Sage Model Notes

Duplex.scfn

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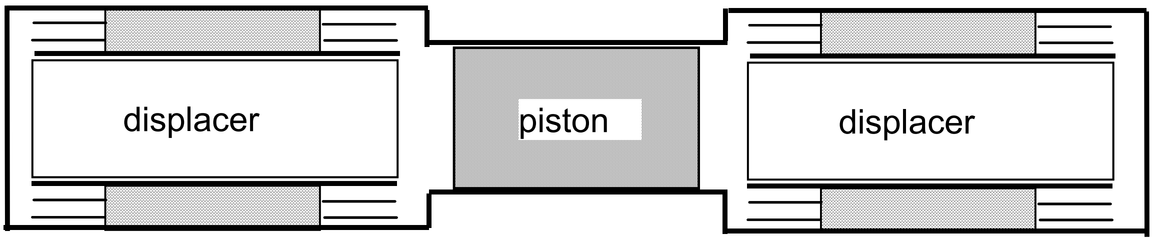
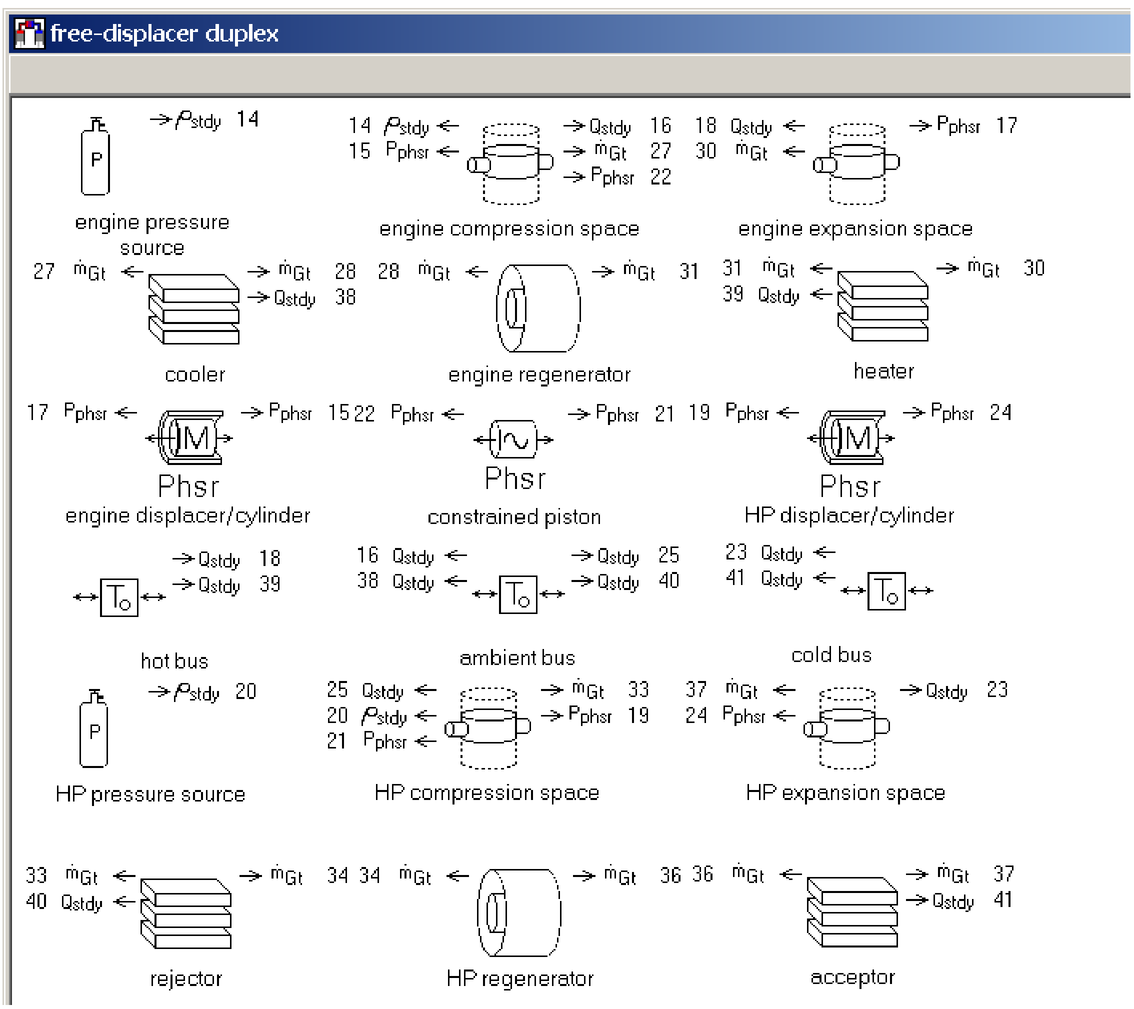
A basic duplex stirling engine/heat-pump. Really two essentially separate machines, an engine and heat pump, driven by a common piston, as in this schematic:

