Université de Jijel
Faculté de technologie
Département génie mécanique
1er année Master

Solution de TD 01

Exercice 01 :

T_{01}=292K, P_{01}= 1bar, η_s=0.85, γ=1.4

1- Calcul la température finale :

$\frac{P_{02}}{P_{02}} = \left(\frac{T_{02S}}{T_{01}}\right)^{\frac{\gamma}{\gamma-1}} \Rightarrow T_{02S} = T_{01}\left(\frac{P_{02}}{P_{01}}\right)^{\frac{\gamma-1}{\gamma}}$ =555.92K

$$T_{02S} = 555.92K$$

$$\eta_s = \frac{T_{02S}-T_{01}}{T_{02}-T_{01}} \Rightarrow T_{02} = T_{01} + \frac{T_{02S}-T_{01}}{\eta_s}$$

A.N. $T_{02} = 602.49K$

Calcule le travail de la compression à la sortie :

$$w = Cp(T_{02}-T_{01}) = 1005(602.49 - 292) = 312kJ/kg$$

$$w = 312kJ/kg$$

Exercice 02 :

$$R_s = 1.22,\ T_{01} = 288K,\quad \Delta T_{0S} = 21K$$

1- Calcule le rendement isentropique

$$R_s = \left(1 + \frac{\eta_s \Delta T_{0S}}{T_{01}}\right)^{\frac{\gamma}{\gamma-1}} \Rightarrow \eta_s = \frac{T_{01}}{\Delta T_{0S}}\left(R_s^{\frac{\gamma-1}{\gamma}} - 1\right)$$

$$\eta_s = 0.8026$$

$$U = \frac{\pi DN}{60} \Rightarrow D = \frac{60.200}{\pi(45000)}$$

$$D = 0.42m$$

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Exercice 03 :

$D_{sup} = 0.95m, \quad D_{inf} = 0.85m, \quad \alpha_1 = 28°, \quad \beta_1 = 56°, \alpha_2 = 56°, \quad \beta_2 = 28°,$

$$N = \frac{5000tr}{m}, \qquad \rho = 1.2kg/m^3$$

1- La viresse de rotor :

$$U = \frac{\pi DN}{60} = \frac{\pi 0.95.5000}{60} = 249\text{m/s}$$

$$\text{U} = 249\text{m/s}$$

2- La vitesse axiale :

$$\frac{U}{Ca} = tg\alpha_1 + tg\beta_1 \;\Rightarrow\; Ca = \frac{U}{tg\alpha_1 + tg\beta_1} = 123.6m/s$$

$$Ca = 123.6m/s$$

3- Le débit massique :

$$\dot{m} = A\rho Ca = \pi({D_{sup}}^2 - {D_{inf}}^2)/4\rho Ca$$

$$\dot{m} = \frac{\pi(0.95^2 - 0.85^2}{4\ (1{,}2)\ (123.6)} = 20.98kg/s$$

$$\dot{m} = 20.98kg/s$$

4- Le travail echangé :

$$W = UCa\ (tg\ \beta 1 - tg\ \beta 2) \;\Rightarrow\; W = 29.86kJ/kg$$

5- La puissance:

$$P = \dot{m}W = 614kW$$

6- Les angles au diamètre inferieur:

A l'entrée : $C_{W1} = Ca\ tg\alpha_1 = 123.6tg28 = 65.72m/s$

On à aussi : $C_{Wi}r_i = cst \;\Rightarrow\; C_{W1inf}r_{inf} = C_{W1sup}r_{sup}$

$$C_{W1inf} = C_{W1sup}\frac{r_{sup}}{r_{inf}} = \frac{(65.72)(0.475)}{0.425} = 73.45m/s$$

Donc : $C_{W1inf} = 73.45m/s$

A la sortie :

$$C_{W2sup} = Ca\ tg\alpha_2 = 183.24tg56 = 183.24m/s$$

On à aussi : $C_{W2inf} = C_{W2sup}\frac{r_{sup}}{r_{inf}} = \frac{(183.24)(0.475)}{0.425} = 204.8m/s$

Donc : $C_{W2inf} = 204.8m/s$

Finalement :

$$tg\alpha_1 = \frac{C_{W1inf}}{Ca} = \frac{73.45}{123.6} \Rightarrow \alpha_1 = 30.72°$$

$$tg\beta_1 = \frac{u_{inf}}{Ca} - tg\alpha_1 = \frac{223}{123.6} - tg30.72 \Rightarrow \beta_1 = 50.43°$$

$$tg\alpha_2 = \frac{C_{W2inf}}{Ca} = \frac{204}{123.6} \Rightarrow \alpha_2 = 58.69°$$

$$tg\beta_2 = \frac{u_{inf}}{Ca} - tg\alpha_2 = \frac{2.4}{123.6} - tg8.69 \Rightarrow \beta_1 = 8.73°$$

7- Le degré de réaction :

$$R = \frac{Ca}{2\ U}\ (tg\ \beta1 + tg\ \beta2) = \frac{123.6}{2\ (223)}\ (tg\ 50.43 + tg\ 8.73)$$

$$R = 37.61\%$$

Exercice 04 :

