Heat pump model

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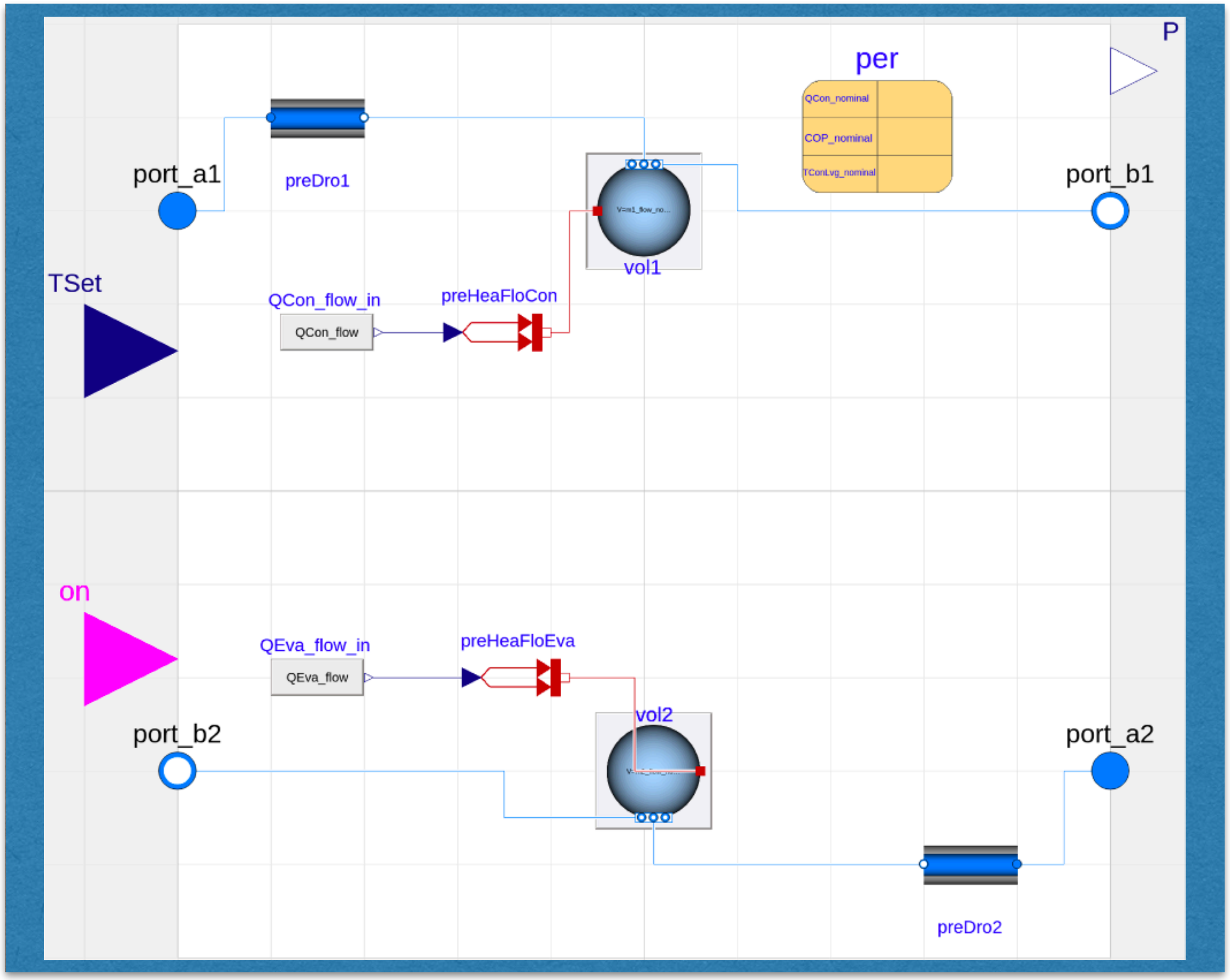
Motivation

Need heat pump model for annual building simulation.

