
(c) Difference in the temperatures of water in the two tanks (S—G)												
0735	—6	—4	—5	—4	—3	—4	—4	—2	—5	—4	—5	—6
0800	—6	—5	—4	—4	—2	—1	—3	—3	—3	—5	—7	—5
1435	—1	0	1	1	0	0	0	1	—1	—1	0	—1
1700	0	2	2	2	1	0	0	—2	—1	0	1	1
Range	6	6	7	6	4	4	4	0	4	4	8	7

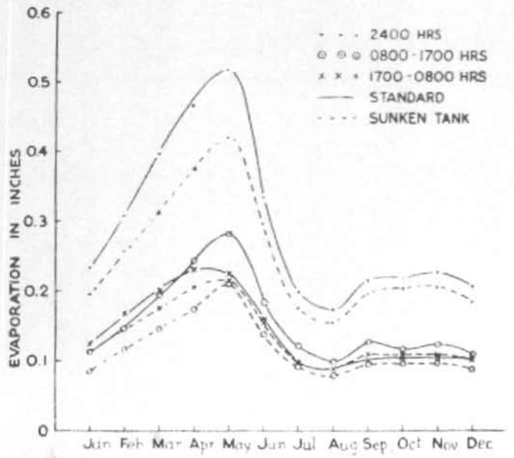

Fig. 1 (a). Mean monthly evaporation from standard evaporimeter and from evaporimeter sunk in the ground

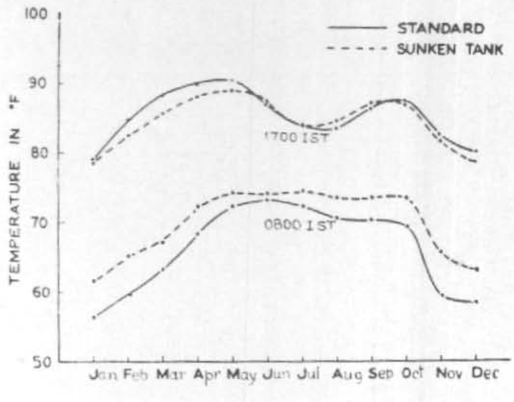

Fig. 1 (b). Temperature of water at 0800 and 1700 IST in the standard and sunken tank

higher than that of the standard. This will result in an increase in the ratio of the evaporation from the sunken one to that from the standard. Ramdas and Katti (1934) have shown that in the dry season, during the night the soil is absorbing moisture and the vapour pressure increases with height. All these factors have contributed to the increase in the ratio from 0·8 during day to 0·9 to 1 during the night. The average factor for the whole day and for all seasons is approximately 0·88 as against Ramdas' 0·845 for converting the evaporation from the standard to that from a sunken tank.

5. Evaporation from tanks of different sizes

To enable estimation of evaporation over wide areas from measurements of the evaporation from the standard USA evaporimeter, Ramdas (1952) conducted experiments at the Central Agricultural Meteorological Observatory with a series of evaporimeters sunk inside the ground with the rim flush with the surface and surrounded by rings of wetted soil of varying diameters upto 20 feet. He found that the evaporation followed the relation $E_\infty = 0 \cdot 7 E_0$ where E_∞ represents the evaporation from a large water sheet like a lake or water-logged area, and E_0 is the evaporation from a 4-ft tank sunk in the ground. It has been mentioned in the previous paragraph that the evaporation from such a sunken pan E_0 is related to the standard with the rim 14″ above ground E and is given by $E_0 = 0 \cdot 845\ E$ (Ramdas 1952). From these relations, it is observed that the evaporation from a lake E_∞ is about 0·6 of the evaporation from a standard USA evaporimeter.

Experiments were conducted at the Central Agricultural Meteorological Observatory to find how the evaporation was related to evaporimeters of different sizes exposed similarly to the standard 4-ft tank. A set of six circular tanks of diameters 2, 4, 8, 12, 16 and 20 ft made from 20 SWG G. I. sheets were installed directly on 4″ high cemented floorings of almost the same size as the tank. These tanks were not painted as with the standard instrument. The mean daily evaporation on 'rainless' days are given in Table 8.

The temperature of the water in the evaporimeters at 0830 IST and 1330 IST are given in Table 9.

The smallest tank with 2-ft diameter is slightly colder than all the others at 0830 IST, *i.e.*, at about the minimum temperature epoch. The 4-ft tank appears to be very slightly colder than the rest except the 2-ft tank. All the other tanks have almost the same temperatures.

