



INTRODUCTION TO MATERIAL BALANCE



BANK OF THE WEST CUSTOMER SUMMARY INFORMATION

Date	Notes	Deposit	Withdrawal	Balance
3/1	Beginning balance			\$1253.89
3/2	Deposit from ABC Co.	\$1500.00		\$2753.89
3/3	Check No. 2133		\$550.00	\$2203.89
3/3	ATM withdrawal 3/2		\$200.00	\$2003.89
3/5	Check No. 2134		\$401.67	\$1602.22
3/15	Check No. 2135		\$321.83	\$1280.39
3/18	ATM withdrawal 3/17		\$200.00	\$1080.39
3/20	Deposit at the bank	\$1250.00		\$2330.39
3/23	Check No. 2136		\$442.67	\$1887.72
3/31	Service charge		\$10.00	\$1877.72
3/31	Closing balance			\$1877.72

Closing balance - Beginning balance = Sum of the deposits - Sum of the withdrawals



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6.1 Material balance

- A material balance is nothing more than the application of the law of the **conservation of mass**: "Matter is neither created nor destroyed."
- **Material balance**
 - is accounting of material
 - is normally carried around a system

Final condition - Initial condition = Sum of inputs - Sum of outputs

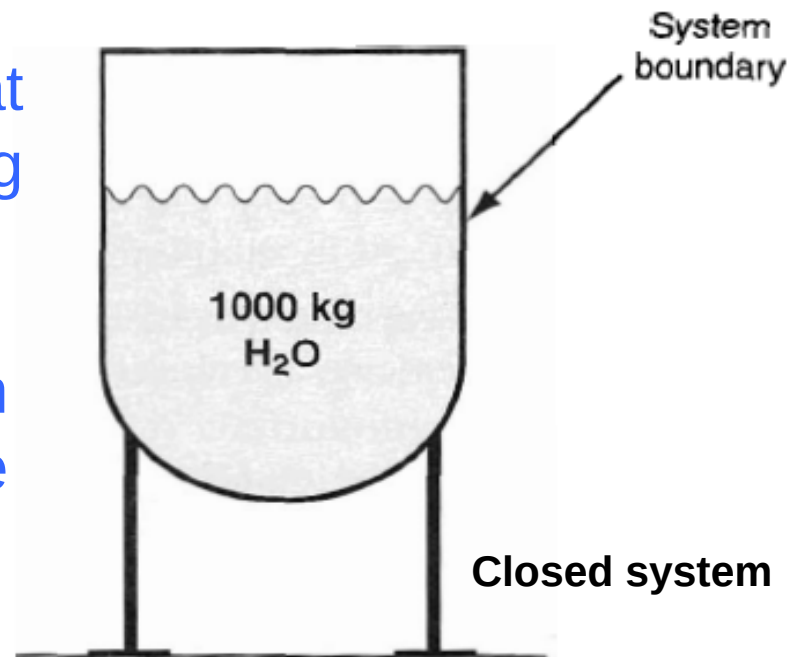


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6.2 Open and Closed Systems.

- **A System** is a portion or whole of a process (or a plant) to be analyzed.
- **Closed system** is a system that does not have material crossing the system boundary.
- **Open system** is a system in which material crosses the system boundary.



