Januar 1992 opg 4

Niels Skovmand - M5

Kølemiddel: **NH_3**

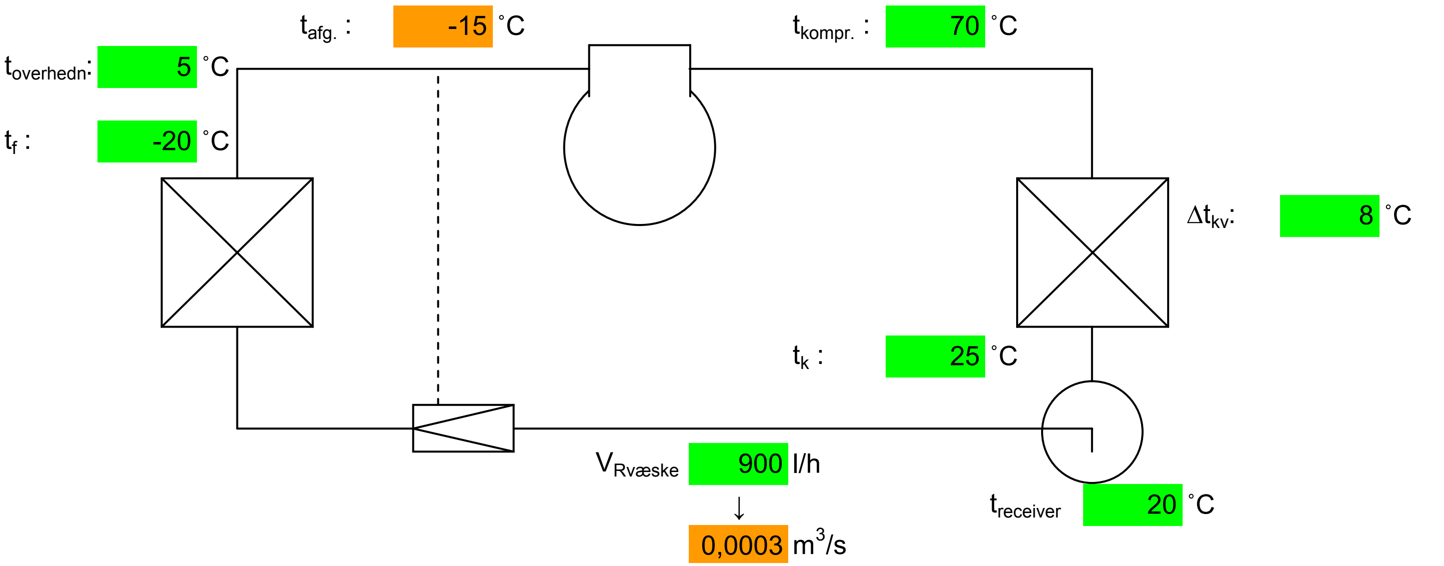
Kompressor: (vandkølede kompressorcylindre)

