

Principles of Chemical Engineering

Mass Transfer

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Syllabus Contents

Absorption

Equipment for Gas - Liquid Operations - Selection of Equipment for Gas-Liquid Operations.

Objectives

- ▶ To give an overview of absorption.
- ▶ To give an overview of equipments for gas-liquid contacting.

Absorption

- ▶ In **absorption** (also called gas absorption, gas scrubbing, or gas washing), there is a transfer of one or more species from the gas phase to a liquid solvent. The species transferred to the liquid phase are referred to as solutes or absorbate.
- ▶ The operation of removing the absorbed solute from the solvent is called **stripping**.
- ▶ Absorption is used to separate gas mixtures, remove impurities, or recover valuable chemicals.
- ▶ The solvent may be a physical solvent — where there is no chemical reaction of solute with the solvent, or a chemical solvent — where solute reacts with the solvent.
- ▶ Water is the most common solvent used in absorption.

Absorption (contd..)

- ▶ Absorption is the chief method for controlling industrial air pollution.
- ▶ Most absorption processes aim at separation of acidic impurities from mixed gas streams. These acidic impurities include CO_2 , H_2S , SO_2 , and organic sulfur compounds. The most important of these are CO_2 and H_2S , which occur at concentrations of 5–50%.

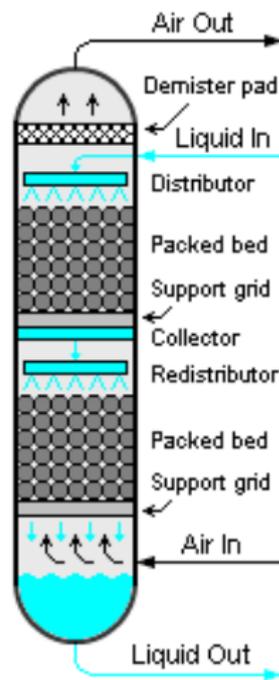
Absorption with Chemical Reaction

To promote the solute removal rate and to enhance the efficiency of the gas absorber, sometime a reactive solvent is used.

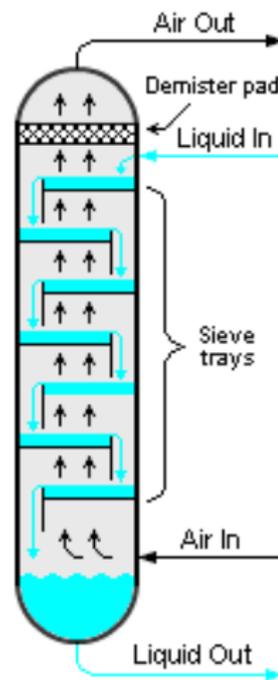
- ▶ Acid gases such as H_2S and CO_2 are often contacted with solvents containing an alkaline component such as sodium hydroxide, or an ethanolamine.
- ▶ The absorption of a basic solute such as ammonia can be promoted by reacting it with an acidic solvent.

The Most Common Equipments for Gas-Liquid Contacting

Packed and Plate Columns

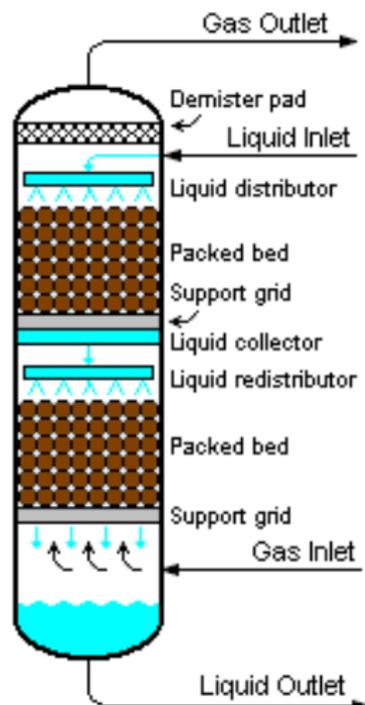


**Packed Bed
Stripper**



**Sieve Tray
Stripper**

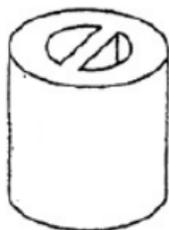
Packed Column



Packing Internals



(a) Raschig ring



(b) Lessing ring



(c) Cross-partition ring



(d) Pall ring



(e) Berl saddle



(f) Intalox saddle



(g) Tellerette



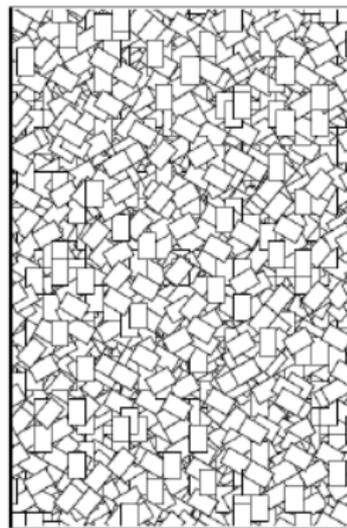
(h) Tri-pack

The packings aim to resolve the conflicting goals of fast flow and large interfacial areas.