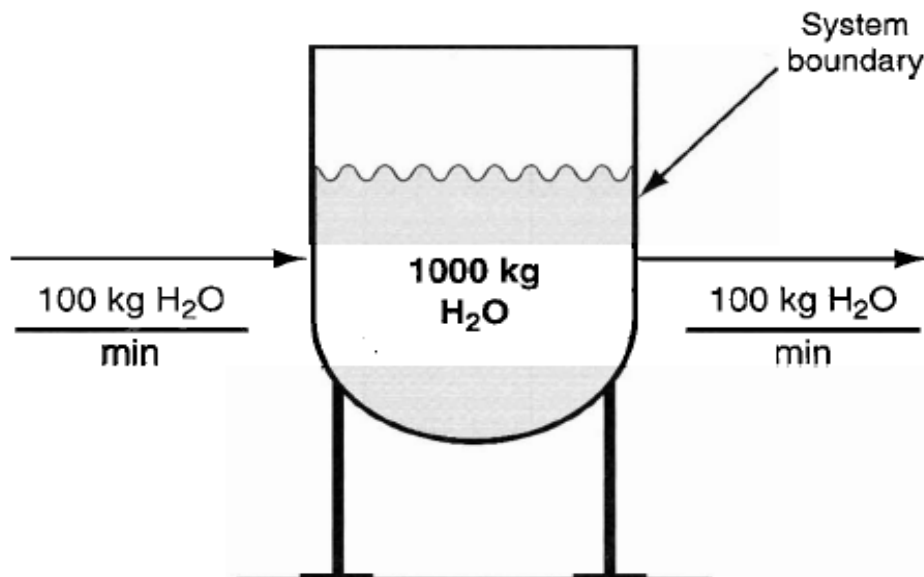


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6.3 Steady-State and Unsteady-State Systems.

- **Steady-state system** is a system for which all the conditions (e.g., temperature, pressure, amount of material) remain constant with time.

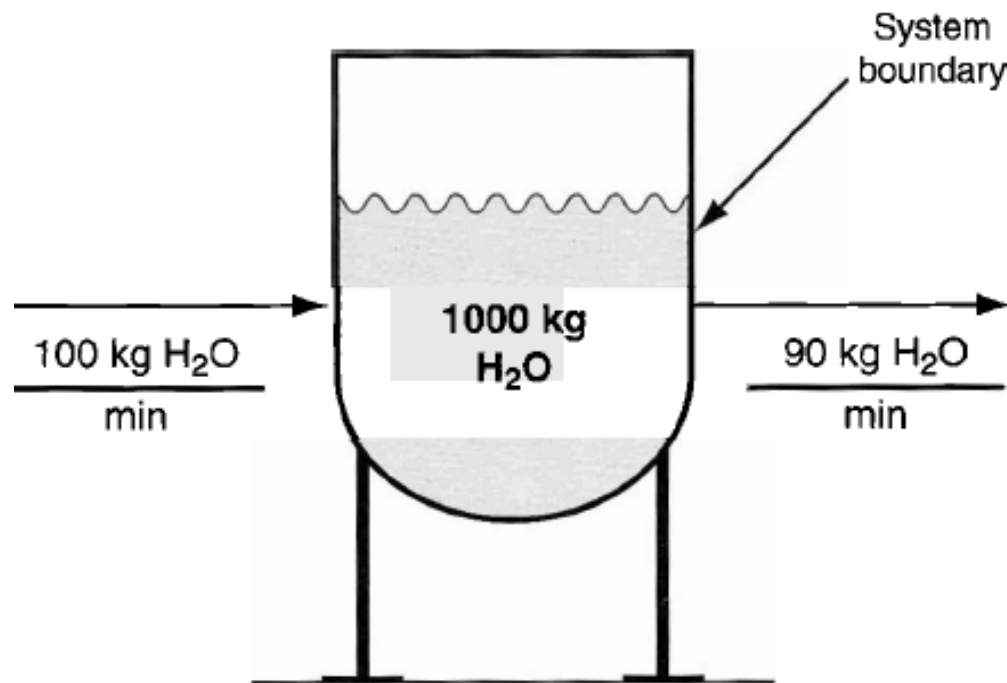




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- **Unsteady-state system** is a system for which one or more of the conditions (e.g., temperature, pressure, amount of material) of the system vary with time. Also known as a transient system.

