LNCT GROUP OF COLLEGES

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Department of Civil Engineering

B.TECH – 6TH SEM

WATER RESOURCES AND IRRIGATION ENGINEERING (WRE)

CE-603(A)

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UNIT-IV

GROUND WATER AND WELL IRRIGATION

NUMERICALS PROBLEM ON AQUIFER

Calculation of Discharge in Confined Aquifer Using Theim’s Formula for Steady Radial Flow:

Discharge through confined aquifer can be calculated from the formula

$$K = \frac{2.303\, Q \log \frac{r}{r_w}}{2\pi\, m\, (h - H_2)}$$

Consider that the recharge to the aquifer within the influence zone of the pumped well equals the rate of discharge of the well so that the drawdown remains stabilised and therefore steady state exists.

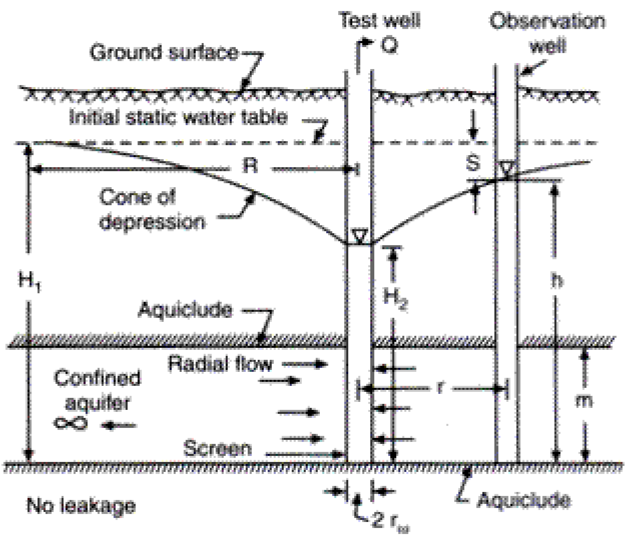

Fig. 18.16. Radial flow to a well in confined aquifer

where

K = coefficient of permeability

m = thickness of aquifer

r_w = radius of the well

T = transmissibility of aquifer = K.m

The above equation is called equilibrium or Thiem's equation and is used to determine piezometric head at any point at a radial distance r from the centre of the well. Carrying the logic further if the piezometric heads in two observation wells say h_1 and h_2 at two points r_1 and r_2 distance radially away respectively from the centre of the pumped well are measured during the pumping test, coefficient of permeability 'K can be easily calculated. The formula can be written as follows ($r_2 > r_1$) The above method is popularly called Thiem's method.

Calculation of Discharge in Unconfined Aquifer Using Theim's Formula for Steady Flow:

Referring Fig. 18.17 and considering the steady state condition, the discharge at any distance r towards the well is given by applying Darcy's formula in conjunction with simplifying assumptions made by Dupit

Q = K A I = 2πr K h dh/dr

Integrating the equation (1) between limits h = H_2 at r = r_w h = head at any distance r

$$h^2 - H_2^2 = \frac{2.303Q}{\pi.K}\log_{10}\frac{r}{r_w} \qquad ...(a)$$

Equation (a) can be used to determine the distribution of head radially outward from the well. If the values of head h_1 and h_2 at any two observation wells at a distance r_1 and r_2 respectively ($r_2 > r_1$) from the test well are measured, coefficient of permeability K can be measured by substituting values in equation (a) above.

Then taking limit when h = H_1 at r = R, (the radius of influence) equation (a) will become

$$H_1^2 - H_2^2 = \frac{2.303Q}{\pi.K}\log_{10}\frac{R}{r_w} \qquad ...(b)$$

It may be mentioned that in equation (a) as well as (b) H_2 is head at well and — therefore is equal to the depth of water in the well.

Sichardt's formula may be used to calculate radius of influence R.

:

It is expressed below to recapatulate:

R = 3000 s√K

where R is radius of influence in metres

s is drawdown at well in metres

K is coeff. of permeability in m/sec.