TABLE 8

Mean daily evaporation in inches with evaporimeters with different diameters*

Month	USA Standard	2-ft	4-ft	8-ft	12-ft	16-ft	20-ft
1955							
Aug	0·154	0·159	0·149	0·129	0·126	0·119	0·118
Sep	0·162	0·180	0·159	0·149	0·133	0·137	0·132
Oct	0·180	0·218	0·189	0·179	0·175	0·165	0·162
Nov	0·192	0·238	0·208	0·187	0·177	0·169	0·155
Dec	0·182	0·234	0·203	0·176	0·166	0·156	0·145
1956							
Jan	0·204	0·249	0·214	0·184	0·175	0·171	0·158
Feb	0·279	0·342	0·296	0·250	0·235	0·222	0·218
Mar	0·406	0·494	0·435	0·359	0·331	0·305	0·301
Apr	0·448	0·543	0·465	0·382	0·342	0·318	0·312
Mean	0·245	0·295	0·258	0·222	0·207	0·196	0·189

*Some of the mean monthly evaporations indicated in this table for the standard evaporimeter are not exactly the same as those given elsewhere in this paper. When observation was missed on any day in any one of the evaporimeters due to some reason, the corresponding observation in all the evaporimeters including that from the standard were omitted in the analysis

However, with the advance of the day and by 1330 IST the 2-ft tank is warmer than all the rest which have an almost similar temperature. In spite of the above conditions, there is a gradual decrease in the evaporation with increase in size of the tank. Fig. 2 shows the relation between the daily evaporation in different seasons and the diameter of the tank. The curves suggest a relation between evaporation E and the diameter of the tank d of the form—

$$E = A \cdot B^{-d} + C$$

From the average daily evaporation for the whole period from August 1955 to April 1956, it is observed that

$$E = 0 \cdot 180 + 0 \cdot 1393 \times 1 \cdot 148^{-d}$$

This equation suggests that the evaporation tends to 0·180 as the diameter is increased indefinitely. This value of evaporation is 0·78 of the evaporation from the 4-ft standard pan.

From the observations in Table 8 the following relation between evaporation and diameter of tank was obtained for August, November and April —

August : $E = \cdot 115 + 0 \cdot 0582 \times 1 \cdot 167^{-d}$

November : $E = \cdot 150 + 0 \cdot 1166 \times 1 \cdot 149^{-d}$

April : $E = \cdot 300 + 0 \cdot 3285 \times 1 \cdot 187^{-d}$

From the above it is found that the ratio of the evaporation from an extended water surface E_∞ to that from the standard evaporimeter E is as follows for each of these months—

August : $E_\infty / E = 0 \cdot 75$

November : $E_\infty / E = 0 \cdot 78$

April : $E_\infty / E = 0 \cdot 67$

Assuming the annual mean factor to convert the evaporation from the standard tank to that from a sunken tank of

TABLE 9

Mean temperature (°F) of the water in the evaporimeters of different diameters

Month	2-ft	4-ft	8-ft	12-ft	16-ft	20-ft
			(*a*) At 0830 IST			
1955						
Aug	73·5	73·4	74·1	74·3	74·2	74·0
Sep	75·0	75·1	75·7	76·1	76·5	76·0
Oct	74·3	74·7	75·2	75·9	75·9	76·0
Nov	63·4	64·1	64·6	65·3	64·7	65·0
Dec	58·8	59·5	60·0	60·6	60·5	61·0
1956						
Jan	60·7	61·3	61·8	62·6	62·4	62·4
Feb	59·3	60·4	61·0	61·7	61·3	60·7
			(*b*) At 1330 IST			
1955						
Aug	83·9	82·5	84·6	84·1	83·8	84·0
Sep	90·4	89·5	89·6	90·2	90·0	90·2
Oct	90·1	88·5	88·5	89·3	89·3	89·8
Nov	84·1	82·3	82·2	82·6	82·5	83·2
Dec	78·0	77·3	77·0	78·2	77·7	78·2
1956						
Jan	82·1	80·4	79·5	80·0	80·0	80·4
Feb	83·5	80·7	80·0	80·2	80·2	80·5

similar size to be 0·866, and that the evaporation from a water surface of large area is 0·78 of that from a 4-ft tank, the ratio of the evaporation from a lake to that from the standard tank is 0·67. This compares very favourably with the factor 0·6 obtained by Ramdas by wetting the ground round a sunken pan to different diameters.