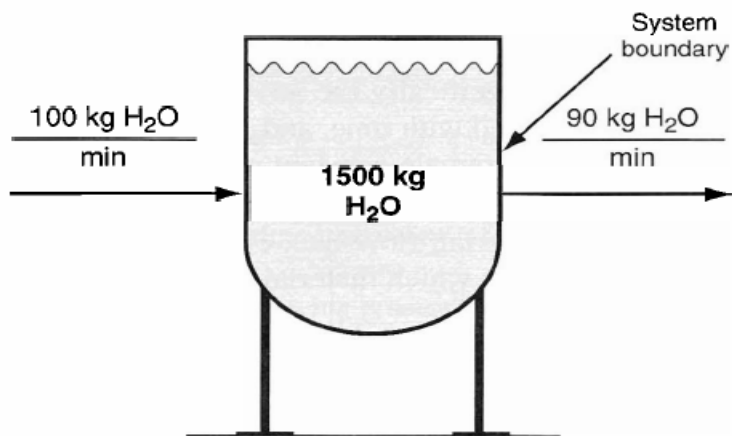




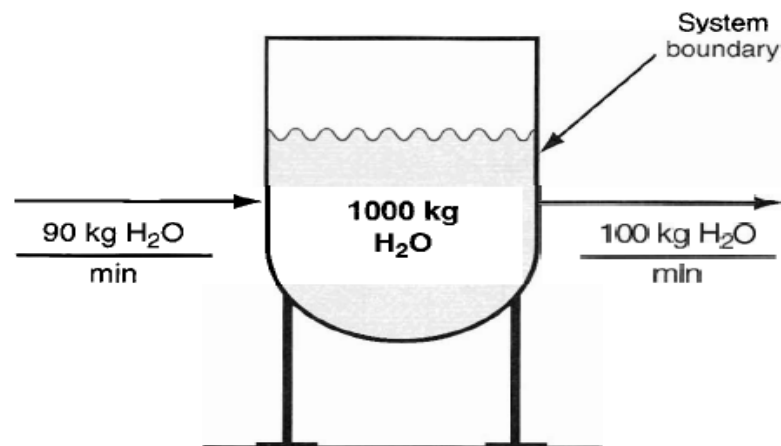
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$$\left\{ \begin{array}{c} \text{Accumulation of material} \\ \text{within the system} \end{array} \right\} = \left\{ \begin{array}{c} \text{Total flow into} \\ \text{the system} \end{array} \right\} - \left\{ \begin{array}{c} \text{Total flow out} \\ \text{of the system} \end{array} \right\}$$



Positive accumulation



Negative accumulation

$$\{ \text{Accumulation} \} = \left\{ \begin{array}{c} \text{Final material} \\ \text{in the system} \end{array} \right\} - \left\{ \begin{array}{c} \text{Initial material} \\ \text{in the system} \end{array} \right\}$$

