Class 20210422 : Boosting part 2

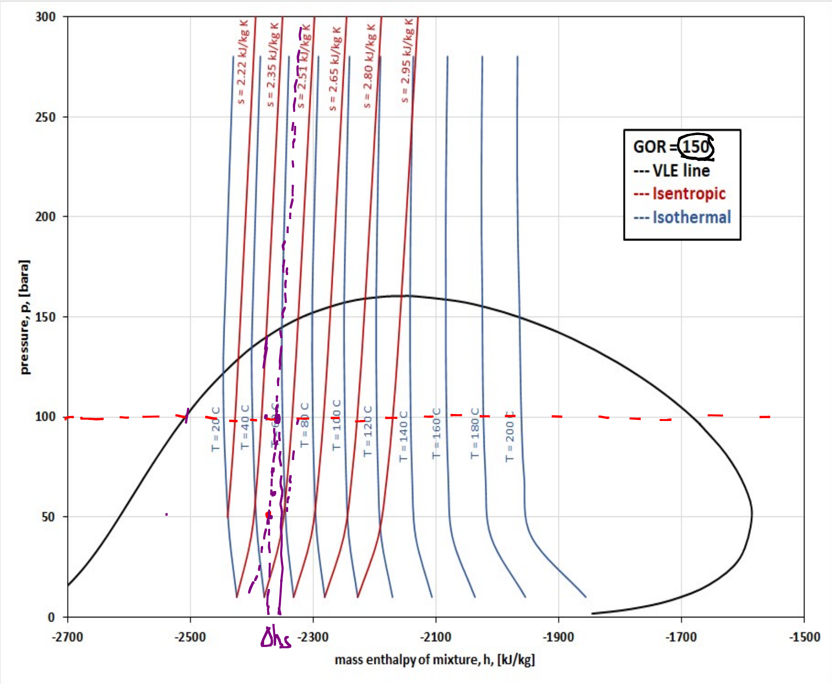
inlet: -2372.68, 50.
outlet (s): -2358.75, 99.5

