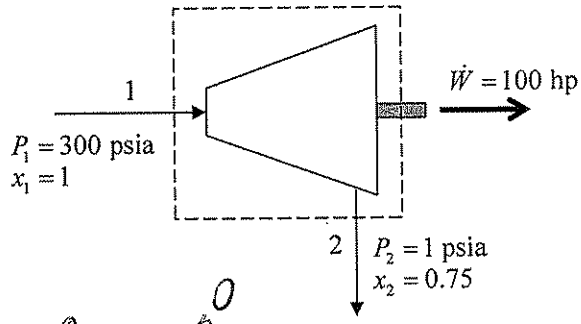
44. Mercury enters the steady flow, steady state, adiabatic turbine of a starship warp drive system as a saturated vapor at 300. psia and exits the turbine with a quality of 75.0% at 1.00 psia. Determine

a. The mass flow rate of mercury required to produce 100. hp of turbine output power.

b. The inlet flow area if the inlet velocity is 1.00 ft/s.



$$\dot{Q} - \dot{W} + \dot{m}_1\left(h_1 + \frac{V_1^2}{2g_c} + \frac{g}{g_c}z_1\right) - \dot{m}_2\left(h_2 + \frac{V_2^2}{2g_c} + \frac{g}{g_c}z_2\right) = \frac{dE_S}{dt}$$

ADIABATIC $\Delta KE \approx 0$ $\Delta PE \approx 0$ STEADY STATE

$$\dot{W} = \dot{m}(h_1 - h_2)$$

$$\dot{m} = \rho_1 A_1 V_1 = \frac{A_1 V_1}{v_1}$$

$h_1 = h_g @ 300\,psi = 157.7\ BTU/lbm$

$h_2 = h_f + x_2 h_{fg} = 13.96 + .75(126.72)$ ($@1\,psia$)

$h_2 = 109\ BTU/lbm$

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"Problem 6.44"

"Station #1"
P[1] = 300[psia]
x[1] = 1
h[1] = 157.7[Btu/lbm]
rho[1] = (1/.276)[lbm/ft^3]
V[1]=1.00[ft/s]
mdot[1] = rho[1]*A[1]*V[1]

"Station #2"
P[2]=1[psia]
x[2] = .75
h2f = 13.959[Btu/lbm]
h2fg = 126.724[Btu/lbm]
h[2] = h2f + x[2]*h2fg
mdot[2]=mdot[1]

"1st Law"
wdot = 100[hp]
wdot = mdot[1]*(h[1]-h[2])*convert(Btu/s,hp)
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SOLUTION

Unit Settings: Eng F psia mass deg

h2f = 13.96 [Btu/lbm] h2fg = 126.7 [Btu/lbm] wdot = 100 [hp]

No unit problems were detected.

Arrays Table: Main

	A_i [ft^2]	h_i [Btu/lbm]	$mdot_i$ [lbm/s]	P_i [psia]	ρ_i [lbm/ft^3]	V_i [ft/s]	x_i
1	0.4006	157.7	1.451	300	3.623	1	1
2		109	1.451	1			0.75