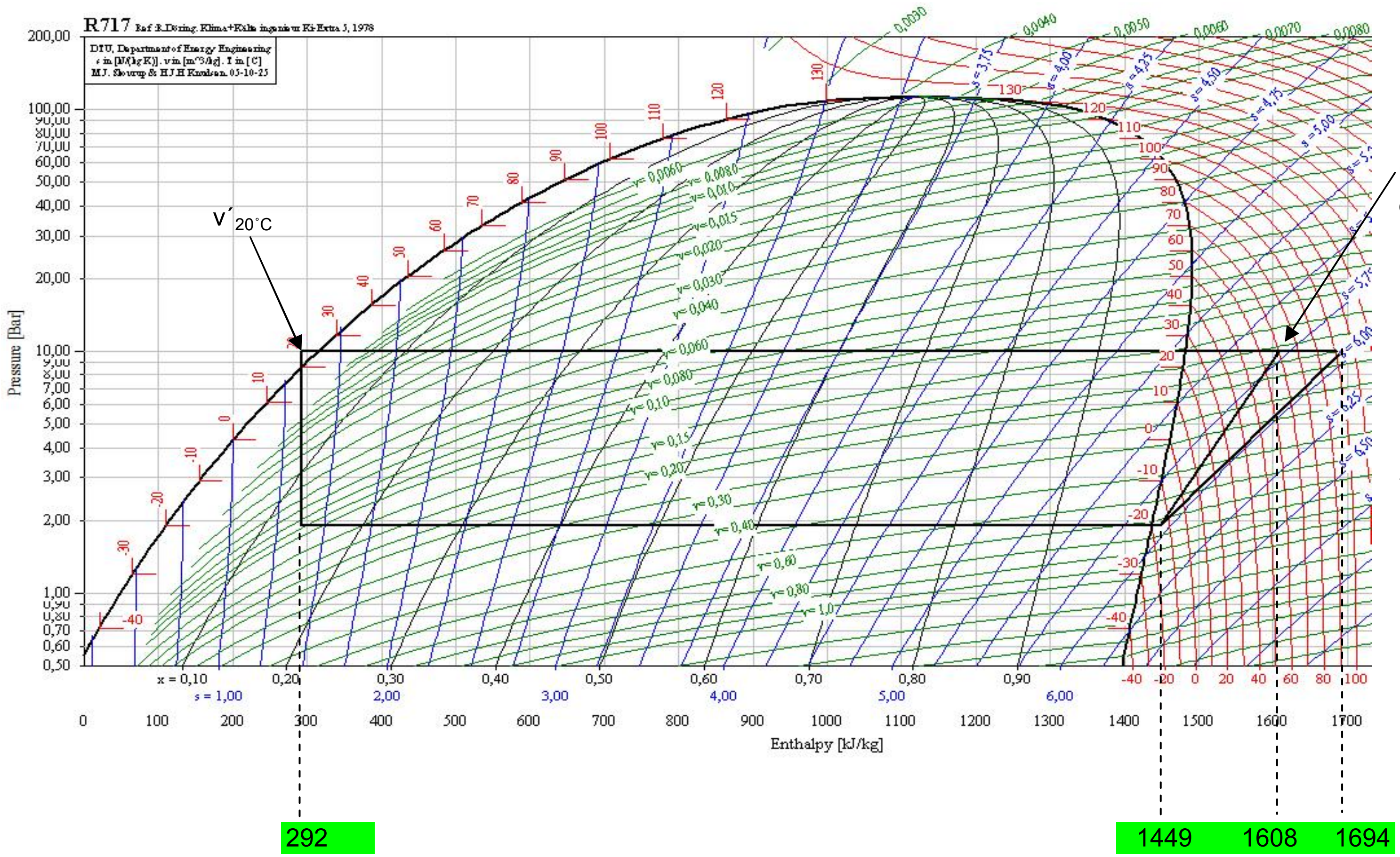
η_{mek} 0,91

$P_{tilført}$ 52 kW

$m_{kv, komp}$ 2500 kg/h → 0,6944 kg/s

c_{kv} : 4,19 kJ/kg





V_{sug}: 0,637 m^3/kg

Δh_f :	1449	-	292	=	1156,3	kJ/kg
Δh_k :	1608	-	292	=	1315,3	kJ/kg
Δh_{Rkom}	1608	-	1449	=	159	kJ/kg
Δh_{is} :	1694	-	1449	=	245,23	kJ/kg
$\Delta h_{i, tab}$:	1694	-	1608	=	86,23	kJ/kg

$v´_{20°C}$ = 1,639 l/kg (tabel for væske = 0,0016 m^3/kg

4.1 Beregn anlæggets kuldeydelse, Q_f, angivet i kW

$$P_i = \eta_{mek} \cdot P_{tilført} = 0{,}91 \cdot 52 = 47{,}32 \text{ kW}$$

$$P_{tab} = P_{tilført} - P_i = 52 - 47{,}32 = 4{,}68 \text{ kW}$$

$$m_R = \frac{V_{Rvæske}}{v'_{20^\circ C}} = \frac{0{,}0003}{0{,}0016} = 0{,}1525 \text{ kg/s}$$

$$\mathbf{Q_f} = m_R \cdot \Delta h_f = 0{,}1525 \cdot 1156{,}3 = \mathbf{176{,}38 \text{ kW}}$$

4.2 Beregn kølevandsmængden gennem kondensatoren, angivet i kg/h

For kondensatoren gælder:

$$Q_k = m_R \cdot \Delta h_k = m_{kv} \cdot c_{kv} \cdot \Delta t_{kv}$$

$$\mathbf{m_{kv,\,kon}} = \frac{m_R \cdot \Delta h_k}{c_{kv} \cdot \Delta t_{kv}} = \frac{0{,}1525 \cdot 1315{,}3}{4{,}19 \cdot 8} = 5{,}99 \text{ kg/s}$$

$$= \mathbf{21547 \text{ kg/h}}$$

(kondensator)

4.3 Beregn kompressorens indicerede virkningsgrad (den isentropiske virkningsgrad)

$$P_{is} = m_R \cdot \Delta h_{is} = 0{,}1525 \cdot 245{,}23 = 37{,}40 \text{ kW}$$

$$\mathbf{\eta_{is}} = \frac{P_{is}}{P_i} = \frac{37{,}40}{47{,}32} = \mathbf{0{,}79}$$