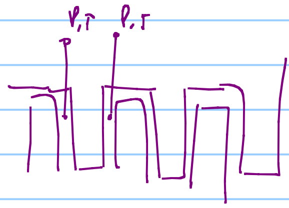
$(h_{2s} - h_1) = 14\ kJ/kg$

$P = \dot{m} \cdot \frac{\Delta h_s}{\eta_{adiab}}$

$= 7.2\ kg/s \cdot \frac{14}{0.6}$

$= 168\ kW$





$T_{out_s} \approx 57°C$

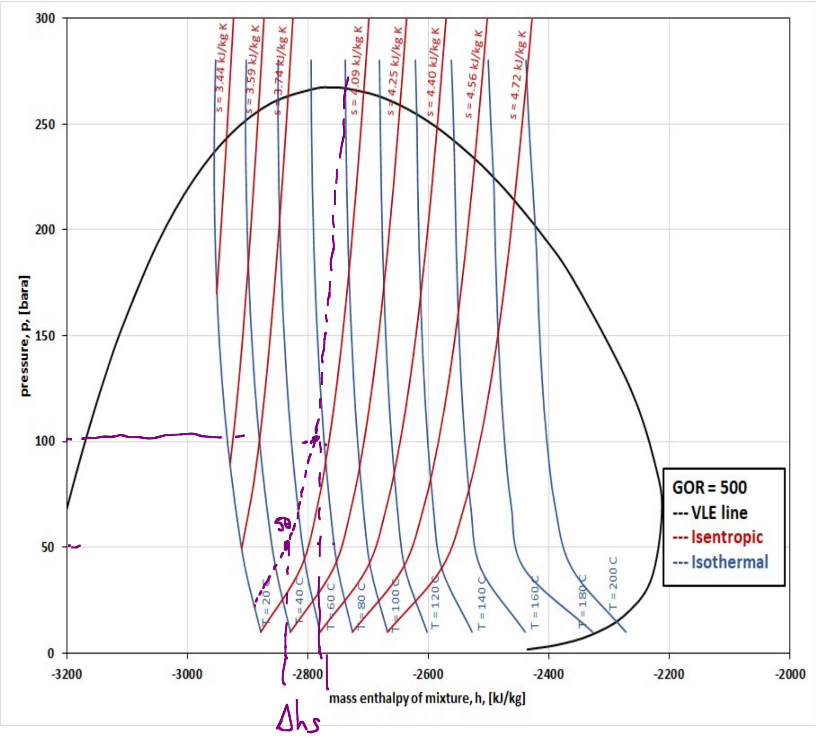
$T_{in} = 50°C$

Δh_s

inlet: -2831.8, 50.3
outlet (s): -2799.56, 99.7

$\Delta h_s \approx 31\ kJ/kg$

$P \approx 372\ kW$



$T_{out_s} = 70\ C$

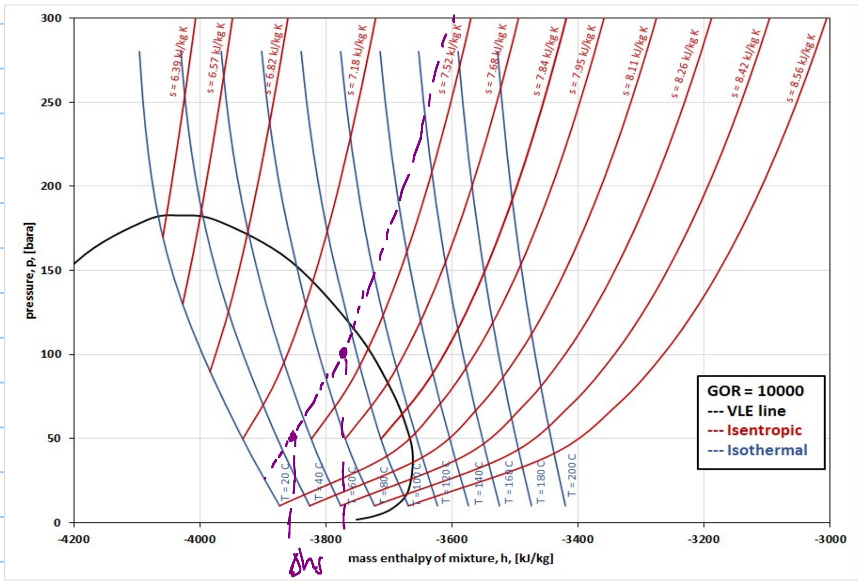
$T_{in} = 50°C$

inlet: -3853.71, 50.7
outlet (s): -3774.67, 99.5

$\Delta h_s \approx 79\ kJ/kg$

