variant 10

Determine volume of oil that could be extracted at low average reservoir pressure, which is being developed under the dissolved gas drive at constant pressure on the bottomhole if the average oil saturation thus reduced to the following data:

initial reservoir pressure changes from 10 MPa with a step of 1.5 MPa;
final reservoir pressure changes from 9 MPa with a step of 1 MPa;
bottomhole pressure changes from 8 MPa with a step of 0.5 MPa;
initial oil saturation changes from 0.7 with a step of 0.01
final oil saturation changes from 0.3 with a step of 0.01
the thickness of the layer changes from 10 m with a step of 0.5 m;
porosity layer 15%;
radius drainage changes from 300m with a step of 10 m;
radius wells 0.1m;
permeability coefficient layer changes from 30 mD increments 5mD;
viscosity of oil at an initial oil saturation changes from 5.5 mPa·s with a step of 0.05 mPa·s;
the viscosity of the oil in the final oil saturation changes from 6.5 mPa·s with a step of 0,05mPa·s;
volume factor of oil at an initial pressure changes from 1.3 with a step of 0.03;
volume factor of oil in the final pressure changes from 1.1 with a step of 0.02;
relative phase permeability for oil at the initial oil saturation changes from 0.75 with a step of 0.01;
relative phase permeability for oil at the end oil saturation changes from 0.65 with a step of 0.01.

Problem 3

Initial reservoir pressure

$$Pin := (10 + 1.5 \cdot 9) \cdot 10^6$$

$$Pin = 2.35 \times 10^7 \text{ pa}$$

final reservoir pressure

$$Pfin := (9 + 1 \cdot 9) \cdot 10^6$$

$$Pfin = 1.8 \times 10^7 \text{ pa}$$

Bottomhole pressure

$$Pbh := (8 + 0.5 \cdot 9) \cdot 10^6$$

$$Pbh = 1.25 \times 10^7 \text{ pa}$$

Initial Oil saturation

$$S1 := 0.7 + 0.01 \cdot 9$$

$S1 = 0.79$

Final oil saturation

$S2 := 0.3 + 0.01 \cdot 9$

$S2 = 0.39$

Thickness

$h := 10 + 0.5 \cdot 9$

$h = 14.5\,m$

Porosity

$m := 15\%$

$m = 0.15$

Drainage radius

$Rd := 300 + 10 \cdot 9$

$Rd = 390\,m$

Well radius

$rw := 0.1\ \ m$

permeability

$k := (30 + 5 \cdot 9) \cdot 10^{-15}$

$k = 7.5 \times 10^{-14}$

Viscosity of oil at initial saturation

$\mu 1 := (5.5 + 0.05 \cdot 9) \cdot 10^{-3}$

$\mu 1 = 5.95 \times 10^{-3}\ pa \cdot s$

Viscosity of oil at initial saturation

$\mu 2 := (6.5 + 0.05 \cdot 9) \cdot 10^{-3}$

$\mu 2 = 6.95 \times 10^{-3}\ \ pa \cdot s$

volume factor of oil at initial pressure

$\beta 1 := 1.3 + 0.03 \cdot 9$

$\beta 1 = 1.57$

volume factor of oil at initial pressure

$\beta 2 := 1.1 + 0.02 \cdot 9$

$\beta 2 = 1.28$

Relative phase permeability for oil at initial saturation

$Foil1 := 0.75 + 0.01 \cdot 9$

$Foil1 = 0.84$

Relative phase permeability for oil at final saturation

$$Foil2 := 0.65 + 0.01 \cdot 9$$
$$Foil2 = 0.74$$

Solution

$Hres := Pin$ $\quad Hres1 := 1.6 \times 10^7$ $\quad Hres1 - Hbn2 := H1$

$Hbn := Pbh$ $\quad Hbn2 := 1 \times 10^7$ $\quad Hres2 - Hbn1 := H2$

$Hres2 := 1.3 \times 10^7$

$Hbn1 := 1 \times 10^7$

$$a := \frac{\frac{Foil1}{\mu 1 \cdot \beta 1} - \frac{Foil2}{\mu 2 \cdot \beta 2}}{(Pin - Pfin)} = 1.225 \times 10^{-6} \qquad b := \frac{Foil1}{\mu 1 \cdot \beta 1} - a \cdot Pin = 61.132$$

$$H1 := \frac{a}{2} \cdot \left(Pin^2 - Pbh^2\right) + b \cdot (Pin - Pbh) = 9.15 \times 10^8 \quad pa$$

$$H2 := \frac{a}{2} \cdot \left(Pfin^2 - Pbh^2\right) + b \cdot (Pfin - Pbh) = 4.39 \times 10^8 \quad pa$$

$$Q1 := \frac{2 \cdot \pi \cdot k \cdot h \cdot (H1)}{\mu 1 \cdot \ln\left(\frac{Rd}{rw}\right)} \text{ explicit, ALL } \rightarrow \frac{2 \cdot \pi \cdot (30 + 5 \cdot 9) \cdot 10^{-15} \cdot (10 + 0.5 \cdot 9) \cdot 915017985.61151075}{(5.5 + 0.05 \cdot 9) \cdot 10^{-3} \cdot \ln\left(\frac{300 + 10 \cdot 9}{0.1}\right)} = 0.12 \frac{m^3}{s}$$

$$Q2 := \frac{2 \cdot \pi \cdot k \cdot h \cdot (H2)}{\mu 2 \cdot \ln\left(\frac{Rd}{rw}\right)} \text{ explicit, ALL } \rightarrow \frac{2 \cdot \pi \cdot (30 + 5 \cdot 9) \cdot 10^{-15} \cdot (10 + 0.5 \cdot 9) \cdot 438979862.3821063}{(6.5 + 0.05 \cdot 9) \cdot 10^{-3} \cdot \ln\left(\frac{300 + 10 \cdot 9}{0.1}\right)} = 0.052 \quad \frac{m^3}{s}$$

$$Qtot := \left(\frac{Q1 + Q2}{2}\right) \text{explicit}, \text{ALL} \rightarrow \frac{0.12708166364246734 + 0.052195134386870352}{2} = 0.09 \ \frac{m^3}{s}$$

$$\Omega := \pi \cdot Rd^2 \cdot h \cdot m = 1.039 \times 10^6 \quad m^3$$

$$Ttot := \frac{\Omega}{Qtot} \cdot \left(\frac{S1}{\beta 1} - \frac{S2}{\beta 2}\right) \text{explicit}, \text{ALL} \rightarrow \frac{1039293.8276789413}{0.089638399014668843} \cdot \left(\frac{0.7 + 0.01 \cdot 9}{1.3 + 0.03 \cdot 9} - \frac{0.3 + 0.01 \cdot 9}{1.1 + 0.02 \cdot 9}\right) = 2.301 \times 10 \text{ days}$$

$$\eta := 1 - \left(\frac{S2 \cdot \beta 1}{S1 \cdot \beta 2}\right) \text{explicit}, \text{ALL} \rightarrow 1 - \frac{(0.3 + 0.01 \cdot 9) \cdot (1.3 + 0.03 \cdot 9)}{(0.7 + 0.01 \cdot 9) \cdot (1.1 + 0.02 \cdot 9)} = 0.394$$