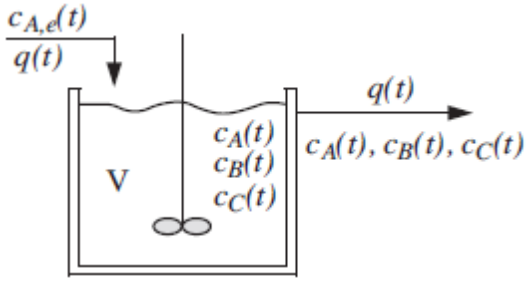
Series 2

Exercise 1

Consider the two reactions:

$A \rightarrow B \qquad r_1 = k_1 c_A$
$A + B \rightarrow C \qquad r_2 = k_2 c_A c_B$

taking place isothermally in a continuously flowing stirred reactor of volume V and with a residence time $= \frac{V}{q}$

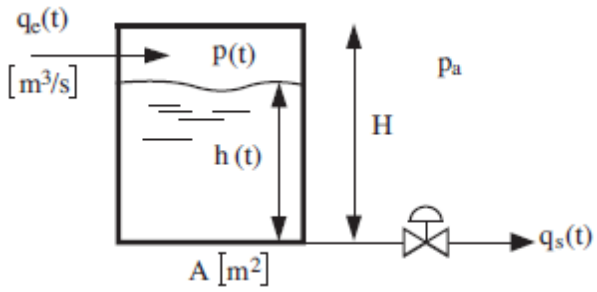


a) Model this dynamic system. Indicate the working hypotheses
b) Identify the independent variables, the dependent variables, as well as the model parameters.
c) Is the resulting model
    a. Dynamic?
    b. Linear?
    c. Stationary?

Exercise 2

Consider a closed tank containing a liquid and a gas. The feed flow of the liquid is $qe(t)$. The leakage rate, $qs(t)$, is proportional to the difference between the upstream and downstream pressures at the outlet valve. The atmospheric pressure, pa, is constant.

a) Write a dynamic model for the system and indicate the simplifying assumptions.
b) Identify the characteristic parameters of the system (input, output, and state variables)
c) Is the operation of the system independent of atmospheric pressure?



Exercise 3

Consider the following exothermic system:

$$A + B \rightarrow C \qquad r_1 = k_1 c_A c_B$$
$$2B \rightarrow D \qquad r_2 = k_2 c_B^2$$

Where C represents the desired product.

The isothermal reaction takes place in a semi-batch reactor equipped with a cooling chamber. The flow rate of the coolant is qM. A fraction of this flow is cooled by liquid ammonia. The reaction medium and the cooling chamber are considered homogeneous. We consider q, qM and T constant.

a) Write the dynamic equations for this system.
b) Is the system linear?
c) What is the minimum number of different equations required to fully represent the system?