Types of Packing Arrangement

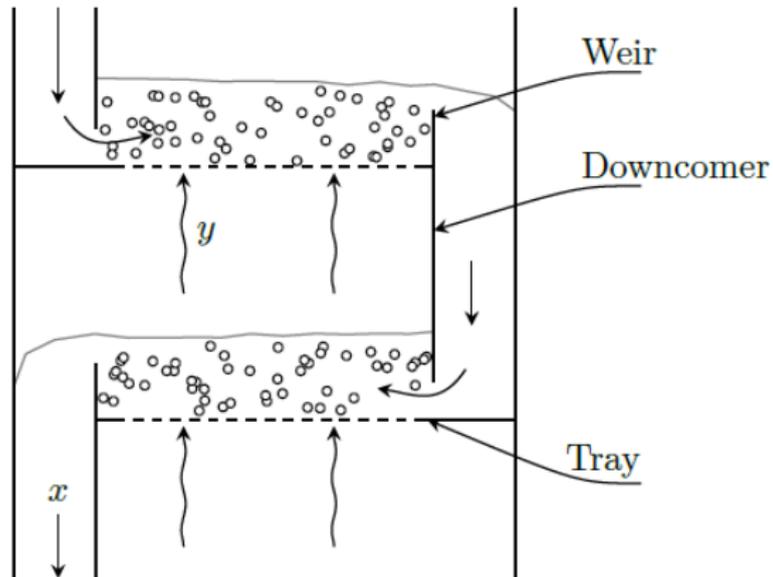


(a) Structured packing

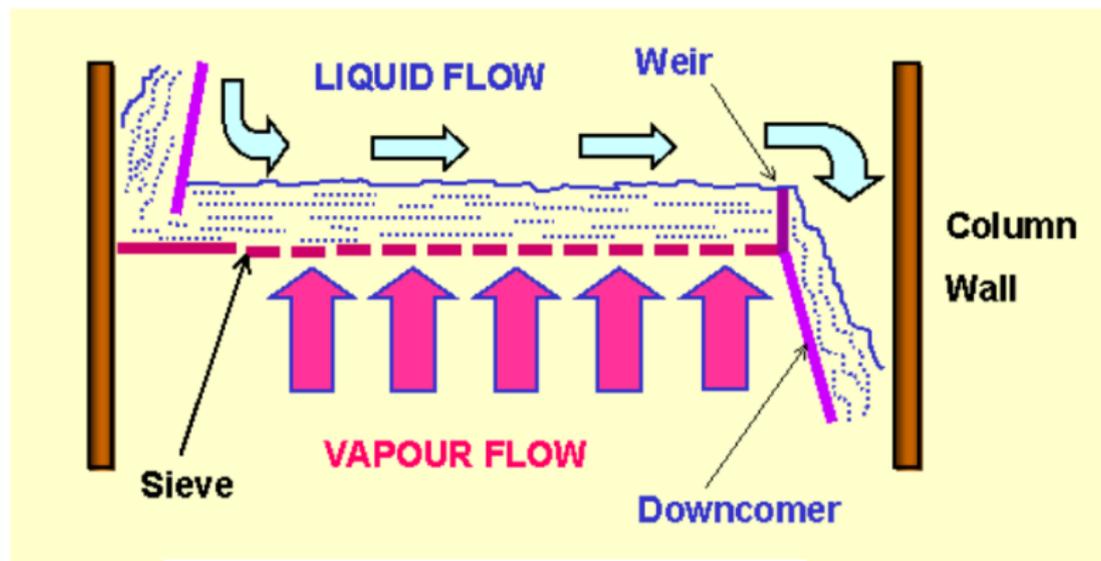


(b) Random packing

Tray Column



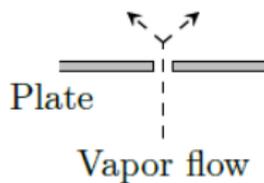
Tray Column (contd..)



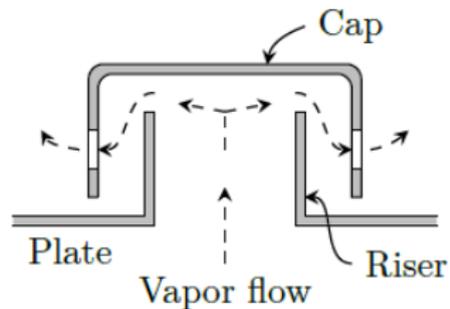
<http://www.separationprocesses.com/Operations/Fig021b.htm>

Tray Column

Types of Trays



(a) Sieve plate



(b) Bubble cap

Choice of Equipments

Plate Towers

- ▶ Provides stage wise contact.
- ▶ Suitable for high capacity.
- ▶ Cooling can be done by providing the plate with cooling coils.
- ▶ Pressure drop is higher.
- ▶ Easy to clean — suitable for dirty liquids.

Choice of Equipments (contd..)

Packed Towers

- ▶ Provides continuous contact.
- ▶ Suitable for smaller capacity.
- ▶ Lower pressure drop is lower compared with plate columns. Hence packed towers are suitable for vacuum applications.
- ▶ Foaming liquids can be handled.
- ▶ More choices in materials of construction for packings makes it suitable for corrosive applications.

As a rule of thumb, plates are always used in columns of large diameters and towers that have more than 20 to 30 stages.

Quiz

1. Differentiate between 'absorption' and 'stripping'.
2. What kind of solvents are used in absorption?
3. Give examples for packing materials for use with a gas-liquid contactor.
4. Compare between 'packed' and 'plate' columns used in gas-liquid contacting.