6. Effect of wire netting cover on evaporation

In the arid regions of the country, the reservoir of the USA evaporimeter may often be the only readily available source of water for stray animals and birds. If these visit the instrument for drinking water, the evaporation recorded will be of no scientific value. By providing a fence round the observatory enclosure, the larger animals can be avoided, but the smaller ones and birds cannot be prevented from drinking water in the tank. Leather (1913) who used a cement lined masonry tank $6\frac{1}{2}$ ft in diameter and 5 ft deep with the water level flush with the ground, suspected that jackals came and drank water in the tank at nights. In 1910 he decided to surround the tank with a guard of wire netting. The netting was 4 ft high and of 2″ mesh. In addition, he fixed a second strip of $\frac{1}{2}$″ mesh and 12″ high. The former prevents any large animals and the latter keeps off small ones. In this case Leather assumed that the evaporation from the tank is not affected by the wire netting; however, no comparative observations appeared to have been made to substantiate this assumption.

TABLE 10

Mean daily evaporation (inches)

Month	Standard tank (A)	3/4″mesh cover placed on rim (B)	Tank covered with a cage (C)	B/A	C/A
1955					
Apr	0·496	0·440	..	0·887	..
May	0·449	0·398	..	0·887	..
Jun	0·372	0·339	0·305	0·911	0·820
Jul	0·193	0·179	0·177	0·927	0·917
Aug	0·154	0·128	0·118	0·831	0·766
Sep	0·167	0·134	0·125	0·802	0·749
Oct	0·181	0·153	0·148	0·845	0·818
Nov	0·185	0·158	0·158	0·854	0·854
Dec	0·176	0·139	0·156	0·790	0·886
1956					
Jan	0·209	0·166	0·186	0·794	0·890
Feb	0·289	0·233	0·248	0·806	0·856
Mar	0·406	0·369	0·385	0·909	0·948
Mean				0·854	0·851
Standard Deviation				0·049	0·057

The East African Meteorological Service has been trying a protecting grid fitted to the top of the tank and they found that such a grid reduced the evaporation by nearly 10 per cent. In Canada, an open mesh wire fence about 5 ft away from the tank is employed so that the fence does not interfere with the evaporation from the tank.

Experiments were conducted at the Central Agricultural Meteorological Observatory at Poona with different sizes of wire mesh so as to estimate their reducing effect on evaporation. Measurements were made with two sizes of G.I. hexagonal wire mesh 1½″ between opposite sides and also 3/4″ size. These were placed just on the tank. Evaporation measurement were also made by protecting the tank in a 3/4″ size wire mesh cage of size 5′ by 5′ and height 3′. The evaporation from a tank with a 3/4″ mesh

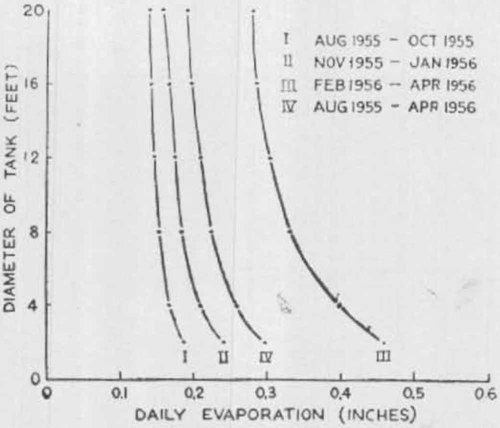

Fig. 2. Mean daily evaporation from tanks of different sizes

net resting directly on the rim, and from that protected with the wire cage are given in Table 10.

The evaporation seems to be reduced by nearly the same extent either by protecting the water with a 3/4″ wire netting directly placed on the rim of the tank or by enclosing the tank in a rectangular cage. The former is easier to accomplish.

The data recorded with evaporimeters covered directly with 1½″ mesh wire gauze during the period January to December 1954 have been compared with that of the standard instrument. The results indicate the following factor for converting evaporation from the covered evaporimeter E_c to that from an uncovered instrument E (Table 11).

While the factor for the 3/4″ mesh cover is 1·21 for 1954, it was found to be 1·14 for the period April 1955 to March 1956. Similar experiments at various places may be necessary before a correction factor could be decided upon.

7. Effect of Cetyl alcohol on the evaporation losses

(Formula $CH_3(CH_2)OH$, density 0·8176 at 50°C, M.P. 49·3°C, B.P. 190°C)

From an interim report issued by the British East African Meteorological Department (see Ref.) on the experiments on

TABLE 11

Nature of cover	Converting factor E/E_c by which E_c has to be multiplied to get the value of E	Standard Deviation of E/E_c
G.I. wire (22-SWG) with hexagonal mesh 1½″ between opposite sides placed on the reservoir	1·144	·0536
G.I. wire (22-SWG) with hexagonal mesh 3/4″ between opposite sides	1·214	·0270

