OR

Amount of water required in the root zone as per volume $= 17 \times 10^{-2}$ (m) $\times 1.6 \times 10^{4}$ (m

$= 2720\ m^3$

So,

$$\eta_s = \frac{2460}{2720} \times 100 \quad \text{or} \quad \eta_s = \frac{15.37}{17} \times 100$$

$$= 90.44\% \qquad\qquad = 90.41\%$$

d.) Water distribution efficiency (η_d)

$$\eta_d = \left(1 - \frac{y}{d}\right) \times 100$$

M.C. depth @ head = 1.7 m
M.C. depth @ tail = 1.1 m

So,

$$\text{Avg./Mean depth (d)} = \frac{1.7 + 1.1}{2} = 1.4\ m$$

& Deviation (y)

depth @ head − Avg./mean depth $= |1.7 - 1.4| = 0.3$
depth @ tail − " $= |1.1 - 1.4| = 0.3$

So,

$$\text{Mean deviation} = \frac{0.3 + 0.3}{2} = 0.3$$

Therefore,

$$\eta_d = \left(1 - \frac{0.3}{1.4}\right) \times 100 = (1 - 0.2142) \times 100 = 78$$

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Formulae to Remember

* Porosity (n)

$$n = \frac{V_v}{V_t}$$

where, V_v = Volume of voids
V_t = Total Volume

* Available water (d_w) / Depth of available water (d_w)

$$d_w = \frac{\gamma_d}{\gamma_w} \times d \times (F.C. - P.W.P.)$$

where, d_w = Depth of available water, cm
d = Depth of root zone, cm
F.C. = Field capacity (decimal)
P.W.P. = Permanent wilting point (decim
also kg/m³ — γ_d = Dry unit weight of soil (kN/m³, gm
kg/m³ — γ_w = Unit weight of water (kN/m³, gm/cc)

* Moisture content (M.C.)

$$M.C.\ (\%) = \frac{M_w}{M_d} \times 100$$

$$= \frac{\text{Mass of water}}{\text{Mass of dry soil}} \times 100$$

$$= \frac{\text{Mass of wet soil} - \text{Mass of dry soil}}{\text{Mass of dry soil}}$$

* Field Capacity (F.C.), %

$$F.C. = \frac{\text{wt. of water content in } 1\ m^3}{\text{wt. of that dry soil in } 1\ m^3}$$

$$F.C. = \frac{\gamma_w \times d_w \times (1\text{-}m^2)}{\gamma_d \times d \times (1\text{-}m^2)}$$

$$F.C. = \frac{\gamma_w}{\gamma_d} \times \frac{d_w}{d} = \frac{\gamma_w \cdot d_w}{\gamma_d \cdot d}$$

* Duty (D), Delta (Δ) & Base period (B)

$$D = \frac{864 \times B}{\Delta}$$

where, D = Duty, ha/cumec
B = Base period, days
Δ = Depth of water, cm

* Gross Command Area (G.C.A.)

G.C.A. = C.C.A. + Uncultivated area

where, C.C.A. = Culturable/Cultivable Command Area

* Irrigation Intesity (I.I.)

$$I.I. = \frac{\text{Irrigable Area (ha)}}{\text{C.C.A. (ha)}} \times 100$$

* Discharge (Q), ~~for~~ when Area (A) & Duty (D) is given

$$\underset{(\text{cumec})}{\text{Discharge } (Q)} = \frac{\text{Area (ha)}}{\text{Duty (ha/cumec)}}$$

* Time factor

$$\text{Time factor} = \frac{\text{Distributary actually operated during base period}}{\text{Base Period}}$$

* Capacity factor

$$\text{Capacity factor} = \frac{\text{Avg. (mean) supply}}{\text{Design supply}}$$

* Full supply coefficient / Duty on capacity

$$= \frac{\text{Estimated area to be irrigated during base period}}{\text{Design full supply discharge at the canal head}}$$

* Nominal Duty

$$= \frac{\text{Actual area irrigated by farmers}}{\text{Avg. (mean) supply}}$$

* Kor period (b), Kor-depth (δ) & Duty (d) relationship

$$\text{Duty}(d), \frac{\text{hec}}{\text{cumec}} = \frac{864 \times b\text{-days}}{\delta\text{-cm}}$$

* Efficiency (η)

$$\eta = \frac{\text{Output}}{\text{Input}}$$

→ Conveyance efficiency (η_c)

$$\eta_c = \frac{\text{Water supplied to farm}}{\text{Water supplied from Canal/river}} \times 100$$

$$\eta_c = \frac{W_f}{W_r} \times 100$$

→ Application efficiency (η_a)

$$\eta_a = \frac{\text{Water stored in root zone}}{\text{Water supplied to farm}} \times 100$$

$$\eta_a = \frac{W_s}{W_f} \times 100$$

→ Water use efficiency (η_u)

$$\eta_u = \frac{\text{Water used including leaching}}{\text{Water supplied to farm}} \times 100 = \frac{W_u}{W_f} \times 100$$

