Required	5kw	6.71	HJ	5000						
Pressure ratio		4:1								
Inlet Pressure Pa	2116200	21.162	bar				6894.757		306.9288736	psia
Inlet Temp C	70	158	F	617.67 R			343.15	K		
Cp	0.24	Btu/lbm	87	J/(kgK)	0.285714286					
γ	1.4				0.333333333			4		
Rgas	53.34	ft-lbf/lbm-sec	287.04	J/kgK	0.730599956					
isentropic overall enthalpy drop										
Δh isentropic	39.9360781	Btu/lbm			$\Delta h_{isentropic} = C_p \cdot T_o \cdot (1-(\frac{1}{3})^{\frac{\gamma-1}{\gamma}})$				9763.764177	J/Kg
kasutegur	0.85									
tip clearance loss	5	%	0.95							
Actual enthalpy drop										
ΔhOa	33.9456664	Btu/lbm			$\Delta h_{OA} = 0{,}85 \cdot \Delta h_{isentropic}$				8299.199551	J/Kg
zero-clearance work										
ΔhOazc	35.7322804	Btu/lbm			$\Delta h_{OAZC} = \frac{0{,}85}{0{,}95} \cdot \Delta h_{isentropi}$				8735.999527	J/Kg
required turbine flow					0.7069	Btu/sec/hp				
m	0.13973209	lbm/sec	$\dot{m} = \frac{P}{\Delta h_{OA}}$						0.60246774	kg/s
tip speed of the turbine					32.174	ft*lbm/lbf*sec2				
Co	1414.11486	ft/sec	$C_0 = \sqrt{2 \cdot \Delta h_{isentropic}}$		778.16	ft*lbf/Btu			139.740933	m/s
blade jet speed ratio		eq 42	$\frac{U_1}{C_0} = 0{,}7$							
U1/Co	0.7	optimum value								
wheel speed										
U1	989.880399	ft/sec			$U_1 = 0{,}7 \cdot C_0$				97.8186531	m/s
rotor inlet absolute tangential velocity component										

VΘ1 903.757614 ft/sec

$$V_{\Theta 1} = \frac{\Delta h_{OAZC}}{U_1}$$

89.30811507 m/s

required rotor blade count

Zr 22.9876543

$$Z_r = \frac{2}{1-(\frac{V_{\Theta 1}}{U_1})}$$

22.98765432

we use 11 full and 11 splitter blades

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recalculate absolute rotor inlet tangential velocity to the wheel speed

0.90909091

$$\frac{V_{\Theta 1}}{U_1} = 1 - \frac{2}{22}$$

0.909090909

required wheel speed

U1 992.004608 ft/sec

$$U_1 = \sqrt{\frac{\Delta h_{OAZC}}{V_{\Theta 1}/U_1}}$$

98.02856461 m/s

recalculate blade-jet ratio

0.70150215

$$\frac{U_1}{C_o}$$

0.701502148

absolute tangential velocity at rotor inlet

VΘ1 901.822371 ft/sec

$$V_{\Theta 1} = \frac{V_{\Theta 1}}{U_1} \cdot U_1$$

89.11687692 m/s

Inlet critical velocity

αcrl 1112.06631 ft/sec

$$\alpha_{cr1} = \sqrt{\frac{2 \cdot \gamma}{1+\gamma} \cdot R_{gas} \cdot T_o}$$

338.9897816 m/s

V1 1036 v1 105

Rotor inlet density

ρ1 0.1278 lbm/ft3

$$\rho_1 = \frac{\rho_1'}{R_{gas} \cdot T_0} \cdot \left[1 - \frac{\gamma - 1}{\gamma + 1} \cdot \left(\frac{V_1}{\alpha_{cr1}} \right)^2 \right]^{\frac{1}{\gamma - 1}}$$

2381348.281 kg/m3

for the rotor exit vector diagram, we assume an exit flow coefficent φ2 is 0,3

exit axial velocity

Vx2 297.601382 ft/sec

$$V_{x2} = \varphi_2 \cdot U_1$$

29.40856938 m/s

to calculate rotor exit pressure, we need to know the critical Mach number at the exit

rotor exit total temperature

T2 468.785498 R

$$T_2 = T_0 - \frac{\Delta h_{OAZC}}{C_p}$$

242.7362123 F

rotor exit critical velocity

αcr2 1838.19154 ft/sec

$$\alpha_{cr2} = \sqrt{\frac{2 \cdot \gamma}{1+\gamma} \cdot R_{gas} \cdot T_2}$$

285.1096329 m/s

static total pressure ratio at rotor exit is calculated from the gas dynamics reaction

p2/pprim2	0.98479339		$\frac{p_2}{p_2'} = \left[1-\frac{\gamma-1}{\gamma+1}\cdot\left(\frac{V_2}{\alpha_{cr2}}\right)^2\right]^{\frac{\gamma}{\gamma-1}}$	0.99380733	

with the diffuser recovery assumed to be 0,4, rotor exit total pressure

p_2'	103.251689	psia	$p_2' = \frac{p_{dis}}{R_p\cdot\left(1-p_2/p_2'\right)+p_2/p_2'}$	531023.0704	Pa

rotor exit density

ρ2	0.97505014	lbm/ft3	$\rho_2 = \frac{\rho_2'}{R_{gas}\cdot T_0}\cdot\left[1-\frac{\gamma-1}{\gamma+1}\cdot\left(\frac{V_2}{\alpha_{cr2}}\right)^2\right]^{\frac{1}{\gamma-1}}$	5.357832848	kg/m3

rotor exit volumetric flow

Q2	0.1433076	ft3/sec	$Q_2 = \frac{\dot{m}}{\rho_2}$	0.112446162	m3/s

required rotor exit flow area

A2	2076.6616	in2	$A_2 = \frac{\rho_2\cdot V_{x2}}{\dot{m}}$	261.5346657	m2

correct head

Δh* isentropic	39.6520767	Btu/lbm	$\Delta h^*_{isentropic} = C_p\cdot T_o\cdot\left(1-\left(\frac{\rho_2}{44{,}1}\right)^{\frac{\gamma-1}{\gamma}}\right)$	29102.45487	J/kg

rotational speed

ω	49847.8656	rad/sec	$\omega = \frac{N_s\cdot\Delta h^{*\,3/4}_{isentropic}}{\sqrt{Q_2}}$ Ns 0.6	3986.815613	rad/s

rotor inlet tip radius

r1	0.23880772	in	$r_1 = \frac{U_1}{\omega}$	8.851747029	m

rotor inlet blade height h1

vr1 125

h1	0.39168206	in	$h_1 = \frac{\dot{m}}{\rho_1\cdot V_{r1}\cdot 2\Pi\cdot r_1}$	3.64093E-11	m

rotor exit hub and tip radius

rrms2	0.13267096	in	$r_{rms2} = \frac{r_1}{1{,}8}$ $\frac{r_1}{r_{rms2}} = 1{,}8$ ving Rodg	4.917637238	m
rh2	#NUM!	in	$r_{h2} = \sqrt{r_{rms2}^{2} - \frac{A_2^{2}}{\Pi}}$	#NUM!	m
rt2	828.678202	in	$r_{t2} = \sqrt{r_{rms2}^{2} + \frac{A_2^{2}}{\Pi}}$	147.6744531	m