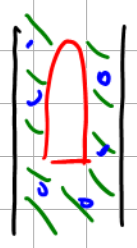


$p^x, T^x \rightarrow$

o g w

ρ

μ

σ_{og} σ_{wg} σ_{ow}

h

$\dot{m}_o$ $\dot{m}_g$ $\dot{m}_w$ $\rightarrow$ q_o q_g q_w $\rightarrow$ ω_{so} ω_{sg} ω_{sw} $\rightarrow$ $\frac{dp}{dx}$, $\frac{dT}{dx}$

2 approaches:

- Compositional z_i (mole frac) C_1, C_2, C_3, i pseudo components + EOS Peng Robinson + EOS parameters
  - mixing rules
  - Binary interaction parameters

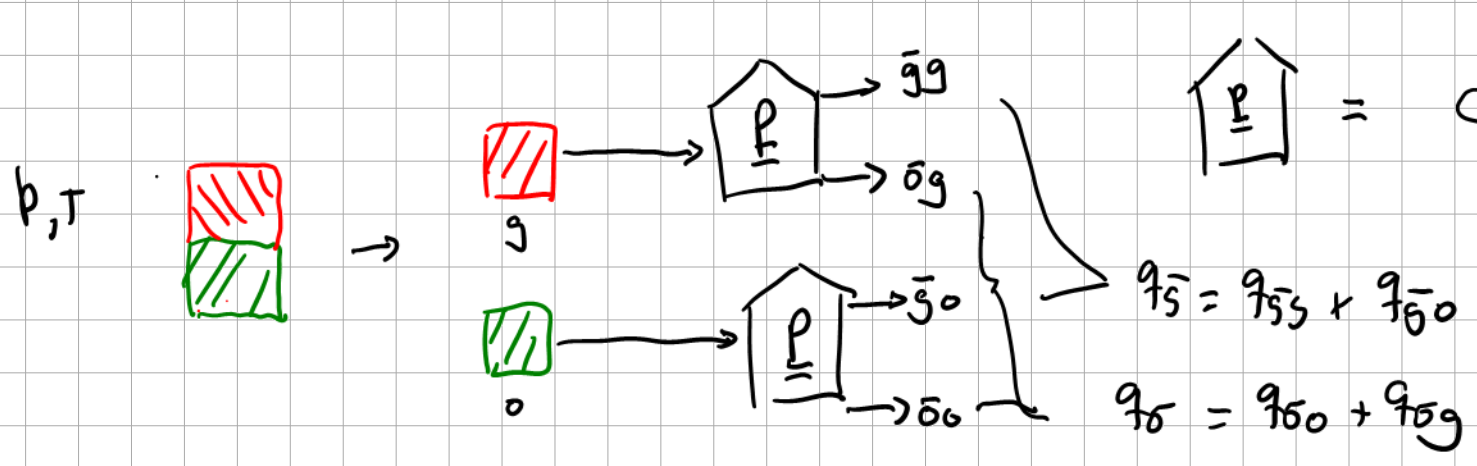
  → mass fraction o, s, w $\quad X_o = \frac{\dot{m}_o}{\dot{m}_o + \dot{m}_g} \quad X_g = (1 - X_o)$

