"Turbo Project"
"Zhaoyi Jiang"

H_0=2.6[m]
Q=2.45[m^3/s]
eta_p=0.95
psi=0.97
g=9.81[m/s^2]

"Procedure"
"Asume alpha is 70"
H=eta_p*H_0
c_1th=(2*g*H)^0.5
c1=psi*c_1th
alpha_1=60[degree]
u1/c1=0.5***sin**(alpha_1)

"Choose D as 1.4m for now"
D1=1.4[m]
N=60[s]*u1/(pi*1[min]*D1)
N_c=N*Q^0.5/(H^0.75)
D2=2*D1/3
cu1=c1***sin**(alpha_1)
cr1=c1***cos**(alpha_1)
wu1=cu1-u1
wr1=cr1
w1=(wr1^2+wu1^2)^0.5
beta_1=**arctan**(wu1/wr1)

w2=0.98*w1
u2=pi*D2*N*1[min]/60[s]
c2=(u2^2+w2^2)^0.5
alpha_2=**arctan**(w2/u2)
beta_2=0[degree]

c3=c2
w3=w2
u3=u2
alpha_3=alpha_2
beta_2=beta_3

u4=u1
w4=0.98*w3
beta_4=beta_1
wu4=w4***sin**(beta_4)
wr4=w4***cos**(beta_4)
cu4=u4-wu4
cr4=wr4
c4=(cu4^2+cr4^2)^0.5
alpha_4=**arctan**(cu4/cr4)

"Power"
We=u4*c4***sin**(alpha_4)
W=u1*c1***sin**(alpha_1)-We
W_dot=1000[kg/m^3]*Q*W
W_dot_id=1000[kg/m^3]*g*Q*H
eta_h=W/(g*H)

"Dimension of Rotor and Distributor"
"Assume lambda is 60 degrees"
z=24
theta_b=360[degree]/z

lambda=60/180*pi
Q=cr1*(D1*pi/6*B-z*0.002[m]/6*B)
Q=B*s_0*c1

SOLUTION

Unit Settings: SI C kPa kJ mass deg

α_1 = 60 [Degree]
α_2 = 65.99 [degree]
α_3 = 65.99 [degree]
α_4 = 2.045 [degree]
B = 1.001 [m]
β_1 = 40.89 [degree]
β_2 = 0 [Degree]
β_3 = 0 [degree]
β_4 = 40.89 [degree]
c1 = 6.753 [m/s]
c2 = 4.792 [m/s]
c3 = 4.792 [m/s]
c4 = 3.245 [m/s]
cr1 = 3.376 [m/s]
cr4 = 3.243 [m/s]
cu1 = 5.848 [m/s]
cu4 = 0.1158 [m/s]
c_{1th} = 6.961 [m/s]
D1 = 1.4 [m]
D2 = 0.9333 [m]
η_h = 0.6917
η_p = 0.95
g = 9.81 [m/s^2]
H = 2.47 [m]
H_0 = 2.6 [m]
λ = 1.047 [rad]
N = 39.89 [1/min]
N_c = 31.69 [$m^{0.75}/(min*s^{0.5})$]
ψ = 0.97
Q = 2.45 [m^3/s]
s_0 = 0.3625 [m]
θ_b = 15 [degree]
u1 = 2.924 [m/s]
u2 = 1.949 [m/s]
u3 = 1.949 [m/s]
u4 = 2.924 [m/s]
W = 16.76 [J/kg]
w1 = 4.466 [m/s]
w2 = 4.377 [m/s]
w3 = 4.377 [m/s]
w4 = 4.29 [m/s]
We = 0.3386 [m^2/s^2]
wr1 = 3.376 [m/s]
wr4 = 3.243 [m/s]
wu1 = 2.924 [m/s]
wu4 = 2.808 [m/s]
$\dot{W}$ = 41063 [w]
$\dot{W}_{id}$ = 59365 [w]
z = 24

No unit problems were detected.