TABLE 12

Month	Evaporation with no cetyl alcohol (inches)	Evaporation with cetyl alcohol (inches)	Mean temperature (°F)
Jan	8·31	2·84	65·2
Feb	6·35	3·03	64·3
Mar	8·45	4·07	66·4
Apr	6·02	2·57	66·1
May	4·39	3·01	63·7
Jun	4·18	3·06	61·3
Jul	3·62	2·78	60·5
Aug	4·16	3·34	61·7
Sep	4·32	3·58	62·3
Oct	5·52	3·90	64·8

TABLE 13

Mean daily evaporation (inches)

Period	Remarks	Cetyl alcohol tank	Mean temp. of water* (°F)	Standard tank	Mean temp. of water* (°F)
25-3-56 to 4-4-56	Cetyl alcohol in flakes	0·464	80·0	0·435	79·4
7-4-56 to 16-4-56	1 gm of cetyl alcohol in the form of cylindrical pieces	0·367	79·5	0·355	79·0
18-4-56 to 25-4-56	2·5 gm of cetyl alcohol in the form of cylindrical pieces	0·512	79·2	0·507	78·4
27-4-56 to 7-5-56	Without cetyl alcohol	0·495	80·8	0·481	80·1

*Mean temperature of water has been obtained from $(N + N' + 2X)/4$ where N and N' are the temperatures at minimum temperature epoch for the air (0730 IST for Poona) on two consecutive days and X is the temperature at the maximum temperature epoch of the air (1430 IST)

TABLE 14

Period	Mean temp. (°F) of experimental tank 0700 IST	Mean temp. (°F) of experimental tank 1430 IST	Mean daily evaporation (inches)	Mean temp. (°F) in standard tank 0700 IST	Mean temp. (°F) in standard tank 1430 IST	Mean daily evaporation (inches)
24-3-1956 to 30-3-1956	68·9	89·6	·479	66·7	90·2	·443
31-3-1956 to 9-5-1956 (20 days)	69·4	90·9	·508	66·6	90·7	·462

Note—From 24 to 30 March 1956 the water in the experimental tank was stirred from 0700 to 1900 IST while from 31 March 1956 to 9 May 1956 it was stirred all day and night

the use of cetyl alcohol to reduce evaporation losses from free water surface, it is observed that the evaporation in each month from 4-ft diameter galvanised iron tanks with and without cetyl alcohol are as given in Table 12.

The effect of surface films of cetyl alcohol on the evaporation of water has also been studied by Mansfield (1955) in Australia. These experiments were repeated at Poona to see how far this substance reduces evaporation during the summer of March-May 1956, when the temperature of the water in the evaporimeter varied between 70° and 90°F and the daily evaporation is about 0·5″. The experiments were conducted with cetyl alcohol in flakes, and with different quantities of the substance in the form of cylindrical pieces about 5 mm long and 3-4 mm in diameter. The results are summarised in Table 13.

It has not been possible to establish from these experiments that cetyl alcohol has in any way reduced the evaporation from the tank. The main difference between the experiments at Poona and those in British East Africa seems to be that while the temperature of the water in the evaporimeter tanks at Poona ranged between 70°F and 90°F, that in East Africa ranged between 60°F and 65°F.

The mean temperature of the water in the evaporimeter at Poona is, therefore, appreciably higher than that in the African experiments. The evaporation during May is about 12″ at Poona, while it is only 4·39″ in Africa. There is plenty of disturbance of the surface due to wind and even contamination due to fine dust blown by the wind at Poona. These factors presumably adversely affect the film of cetyl alcohol from functioning effectively in preventing evaporation. It appears that further experiments have to be conducted with USA evaporimeters under different conditions in the tropical regions to confirm these observation.

8. Effect of stirring the water in the tank

The exposed surface of the water continuously changes when water is flowing through canals and channels. This effect was stimulated by stirring the water continuously. To examine the effect of only stirring, a small pump was fixed on the side of the tank away from the direction of the prevailing wind. The water was stirred by dipping the suction pipe at the bottom of the tank and then delivering it just near the surface of the water so that the water at the bottom of the tank is continuously transferred to surface.

The daily loss of water by evaporation in the standard tank and in one with water in circulation was measured on a number of days from March to May 1956. The details are given in Table 14.

It appears from the above that the evaporation in the stirred instrument is slightly greater than that in the standard. The temperature of the water during 1430 IST is nearly the same in both the tanks and presumably circulation of the water has not appreciably altered the situation arising out of the convection due to heating from below and the sides of the tanks. However, during the night when general cooling takes place, the circulation of the water seems to keep the temperature of the water slightly warmer than that in the topmost layer of the undisturbed water in the standard tank.

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