  $\dot{m}_o = \dot{m} X_o$

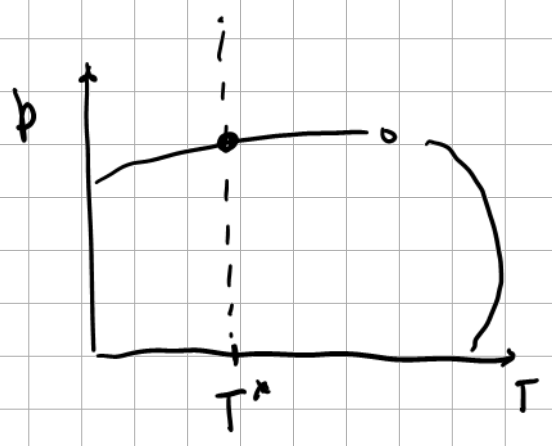
  $\dot{m}_g = \dot{m} X_g$

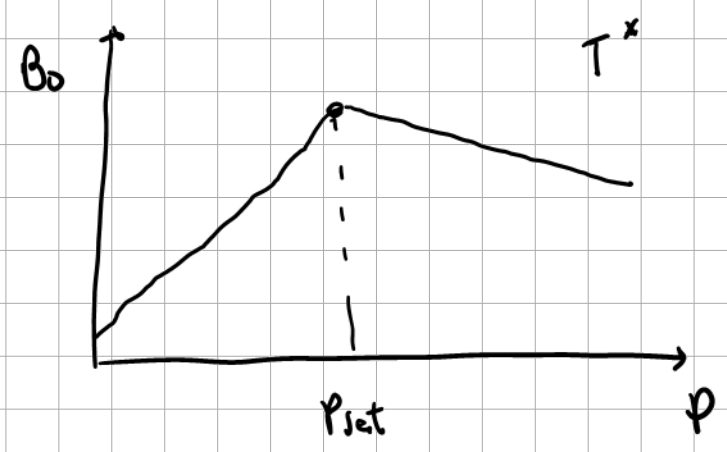
  run in two ways
  - live: flash calculation (equilibrium calculation) → property estimation
  - precompute tables and interpolate on table

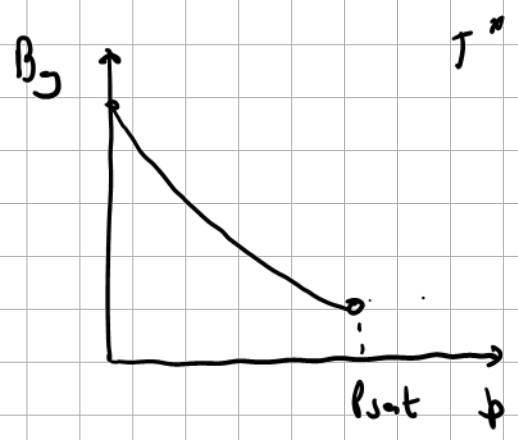
- Black oil tables generated by:
  - EOS
  - correlations
  - lab experiments

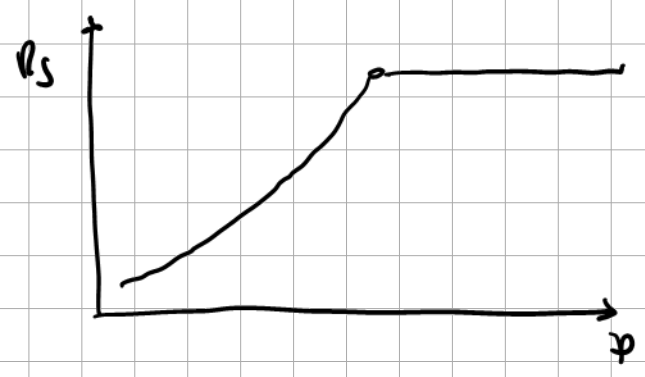


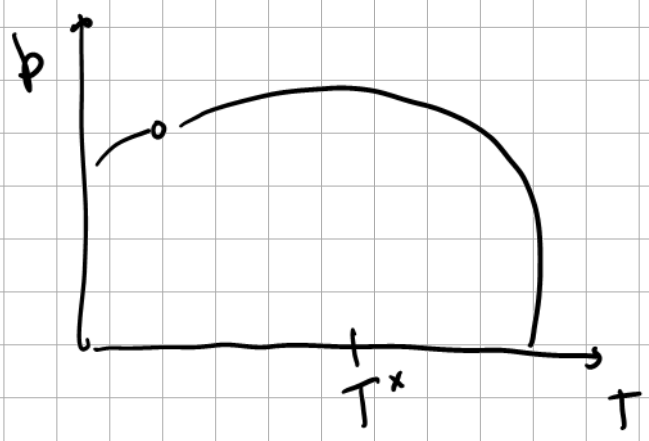
$B_o = \frac{V_o}{V_{\bar{o}o}}$ $\quad B_g = \frac{V_g}{V_{\bar{g}g}}$ $\quad R_s = \frac{V_{\bar{g}o}}{V_{\bar{o}o}}$ solution gas-oil ratio $\quad r_s\ (r_v) = \frac{V_{\bar{o}g}}{V_{\bar{g}g}}$ solution oil-gas ratio

