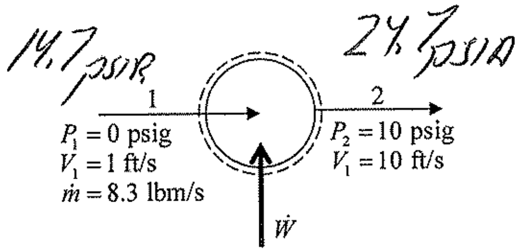
46. The water pump on the engine of an automobile has a mass flow rate of 8.30 lbm/s. The water enters at 0.00 psig with a velocity of 1.00 ft/s and leaves at 10.0 psig with a velocity of 10.0 ft/s with no change in height or temperature. Assuming that the water is an incompressible liquid with a density of 62.4 lbm/ft^3 and the pump is adiabatic, determine the power (in horsepower) required to drive the pump.



$$\overset{0}{\cancel{\dot{Q}}} - \dot{W} + \dot{m}_1\left(h_1 + \frac{V_1^2}{2g_c} + \cancel{\frac{g}{g_c}z_1}\right) - \dot{m}_2\left(h_2 + \frac{V_2^2}{2g_c} + \cancel{\frac{g}{g_c}z_2}\right) = \overset{0}{\cancel{\frac{dE_G}{dt}}}$$

ADIABATIC NEGLECT PE NEGLECT PE STEADY STATE

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

$$h_1 - h_2 = \underset{\Delta T = 0}{\overset{0}{\cancel{u_1 - u_2}}} + \underset{\uparrow \atop = 1/\rho}{v}(P_1 - P_2)$$

INCOMPRESSIBLE SUBSTANCE MODEL

```
"Problem 6.46"

"Station #1"
P[1] = 14.7[psia]
V[1]=1.00[ft/s]
rho=62.4[lbm/ft^3]
mdot = 8.3[lbm/s]
h[1]=1/rho*P[1]*convert(psia,lbf/ft^2)*convert(lbf-ft,Btu)
ke[1]=v[1]^2/gc*convert(lbf-ft,Btu)
gc=32.2[lbm-ft/lbf-s^2]

"Station #2"
P[2]=24.7[psia]
V[2]=10[ft/s]
h[2]=1/rho*P[2]*convert(psia,lbf/ft^2)*convert(lbf-ft,Btu)
ke[2]=v[2]^2/gc*convert(lbf-ft,Btu)

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

SOLUTION

Unit Settings: Eng F psia mass deg

```
gc = 32.2 [lbm-ft/lbf-s^2]          mdot = 8.3 [lbm/s]          ρ = 62.4 [lbm/ft^3]
wdot = -0.3946 [hp]

No unit problems were detected.
```

Arrays Table: Main

```
          Pi       Vi       hi          ke_i
        [psia]   [ft/s]  [Btu/lbm]   [Btu/lbm]
----------------------------------------------------
1    |   14.7      1     0.04359    0.00003991
2    |   24.7     10     0.07325      0.003991
```