Errata: August 18, 2014

A subtle error was discovered by Ty Neises at NREL (Ty.Neises@nrel.gov) in the EES codes developed by Doug Gavic. The error is that Mr. Gavic restricted one too many variables, resulting in a violation of the mass balance. Mr. Neises' note is shown below. The codes can be easily corrected, as noted by Mr. Neises. However, the results obtained using these models are incorrect.

Consider modeling the performance of a defined cross-flow CO2-air heat exchanger. Given fixed dimensions and inlet operating conditions in the left column of the table below, the relevant performance outputs of the heat exchanger are shown in the column on the right.

HX Dimensions and Operating Inputs	Constrained Performance Outputs
Number of loops passes (tubes in air flow dir.)	CO2 Outlet Temp
Tube length (CO2 flow direction)	CO2 Pressure Drop
Parallel Passes (3rd dim)	
CO2 Inlet Temp	
CO2 Mass Flow Rate	
Fan Power	
Ambient Temperature	

In the design process, the two performance outputs can be set and two of the HX dimensions can be calculated. In Doug's model, CO2 outlet temperature and pressure are set and the tube length and number of parallel passes are calculated. But, the model also constrains the aspect ratio: the ratio between the tube length and parallel dimension. This should over-constrain the model; however, the pipe flow calculations for the pressure drop and CO2 heat transfer coefficient calculates a velocity that achieves the target pressure drop (see screen shot of code below). Because of this, mass is not conserved in these calculations (i.e. inlet mass flow rate divided by number of parallel passes). Also note that velocity is assumed constant where it should be changing at each node due to varying density.

```
"Dimensions"
$ifnot Type$='C'
$if DesignPoint$='SimpleHigh'
W=15[m]                                          "Width of heat exchanger"
$endif
$ifnot DesignPoint$='SimpleHigh'
W=20[m]                                          "Width of heat exchanger"
$endif
$endif
3*H=W                                            "Height of heat exchanger"
A_fr=W*H                                         "Frontal area of heat exchanger"
```

```
"*********************CO2 Side Resistance*********************"
U_H=U_fts*convert(ft/s,m/s)                                                    "Converting from ft/s to m/s"
DELTAP_H=PressureDropRatio_eq*P_H_out
PressureDropRatio_eq=PressureDropRatio/100[%]

"Determine heat transfer coefficient, pressure drop, and pump power"
duplicate j=1,N_loops
duplicate i=1,N
"Reynolds number"
Re_H[i,j]=rho_H[i,j]*U_H*D_h_H/mu_H[i,j]
"Pipe flow correlation"
$if Config_Cat$='Round'
call PipeFlow_N(Re_H[i,j],Pr_H[i,j],999999,(.0000015[m]/D_in): Nusselt_T_H[i,j],Nusselt_H_H[i,j],f_H[i,j])
$endif
$if Config_Cat$='Flat'
call PipeFlow_N(Re_H[i,j],Pr_H[i,j],999999,(.0000015[m]/D_h_H): Nusselt_T_H[i,j],Nusselt_H_H[i,j],f_H[i,j])
$endif
"Heat transfer coefficient"
Nusselt_T_H[i,j]=(h_H[i,j]*D_h_H)/k_H[i,j]
"Water-side resistance"
R_in[i,j]=1/(h_H[i,j]*per_H*N_t_row*L_sub)
end
end
```