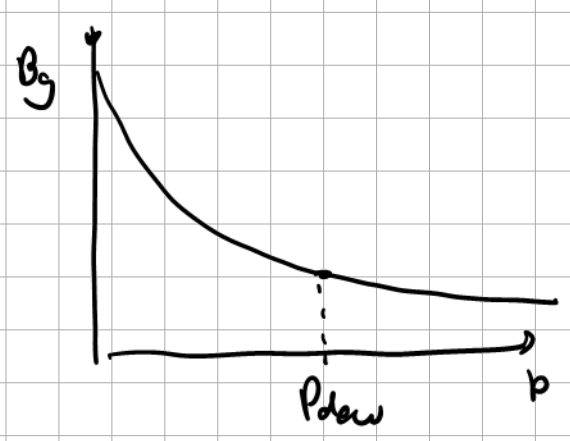


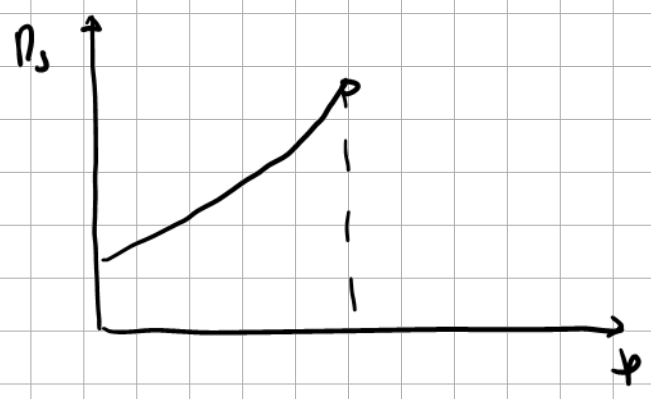












$\begin{bmatrix} q_{\bar{g}} \\ q_{\bar{o}} \\ q_{\bar{w}} \end{bmatrix} = \begin{bmatrix} \frac{1}{B_g} & \frac{R_s}{B_o} & 0 \\ \frac{r_s}{B_g} & \frac{1}{B_o} & 0 \\ 0 & 0 & \frac{1}{B_w} \end{bmatrix}_{(p,T)} \cdot \begin{bmatrix} q_g \\ q_o \\ q_w \end{bmatrix}$	$\begin{bmatrix} q_g \\ q_o \\ q_w \end{bmatrix} = \begin{bmatrix} \frac{B_g}{1 - R_s \cdot r_s} & \frac{-R_s \cdot B_g}{1 - R_s \cdot r_s} & 0 \\ \frac{-B_o \cdot r_s}{1 - R_s \cdot r_s} & \frac{B_o}{1 - R_s \cdot r_s} & 0 \\ 0 & 0 & B_w \end{bmatrix}_{(p,T)} \cdot \begin{bmatrix} q_{\bar{g}} \\ q_{\bar{o}} \\ q_{\bar{w}} \end{bmatrix}$
Standard conditions calculated from local conditions	Local conditions calculated from standard conditions

$q_{\bar{s}} = q_{\bar{s}g} + q_{\bar{s}o}$

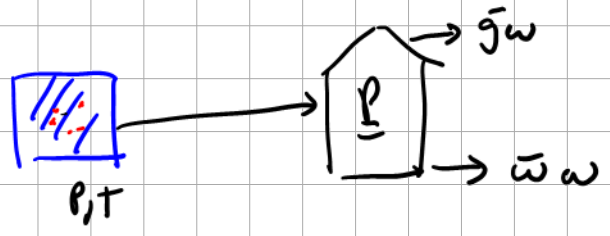
$q_{\bar{o}} = q_{\bar{o}o} + q_{\bar{o}g}$

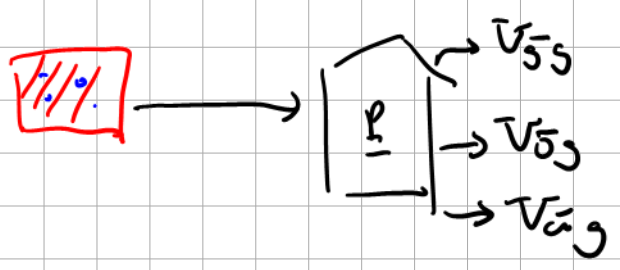
for conventional / heavy oil $r_s = 0$

not adequate for volatile oils

gas condensate

Water BO properties





$$B_w = \frac{V_w}{V_{\bar{w}w}}$$

Some cases it could be important to include surface gas from local water and surface water from local gas.