VARIANT 10

Determine the volume of water that is pumped into the reservoir and the amount of water injection wells if the oil reservoir developed a number of wells in the unilateral pressures for these data

the amount of oil changes from 4000x1000 with a step of 200 m and 150 m respectively;

the number of production wells changes from 10 in increments of 1 well;

distance from the oil water contact to production wells varies from 800 m with a step of 200 m;

distance from the oil water contact to the discharge line changes from 1000 m with a step of 100 m;

pressure discharge line changes from 20 MPa with a step of 0,5MPa;

bottom hole pressure changes from 17 MPa with a step of 0.5 MPa;

reservoir permeability coefficient changes from 10 mD with a step of 5mD;

layer thickness changes from 8 m with a step of 0.5 m;

coefficient of dynamic viscosity of oil changes from 2.5 mPa s with a step of 0.05 mPa s;

coefficient of dynamic viscosity of water 1 mPa s;

head pressure injection wells 8 MPa with a step of 0.5 MPa;

hole depth changes from 2000 m with a step of 30 m;

diameter tubing string (conditional) 60 mm;

pollution factor of face zone injection wells 2.5;

water flow path is missing.

Problem 6

Determine the volume of water that is pumped into the reservoir and the amount of water injection

Data

The amount of oil, m $l := 4000 + 9 \cdot 200 = 5800$ m

$B := 1000 + 9 \cdot 150 = 2350$ m

The number of production wells $n := 10 + 9 \cdot 1 = 19$

Distance from the oil water contact to production wells, m $L_{w1} := 800 + 9 \cdot 200 = 2600$ m

Distance from the oil water contact to the injection line, m $L_{wd} := 1000 + 9 \cdot 100 = 1900$ m

Pressure injection line, Pa $P_{inj.line} := (20 + 9 \cdot 0.5) \cdot 10^6 = 2.45 \times 10^7$ Pa

Bottom hole pressure, Pa $P_{bh} := (17 + 9\cdot 0.5)\cdot 10^{6} = 2.15 \times 10^{7}$ Pa

Reservoir permeability coefficient, mD $k := (10 + 9\cdot 5)\cdot 10^{-15} = 5.5 \times 10^{-14}$ m

Layer thickness, m $h := 8 + 9\cdot 0.5 = 12.5$ m

Coefficient of dynamic viscosity of oil, Pa*s $\mu_o := (2.5 + 9\cdot 0.05)\cdot 10^{-3} = 2.95 \times 10^{-3}$ Pa·s

Coefficient of dynamic viscosity of water, Pa*s $\mu_w := 1\cdot 10^{-3}$ Pa·s

Head pressure injection wells, Pa $P_{inj} := (8 + 0.5\cdot 9)\cdot 10^{6} = 1.25 \times 10^{7}$ Pa

Hole depth, m $H := 2000 + 9\cdot 30 = 2270$ m

Diameter tubing string(conditional), m $d := 0.0503$ m

Pollution factor of face zone injection wells $\psi := 2.5$

Water loss $Q_{loss} := 0$

Water density, kg/m3 $\rho_w := 1100$ $\frac{kg}{m^3}$

Well radius, m $r_w := 0.1$ m

$g := 9.81$ $\frac{m}{s^2}$

Number of injection wells

$$n_{inj} = \frac{Q_l\cdot\psi\cdot\mu_w\cdot\ln\left(\frac{B}{\pi\cdot r_w}\right) - \ln(n_{inj1})}{2\cdot\pi\cdot 0.5\cdot k\cdot h\cdot(P_{bh.inj} - P_{inj.line})}$$

$$P_{bh.inj} = P_{inj} + \rho_w \cdot g \cdot H - \Delta P_{loss}$$

$$\upsilon = \frac{4 \cdot Q_{inj}}{\pi \cdot d^2}$$

$$Re = \frac{\upsilon \cdot d}{\nu}$$

$$\Delta P_{loss} = \lambda \cdot \frac{L}{d} \cdot \frac{\upsilon^2}{2} \cdot \rho_w$$

