c) GOR = 1206.6 Sm^3/Sm^3 @ P_d = 201 bar

At P_d = 201 bar

1 kgmol reservoir fluid :

mol % gas $= (z C_1) + (z C_2) + (z C_3) + (z C_4)$
$= 75.2 + 7.7 + 4.4 + 3.1 = 90.4\ \%$

mol % oil $= C_5 + C_6 + C_{7+}$
$= 2.2 + 2.2 + 5.2 = 9.6\ \%$

From 1 kg mol : 0.904 kg mol becomes gas
0.096 kg mol becomes oil

Volum gas : $V_{g,sc} = n_g \cdot V_m = 0.904 \cdot 23.6447$
$= \underline{21.37\ Sm^3}$

Volum oil : $V_{STO\,(sc)} = \dfrac{m_{STO}}{\rho_{STO}} = \dfrac{n_{STO} \cdot M_{STO}}{\rho_{STO}} = \dfrac{0.096\ \text{kg mol} \cdot 143\ \text{kg/kgmol}}{775\ \text{kg/m}^3}$

$= \underline{0.0177\ Sm^3}$

$GOR = \dfrac{V_{g,sc}}{V_{STO}} = \dfrac{21.37\ Sm^3}{0.0177\ Sm^3} = \underline{\underline{1206.4\ Sm^3/Sm^3}}$

At 170 bar : Based on 1 kg mol reservoir fluid :

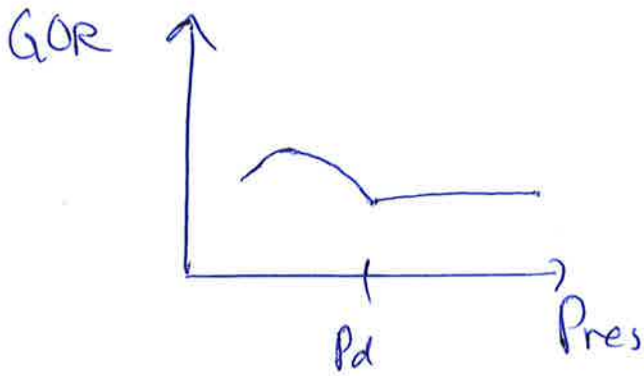
$$GOR = \frac{V_{g,sc}}{V_{STO}} = 1733.8 \ Sm^3/Sm^3$$

use compositions given at 170 bar.

ρ_{STO} M_{STO}

GOR_i at P_i $P_i > P_d$

$$GOR_i = GOR_d = GOR_1 (201 \text{ bar}) = \underline{1206.4 \ Sm^3/Sm^3}$$



Reservoir containing ~~heptrog~~ hydrocarbons and water

$S_{HC} + S_w = 1$

d) IGIP ? IOIP ?

HCPV ?

Bulk volume $10^6 \ m^3$

$\phi = 0,23$

$S_{wi} = 0.15$

$$HCPV = V_b \cdot \Phi \cdot (1 - S_{wi}) = 10^6 m^3 \cdot 0,23 \cdot (1 - 0,15)$$

$$= \underline{195500 \ m^3} = V_i$$

Number of moles reservoir fluid in HCPV :

$$\boxed{PV = Z n R T}$$

$$P_i \cdot V_i = Z_i \cdot n_i \cdot R \cdot T_{res}$$

$$n_i = \frac{P_i \cdot V_i}{Z_i R T_{res}} = \frac{350 \text{ bar} \cdot 100 \frac{kPa}{bar} \cdot 195500 \text{ m}^3}{1.107 \cdot 8.3145 \cdot (115 + 273{,}15)}$$

$$= 1\,915\,276 \text{ kg mol}$$

Pd : From 1 kg mol res. fluid < 0.904 kgmol gas, 0.096 kgmol oil

$$\underline{\underline{IGIP}} = n_i \cdot 0{,}904 \cdot V_m = 1915276 \text{ kgmol} \cdot 0.904 \cdot 23.6447 \text{ m}^3/\text{kgmol}$$

$$= 4\,0{,}938667 \text{ Sm}^3 = \underline{\underline{4.09 \cdot 10^7 \text{ Sm}^3}}$$

$\underline{\underline{IOIP}}$: $GOR_i = \frac{IGIP}{IOIP} \Rightarrow IOIP = \frac{IGIP}{GOR_i}$

$$= \frac{4{,}09 \cdot 10^7 \text{ Sm}^3}{1206.2 \text{ Sm}^3/\text{Sm}^3} = \underline{\underline{33856 \text{ Sm}^3}}$$

(1209.2)

$\underline{\underline{IOIP}}$: $\frac{m_{STO}}{\rho_{STO}} = \frac{n_{STO} \cdot M_{STO}}{\rho_{STO}} = \frac{(n_i - n_g) \cdot M_{STO}}{\rho_{STO}}$

$$= \frac{0.1838 \cdot 10^6 \cdot 143}{775} = \underline{\underline{3.39 \cdot 10^4 \text{ Sm}^3}}$$

e) Production of STO oil (Sm³) and gas (Sm³) in $P_i \rightarrow P_d$.