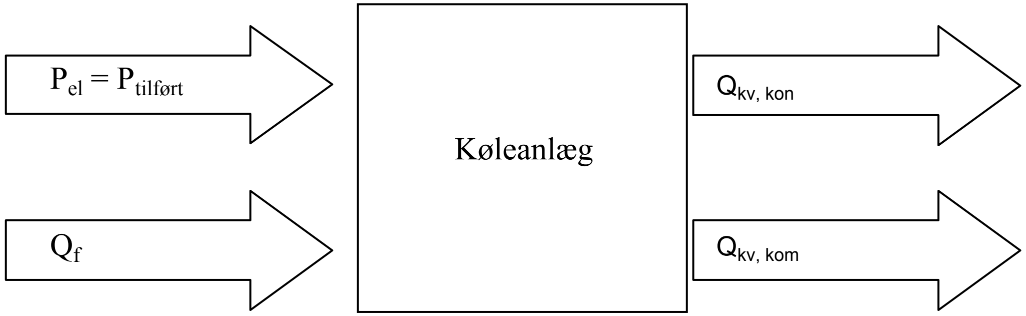
4.4 Beregn kølevandets temperaturstigning gennem cylindrenes kølekapper

$$P_{tilført,\ komp} = Q_{R,\ kom} \cdot Q_{kv,\ kom} = Q_{R,\ kom} + m_{kv,\ kom} \cdot c_{kv} \cdot \Delta t_{kv,\ kom}$$

$$Q_{R,\ kom} = m_R \cdot \Delta h_{Rkom} = 0{,}1525 \cdot 159 = 24{,}25\ \text{kW}$$

$$\Delta t_{kv,\ kom} = \frac{P_{tilført,\ kor} - Q_{R,\ kom}}{m_{kv,\ kom} \cdot c_{kv}} = \frac{52 - 24{,}25}{0{,}6944 \cdot 4{,}19} = 9{,}5\ ^{\circ}\text{C}$$

4.5 Opstil en varmebalance for køleanlægget



Energi tilført:			
$P_{tilført}$	=	52	kW
Q_f	=	176,38	kW
I alt	**=**	**228,38**	**kW**

Energi bortledt:			
$Q_{kv,\ kon}$	=	200,63	kW
$Q_{kv,\ kom}$	=	27,748	kW
I alt	**=**	**228,38**	**kW**

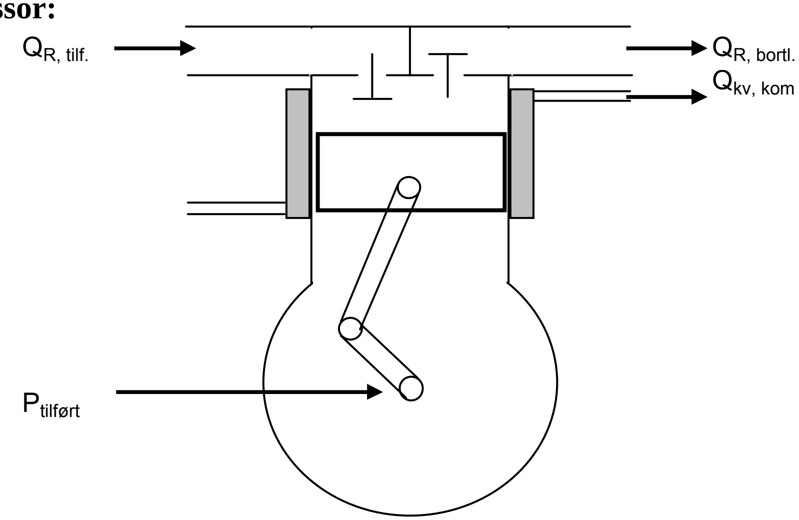
$$\sim \quad m_{kv,\ kon} \cdot c_{kv} \cdot \Delta t_{kv,\ kon} = 5{,}99 \cdot 4{,}19 \cdot 8$$

$$\sim \quad m_{kv,\ kom} \cdot c_{kv} \cdot \Delta t_{kv,\ kom} = 0{,}69 \cdot 4{,}19 \cdot 9{,}5$$

Bonus opgave

Varmebalance for kompressor:

Varme ind		
$Q_{R,\ tilf.}$	220,94	kW
$P_{tilført}$	52	kW
I alt ind:	272,94	kW



Varme ud		
$Q_{R,\ bortl.}$	245,20	kW
$Q_{kv,\ kom}$	27,748	kW
I alt ud:	272,94	kW

$Q_{R,\ tilf.} = m_R \cdot h_{tilgang} = 0{,}1525 \cdot 1449 = $ **220,94 kW**

$Q_{R,\ bortl.} = m_R \cdot h_{afgang} = 0{,}1525 \cdot 1608 = $ **245,20 kW**