

AQUIFER PROPERTIES

Different aquifer properties are:

✓ **Porosity (α)**

✓ **Void ratio(e)**

$$\alpha = \frac{e}{1+e} \times 100$$

Aquifer type	Effective porosity(%)	
Lime stone	0-20	
Sand	25-50	
Clay	40-70	

✓ **Effective porosity:**

✓ The portion of void space in a porous material through which fluid can flow.

✓ It is the portion that experience the flow process.

✓ **Permeability**

- ✓ Measure of media's ability to transmit fluid under a hydro potential gradient.
- ✓ It is the property of soil (not water property).

Hydraulic conductivity:

- ✓ Volume of water that moves through a porous medium in unit time under a unit hydraulic gradient through a unit area measured at right angle to the direction of flow.
- ✓ Property of both soil and water.

$$K = \frac{Q}{A \times i} \quad \text{Or,} \quad K = \frac{q}{i}$$

Where, K = hydraulic conductivity of the aquifer, Q = groundwater discharge (rate of groundwater flow), A = cross-sectional area of the aquifer, i = hydraulic gradient, and q = specific groundwater discharge or Darcy flux.

✓ Transmissivity (T)

- ✓ Rate at which water is transmitted through its unit width under a unit hydraulic gradient.
- ✓ Co-efficient of transmissivity or transmissibility.
- ✓ Characterizes the ability of aquifer to transmit the water.

$$T = K \times b \times i$$

Where,

K=hydraulic conductivity(m/day),

b=thickness(m),

i=hydraulic gradient.

Specific retention (S_r)

- ✓ Defined as the ratio of the volume of water that the soil after being saturated, will retain against the force of gravity to its own volume.
- ✓ It is also known as field capacity or water holding capacity.

$$S_r = \frac{V_r}{V}$$

Where, V_r = volume of water retained mostly by molecular attraction and surface tension

V = total volume.

Specific yield(S_y)

- ☑ Represents water yield from water bearing material
- ✓ It is the ratio of volume of water that (the material after being saturation) will yield by gravity to its own volume.
- ✓ It is also called effective porosity.
- ✓ It is a property of an **unconfined aquifer**.

$$S_y = \frac{V_a}{V}$$

Where, V_a = volume of water drain by gravity;

V = total volume

- **Relationship between specific yield, specific retention and porosity**

$$\text{Porosity} = \text{Specific yield} + \text{Specific retention}$$

Specific storage (S_s)

- ✓ It is defined as the volume of water that a unit volume of the aquifer releases from storage under a unit decline in hydraulic head.
- ✓ It is a property of confined aquifer.

Storage co-efficient/ Storativity

(S_c)

- ✓ It is the volume of water release from storage per unit surface area of the aquifer per unit decline in the component of hydraulic head normal to the surface.
- ✓ It is a property of both confined and unconfined aquifer.
- ✓ Storage coefficient is a dimensionless aquifer parameter.
- ✓ It value varies from 0.00005 to 0.005 (confined aquifer) and 0.1-0.3 for unconfined aquifer.

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Specific Storage

- ✓ The 'Specific Storage' (S_s) of an aquifer is defined as the volume of water released from or taken into storage per unit volume of an aquifer per unit change in hydraulic head.
- ✓ The specific storage has the dimension of $[L^{-1}]$.
- ✓ Mathematically, it is expressed as follows:
 - ✓ $S = S_s \times b$
- ✓ Where S_s = specific storage of the aquifer material, and b = thickness of the aquifer.

Hydraulic resistance

- ☑ It is the reciprocal of leakage factor.
- ✓ It is a property of semi-confined aquifer.
- ✓ It is the ratio of b/K of saturated thickness b , of the semi-pervious layer and hydraulic conductivity K , of the semi-pervious layer of the vertical flow.

$$c = \frac{B \times B}{K \times b}$$

Where,

- ✓ B =leakage factor (m);
- ✓ K =hydraulic conductivity of the aquifer (m/day);
- ✓ b =thickness of the aquifer (m)

Leakage factor

- ✓ It is a property of semi-confined aquifer.
- ✓ It determines the distribution of leakage into or from the semi-pervious aquifer.

$$B = \sqrt{Kbc}$$

Where,

- ✓ K=hydraulic conductivity of the aquifer (m/day);
- ✓ b=thickness of the aquifer (m);
- ✓ c=hydraulic resistance (days)

Intrinsic permeability

- Intrinsic permeability' or 'permeability' of porous media (soils or subsurface formations) is defined as their ability to transmit a fluid (liquid or gas) through them.
- It is a property of the medium only and is independent of the fluid properties.
- The dimension of k is $[L^2]$ and its SI unit is m^2 .

Example 1

- The void ratio of an unconsolidated clay sample is 1.19. determine the porosity of the sample.
- In an area of 120 ha. The water table dropped by 5cm, if the porosity is 28% and specific retention is 9%, determine the specific yield of the aquifer and change in ground water storage.

Example 2

- In an area of 200 ha, the water table declines by 3.5 m. If the porosity of the aquifer material is 30% and the specific retention is 15%, determine: (i) specific yield of the aquifer, and (ii) change in groundwater storage.