→ Water Storage efficiency (η_s)

$$\eta_s = \frac{\text{Water stored in root zone}}{\text{Water need/required in root zone}} \times 100$$

$$\eta_s = \frac{W_s}{W_n} \times 100$$

→ Consumptive use efficiency (η_{cu})

$$\eta_{cu} = \frac{\text{Water Consume (Consumptive use) by plant}}{\text{water depleted/reduced from root zone}} \times 100$$

$$\eta_{cu} = \frac{W_{cu}}{W_d} \times 100$$

→ Water distribution efficiency (η_d)

$$\eta_d = \left(1 - \frac{y}{d}\right) \times 100$$

where,

y = Average (mean) deviation

d = Average (mean) depth

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* Define following terms

- Evaporation (E)
- Transpiration (T)
- Evapotranspiration (ET)
- Consumptive use (Cu)
- Potential evapotranspiration (PET)
- Actual evapotranspiration (AET)
- Effective Rainfall (ER)
- Net Irrigation Requirement (NIR)
- Gross Irrigation Requirement (GIR)
- Infiltration (I)
- Deep percolation (Pd)

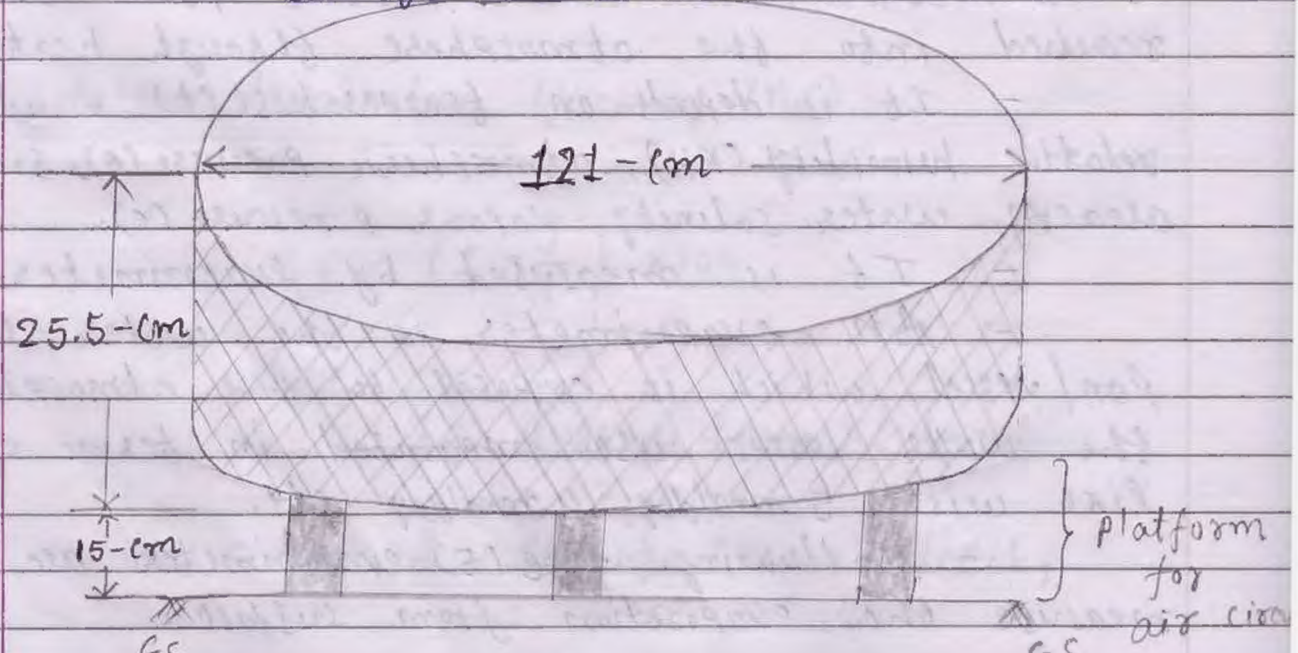
⇒ Evaporation (E)

- It is the process in which the water is converted into water vapour from surface & reached into the atmosphere through heat energy.
- It is depends on temperature (t), wind velocity, relative humidity (RH), atmospheric pressure (a), surface area (A), water solinity, vapour pressure (e).
- It is measured by evaporimeters
- An evaporimeter is the water-containing pan/vessel which is exposed to the atmosphere & the water losses are measured in terms of depth like wise 5 mm/day, 4 mm/day etc.
- Following five (5) evaporimeters are used to measure the evaporation from surface.