$P = \frac{7.2 \cdot 79}{0.6}$

$P = 948\ kW$



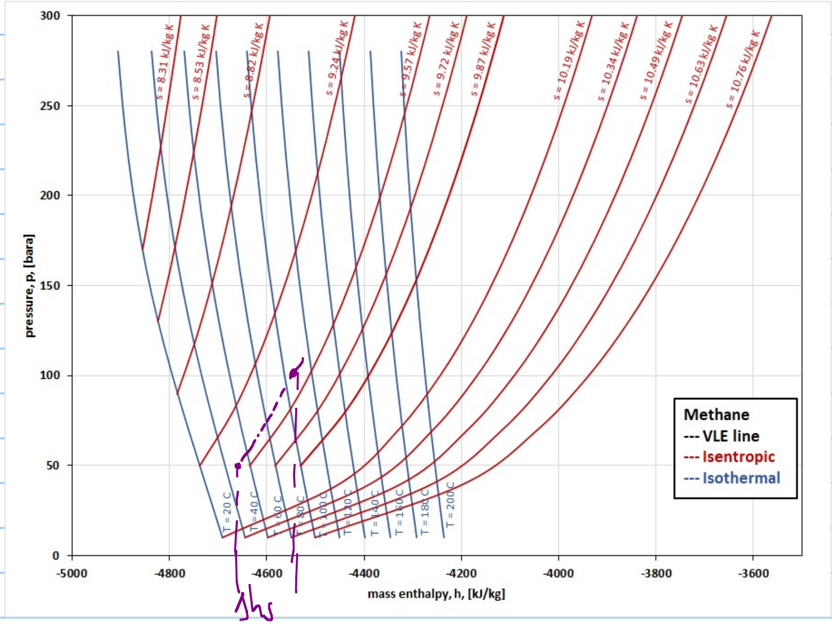
$T_{out_s} \approx 93°C$

$T_{in} = 50°C$

inlet: -4661.43, 50.7
outlet (s): -4544.75, 99.5

$\Delta h_s = 117$ kJ/kg

$P = 1404$ kW



$T_{out,s} = 105$ °C

$T_{in} = 50$ °C

Power required to compress 7.2 kg/s of the fluid from 50 bara, 50 °C to 100 bara, assuming an adiabatic efficiency of 0.6, and for different fluids:

fluid	P (kW)	$T_{out,s}$	q_o	q_g
Dead oil	77	51	50000 stb/d	0
GOR = 150	167	57		
GOR = 500	372	75		
GOR = 10000	948	93		
methane	1404	105		