Transition from old EnergyPlus input data should be as easy as practically possible.

Approach



Model based on equation fit

- Same method is used in both cooling and heating modes.
- Control input: discrete, either heating on, cooling on or off.

The governing equations are:

Cooling mode:

$$\frac{\dot{Q}_{eva}(T_{eva,l}, T_{con,e})}{\dot{Q}_{eva,nom}} = A_1 + A_2\frac{T_{eva,l}}{T_{nom}} + A_3\frac{T_{con,e}}{T_{nom}} + A_4\frac{\dot{V}_{eva}(T_{eva,l}, T_{con,e})}{\dot{V}_{eva,nom}} + A_5\frac{\dot{V}_{con}(T_{eva,l}, T_{con,e})}{\dot{V}_{con,nom}}$$

$$\frac{P_{com}(T_{eva,l}, T_{con,e})}{P_{com,nom,cooling}} = B_1 + B_2\frac{T_{eva,l}}{T_{nom}} + B_3\frac{T_{con,e}}{T_{nom}} + B_4\frac{\dot{V}_{eva}(T_{eva,l}, T_{con,e})}{\dot{V}_{eva,nom}} + B_5\frac{\dot{V}_{con}(T_{eva,l}, T_{con,e})}{\dot{V}_{con,nom}}$$

Heating mode:

$$\frac{\dot{Q}_{con}(T_{eva,l}, T_{con,e})}{\dot{Q}_{con,nom}} = C_1 + C_2\frac{T_{eva,l}}{T_{nom}} + C_3\frac{T_{con,e}}{T_{nom}} + C_4\frac{\dot{V}_{eva}(T_{eva,l}, T_{con,e})}{\dot{V}_{eva,nom}} + C_5\frac{\dot{V}_{con}(T_{eva,l}, T_{con,e})}{\dot{V}_{con,nom}}$$

$$\frac{P_{com}(T_{eva,l}, T_{con,e})}{P_{com,nom,h}} = D_1 + D_2\frac{T_{eva,l}}{T_{nom}} + D_3\frac{T_{con,e}}{T_{nom}} + D_4\frac{\dot{V}_{eva}(T_{eva,l}, T_{con,e})}{\dot{V}_{eva,nom}} + D_5\frac{\dot{V}_{con}(T_{eva,l}, T_{con,e})}{\dot{V}_{con,nom}}$$

Model based on DOE-2 curves

Control input: On/off, and condenser leaving temperature.

Computes off-design conditions with three performance curves:

1) Cooling capacity function as a function of temperature

$$CAP(T) = \frac{\dot{Q}_{eva}(T_{eva,l}, T_{con,e})}{\dot{Q}_{eva,nom}} = a + b\, T_{eva,l} + c\, T_{eva,l}^2 + d\, T_{con,e} + e\, T_{con,e}^2 + f\, T_{eva,l}\, T_{con,e}$$

2) EIR temperature correction

$$EIR(T) = \frac{\dfrac{P_{com}(T_{eva,l}, T_{con,e})}{\dot{Q}_{eva}(T_{eva,l}, T_{con,e})}}{\dfrac{P_{com,nom}}{\dot{Q}_{eva,nom}}} = g + h\, T_{eva,l} + j\, T_{eva,l}^2 + i\, T_{con,e} + k\, T_{con,e}^2 + l\, T_{eva,l}\, T_{con,e}$$

3) EIR correction due to part load

$$f_{EIR,PLR}(PLR) = \frac{P_{com}(T_{eva,l}, T_{con,e})}{P_{com,nom}\, CAP(T)\, EIR(T)} = m + n\, PLR + o\, PLR^2$$

Note that the PLR is defined as the available capacity at the same evaporator and condenser temperature

$$PLR = \frac{\dot{Q}_{eva}(T_{eva,l}, T_{con,e})}{\dot{Q}_{nom} \,.\, CAP(T)}$$

Questions