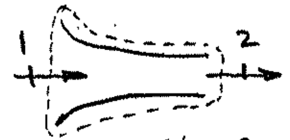
Given: A steam whistle

$P_1 = 60$ psia
$T_1 = 600°F$
$V_1 = 10\ \frac{ft}{s}$



$P_2 = 14.7$ psia
$T_2 = 500°F$

Steady, adiabatic, aergonic

Find: V_2 (ft/s)

Solution: The First Law applied to the nozzle is,

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

Continuity: $\dot{m}_1 - \dot{m}_2 = \cancel{\frac{dm_{sys}}{dt}}$ $\quad \dot{m}_1 = \dot{m}_2 \equiv \dot{m}$

Therefore,

$$\cancel{\dot{m}}\left(h_1 + \frac{V_1^2}{2g_c}\right) - \cancel{\dot{m}}\left(h_2 + \frac{V_2^2}{2g_c}\right) = 0$$

$$\frac{V_2^2}{2g_c} = (h_1 - h_2) + \frac{V_1^2}{2g_c} \rightarrow V_2 = \sqrt{2g_c(h_1 - h_2) + V_1^2}$$

State 1	$P_1 = 60$ psia, $T_1 = 600°F$	$h_1 = 1332.1\ \frac{Btu}{lbm}$	Table C.3a
State 2	$P_2 = 14.7$ psia, $T_2 = 500°F$	$h_2 = 1287.3\ \frac{Btu}{lbm}$	Table C.3a

Then,

$$V_2 = \sqrt{2g_c(h_1 - h_2) + V_1^2}$$

$$V_2 = \sqrt{2\left(32.174\ \frac{lbm\text{-}ft}{lbf\text{-}s^2}\right)(1332.1 - 1287.3)\ \frac{Btu}{lbm}\left|\frac{778.16\ ft\text{-}lbf}{Btu}\right. + \left(10\ \frac{ft}{s}\right)^2}$$

$$V_2 = \underline{\underline{1498}}\ \frac{ft}{s}$$

Notice $V_1 << V_2$
$\therefore KE_1 \cong 0$

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P[1]=60[psia]
T[1]=600[F]
h[1]=Enthalpy(steam_iapws,T=T[1], P=P[1])
Vel[1] = 10[ft/s]

P[2]=14.7[psia]
T[2]=500[F]
h[2]=Enthalpy(steam_iapws,T=T[2],P=P[2])
gc=32.2[lbm-ft/(lbf-s^2)]
Vel[2] = Sqrt(2*gc*(h[1]-h[2])*convert(btu,ft-lbf) + Vel[1]^2)
```

SOLUTION

Unit Settings: Eng F psia mass deg

gc = 32.2 [lbm-ft/(lbf-s^2)]

No unit problems were detected.

Arrays Table: Main

	h_i [Btu/lbm]	P_i [psia]	T_i [F]	Vel_i [ft/s]
1	1332	60	600	10
2	1287	14.7	500	1499

```
P[1]=60[psia]
T[1]=600[F]
h[1]=Enthalpy(steam_iapws,T=T[1], P=P[1])
Vel[1] = 100[ft/s]

P[2]=14.7[psia]
T[2]=500[F]
h[2]=Enthalpy(steam_iapws,T=T[2],P=P[2])
gc=32.2[lbm-ft/(lbf-s^2)]
Vel[2] = Sqrt(2*gc*(h[1]-h[2])*convert(btu,ft-lbf) + Vel[1]^2)
```

SOLUTION

Unit Settings: Eng F psia mass deg

gc = 32.2 [lbm-ft/(lbf-s^2)]

No unit problems were detected.

Arrays Table: Main

	h_i [Btu/lbm]	P_i [psia]	T_i [F]	Vel_i [ft/s]
1	1332	60	600	100
2	1287	14.7	500	1503

```
P[1]=60[psia]
T[1]=600[F]
h[1]=Enthalpy(steam_iapws,T=T[1], P=P[1])
Vel[1] = 500[ft/s]

P[2]=14.7[psia]
T[2]=500[F]
h[2]=Enthalpy(steam_iapws,T=T[2],P=P[2])
gc=32.2[lbm-ft/(lbf-s^2)]
Vel[2] = Sqrt(2*gc*(h[1]-h[2])*convert(btu,ft-lbf) + Vel[1]^2)
```

SOLUTION

Unit Settings: Eng F psia mass deg

gc = 32.2 [lbm-ft/(lbf-s^2)]

No unit problems were detected.

Arrays Table: Main

	h_i [Btu/lbm]	P_i [psia]	T_i [F]	Vel_i [ft/s]
1	1332	60	600	500
2	1287	14.7	500	1580

```
P[1]=60[psia]
T[1]=600[F]
h[1]=Enthalpy(steam_iapws,T=T[1], P=P[1])
Vel[1] = 1000[ft/s]

P[2]=14.7[psia]
T[2]=500[F]
h[2]=Enthalpy(steam_iapws,T=T[2],P=P[2])
gc=32.2[lbm-ft/(lbf-s^2)]
Vel[2] = Sqrt(2*gc*(h[1]-h[2])*convert(btu,ft-lbf) + Vel[1]^2)
```

SOLUTION

Unit Settings: Eng F psia mass deg

gc = 32.2 [lbm-ft/(lbf-s^2)]

No unit problems were detected.

Arrays Table: Main

	h_i [Btu/lbm]	P_i [psia]	T_i [F]	Vel_i [ft/s]
1	1332	60	600	1000
2	1287	14.7	500	1802