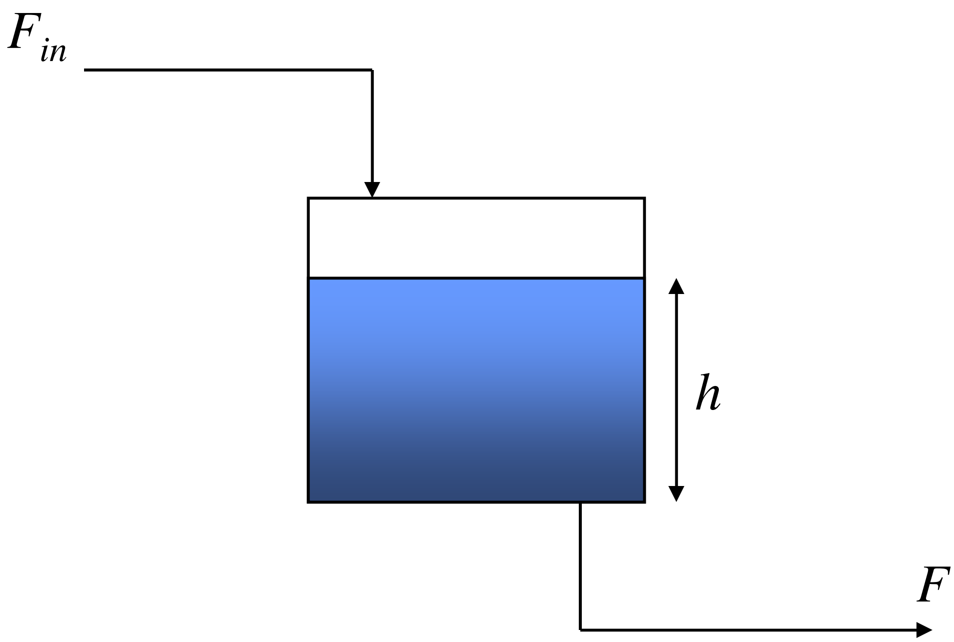
Process Modeling

- Application of a mass balance

Holding Tank



- *Modeling objective*: Control of tank level
- *Fundamental quantity:* Mass
- *Assumptions*: Incompressible flow

Process Modeling

Total mass in system = $\rho V = \rho A h$

Flow in = ρF_{in}

Flow out = ρF

Total mass at time t = $\rho A h(t)$

Total mass at time $t+\Delta t$ = $\rho A h(t+\Delta t)$

Accumulation

$$\rho A h(t+\Delta t) - \rho A h(t) = \Delta t(\rho F_{in} - \rho F),$$

$$\frac{\rho A h(t+t\Delta) - \rho A h(t)}{\Delta t} = \rho(F_{in} - F),$$

$$\lim_{\Delta t \to 0} \frac{\rho A h(t+t\Delta) - \rho A h(t)}{\Delta t} = \rho(F_{in} - F),$$

$$\boxed{\rho A \frac{dh}{dt} = \rho(F_{in} - F).}$$

Process Modeling

Model consistency

"Can we solve this equation?"

Variables: h, ρ, F_{in}, F, A	5
Constants: ρ, A	2
Inputs: F_{in}, F	2
Unknowns: h	1
Equations	1
Degrees of freedom	0

There exists a solution for each value of the inputs F_{in}, F

Process Modeling

Solve equation

- Specify initial conditions $h(0)=h_0$ and integrate

$$h(t) = h(0) + \int_0^t \left(\frac{F_{in}(\tau) - F(\tau)}{A} \right) d\tau$$