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Answer: (1)

(i) Confined : $T = 1000\ m^2/d$, $R = 5\ km$

steady state drawdown at well face at $r = r_w = 0.25\ m$

$$S = \frac{Q}{2\pi T} \ln\left(\frac{R}{r}\right)$$

$$\Rightarrow 10 = \frac{Q}{2\pi \times 1000} \ln\left(\frac{5000}{0.25}\right)$$

$$\boxed{Q = 6344.41\ m^3/d}$$

(ii) Unconfined

a) $K = 15\ m/d$, $H = 66.7\ m$, $R = 5\ km$
$S = 10\ m$

Steady State Drawdown Equation

$$(2H - S)(S) = \frac{Q}{\pi K} \ln(R/r)$$

$$\Rightarrow (2 \times 66.7 - 10)(10) = \frac{Q}{\pi \times 15} \ln\left(\frac{5000}{0.25}\right)$$

$$\boxed{Q = 5871.75\ m^3/d}$$

b) $K = 90\ m/d$, $H = 11.1\ m$, $R = 5\ km$

$$(2H - S)(S) = \frac{Q}{\pi K} \ln(R/r)$$

$$\Rightarrow (2 \times 11.1 - 10)(10) = \frac{Q}{\pi \times 90} \ln\left(\frac{5000}{0.25}\right)$$

$$\boxed{Q = 3483.08\ m^3/d}$$

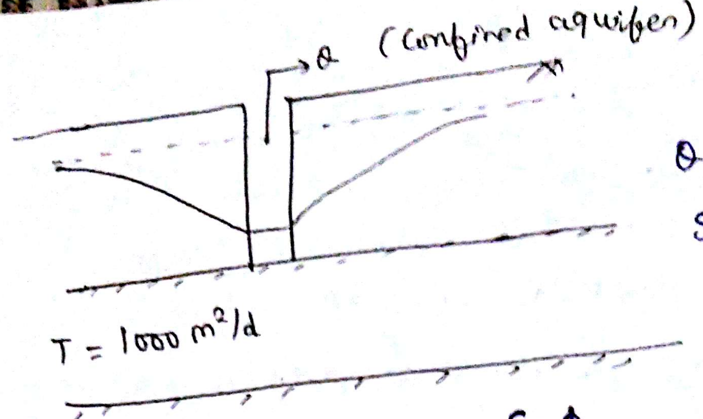
For Same Transmissivity in unconfined aquifer, aquifer having low value of 'K' will give more steady state Pumping Rate.

In (ii) Equivalent Transmissivity $(T) = KH \simeq 1000\ m^2/d$

→ steady state Pumping Rate is more in case of confined aquifer than unconfined for given T.

[P.T.O.]

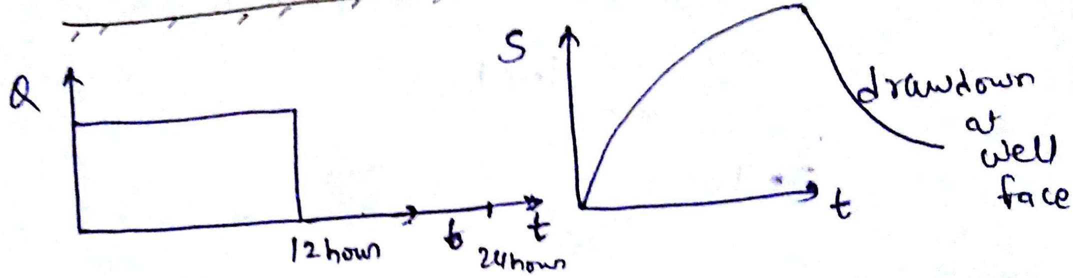
Answer: (2)



$Q = 6344.41\ m^3/d$

$S_t = 0.0001$

$T = 1000\ m^2/d$



<u>Drawdown at well face</u>

$r = r_w = 0.25 m$

(i) at $t = 3$ hour

$$S = \frac{Q}{4\pi T} W(u) \quad , \quad u = \frac{r^2 S_t}{4Tt} \Rightarrow \frac{(0.25)^2 (0.0001)}{4 \times 1000 \times (3/24)} = 1.25 \times 10^{-8}$$