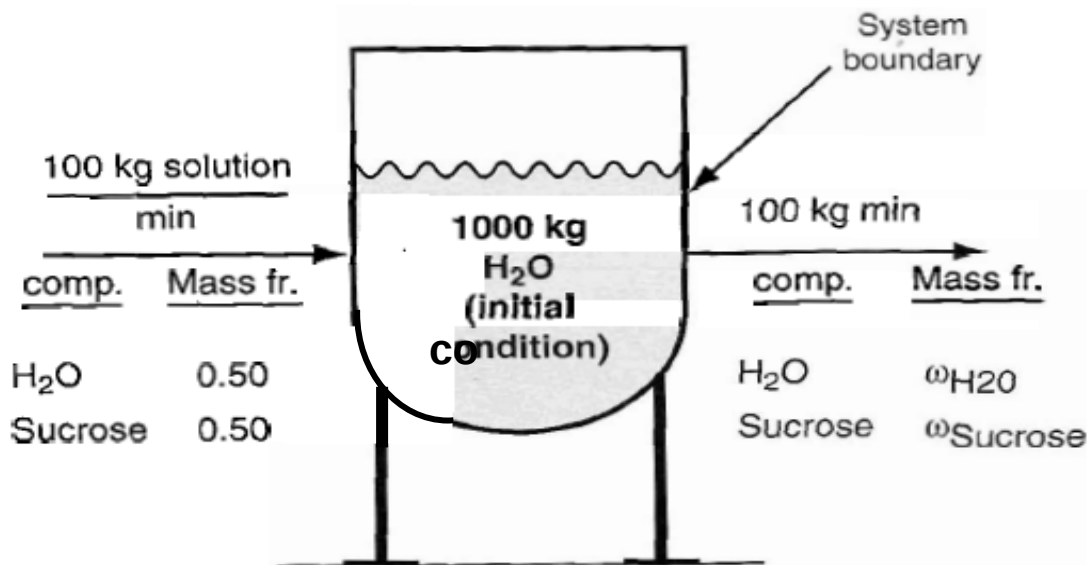


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$$\left\{ \begin{array}{c} \text{Final material} \\ \text{in the system} \\ \text{at } t_2 \end{array} \right\} - \left\{ \begin{array}{c} \text{Initial material} \\ \text{in the system} \\ \text{at } t_1 \end{array} \right\} = \left\{ \begin{array}{c} \text{Flow into} \\ \text{the system} \\ \text{from } t_1 \text{ to } t_2 \end{array} \right\} - \left\{ \begin{array}{c} \text{Flow out of} \\ \text{the system} \\ \text{from } t_1 \text{ to } t_2 \end{array} \right\}$$

6.4 Multiple Component Systems

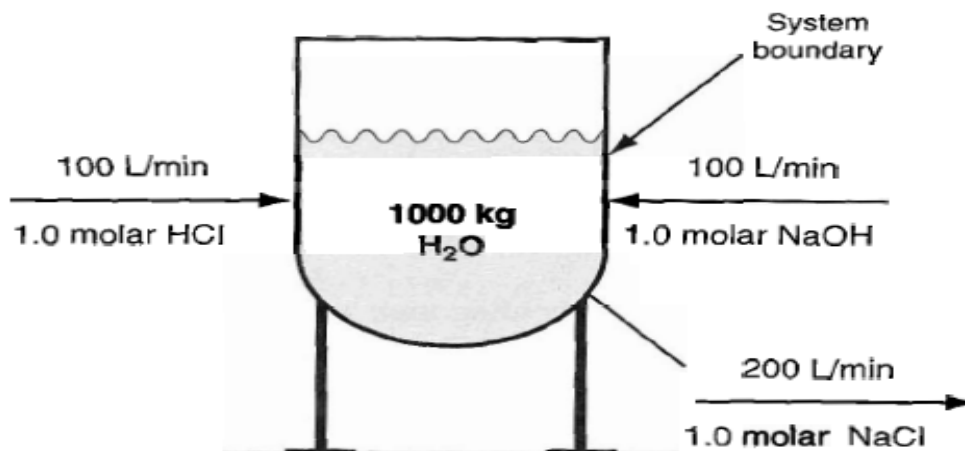




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6.5 Accounting for Chemical Reactions in Material Balances.



$$\left\{ \begin{array}{c} \text{Accumulation} \\ \text{within the} \\ \text{system} \end{array} \right\} = \left\{ \begin{array}{c} \text{Input} \\ \text{through} \\ \text{the system} \\ \text{boundaries} \end{array} \right\} - \left\{ \begin{array}{c} \text{Output} \\ \text{through} \\ \text{the system} \\ \text{boundaries} \end{array} \right\} + \left\{ \begin{array}{c} \text{Generation} \\ \text{within the} \\ \text{system} \end{array} \right\} - \left\{ \begin{array}{c} \text{Consumption} \\ \text{within the} \\ \text{system} \end{array} \right\}$$