1. 1- class A Pan evaporation (0.70)
2- ISI Standard Pan (0.80)
3- Colorado sunken Pan (0.78)
4- Floating pan (0.80)
5- Piche evaporimeter (0.70)

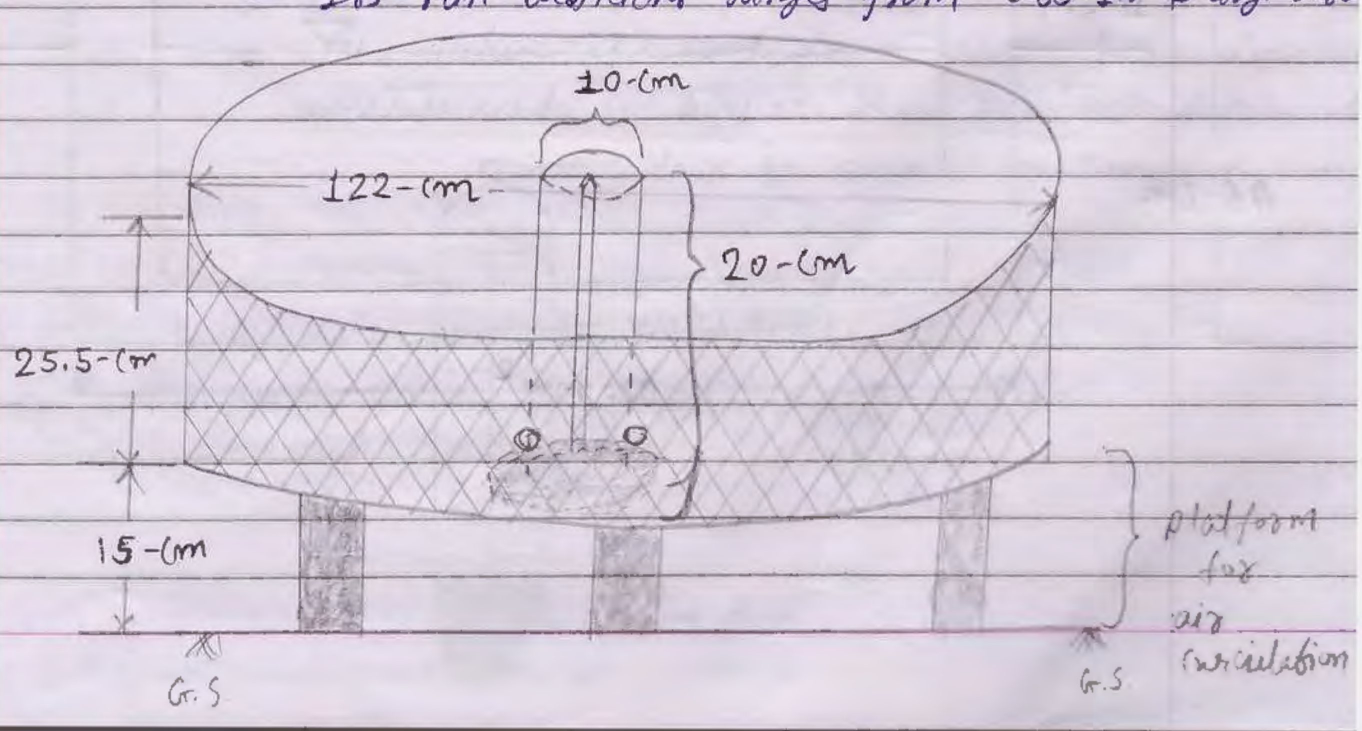
1- Class A Pan evaporimeter

- Its diameter is 1210 mm (121-cm)
- Its depth from bottom to top is 255 mm (25
- Its depth maintained between 18-20 cm from bottom
- It is placed on a wooden frame of 15-cm height from ground which allow the air circulation from bottom
- It is unpainted
- It is made from galvanized iron sheet
- Its Pan coefficient (Cp) range from 0.6-0.8 & average value is 0.70



2- ISI Standard Pan

- It is also known as modified class-A Pan.
- Its diameter is 1220 mm (122-cm)
- Its depth from bottom 255-mm (25.5-cm)
- The top of the Pan is coversed by hexagonal net
- In a screened Pan the evaporation is 14% less than the un-screened Pan.
- The water is filled 5-cm below the top of the evaporimeter & not allow to drop more than 7.5-cm below the rim
- It is white painted & place over 15-cm wooden frame from ground level which allow the air circulation below it.
- The readings must be taken at 8:30 AM in morning & at 5:30 PM in evening
- A stilling well of 10-cm diameter & 20-cm deep provided small hole at bottom is placed in the middle of evaporimeter for accurate readings due to wind effect.
- Its Pan coefficient ranges from 0.65-1.0 & avg. 0.80



3.> Colorado Sunken Pan

- It was developed by Sharma & Dastane (1968)
- It is 920 mm² in square area
- Its 460 mm deep/depth
- Its unpainted
- Its burried into the soil upto 100 mm of the top
- The aerodynamics & radiations characteristics are similar to a lake.
- Its Pan coefficient (Cp) ranges from 0.75 - 0.86 & average value is 0.78

Disadvantages

- Difficult to detect (सोटिया) the leakages
- Extra Care is needed to keep the surrounding area free from grass & dust
- Expensive to install it in the soil