$\rho_o = 800$ kg/m³

$\rho_g = 0.8$ kg/m³

$\dot{m} = q_o \cdot \rho_o + q_g \cdot \rho_g$

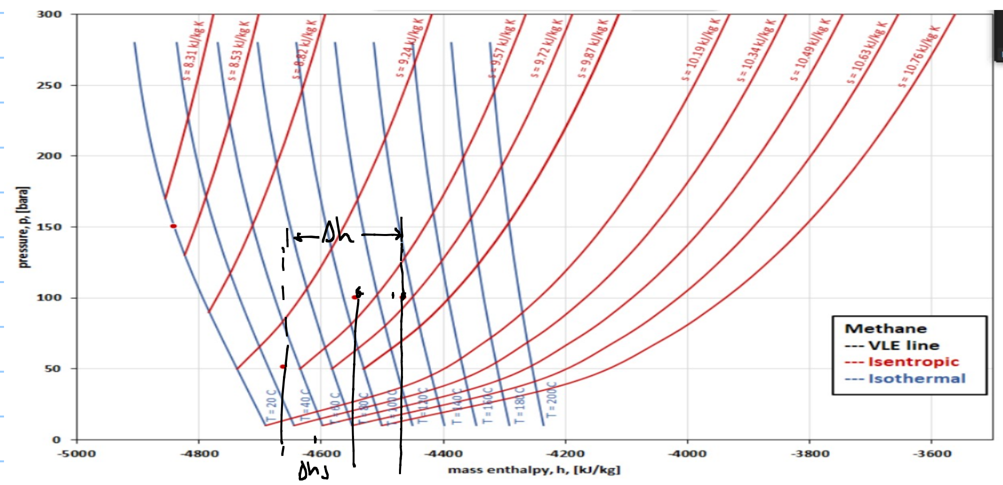
$GOR = \frac{q_g}{q_o}$

$\dot{m} = q_o \rho_o + q_o GOR \cdot \rho_g$

$\dot{m} = q_o (\rho_o + GOR\, \rho_g)$

$7.2 = q_o (800 + GOR \cdot 0.8)$

500
150
10000



$\Delta h_r = \frac{\Delta h_s}{0.6}$

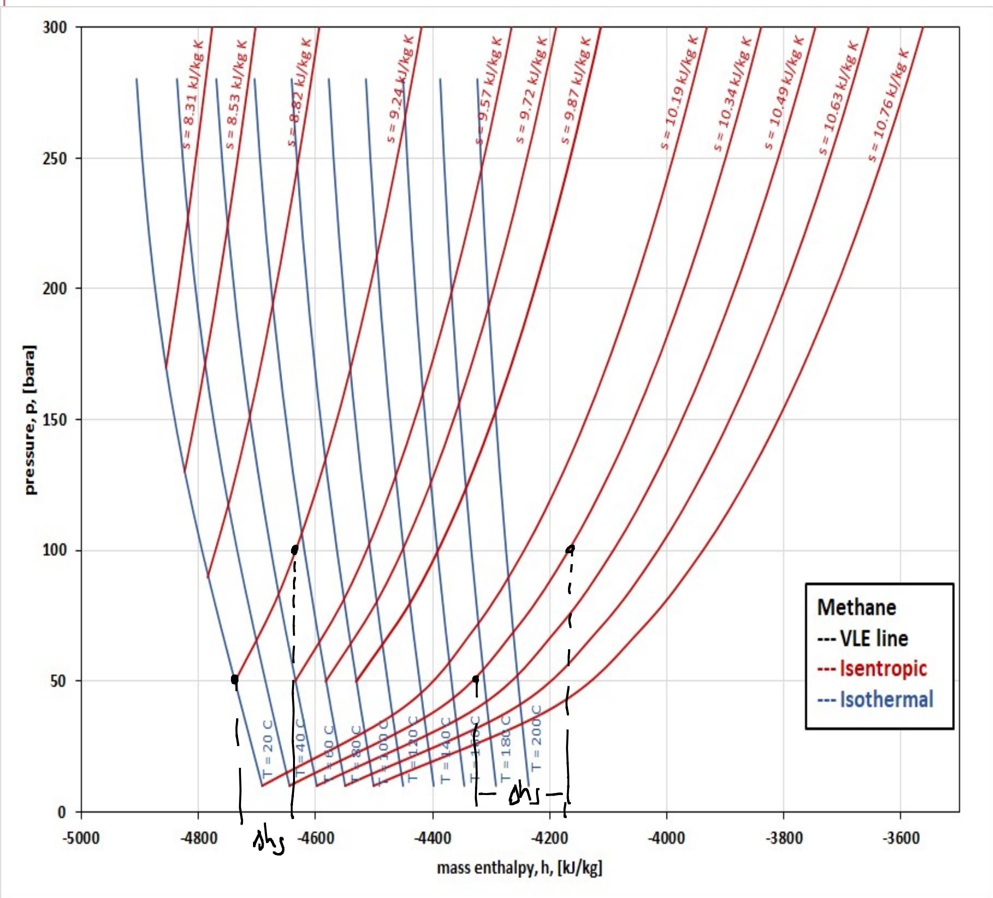
$\Delta h = (\Delta h_s) \cdot 1.66$

$T_{out} \approx 135$ °C

η_{adiab} 0.6 [-]

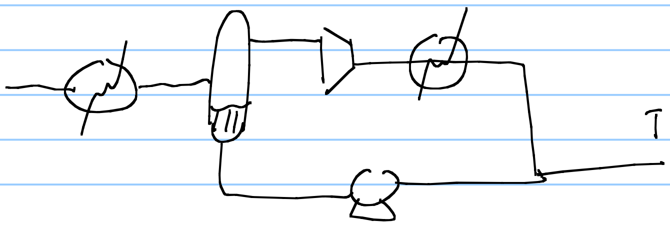
Power [kW]	$T_{out,s}$ [C]	Δh_s [kJ/kg]	Δh [kJ/kg]	h_{in} [kJ/kg]	h_{out} [kJ/kg]	T_{out} [C]
77	51	6.4	11	-2087.9	-2077.2	51
168	57	14.0	23	-2372.7	-2349.4	60
372	70	31.0	52	-2831.8	-2780.1	78
948	93	79.0	132	-3853.7	-3722.0	110
1404	105	117.0	195	-4661.4	-4466.4	135

- $T_{out,s}$, Δh_s: read from chart
- Δh: calculate from $\Delta h = \Delta h_s / \eta$
- h_{in}: read from charts
- h_{out}: calculate $h_{out} = h_{in} + \Delta h$
- T_{out}: read from chart with $P_{out} = 100$ bara, h_{out}



Compression at lower inlet temperatures require a smaller Δh_s

Therefore, to avoid high outlet temperatures and reduce compression power, coolers are sometimes installed upstream and downstream the compressor (Example Aasgard



