ME 201
Thermodynamics

First Law for Transient Systems Guide

In a simple transient system, we will have only one inflow or outflow, so the energy equation can be written

$$\frac{d}{dt}(m \cdot u) = \{\dot{m}_{in} \cdot e_{in} \ \ \text{OR} - \dot{m}_{out} \cdot e_{out}\} + \dot{Q} - \dot{W}_{sh} - \dot{W}_{bnd}$$

where $\dot{Q}$ now represents the net heat transfer rate into the control volume system (so it is positive for energy added by heat transfer and negative for energy removed by heat transfer) and $\dot{W}_{sh}$ represents the net shaft power out of the control volume system (so it is positive for energy removed by shaft work and negative for energy added by shaft work).

Some real world examples include

Blowing up a Balloon
Leaking Tank
Rocket Engine
Internal Combustion Engine During Exhaust or Intake

In dealing with a transient system energy problem, the conservation of mass equation will always be needed.

$$\frac{dm}{dt} = \{\dot{m}_{in} \ \text{OR} - \dot{m}_{out}\}$$

Quite often during a transient process with a single outflow the conditions inside the system will change between the initial state and the final state. In these cases the energy outflow must also be changing. The energy outflow should be evaluated at the average temperature and pressure of the system for a single phase system and at the average quality for a two phase system.