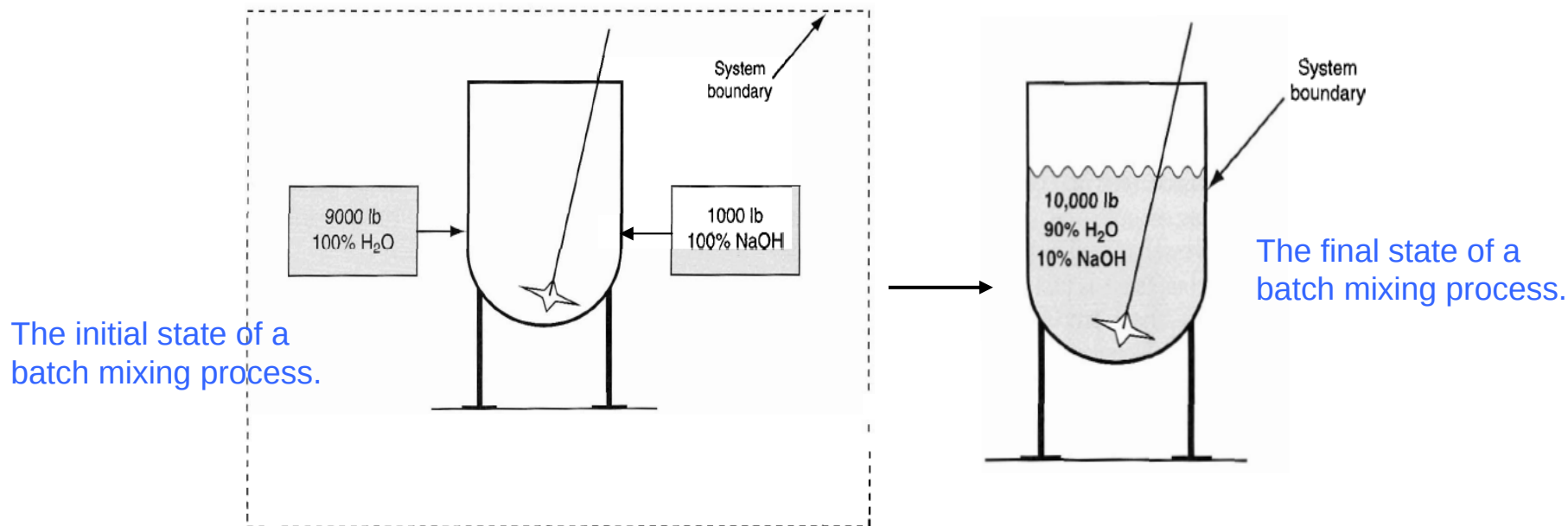


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6.6 Material Balances for Batch and Semi-Batch Processes

- **Batch process** is a process in which material is neither added to nor removed from the process during its operation.

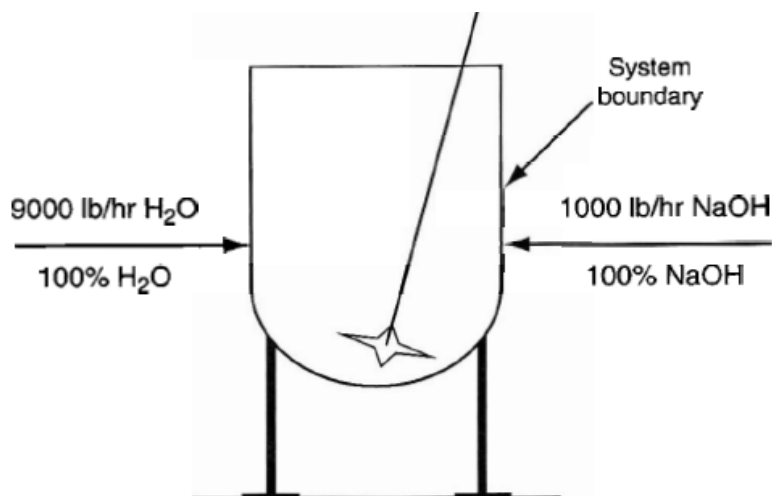




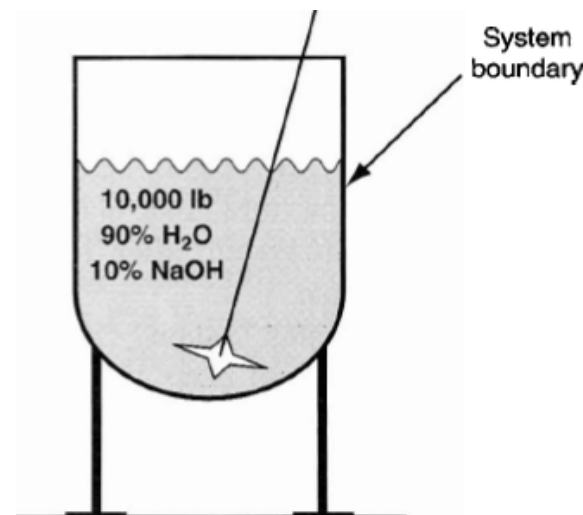
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- **Semi-batch process** is a process in which material enters the system but product is not removed during operation.



Initial condition for the semi-batch mixing process. Vessel is empty.



Condition of a semi-batch mixing process after 1 hour of operation.