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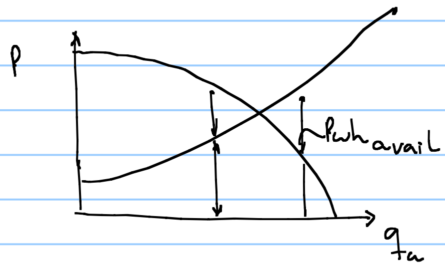
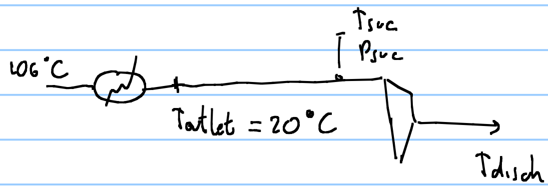


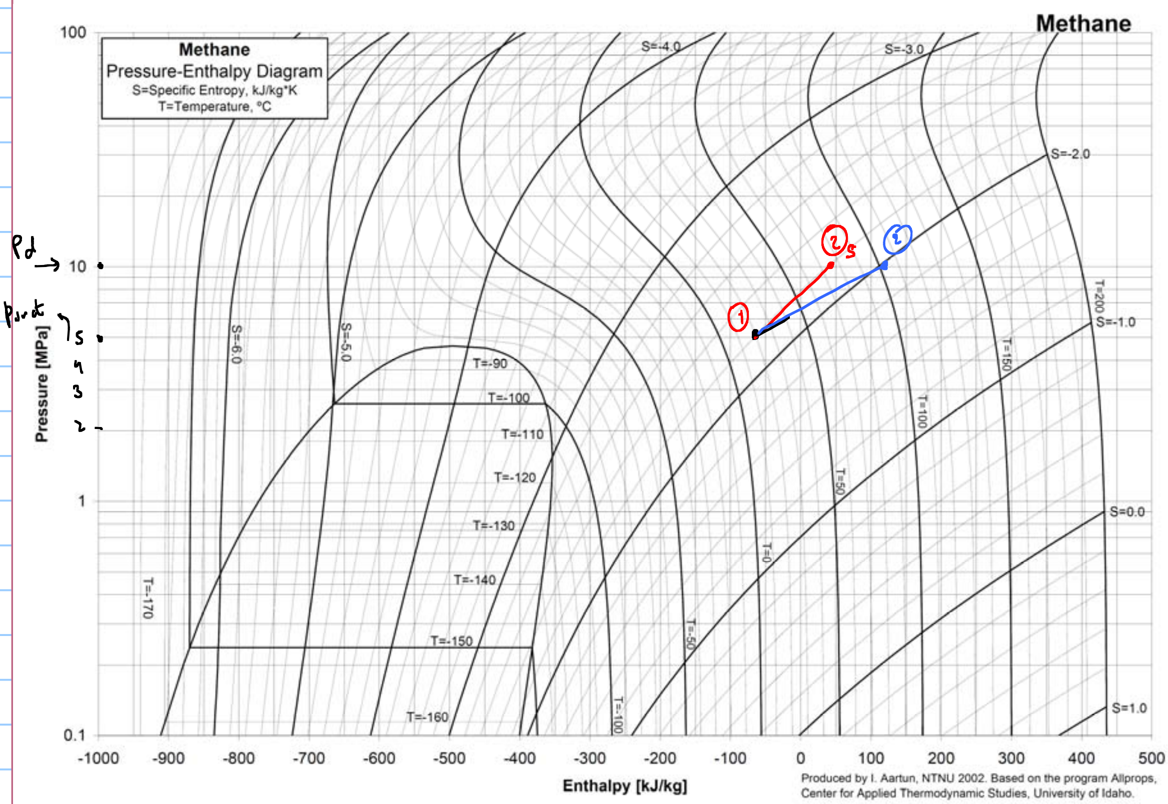
Åsgard subsea compression

$T_{wellstream} = 106\,°C$

$P_{suct} = 50$ bara

$P_{dis} = 100$ bara





ideally, the most efficient compression process is isentropic
S = const

if isentropic
$T_{disc} \simeq 75\,°C$

$P_s = \dot{m}\,(h_{2s} - h_1)$

$h_{2s} = 50$ kJ/kg

$h_1 \simeq -65$ kJ/kg

$q_g = 20$ E6 Sm³/d

$P_{sc} = 1.01325$ bara

$T_{sc} = 15.56\,°C$

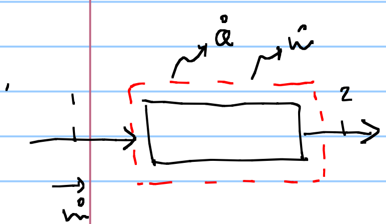
$\dot{m} = q_g \cdot \rho_{sc} =$

$\rho_{sc} \simeq 0.68$ kg/m³

$\dot{m} = 157$ kg/s

$P_{is} = 157 \cdot (115$ kJ/kg$)$

$P_{is} = 18101$ kW



$$\dot{Q} - \dot{W} = \dot{m}\,(e_2 - e_1)$$

no

$$\cancel{\dot{Q}} - \dot{W} = \dot{m}\left(h_2 + \cancel{\frac{v_2^2}{2g}} + \cancel{z_2} - h_1 - \cancel{\frac{v_1^2}{2g}} - \cancel{z_1}\right)$$

