- EXERCISE n° 01 -

An impulse vapor turbine expands the fluid from the feeding conditions p_o = 100 bar, T_o = 450 °C, to the discharge conditions p_2 = 10 bar, T_2 = 200 °C, being negligible the kinetic energy change through the whole machine.
…Calculate the isentropic efficiency ($\eta_{is,t}$)
…Moreover, calculate the volume relative (or percent) change, which the vapor undergoes to, along the actual expansion process.
Results:
.$\eta_{is,t} \cong 0.762$, PC(v) ≅ 685.7 %

- EXERCISE n° 02 -

A vapor reaction turbine has the feeding conditions p_o = 120 bar, T_o = 500 °C and the isentropic efficiency $\eta_{is,t} = 0.90$. At the machine outlet, a saturated vapor mass flow rate is discharged.
…Find out the corresponding discharge pressure and temperature.
…Moreover, find the discharge "steam-to-liquid" ratio, which would be obtained if the expansion were isentropic.
Results:
.$p_{dsc} \cong 7.4$ [bar] , $T_{dsc} \cong$ … [°C] , x ≅ 0.955

- EXERCISE n° 03 -

An axial turbine has the kinematic reaction index KDR = 0.5. The velocity triangles are symmetrical, with the angle $\alpha_1 = 30°$, and show their configuration for maximum efficiency. The FDL coefficients are $\varphi = 0.95$, $\psi = 0.90$ and the kinetic energy change through the whole machine is quite negligible.
…Calculate the isentropic reaction index IDR (or χ).
Results:
.IDR ≅ 0.534

- EXERCISE n° 04 -

A single stage vapor turbine (centripetal hybrid flow, with radial inlet and axial outlet) has the inlet diameter d_1 = 25 cm and rotation speed n = 30'000 rpm.
The feeding conditions are: p_o = 10 bar, T_o = 380 °C, S_o = entropy per unit mass. The discharge conditions are: p_2 = 3 bar, while the entropy per unit mass (S_2) is 2.5% lower than "S_o".
…Explain why the machine cannot be considered adiabatic and tell whether the fluid receives or loses heat.
…Draw a sketch of the velocity triangles with $u_1 = 0.75 \cdot C_{u1}$, $C_{u2} = 0$, $C_2 = C_o$ (*distributor inlet*).
…Calculate the exchanged heat amount.
Results:
.$Q < 0$, $|Q| > L_w$, $Q \cong -192.383$ [kJ/kg]

- EXERCISE n° 05 -

Let's consider the following velocity triangles of a centripetal turbine:
Al the runner inlet: $C_{m1} = U_2$, $C_{u1} = 4 \cdot U_2$
At the runner outlet: $C_{m2} = 2 \cdot U_2$, $C_{u2} = - U_2$
From inlet to outlet $U_2 = U_1/3$.
…Draw a sketch of the velocity triangles
…Calculate the kinematic reaction index (KDR) with $C_{m1} = C_o$ (*distributor inlet*).
Results:
.KDR ≅ 0.538

- EXERCISE n° 06 -

A Curtiss wheel with two bladed crowns on the runner disc shows the following design and working characteristics:
$\alpha_1 = 15°$, $C_{m1} = 100$ m/s, $\sigma = U_1/C_1 = 0.2$, $\varphi' = \varphi = 0.95$, $\psi' = \psi = 0.90$.
…Calculate the indicated work contribution of each individual bladed crown and the whole indicated work of the machine, according to the following cases:
A) symmetrical second distributor, with $\alpha_3 = 180° - \alpha_2$
B) asymmetrical second distributor, with $\alpha_3 = \alpha_1$.
Results:
.$L_{i,I} \cong 43.449$ [kJ/kg] , A: $L_{i,II} \cong 15.025$ [kJ/kg] , $L_{i,tot} \cong 58.474$ [kJ/kg] ,
.$L_{i,I} \cong 43.449$ [kJ/kg] , B: $L_{i,II} \cong 16.868$ [kJ/kg] , $L_{i,tot} \cong 60.314$ [kJ/kg]

- EXERCISE n° 07 -

An adiabatic gas turbine expands air from the feeding conditions $p_o = 7$ bar, $T_o = 1300$ K to the discharge pressure $p_s = p_a = 1$ bar (*atmospheric pressure*), with polytropic efficiency $\eta_{yt} = 0.87$, being negligible the kinetic energy change through the whole machine.
…Calculate the corresponding isentropic efficiency ($\eta_{is,t}$) and discharge temperature (T_s)
…Moreover, calculate the following energy quantities per unit mass: the indicated work (L_{it}), the isentropic work ($L_{is,t}$), the FDL wasted work (L_w), the equivalent energy head ($g \cdot H_t$), the thermal recovery amount (RC).
Results:
.$\eta_{is,t} \cong 0.89921 \cong 0.899 \cong 0.90$, $T_S \cong 801.449$ [K] , $L_{it} \cong 501.143$ [kJ/kg] , $L_{is,t} \cong 557.316$ [kJ/kg] , $L_{wt} \cong 74.883$ [kJ/kg] , $g \cdot H_t \cong 576.027$ [kJ/kg] , RC ≅ 18.711 [kJ/kg] .

- EXERCISE n° 08 -

A reaction gas turbine expands the fluid from the feeding conditions p_o = 9 bar, T_o = 1400 K to the discharge pressure $p_s = p_a$ = 1 bar (*atmospheric pressure*). Along the expansion a given heat amount is transferred to the gas in a gradual and continuous way, such to obtain a resulting constant-temperature process (*that is: "isothermic"*).
The FDL (L_{wt}) are 13% of the equivalent energy head ($g \cdot H_t$), while the kinetic energy change through the whole machine can be considered quite negligible.
… Calculate the heat supply per unit mass (Q) and the corresponding indicated work per unit mass (L_{it}).
Use: k' = 1.37, R' = 292 J/(kg·K)
Results:
.Q ≅ 781.456 [kJ/kg] , L_{it} ≅ 781.456 [kJ/kg] , (Q = L_{it}) .

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