Since $u < 0.05$

So, we can use Cooper Jacob equation

$$W(u) = -0.5772 - \ln u$$
$$= 17.62$$

$$S = \frac{6344.41}{4\pi \times 1000} \times 17.62 \Rightarrow 8.89 m$$

(ii) at $t = 6$ hour

$$S = \frac{2.303 Q}{4\pi T} \log\left(\frac{2.2456\, Tt}{r^2 S_t}\right) \quad \{\text{Cooper-Jacob eq}^n\}$$

$$S = \frac{2.303 \times 6344.41}{4\pi \times 1000} \log\left(\frac{2.2456 \times 1000 \times \frac{6}{24}}{(0.25)^2 \times 0.0001}\right)$$

$$S = 9.24 m$$

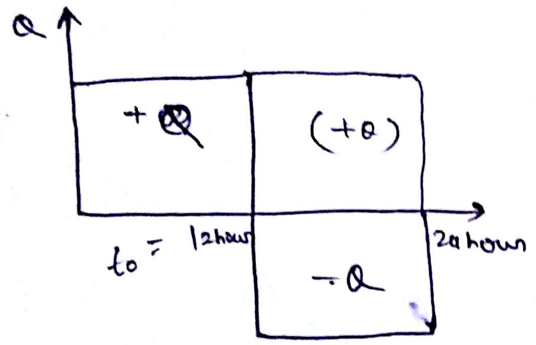
(iii) at $t = 12$ hour

$$S = \frac{2.303 \times 6344.41}{4\pi \times 1000} \log\left(\frac{2.2456 \times 1000 \times \frac{12}{24}}{0.25^2 \times 0.0001}\right)$$

$$\boxed{S = 9.59 m}$$

(iv) at = 15 hour

after $t > 12$ hour Recovery of well will start.



$t = t_0 = 12$ hour ⇒ 0.5 day

at $t = t_1 > 12$ hour

$$S(t_1) = \frac{Q}{4\pi T} W\left(\frac{r^2 S_t}{4Tt_1}\right) - \frac{Q}{4\pi T} W\left[\frac{r^2 S_t}{4T(t_1 - t_0)}\right]$$

$$S(t_1) = \frac{Q}{4\pi T}\left[W\left(\frac{r^2 S_t}{4Tt_1}\right) - W\left(\frac{r^2 S_t}{4T(t_1 - t_0)}\right)\right]$$

Cooper Jacob eqn

$$S(t_1) \Rightarrow \frac{2.303Q}{4\pi T} \log\left[\frac{2.2456 \times 1000\ t_1}{0.25^2 \times 0.0001}\right] - \frac{2.303Q}{4\pi T} \log\left[\frac{2.2456 \times 1000\ (t_1 - t_0)}{0.25^2 \times 0.0001}\right]$$

So, at $t = t_1 = 15$ hour ⇒ $\frac{15}{24}$ ⇒ 0.625 day

$$S = \frac{2.303 \times 6344.41}{4\pi \times 1000} \log\left[\frac{t_1}{t_1 - t_0}\right]$$

$$S = \frac{2.303 \times 6344.41}{4\pi \times 1000} \log\left(\frac{0.625}{0.625 - 0.5}\right)$$

$$\boxed{S = 0.812 \text{ m}}$$

(v) at t = t_1 = 24 hour = 1 day

$$S = \frac{2.303 \times 6344.41}{4\pi \times 1000} \log\left(\frac{1}{1 - 0.5}\right)$$

$$\boxed{S = 0.35 \text{m}}$$

CE 535 / 423 – Groundwater Engineering

TUTORIAL – 4

Q1. Consider the following "equivalent aquifers"

i) Confined: $T = 1000\ m^2/day$, $R = 5\ km$

ii) Unconfined: (a) $K = 15\ m/day$, $H = 66.7\ m$, $R = 5\ km$

(b) $K = 90\ m/day$, $H = 11.1\ m$, $R = 5\ km$

iii) Leaky Confined: $T = 1000\ m^2/day$, $L = 1200m$

Effective Well radius = 25 cm

Compute in each case the permissible pumping rate, given that the steady state drawdown at the well face is 10 m.

Comment upon results.

Q2. Consider the well tapping confined aquifer, enumerated in Q1 (i) above. Water is pumped from the well at the design discharge rate (computed by you) for a period of 12h. Compute the drawdown at the well face at times: 3h, 6h, 12h, 15h and 24h. Given S=0.0001.