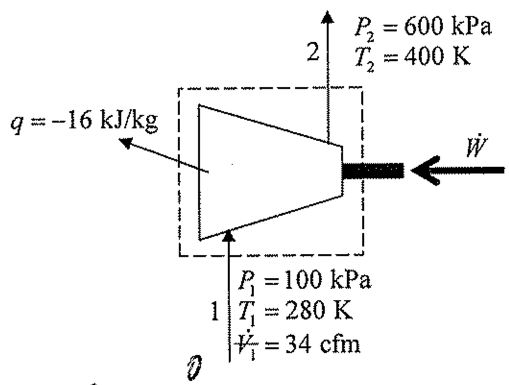
Air enters a compressor at 100 kPa, 280 K and is compressed to 600 kPa, 400 K in a steady state process. The volumetric flow of the air entering the compressor is 34 cfm (ft^3/min). The compressor is experiencing a heat loss of 16 kJ/kg. Assuming that the changes in kinetic and potential energies are negligible, determine the power required to run the compressor.



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

0 STEADY STATE

NEGLECT KE + PE TERMS

$$q - w + h_1 - h_2 = 0$$

1ST LAW SPECIFIC ENERGY BASIS

$$q = -16\ \text{KJ/Kg}$$

$$\dot{m} = \frac{AV}{v_1}$$

$AV = 34\ \text{FT}^3/\text{min}$ @ INLET CONDITIONS

$$v_1 = \frac{RT_1}{P_1}$$

$$\dot{W} = \dot{m}\, w$$

```
"COMPRESSOR PROBLEM (ideal gas properties)"

"Station 1"
P[1]=100[kPa]
T[1]=7[C]
h[1]=Enthalpy(air,T=T[1])
v[1]=Volume(air,T=T[1], P=P[1])
cfm = 34[ft^3/min]*convert(ft^3,m^3)/convert(min,s)
mdot[1] = cfm/v[1]

"Station 2"
P[2]=600[kPa]
T[2]=137[C]
h[2]=Enthalpy(air,T=T[2])

"1st LAW"
q=-16[kJ/kg]
q-w+h[1]-h[2]=0
wdot=w*mdot[1]
```

SOLUTION

Unit Settings: SI C kPa kJ mass deg

cfm = 0.01605 [m^3/s]   q = -16 [kJ/kg]   w = -147.1 [kJ/kg]

wdot = -2.935 [kw]

No unit problems were detected.

Arrays Table: Main

	P_i [kPa]	h_i [kJ/kg]	T_i [C]	v_i [m^3/kg]	$mdot_i$ [kg/s]
1	100	280.5	7	0.8041	0.01996
2	600	411.6	137		

```
"COMPRESSOR PROBLEM"

"Station 1"
P[1]=100[kPa]
T[1]=7[C]
h[1]=Enthalpy(air_ha,T=T[1], P=P[1])
v[1]=Volume(air_ha,T=T[1],P=P[1])
cfm = 34[ft^3/min]*convert(ft^3,m^3)/convert(min,s)
mdot[1] = cfm/v[1]

"Station 2"
P[2]=600[kPa]
T[2]=130[C]
h[2]=Enthalpy(air_ha,T=T[2], P=P[2])

"1st LAW"
q=-16[kJ/kg]
q-w+h[1]-h[2]=0
wdot=w*mdot[1]
```

SOLUTION

Unit Settings: SI C kPa kJ mass deg

cfm = 0.01605 [m^3/s]　　q = -16 [kJ/kg]　　w = -139.6 [kJ/kg]

wdot = -2.787 [kw]

No unit problems were detected.

Arrays Table: Main

	P_i [kPa]	h_i [kJ/kg]	T_i [C]	v_i [m^3/kg]	$mdot_i$ [kg/s]
1	100	280.3	7	0.8039	0.01996
2	600	404	130		