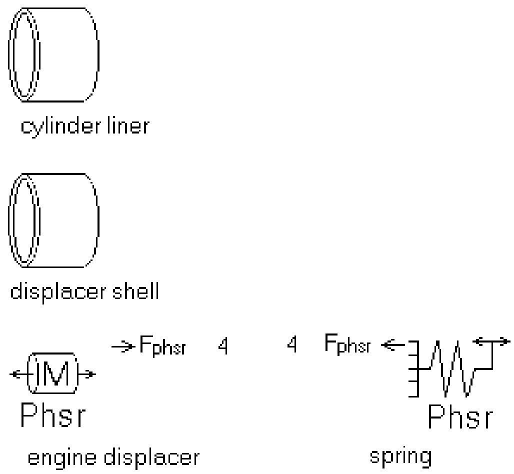


This is an early Sage model with all components implemented at the top level (instead of in submodels):



The engine components are at the top and the heat pump components at the bottom, separated by the *constrained piston* and two *displacer/cylinder* components in the middle. The orientations of the heat pump, piston and displacer/cylinder components are faithful to the orientation of the schematic but the engine components are flipped around so that the hot end is toward the right (positive direction) instead of the left.

The *piston* motion is constrained while both displacer motions are free. The displacers are inside the *displacer/cylinder* components. Here is a view inside the *engine displacer/cylinder*:



The *spring* helps resonate the *engine displacer* and the difference of the es- and cs-facing area attachments within the displacer provides the driving force. This differential area is normally implemented in the form of a drive rod, with endpoint terminating in a constant-pressure space. But no drive rod is shown in the schematic. Absent from the model are gas flows down a clearance seal + appendix gap and thermal conduction down the displacer shell and cylinder liner. These things can be easily added to the model (*see* sample file FPSE.stl).

Both engine and heat pump employ annular regenerator arrangements as separate model components outside the displacer cylinders. The regenerator annulus ID is specified independently of the displacer cylinder diameter though both could be recast according to user-defined geometrical inputs (*see again* sample file FPSE.stl). All heat exchangers are rectangular-channel type. They may also be thought of as arranged annularly around the displacer cylinders, although this is not built into the model components used.

Temperatures

The hot, ambient and cold temperatures are located in model components *hot bus*, *ambient bus* and *cold bus*. Heat exchanger, compression-space and expansion-space wall temperatures are thermal-busbar anchored to the appropriate bus temperatures. Therefore to change the hot temperature, just change the *hot bus* temperature, etc. There are lots of *Tinit* temperature profiles in various model components containing gas domains, but these are just for establishing initial values. If, however, you make significant temperature changes or have convergence trouble, you should take the time to bring them up to date with the bus temperatures.

Charge Pressures

The gas domains for the engine and heat pump are completely isolated, so they each require their own pressure source component. This means you could charge them each to different pressure levels, if you wanted. The piston is intentionally isolated from a cylinder wall so you will not be tempted to model a leakage flow path connecting the two compression spaces. If you do, a singular system might result because of the over-specified mean pressure. If you want to model inter-compression-space leakage then you can replace the current piston component with the appropriate piston/cylinder equivalent and delete one of the pressure source objects.

Bottom-Line Outputs

Overall energy-balance variables are available in various user-defined variables. Net heat lift, rejection and input are in variables *Qnet*, *Qrej* and *Qin* located in the appropriate temperature busses. Net PV power delivered to the piston is in variable *Wnet* of the *constrained piston* component.