Abstract: Natural gas processing facilities form a part of the energy infrastructure associated with agile power production. At this stage, they are an important part of carbon emissions reduction. Energy efficiency and adaptability of the facility dictate that high-performance control be applied and that this be reconfigurable with modest design effort. Traditionally, mechanical thermal-fluid systems have been modeled by bond graph methods involving differential-algebraic equations, where the algebraic aspects are connected to conservation-of-mass constraints. Some Model Predictive Control methods have been applied directly to such systems, but generally they are not amenable to feedback controller design. Here we present methods of modeling these systems subsuming conservation of mass into the linear state equations, thereby removing the algebraic parts and admitting multiinput-multioutput linear control design methods directly. These models of compressible fluid flow capture the resonant wave modes along with the bulk fluid flows of interest for the facility. We show how the models may be interconnected in a simple and familiar fashion subsuming Mason's Gain Rule. The complex system is then combined with antialiasing filters, model reduction and control design to illustrate the applicability of the approach and the presence and role of mass conservation.

Note: There is some possibility, depending on the speaker’s dexterity and practice, of balloon animals being used to illustrate the control-critical presence of integrators in the linear composite system models as the natural consequence of the implicit conservation of mass. Loud noises and sounds in poor taste are possible.

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