in a compressor $\quad \dot{W} = \dot{m}\,(h_2 - h_1)$

Approximate the real compression process with a polytropic compression

$$p \cdot v^n = \text{constant} \qquad n = k \qquad k = \frac{C_p}{C_v}$$

$n = k$ ↳ isentropic; methane $k = 1.3$

For a real compression process, the output temperature can be predicted by

$$\frac{T_2}{T_1} = (r_p)^{\frac{n-1}{n}} \qquad r_p = \frac{P_2}{P_1}$$

polytropic exponent

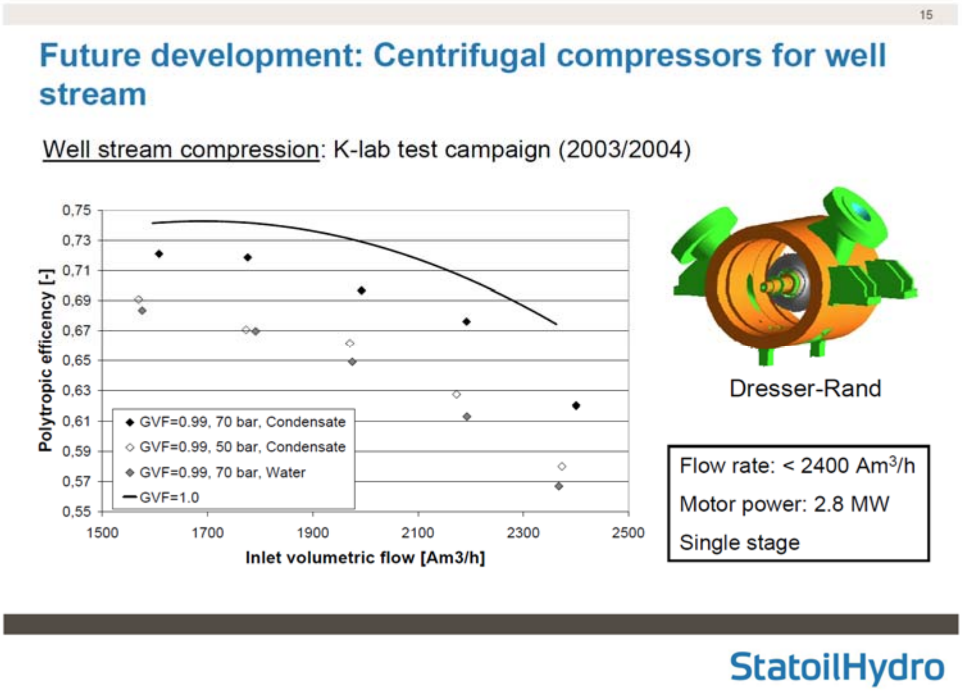
$$T_2 = T_1 \, r_p^{\frac{n-1}{n}}$$

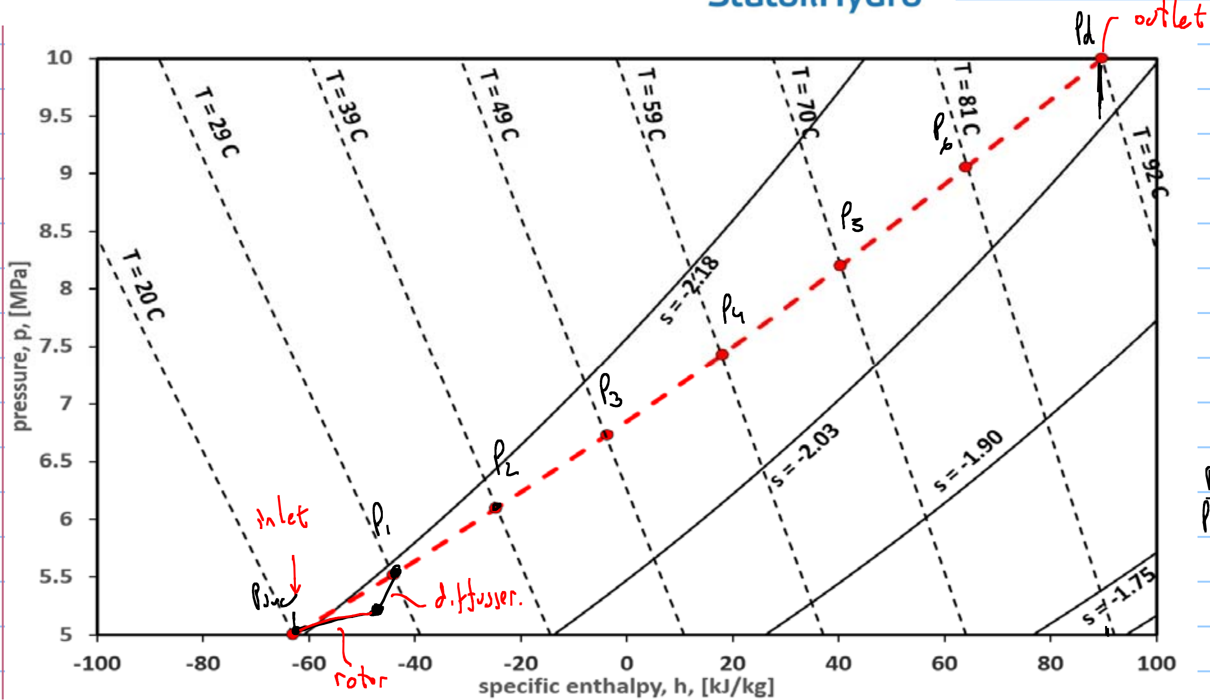
absolute [K] [°R]

for the plot $n = 1.46$

$$\eta_p = \frac{k-1}{k}\left(\frac{n}{n-1}\right)$$

$$\eta_p = 0.73$$





N_{stages} 7

assume that

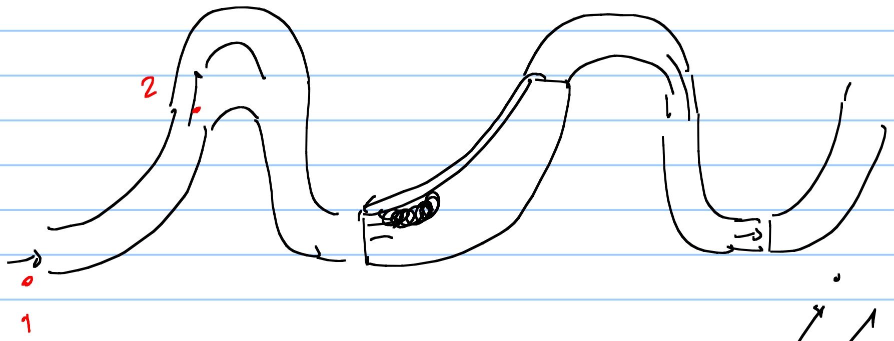
$$\eta_{p_{stage}} = \eta_{p_{compressor}}$$

