Air Receiver using Prode Physical Properties

Modified from a worksheet by Oscar Delgado to demonstrate the use of Prode Physical Properties (PPP) within Mathcad.

$mc\_AOpen("") = 0$ opened test2.ppp archive

$stream := 20$

$mc\_edS(20) = 1$ create stream 20 in Prode window for dry air SRK standard model

Input

$\phi_{hum} := 0.1$

pressure bands, Pa abs	temperatures, avg	process requirements
$Pressure1 := (135 + 14.7) \cdot psi$	$Temp := 129\ °F$	$time := 30 \cdot min$
$Pressure2 := (50 + 14.7) \cdot psi$	$Temp_{atm} := 77\ °F$	$flow_{req} := 32 \cdot \frac{ft^3}{min}$
$P_{atm} := 14.7 \cdot psi$		

Saturation pressure from Prode Physical Properties

$H2O\_code := mc\_getCC(stream, 3) = 1.631 \times 10^3$ component # for water in PPP database

$$P_{sat\_temp} := mc\_CompVP\left(H2O\_code, \frac{Temp}{K}\right) \cdot Pa = 2.168 \cdot psi$$

$$P_{sat\_temp\_atm} := mc\_CompVP\left(H2O\_code, \frac{Temp_{atm}}{K}\right) \cdot Pa = 0.461 \cdot psi$$

Computations

$$P_{H2O\_temp} := \phi_{hum} \cdot P_{sat\_temp} = 0.217 \cdot psi$$

$$P_{H2O\_temp\_atm} := \phi_{hum} \cdot P_{sat\_temp\_atm} = 0.046 \cdot psi$$

compositions

$$y_{H2O\_P1} := \frac{P_{H2O\_temp}}{Pressure1} = 1.449 \times 10^{-3}$$

$$y_{H2O\_P2} := \frac{P_{H2O\_temp}}{Pressure2} = 3.351 \times 10^{-3}$$

$$y_{H2O\_avg} := \frac{y_{H2O\_P1} + y_{H2O\_P2}}{2}$$

$$y_{air} := 1 - y_{H2O\_avg} = 0.998$$

$$y_{H2O\_atm} := \frac{P_{H2O\_temp\_atm}}{P_{atm}} = 3.139 \times 10^{-3}$$

$$y_{air\_atm} := 1 - y_{H2O\_atm} = 0.997$$

$$comp := \begin{pmatrix} .79 \\ .21 \end{pmatrix} \cdot y_{air}$$

$$comp_{atm} := \begin{pmatrix} .79 \\ .21 \end{pmatrix} \cdot y_{air\_atm}$$

$$comp := stack\left(comp, y_{H2O\_avg}\right)$$

$$comp_{atm} := stack\left(comp_{atm}, y_{H2O\_atm}\right)$$

modify stream 20 composition in Prode archive and obtain density

```
GD(str, x, t, p) := | n ← rows(x)
                    | "change the composition"
                    | for  i ∈ 0 .. n − 1
                    |   valid_x_i ← mc_putZ(str, i + 1, x_i)
                    | "set t and p and flash"
                    | valid_flsh ← mc_setOp(str, t, p)
                    | "gas density from PPP"
                    | ρ ← mc_StrGD(str)
                    | (ρ   valid_x   valid_flsh )
```

$$(\rho \quad valid\_x \quad valid\_flsh) := GD\left(stream, comp, \frac{Temp}{K}, \frac{Pressure1}{Pa}\right)$$

$$\rho_{mix\_1} := \rho \cdot \frac{kg}{m^3} = 10.941 \frac{kg}{m^3}$$

$$valid\_x = \begin{pmatrix} 1 \\ 1 \\ 1 \end{pmatrix} \qquad valid\_flsh = 1$$

These variables should be 1 if there were no errors with PPP. They can be used to aid in debugging.

$(\rho \quad valid\_x \quad valid\_flsh) := GD\left(stream, comp, \frac{Temp}{K}, \frac{Pressure2}{Pa}\right)$

$\rho_{mix\_2} := \rho \cdot \frac{kg}{m^3} = 4.729 \frac{kg}{m^3}$

$(\rho \quad valid\_x \quad valid\_flsh) := GD\left(stream, comp_{atm}, \frac{Temp_{atm}}{K}, \frac{P_{atm}}{Pa}\right)$

$\rho_{mix\_atm} := \rho \cdot \frac{kg}{m^3} = 1.178 \frac{kg}{m^3}$

size the receiver

$Vol_{drum} := \frac{time \cdot flow_{req} \cdot \rho_{mix\_atm}}{\rho_{mix\_1} - \rho_{mix\_2}} = 5.155 \cdot m^3$

The result compares well with the 5.162 m^3 obtained by Oscar Delgado.

mc_ASave("") = 0

saved test2 archive