

DEPARTMENT OF CHEMICAL ENGINEERING
University of Engineering & Technology, Lahore

Mass Transfer Lab

Introduction

Separation equipments account for a major part of the capital investment in process industry. Fundamental laws governing the design and operation of these equipments are covered in the course “Mass Transfer”.

The purpose of this lab is to introduce the undergraduate students with the most important separation equipments in the process industry, and provide a hands-on training of the proper operation of these units. This helps in not only understanding the theoretical fundamentals of the subject but also helps to visualize its real-world applications in the process industry.

List of Equipment

1. Continuous Distillation Column
2. Batch Distillation Column
3. Liquid/Liquid Extraction Unit
4. Gas/Liquid Absorption Column
5. Gaseous Diffusion Apparatus
6. Tray Drier
7. Ion Exchange Apparatus
8. Fluid Bed Drier

Details of Equipment

Continuous Distillation Column

This unit is used to demonstrate the working of a continuous distillation system. The material and energy balances of a distillation system, calculation of number of theoretical trays, tray efficiency, and column profiles are studied on this unit. It also has the facility to perform azeotropic/extractive distillation.



Batch Distillation Column

Very similar to the continuous distillation column in construction (with the exception of reboiler), this unit is used to demonstrate the batch distillation process at constant reflux ratio and at constant product composition. Additionally, the effect of process variables, like reflux ratio, may also be studied.



Liquid/Liquid Extraction Column

This packed column is used for calculation of distribution coefficient in liquid-liquid extraction processes. The first stage of the process is to extract the solute from feed using a solvent. The column is equipped with an additional distillation system in order to complete the second step of separation.