T < 120°C

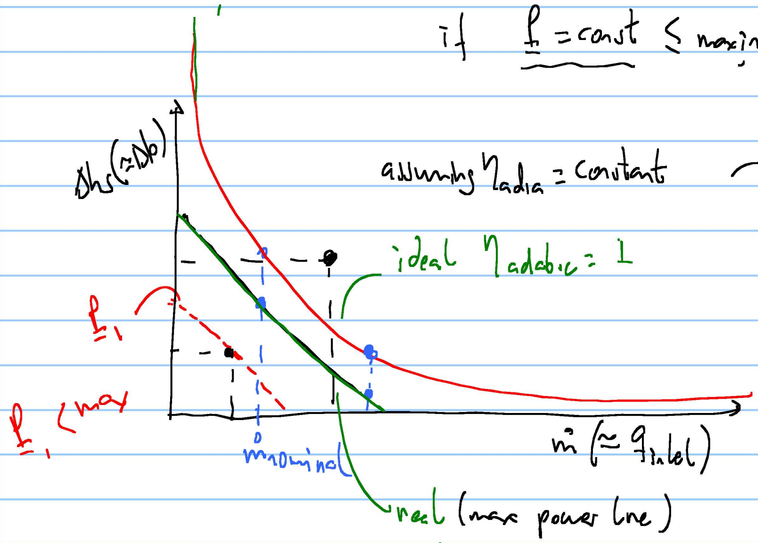
Performance map of boosters

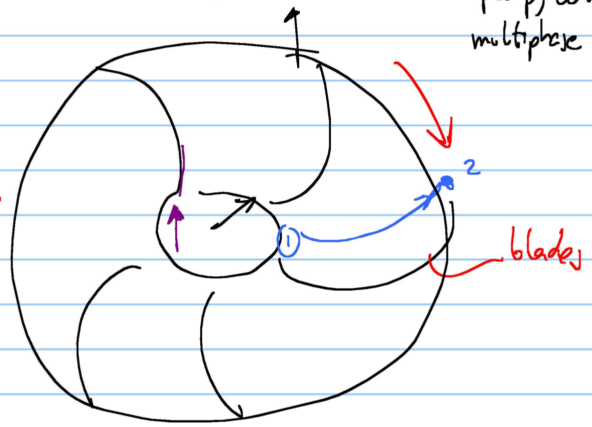
- $q_1, \Delta p_1$ (should fall inside the performance map of the booster)
- $q_2, \Delta p_2$
- $q_3, \Delta p_3$
- ⋮

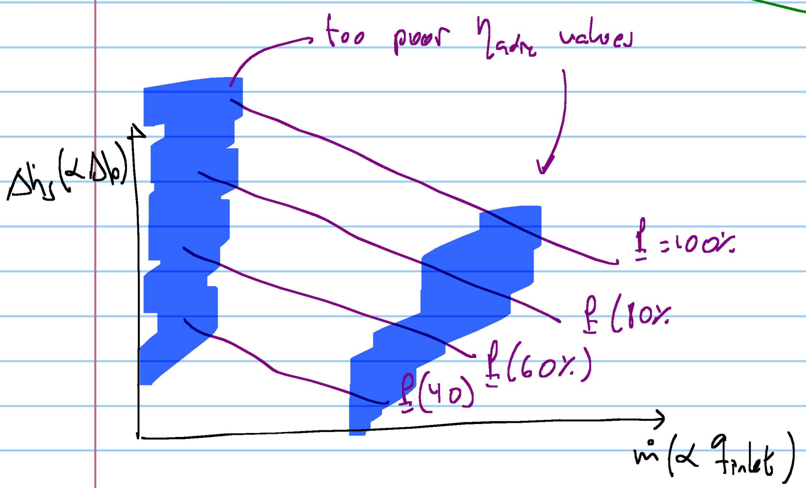
$$P = \dot{m} \frac{\Delta h_s}{\eta_{adia}} \quad (\dot{m} \sim q_{inlet}) \quad \sim \propto \Delta p$$

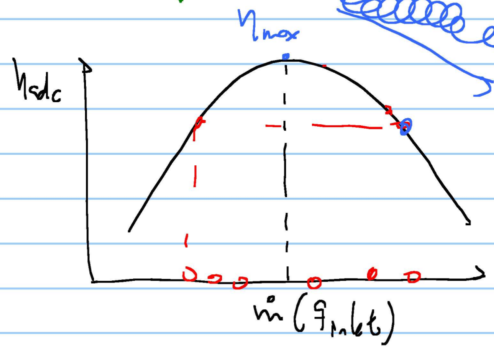
if P = const ≤ maximum capacity

assuming η_{adia} = constant → rotor-dynamic machines → centrifugal, axial pump, compressor multiphase boosters