$$n_{produced} = n_{i \text{ in HCPV}} - n_{\text{left in reservoir}} \qquad n = \frac{PV}{ZRT}$$

$$= n_i - \frac{P_d \cdot V_d^{\,HCPV}}{Z_d R T_{res}}$$

$$= 1\,915\,276 \text{ kgmol} - \frac{201 \text{ bar} \cdot 100 \frac{kPa}{bar} \cdot 195500 \text{ m}^3}{0.771 \cdot 8.3145 \cdot (115 + 273.15) \text{ °K}}$$

$$= 1\,915\,276 \text{ kgmol} - 1\,579\,257 \text{ kgmol}$$

$$= \underline{336\,019 \text{ kg mol}}$$

Production of gas:

$$\underline{V_g} = n_p \cdot 0.904 \cdot V_m = 336019 \text{ kg mol} \cdot 0.904 \cdot 23.6447 \frac{Sm^3}{kgmol}$$

$$= \underline{\underline{7\,122\,296 \text{ Sm}^3 = 7.1 \cdot 10^6 \text{ Sm}^3}}$$

V_{STO}: $GOR_d = 1206.4 \text{ Sm}^3/\text{Sm}^3$

$$\forall \; GOR = \frac{V_{g,sc}}{V_{STO}} \Rightarrow \underline{\underline{V_{STO}}} = \frac{V_g}{GOR} = \frac{7.1 \cdot 10^6 \text{ Sm}^3}{1206.4 \text{ Sm}^3/\text{Sm}^3}$$

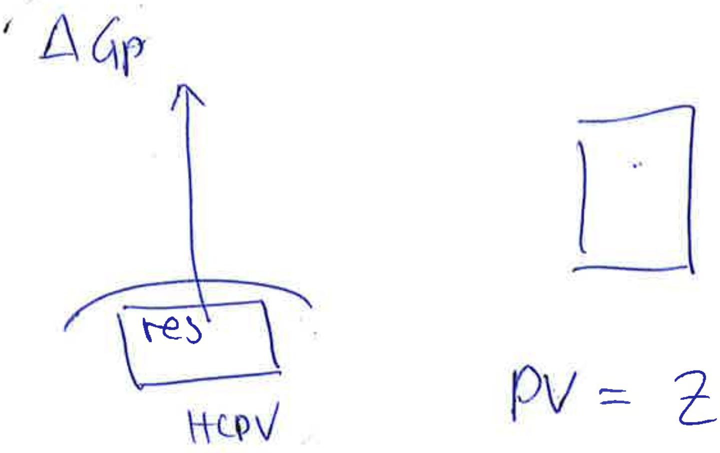
$$= \underline{\underline{5890 \text{ Sm}^3}}$$

f) CVD-analysis data are used to calculate production when $P_{res} < P_d$.

Number of moles of wellstream produced:

Δn_j

$$\Delta n_j = (HCPV) \cdot \frac{\Delta V_j}{V_{celle}} \cdot \frac{p_j}{(Z_g)_j R T_{res}}$$



$\frac{\Delta V_j}{V_{celle}}$

$PV = ZnRT$

g) Gas produced (Sm^3) and STO (Sm^3)

$P_d \longrightarrow 170$ bar.

$$\Delta n_j = \frac{HCPV \cdot \Delta V_j \cdot p_j}{V_{celle} \cdot (Z_g)_j \cdot R \cdot T_{res}}$$

$$= \frac{195500\ m^3 \cdot 170 \cdot 10^{-6} m^3 \cdot 170\ bar \cdot 100\ \frac{kPa}{bar}}{950 \cdot 10^{-6} m^3 \cdot 0.794 \cdot 8.3145 \cdot (115 + 273.15)°K}$$

$$= \frac{564995}{2.4343} = \underline{232094.5\ kg\ mol}$$

1) At 170 bar mol % of well stream : 93.1 % gas
6.9 % oil

Produced gas in pressure interval 201 → 170 bar

$$V_g = \Delta n_j \cdot \text{mol \% gas} \cdot V_m$$

$$= 232094.5 \text{ kgmol} \cdot 0.931 \cdot 23.6447 \text{ Sm}^3/\text{kgmol}$$

$$= 5\,109\,145 \text{ Sm}^3 = 5.1 \cdot 10^6 \text{ Sm}^3$$

$$V_{STO} = \frac{\Delta n_j \cdot \text{mol \% liq.} \cdot M_{STO}}{\rho_{STO}}$$

$$= \frac{232\,094.5 \text{ kgmol} \cdot 0.069 \cdot 138 \text{ kg/kgmol}}{750 \text{ kg/m}^3}$$

$$= 2946.7 \text{ Sm}^3$$

2) ~~Rel perm~~ Relative permeability data at end-point saturations

$S_{or} = 0.17$ $S_{gr} = 0.20$

According to the CVD - data, the maximum liquid volume is 10,1 %, which is lower than S_{or}. $0.10 < 0.17$

⇒ oil is immobile, it does not flow.

The calculations are ok.

If liq condensed (oil condensed) reaches a saturation higher than S_{or}

$\Rightarrow$ oil is mobile, and it can flow to the well.

Extra oil is produced, in addition to the oil produced from the gas. (condensed from gas).