1- Les angles au diamètre moyen :

$$\Delta T_{0S} = (T_{02} - T_{01}) = \frac{\lambda UCa}{Cp}(tg\ \beta1 - tg\ \beta2) \Rightarrow 24 = \frac{(0.93)(205)(155.5)}{1005}\ (tg\ \beta1 - tg\ \beta2)$$

Où :

$$tg\ \beta1 - tg\ \beta2 = 0.814 \ldots\ldots\ldots (1)$$

D'autre coté :

$$R = \frac{Ca}{2\ U}\ (tg\ \beta1 + \ tg\ \beta2) \Rightarrow tg\ \beta1 + \ tg\ \beta2 = \frac{(0.5)2(205)}{155.5}$$

Où:

$$tg\ \beta1 + \ tg\ \beta2 = 1.318 \ldots\ldots (2)$$

De (1) et (2) on trouve $\beta1 = 46.83 = \alpha_2\ et\quad \beta2 = 14.14 = \alpha_1$

2- Le diamètre moyen :

$$r = \frac{U}{2\pi N} = \frac{205}{2\pi 152} = 0.215$$

Donc ; $Dm = 0.430m$

3- La surface de l'écoulement :

$$\dot{m} = A\rho Ca \Rightarrow A = \frac{\dot{m}}{\rho Ca}$$

$$\rho = \frac{P1}{RT1}$$

$T1 = T01 - C_1^2/2Cp$,

C1=Ca/Cosα_1=155.5/Cos14.14= 160.31m/s

Donc: $T1 = \ 290 - \frac{16.31^2}{2(1005)} = 277.21K.$

De plus:

$$\frac{P_1}{P_{01}} = \left(\frac{T_1}{T_{01}}\right)^{\frac{\gamma}{\gamma-1}} \Rightarrow P_1 = 1\left(\frac{277.21}{290}\right)^{3.5} = 0.854bar$$

$$\rho = \frac{P1}{RT1} = \frac{(0.854)\ 10^5}{287\ (277.21)} = 1.073kg/m^3$$

Donc

$$A = \frac{22}{1.73\ (155.5)} = 0.132$$

$$A = 0.132m^2$$

Exercice 05 :

1- Les angles :

$$\mathrm{R} = 0.5 \Rightarrow \beta 1 = \alpha_2 \; et \quad \beta 2 = \alpha_1$$

$$\cos \alpha_1 = \frac{Ca}{C1} = \frac{180}{185} = 0.973 \Rightarrow = \alpha_1 = \beta 2 = 13.35°$$

$$C_{W1} = \sqrt{C1^2 - Ca^2} = \sqrt{1851^2 - 180^2} = 42.72 m/s$$

$$tg\beta_1 = \frac{U}{Ca} - tg\alpha_1 = 0.874 \Rightarrow = \beta_1 = \alpha 2 = 41.15°$$

2- La température statique :

$$T1 = T01 - \frac{C1^2}{2Cp} = 290 - \frac{185^2}{2\,(1005)} = 273K$$

3- Le rapport de pression :

$$R_s = \left(1 + \frac{\eta_s \Delta T_{0S}}{T_{01}}\right)^{\frac{\gamma}{\gamma - 1}}$$

$$\Delta T_{0S} = \frac{\lambda UCa}{Cp}(tg\ \beta 1 - \ tg\ \beta 2) = \frac{0.85(200)(180)}{1005}(0.874 - \ 0.237)$$

$$\Delta T_{0S} = 19.62K$$

$$R_s = \left(1 + \frac{0.86(19.62)}{290}\right)^{3.5} = 1.22$$

Exercice 06 :

$$\mathrm{R} = 0.5 \Rightarrow \beta 1 = \alpha_2 \; et \quad \beta 2 = \alpha_1$$

$$et \quad \beta 2 = \alpha_1 = 30°, \ \beta 1 = !!$$

$$\cos \beta 1 = \frac{Ca}{V1}, \quad V1 = !!!$$

$$\mathrm{R} = 0.5 \Rightarrow \mathrm{V}1 = C_2$$

$C2^2 = Ca^2 + (U - V2x)^2 \Rightarrow V1 = C_2 = \sqrt{Ca^2 + (U - V2x)^2}$, $V2x = !!!$

$$tg\ \beta 2 = \frac{V2x}{Ca} \Rightarrow V2x = 158tg30 = 91.22m/s$$

donc:

$V1 = C_2 = \sqrt{158^2 + (245 - 91.22)^2} = 220.48m/s$

$$\cos \beta 1 = \frac{Ca}{V1} = \frac{185}{220.48} = 0.716 \Rightarrow \beta 1 = \alpha_2 = 44.23°$$

$$\Delta T_{0S} = \frac{\lambda UCa}{Cp}(tg\ \beta 1 - tg\ \beta 2) = \frac{(245)\ 185}{1005p}(tg\ 44.23 - tg\ 30) = 15.21K$$

$$R_T = \left(1 + \frac{N\Delta T_{0S}}{T_{01}}\right)^{\frac{n}{n-1}}$$

On à $\frac{n}{n-1} = \eta_s \frac{\gamma}{\gamma-1} = 3.05$

$$4.5 = \left(1 + \frac{N15.21}{290}\right)^{3.05} \Rightarrow N = 12$$

Donc N=12 étage