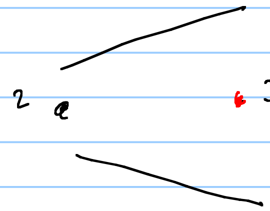
$r_{p_{stage}}$ is constant for each stage

$$\frac{P_{disc}}{P_6} \cdot \frac{P_6}{P_5} \cdot \frac{P_5}{P_4} \cdot \frac{P_4}{P_3} \cdot \frac{P_3}{P_2} \cdot \frac{P_2}{P_1} \cdot \frac{P_1}{P_{suc}}$$

$$(r_{p,stage})^N = r_{p_{compressor}}$$

$$r_{p,stage} = \sqrt[N]{r_{p_{compressor}}}$$





$$\cancel{\dot{Q}} - \cancel{\dot{W}} = \dot{m}\left(h_3 + \frac{v_3^2}{2g} - h_2 - \frac{v_2^2}{2g}\right)$$

$$Power = \frac{\dot{m}\,(\Delta h_p)}{\eta_p \cdot \eta_m} = \frac{(h_{disc\_p} - h_{suc\_p}) \cdot \dot{m}}{\eta_p \cdot \eta_m}$$

η_m: mechanical efficient (95% - 98%)

η_p: 0.6 - 0.75

$$\Delta h_p = T_{suc} \cdot Z_{av} \cdot R \cdot \frac{n}{n-1}\left(r_p^{\frac{n-1}{n}} - 1\right)$$