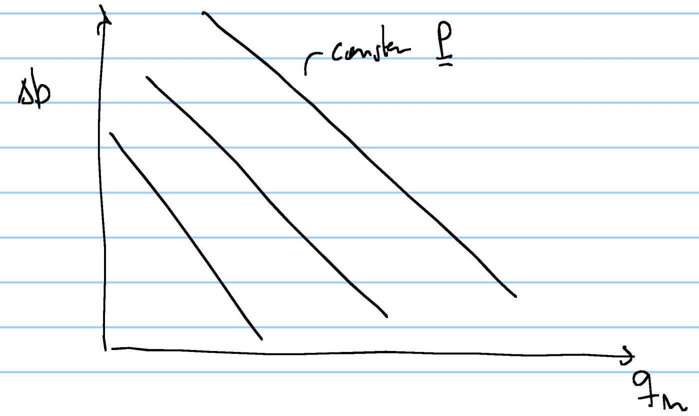




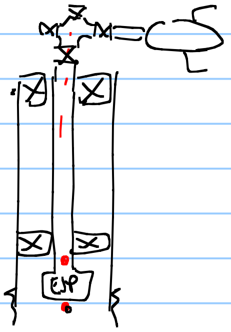


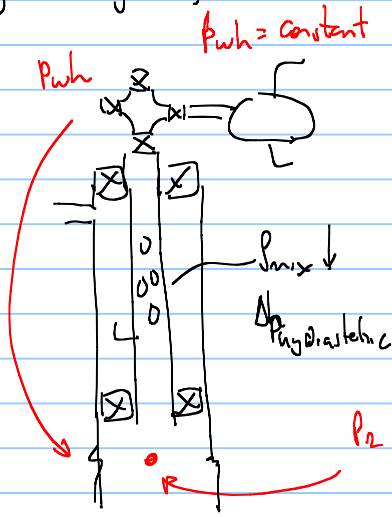
$\eta_{adiabatic} = f(\dot{m})$

for a liquid pump $\Delta h_s = \frac{\Delta p}{\rho}$ $\quad \dot{m} = q_{in} \cdot \rho_{in} = q_{in} \cdot \rho$



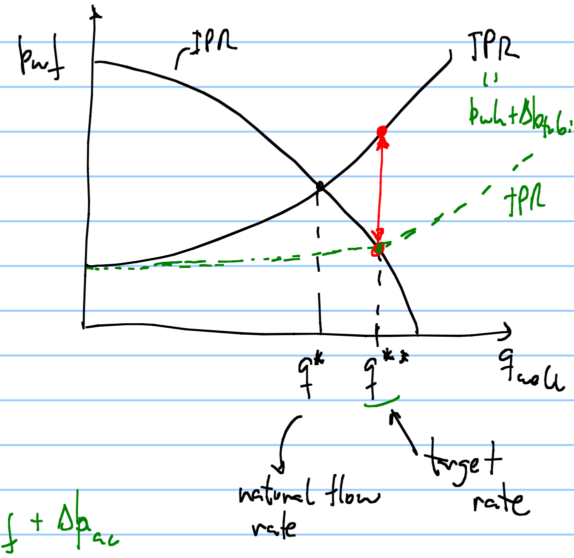
difference between boosting and gas lift





without any artifical lift

Bottomhole equilibrium



$p_{wf} = p_{wh} + \Delta p_{tubing}$

$p_{wf} = p_{wh} + \Delta p_h + \Delta p_f + \Delta p_{ac}$

Δp_h ↓ Δp_f ↑ $v = \frac{q}{A} = \frac{q_o + q_g}{A}$, $q_g = q_{g,res} + q_{g,gas\ lift}$

in gas lift $\Delta p_f \uparrow << \Delta p_h \downarrow$