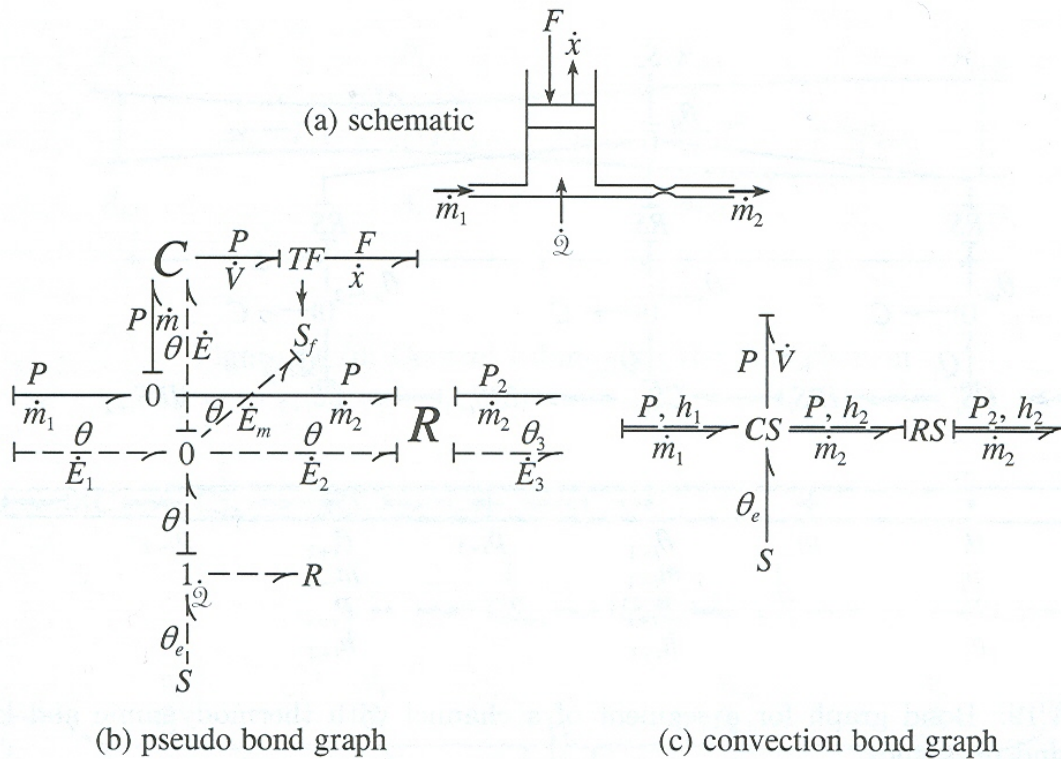


## Convection bonds and “pseudo” bonds

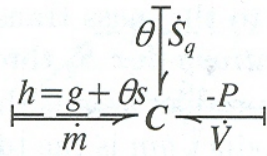
Even in the simplest case of matter transport, power has two components, one due to the rate of work done, the other due to transported internal energy of the material.

“Pseudo” bond graphs depict two distinct bonds. One (the solid lines in figure b) depicts pressure and mass flow rate. The other (the dotted lines in figure b) depicts temperature and energy flow rate (i.e., power). Neither of these effort-flow products is power flow. Furthermore, the mechanical power due to volume change is *not* associated with the rate of volume change but is added via a controlled source.

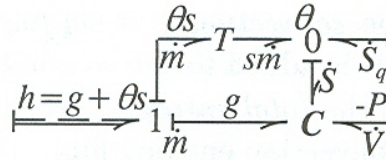


“Convection” bond graphs (figure (c)) depict a single mass flow rate conjugated with two effort variables, pressure and specific enthalpy. Pressure determines mass flow rate and is associated with the causal stroke. Power flow is determined by the product of specific enthalpy and mass flow rate.

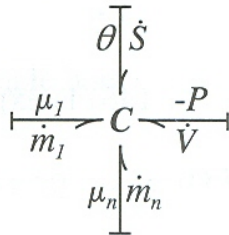
Convection bonds may be reticulated into two “proper” bonds as shown below. One depicts temperate and total entropy flow rate (whose product is one component of power flow). The other depicts specific Gibbs free energy and mass flow rate (whose product is the other component of power flow).



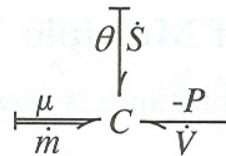
(a) previous version,  
pure substance



(b) reticulated version,  
pure substance



(c) C element, more than  
one species



(d) vector bond version  
of (c)