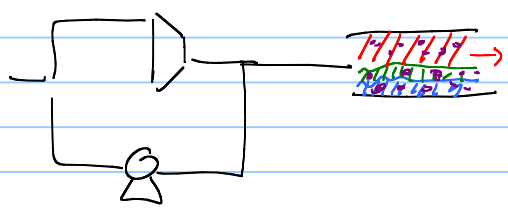
$$Z_{av} = \frac{Z_{suc} + Z_{dis}}{2}$$

$$R = \frac{R_u}{MW}$$

- Simplified method to estimate subsea compression requirements

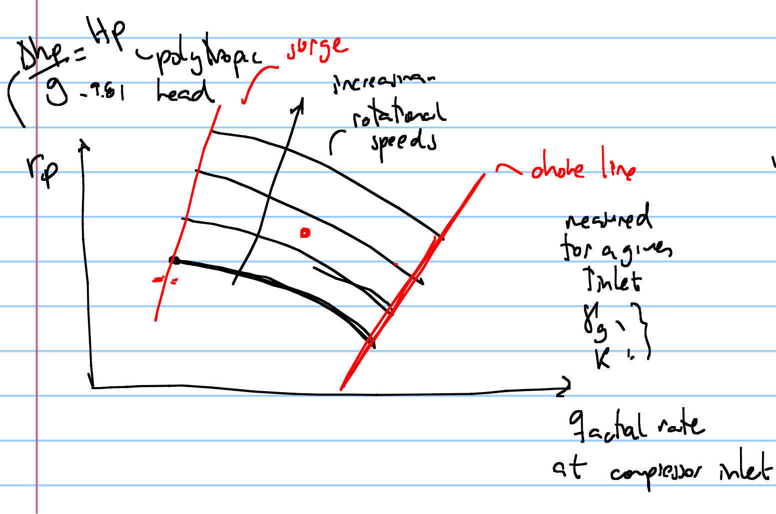
1. Limit on required compression power ≈ 11.5 MW per unit. (current)

2. Limitation in outlet temperature:
   - operating temperature of downstream pipelines < 150 °C
   - max operating temperature of compressor seals
   - max temperature to avoid vaporization of hydrate inhibitor. (MEG, TEG, MeOH)



3. minimum suction pressure. (10-20 bara)

4. if map is available → operating point must fall on the performance map. beware of choke line and surge line!



if the map is not available?

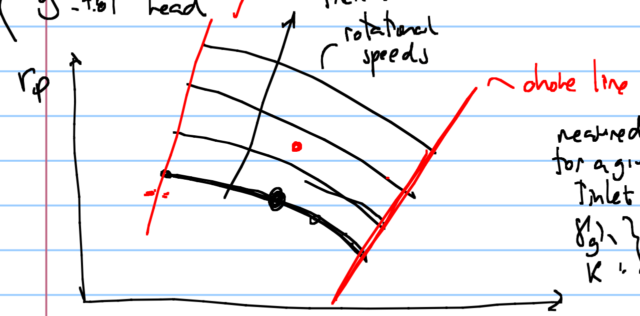
→ $r_{p_{max}} \approx 3.0$ *

$\Delta p_{max} \approx 50$ bara *

* current limitations

$\frac{\Delta h_p}{g} = H_p$ ← polytropic head

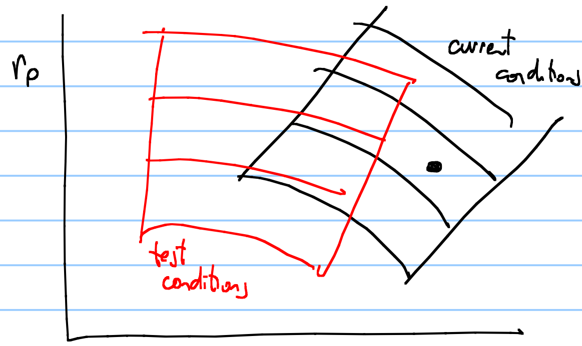
$g = 9.81$



measured for a given
Inlet 15.56°C
γ_g 1
K 1.3

q_{actual} rate at compressor inlet

for my current conditions



$T_{in} = 20°C$
$\gamma_g = 0.55$
$k = 1.3$

$$q_{current} = q_{test} \sqrt{\frac{K_{curr}}{K_{test}}} \sqrt{\frac{MW_{test}}{MW_{current}}} \sqrt{\frac{T_{current}}{T_{test}}}$$

$$H_{p,current} = H_{p_{test}} \frac{K_{current}}{K_{test}} \cdot \frac{MW_{test}}{MW_{current}} \frac{T_{current}}{T_{test}}$$