Introduction to Particle Technology

Ashfaq M Ansery
Lecturer, ChE Department, BUET

What is a Particle?

What is a Particle?

- a minute part of matter

www.sd5.k12.mt.us/glaciereft/geogloss.htm

- a very small speck of solid matter

www.rwater.com/glossary/gloss_mz.htm

- Unit of matter of indeterminate dimensions and volume

www.unistates.com/rmt/explained/glossary/rmtglossarypq.html

What is Particle Technology?

- Techniques for processing and handling particulate solids

Why?

- Most chemical engineers will find themselves working with particles at some point in their professional life

Where?

- Chemical engineers meet particulate solids in carrying out many unit operations
  - Crushing
  - Drying
  - Filtering
  - Crystallization
  - Solid fluid reacting
  - Dust collecting etc

Goals

- Characterize particles and particulate systems
- Identify and design important traditional unit operations

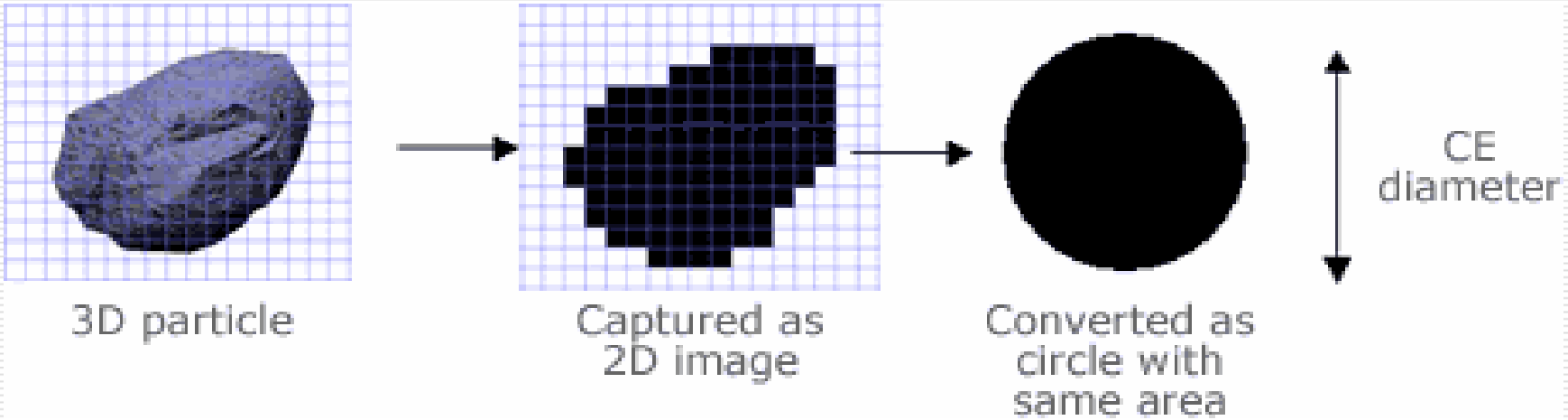
AND

- You will know where to turn to look for more information

Characterization of Solid Particles

- Individual solid particles are characterized by their size, shape, and density

Particle Size



Particle Size

- Diameter of a sphere which has the same property as the particle itself -- that is, the same volume, same settling velocity, etc
- Diameter of a circle which has the same property as the projected outline of the particle -- that is, the same projected area or same perimeter
- Linear dimension measured parallel to a particular direction

Unit

- **Coarse particles**: inches or millimeters
- **Fine particles**: screen size
- **Very fine particles**: micrometers or nanometers
- **Ultra fine particles**: surface area per unit mass, m^2/g

Particle-size Measurement

- Sedimentation
- Microscopy
- Sieving

Laboratory Method for PSM

Method	Approximate Size (μm)	Type of Size Distribution
Gravity Sedimentation	2-100	By mass
Microscopy ➢Optical ➢Electron	 0.8-150 0.001-5	By number
Sieving	37-4000	By mass

