

Mass Transfer Operation Lab

Subject Overview:

Mass transfer describes the transport of mass from one point to another and is one of the main pillars in the subject of Transport Phenomena. Mass transfer may take place in a single phase or over phase boundaries in multiphase systems. In the vast majority of engineering problems, mass transfer involves at least one fluid phase (gas or liquid), although it may also be described in solid-phase materials. It is most important subject to understand the various process and operation studied in chemical engineering.

- **Packed Distillation Column**



In Packed distillation column, The gas-liquid contact in a packed column is continuous, not stage-wise, as in a plate column. The liquid flows down in the column over a packing surface and the vapor (or the gas) moves counter-currently, up the column. The intimate contact between liquid and gas phases attempt by packing.

- **Forced Draft Tray Dryer**



This is a dryer in which moisture removal takes place by means of forced draft action created by hot air. The set-up consists of an insulated double wall chamber. Inside the chamber a tray is attached directly to a electronic weighing balance, which is fitted on the bottom, outside the chamber. Material for drying is placed in the tray and regular loss of weight is monitored. Air from a blower passes through a heating chamber and is used as drying agent. Arrangement is done to vary the airflow rate.

- **Steam Distillation Unit**



Steam distillation is a separation process used to purify or isolate temperature sensitive materials, like natural aromatic compounds. Steam or water is added to the distillation apparatus, lowering points of the compounds. The goal is to heat and separate the components at temperatures below their decomposition point

- **Humidification and Dehumidification**



Humidification operations: In this operation, water transfers from liquid phase to gas phase. Hence, moisture content of air increases. Air with particular moisture content is useful for drying of a solid under controlled condition. Dehumidification operations: It is the reverse phenomena of humidification. A portion of water vapor from moist warm air is condensed by contacting cold water in air conditioning.

- **Vapor in Air Diffusion Coefficient**



Using a small sample of the liquid in a narrow vertical tube, and observing its rate of evaporation into stream of air passed across the top of the tube can conveniently be used to study the diffusion of vapour of a volatile liquid into air. The set up consists of a glass tube placed in a water bath. A horizontal glass tube is fixed to the upper end of the tube and air is drawn through this by a small air pump included within the unit. Air flows over this tube maintaining partial pressure difference. A Travelling microscope with sliding vernier scale is provided to measure the rate of fall of solvent within capillary. A stirrer is fitted to maintain constant temperature inside the bath.

- **Batch Crystallizer**



Crystallization is also a chemical solid–liquid separation technique, in which mass transfer of a solute from the liquid solution to a pure solid crystalline phase occurs. In batch crystallizer we can produce pure solid crystalline product by intensifying it by stirring and temperature.

- **Liquid Extraction in Packed Column**



A Liquid Extraction in Packed Column consists of a vertical cylindrical vessel fitted with packing. The packings used in column extractor are similar to the ones used in distillation. It is important that the packing be wetted preferentially by the continuous phase, thus ensuring that the drops of dispersed phase will not be severely coalesced within the packed volume. Liquid Extraction in Packed Column have better efficiency because of improved contacting and reduced back mixing. Light and heavy liquids, either one of which is dispersed in the form of droplets, pass counter-currently through the column. At the top or bottom of the column, the dispersed phase coalesces at an interface layer. Because the packing elements reduce the cross-sectional area for flow and decrease the velocity of the dispersed phase, the column diameter for a given rate will always be greater than for a spray column because the reduced flow capacity is less important than the improved mass transfer.

- **Sieve Tray Distillation Column**



Sieve tray distillation column is only used for continuous/flash distillation processes. Sieve trays are design to look like the usual sieves use in meachanical separations. The sieve trays have metal plates with holes wherein the vapor passes straight upward through the liquid on the plate. The effectiveness of the tray depends on the number and size of the holes and the arrangement of it.

- **Single Effect Evaporator**



Evaporation deals with the concentration of a non-volatile solute from a solution by the removal of required amount of volatile solvent. Usually the solvent is water. By vaporizing a part of the solvent, useful product i.e. The concentrated solution or thick is produced, and the vapour is discarded. Long tube evaporators are usually used for the concentration of foamy liquids. The set-up consists of stainless steel tubes surrounded by a stainless steel jacket and fitted with accumulator. Dilute solution is feed to tubes. Steam from a steam generator is supplied to shell to concentrate the dilute feed solution to a desired level. The jacket is fitted with a steam trap and the condensate is collected at the end of trap. The vapours of volatile solvent are condensed in a shell & tube type condenser and the balance non-volatile solute collected in the accumulator is recycled through the evaporator.

- **Cooling Tower with Wet Bulb and Dry Bulb**



The apparatus consists of a rectangular transparent tower with three different packing in addition a hot water reservoir, pump and a centrifugal fan. Cold water trickles down over the packing material as it cools down by a forced draught of air supplied at the base of the tower by the fan. The water cooled down is recollected in hot water reservoir and the amount of water is kept constant by addition of water from a make-up water reservoir. Air flow rate can be measured by an orifice plate and noted as pressure difference while water flow rate is measured by using a rotameter and controlled by use of valves. Air inlet and outlet temperatures (both dry and wet), water inlet and outlet temperatures and temperatures of make-up water reservoir and hot water reservoir is measured by use of digital thermometers.

- **Simple Distillation Setup**



Simple distillation is a procedure by which two liquids with different boiling points can be separated. Simple distillation (the procedure outlined below) can be used effectively to separate liquids that have at least fifty degrees difference in their boiling points. As the liquid being distilled is heated, the vapors that form will be richest in the component of the mixture that boils at the lowest temperature. Purified compounds will boil, and thus turn into vapors, over a relatively small temperature range (2 or 3°C); by carefully watching the temperature in the distillation flask, it is possible to affect a reasonably good separation. As distillation progresses, the concentration of the lowest boiling component will steadily decrease. Eventually the temperature within the apparatus will begin to change; a pure compound is no longer being distilled. The temperature will continue to increase until the boiling point of the next-lowest-boiling compound is approached. When the temperature again stabilizes, another pure fraction of the distillate can be collected. This fraction of distillate will be primarily the compound that boils at the second lowest temperature. This process can be repeated until all the fractions of the original mixture have been separated.