Solution

$$\Omega_{injw} := \frac{\mu_w \cdot L_{wd}}{B \cdot k \cdot h} \quad \text{...} (9.1)$$

$$\Omega_{injw} := \frac{1 \cdot 10^{-3} \cdot 1900}{2350 \cdot 5.5 \cdot 10^{-14} \cdot 12.5} = 1.176 \times 10^9 \qquad \frac{Pa \cdot s}{m^3}$$

$$\Omega_{\omega 1} := \frac{\mu_o \cdot L_{w1}}{B \cdot k \cdot h}$$

$$\Omega_{\omega 1} := \frac{2.95 \cdot 10^{-3} \cdot 2600}{2350 \cdot 5.5 \cdot 10^{-14} \cdot 12.5} = 4.747 \times 10^9 \qquad \frac{Pa \cdot s}{m^3}$$

$$\omega_1 := \frac{\mu_o \cdot \ln\left(\frac{\sigma}{\pi \cdot r_w}\right)}{2 \cdot \pi \cdot k \cdot h \cdot n} \qquad \text{where} \quad \sigma := \frac{B}{2n}$$

$$\sigma := \frac{2350}{2 \cdot 19} = 61.842$$

$$\omega_1 := \frac{2.95 \cdot 10^{-3} \cdot \ln\left(\frac{61.842}{\pi \cdot 0.1}\right)}{2 \cdot \pi \cdot \left(5.5 \cdot 10^{-14}\right) \cdot 12.5 \cdot 19} = 1.9 \times 10^8 \qquad \frac{Pa \cdot s}{m^3}$$

-Production of liquid deposit

$$Q_l := \frac{P_{inj.line} - P_{bh}}{\Omega_{injw} + \Omega_{\omega 1} + \omega_1}$$

$$Q_l := \frac{2.45\cdot 10^7 - 2.15\cdot 10^7}{1.176\times 10^9 + 4.747\times 10^9 + 1.9\cdot 10^8} = 4.91\times 10^{-4} \qquad \frac{m^3}{s}$$

Speed in the tubing

$$\upsilon := \frac{4\cdot Q_l}{\pi\cdot d^2}$$

$$\upsilon := \frac{4\cdot 4.91\cdot 10^{-4}}{\pi\cdot 0.0503^2} = 0.247 \qquad \frac{m}{s}$$

Reynolds number

$$Re := \frac{\upsilon\cdot d\cdot \rho_W}{\mu_W}$$

$$Re := \frac{0.247\cdot 0.0503\cdot 1100}{1\cdot 10^{-3}} = 13666.51$$

$\rho_W = 1.1 \times$

Hydraulic resistance coefficient

$$\lambda := \begin{cases} \dfrac{0.3164}{Re^{0.25}} & \text{if } Re \geq 2320 \\ \dfrac{64}{Re} & \text{if } Re < 2320 \end{cases}$$

Turbulent flow regime

Laminar flow regime

$$\lambda := \frac{0.3164}{Re^{0.25}}$$

$$\lambda := \frac{0.3164}{13666.51^{0.25}} = 0.029$$

Deep descent tubing

$$L := H - \frac{h}{2}$$

$$L := 2270 - \frac{12.5}{2} = 2263.75 \quad \text{m}$$

Friction pressure loss

$$\Delta P_{loss} := \lambda \cdot \frac{L}{d} \cdot \frac{\upsilon^2}{2} \cdot \rho_w$$

$$\Delta P_{loss} := 0.029 \cdot \frac{2263.75}{0.0503} \cdot \frac{0.247^2}{2} \cdot 1100 = 4.379 \times 10^4 \quad \text{Pa}$$

The pressure at the bottom hole pressure

$$P_{bh.inj} := P_{inj} + \rho_w \cdot g \cdot H - \Delta P_{loss}$$

$$P_{bh.inj} := 1.25 \cdot 10^7 + 1100 \cdot 9.81 \cdot 2270 - 4.379 \times 10^4 = 3.695 \times 10^7 \quad \text{Pa}$$

Number of injection wells

Given $n_{inj} := 1$

$$n_{inj} = \frac{Q_l \cdot \psi \cdot \mu_w \cdot \ln\left(\frac{B}{\pi \cdot r_w}\right) - \ln(n_{inj1})}{2 \cdot \pi \cdot 0.5 \cdot k \cdot h \cdot (P_{bh.inj} - P_{inj.line})}$$

$$n_{inj} := \frac{4.91 \times 10^{-4} \cdot 2.5 \cdot 1 \cdot 10^{-3} \cdot \ln\left(\frac{2350}{\pi \cdot 0.1}\right) - \ln(1)}{2 \cdot \pi \cdot 0.5 \cdot (5.5 \cdot 10^{-14}) \cdot 12.5 \cdot (3.695 \times 10^7 - 2.45 \cdot 10^7)} = 0.407$$

n_{inj} = 1

Conclusion number of injection wells= 1

Conclusion

After finding the volume of water that is pumped into the reservoir [$\upsilon = 0.247$] and finding the amount of water injection well [$n_{inj} = 0.407$].I can conclude that, the amount of water injection wells doesn't developed a number of wells in the unilateral pressure .

‹ 10^3