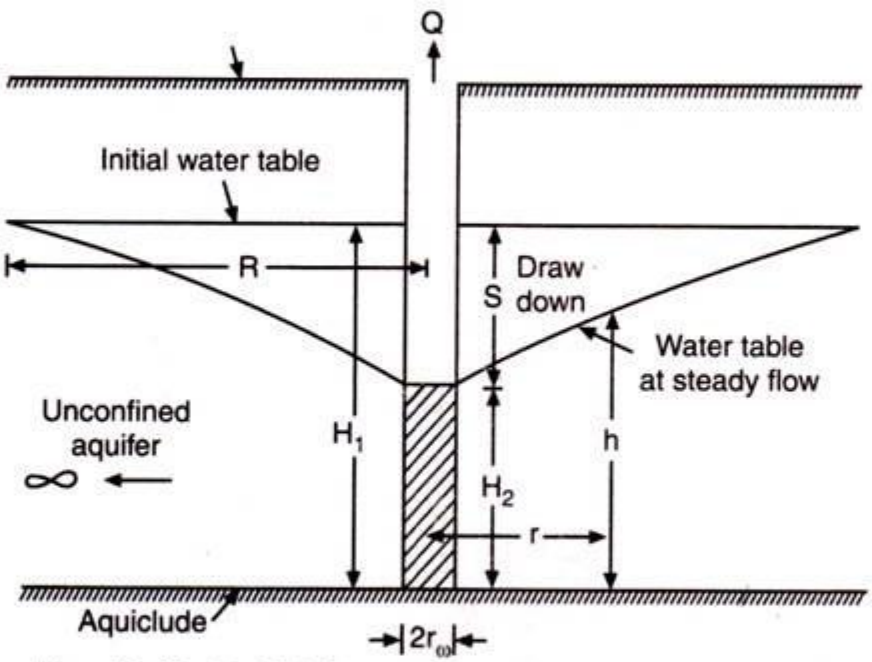

Fig. 18.17. Radial flow to a well in unconfined aquifer

Problem:

A tube well is 0.46 m in diameter. The unconfined aquifer is of 18 m depth. After drawdown depth of water is 12 m in the well. Permeability of soil is 24.50 m/day. Radius of circle of influence is 275 metres. Calculate discharge of the tube well.

Solution: Formula to be used is

$$Q = \frac{\pi . K(H_1^2 - H_2^2)}{2.303 \log_{10} R/r}$$

$$K = 24.50 \text{ m/day;}$$

$$R = 275 \text{ m; } r = 0.23 \text{ m.}$$

$$H_1 = 18 \text{ m; } \quad H_2 = 12 \text{ m.}$$

$$\therefore \qquad Q = \frac{\pi \times 24.5(18^2 - 12^2)}{2.303 \log_{10} \frac{275}{0.23}}$$

$$= \frac{\pi \times 24.5 \times 180}{2.303 \times \log_{10} 1200}$$

$$= \frac{\pi \times 24.5 \times 180}{2.303 \times 3.079}$$

$$= 2{,}000 \text{ m}^3\text{/day.}$$

$\therefore$ Discharge of the tube well is 2000 m^3/day or 23.15 litres/sec.

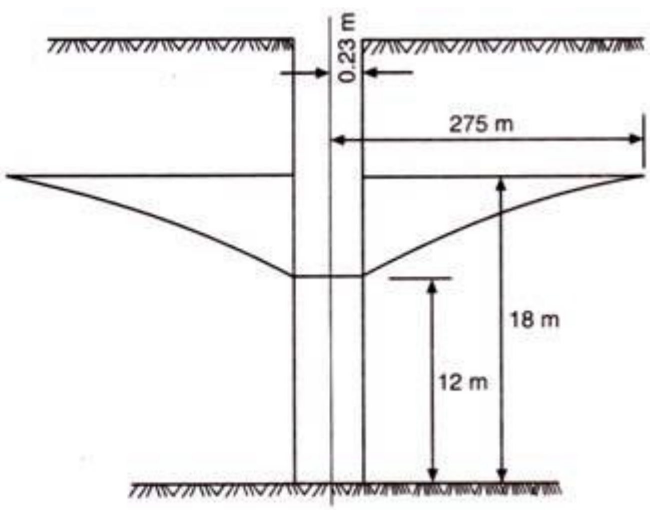

Fig. 18.18. Problem 1