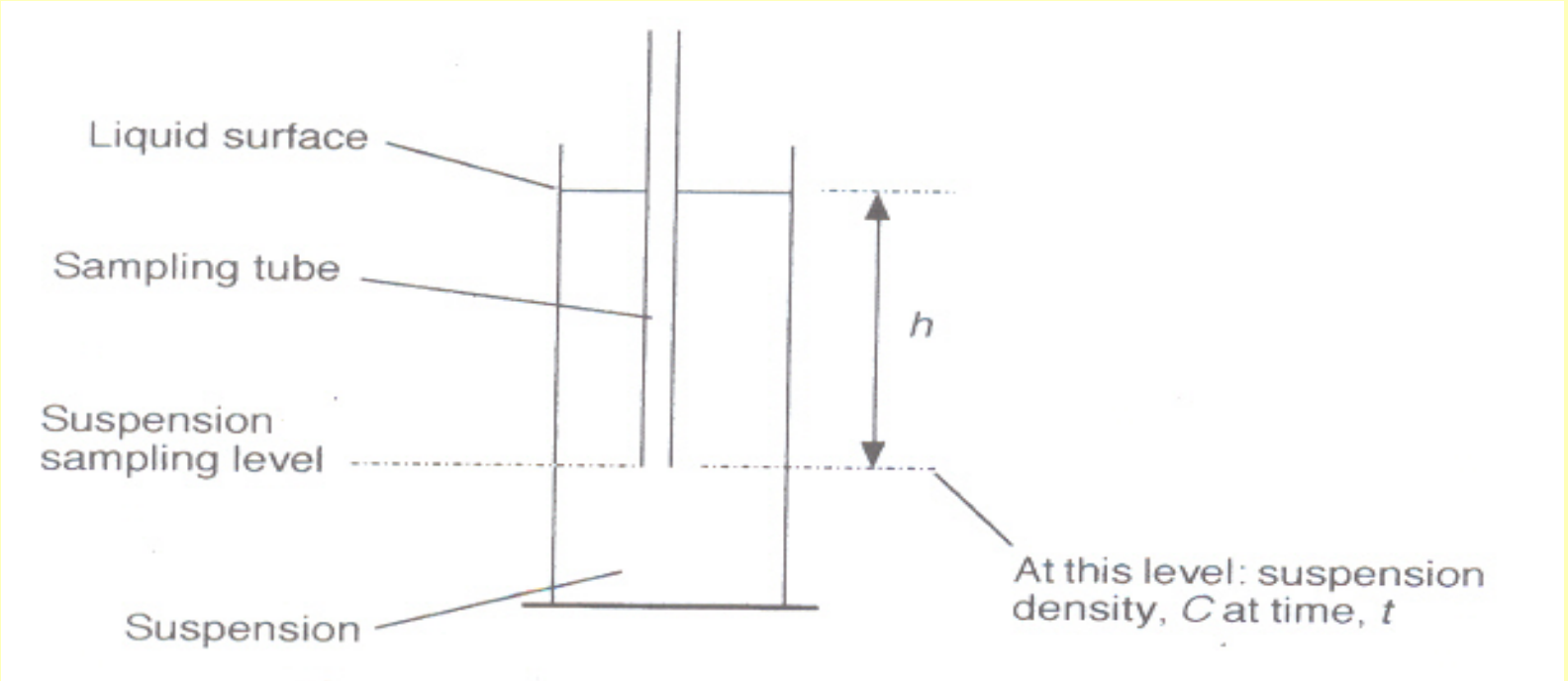
Sedimentation

Assumptions:

- The suspension is sufficiently dilute for the particles to settle as individuals
- Motion of the particles in the liquid obeys Stokes' law ($Re_p < 0.3$, $C_D = 24/Re_P$)
- Particles are assumed to accelerate rapidly to their terminal free fall velocity U_T so that the time for acceleration is negligible

Sedimentation (cont..)

Figure: Size Analysis by Sedimentation



Sedimentation (cont..)

- Terminal Settling Velocity

(from Stokes' law)

$$U_T = \frac{d^2(\rho_p - \rho_f)g}{18\mu}$$

Microscopy

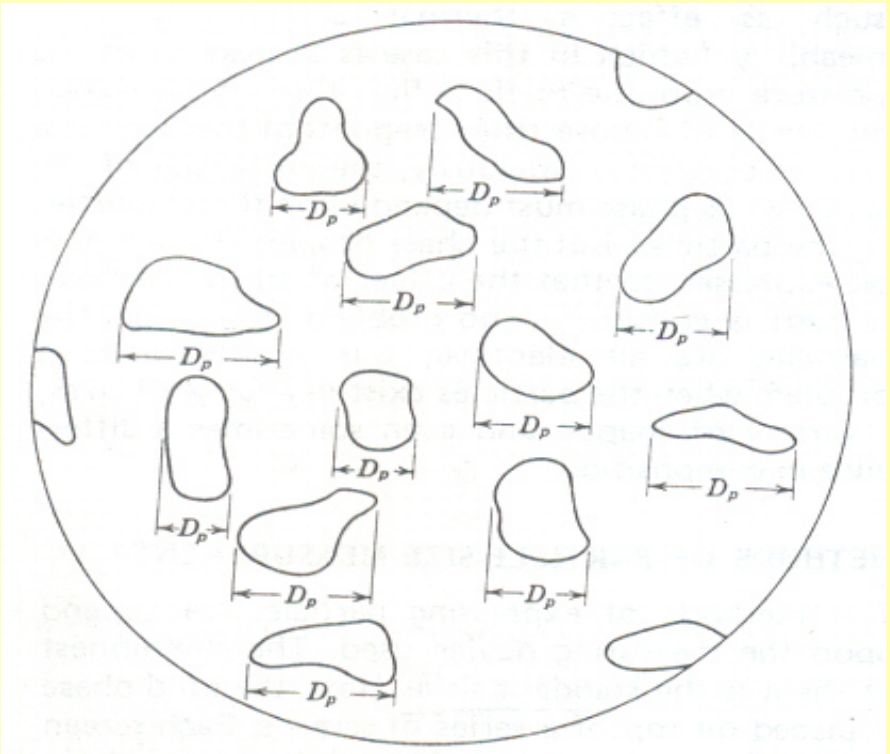
- A sample of the material is put under a microscope
- each particle within the field of vision is measured by an optical micrometer

For irregularly shaped particles

- Choose a direction of measurement and take the longest distance across the particle in this direction

Microscopy (cont..)

Figure: PSM with a Micrometer



Microscopy (cont..)

Advantages:

- The answers obtained are not dependent upon the perfection of a screen
- Agglomeration of particles can be easily detected

Disadvantage:

- Time consuming and extremely laborious

Summary of the Lecture

- What is Particle?
- What is Particle Technology?
- Why are we (**chemical engineers**) interested in this subject?
- What is the goal of this course?
- What do you mean by Particle size?
- How can we measure it?
  - Sedimentation
  - Microscopy

Reference

- Foust *et al*: **Principles of Unit Operations**, second edition, John Wiley & Sons
- Rhodes Martin.: **Introduction to Particle Technology,** John Wiley & Sons, 2004, Page#66-68