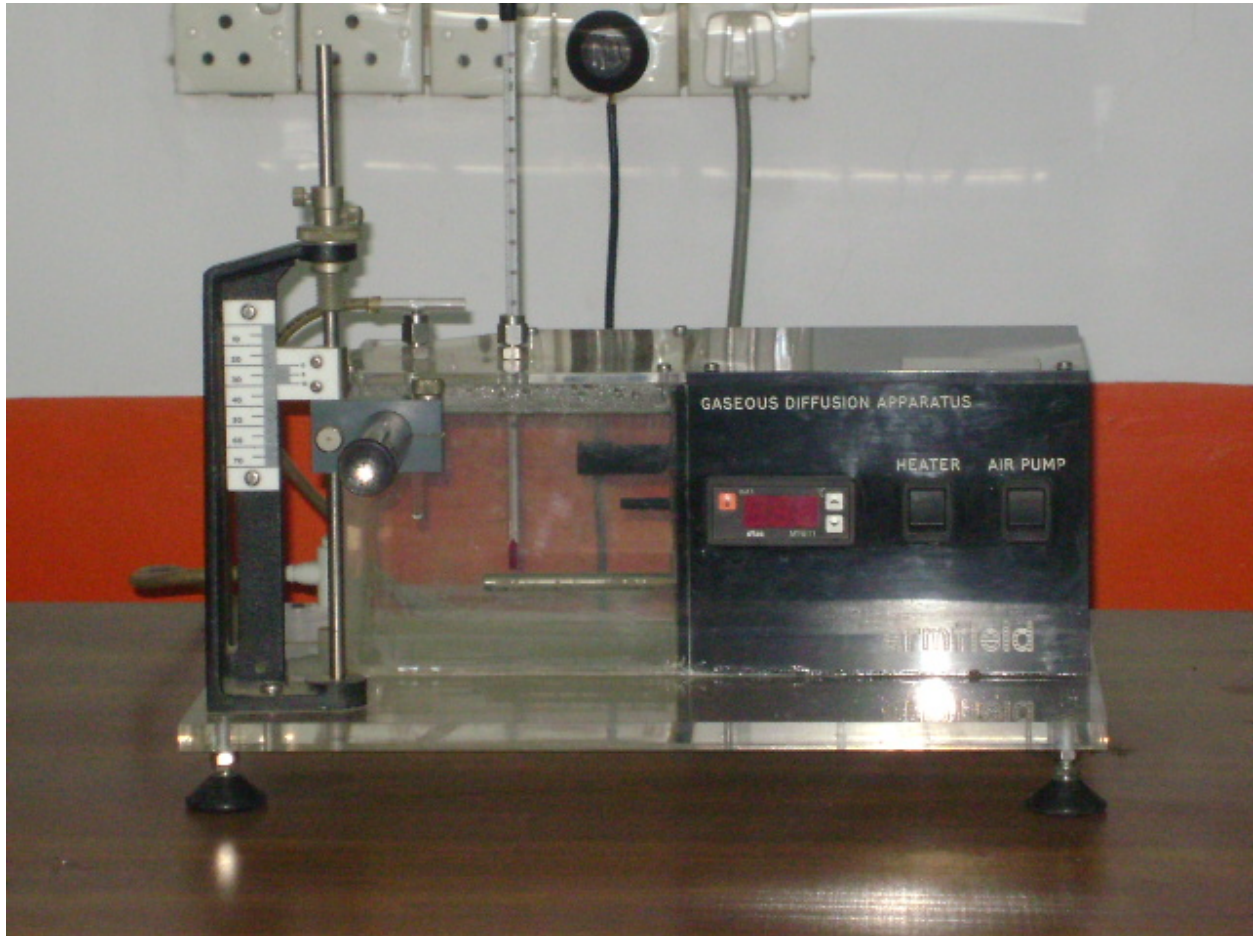
Gas/Liquid Absorption Column

This packed column is used to demonstrate the operational problems of packed column such as flooding, channeling and entrainment. Facility is also available for measurement of the chemi-sorption equilibrium using a gravimetric analysis.



Gaseous Diffusion Apparatus

Diffusion is the basis of mass transfer operations. This apparatus is used to measure the diffusivity of a volatile component at a controlled temperature.



Tray Drier

This unit is used to study the operation of a tray drier and understand the theoretical fundamentals of the subject like drying curve, effect of temperature and air velocity on the drying rate, etc.



Ion-Exchange Apparatus

Water softening and several other industrial operations make use of the ion exchange process. This lab-scale equipment is used to demonstrate the use of cationic and anionic resins for this purpose, to measure the exchange capacity, and the normal operation and regeneration of the ion-exchange system.



Fluid Bed Drier

By fluidizing a bed of solid particles, the exposed surface of wet particles can be greatly enhanced, thereby significantly increasing the rate of drying. This lab-scale equipment is used to demonstrate this very principle.



List of Experiments

1. To perform the material balance of steady state distillation of a binary mixture under continuous operation.
2. To determine the theoretical number of trays and overall column efficiency for a continuous distillation column.
3. To plot the composition versus refractive index profile for alcohol-water mixture.
4. To calculate the number theoretical plates for a batch distillation column and to determine the overall column efficiency at varying boil-up rates.
5. To study the operation of a batch distillation column at constant reflux ratio, and perform the material balance of the system.
6. To determine the distribution coefficient for the system trichloroethylene - propionic acid – water and to show its dependence on concentration.
7. To demonstrate how a mass balance is performed on the extraction column, and to measure the mass transfer coefficient and its variation with flow rate with the aqueous phase as the continuous medium.
8. To demonstrate how a mass balance is performed on the extraction column and to measure the mass transfer coefficient and its variation with flow rate with the organic phase as the continuous medium.
9. To determine the air pressure differential across the dry absorption column as a function of the air flow rate.
10. To examine the air pressure differential across the absorption column as a function of air flow rate for different water flow rates down the column.
11. To determine the diffusion coefficient of a gas by evaporation from a liquid surface.
12. To produce drying and drying rate curves for a wet solid being dried with air of fixed temperature and humidity.
13. To investigate the influence of air velocity on the drying rate of a wet solid in air of fixed temperature and humidity.
14. To investigate the influence of air temperature on the drying rate of a wet solid in air of fixed velocity.

15. To plot the drying process on psychrometric chart and use the results to perform a mass balance on the air in a tray drier.
16. To determine the exchange capacity of a cationic resin in the softening of water.
17. To determine the regeneration efficiency of an ion-exchange softening system.
18. To study the demineralization of water and to determine the exchange capacities of a hydrogen ion cation exchanger and an anion exchanger.
19. To determine the regeneration efficiency of a cation resin and an anion resin.