Particle Size Measurement

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Sieving

Sieving (cont..)

- Each screen has smaller openings than the one above, usually in $2^{1/n}$ series

$$\frac{D_1}{D_2} = \frac{D_2}{D_3} = \frac{D_3}{D_4} = \ldots\ldots = \frac{D_{n-1}}{D_n} = \ldots = constant$$

constant = $2^{1/4}$ (e.g. 0.0015,0.0017,0.0021 inch)

$2^{1/2}$ (e.g. 0.0015, 0.0021 inch)

Sieving (cont..)

Table: Tyler Standard Screen Sizes

Aperture (in) $(2^{1/2}) \times 10^4$	Aperture (in) $(2^{1/4}) \times 10^4$	Mesh Number	Wire Diameter (in)
29	35	170	0.0024
	29	200	0.0021
21	24	230	0.0016
	21	270	0.0016
15	17	325	0.0014
	15	400	0.0010

Sieving (cont..)

- The sample is placed on top of a series of screens with a lid above
- The stack of screens clamped into a shaker
- Shaking is continued for a fixed time

Sieving (cont..)

- As the sieves are shaken, the particles fall through them until a screen is reached in which the openings are too small for the particle to pass
- The sieves are removed
- The material held on each of the sieves is collected and weighed

Sieving Efficiency

$$Efficiency = \frac{\text{percentage material actual passsing}}{\text{percentage meterial capable of passing}}$$

Factors Affecting the Efficiency

- Rate of feeding
- Particle size
- Moisture
- Worn or damaged screens
- Blinding (clogging) of screens
- Electrostatic charge

Screening terminology

- **Mesh**

  number of openings per linear inch.

For example

  14 mesh will have 14 openings per inch

  12 mesh will have 12 openings per inch

- The higher the mesh number the smaller a particle has to be to pass through the column

Screening terminology

- **Undersize**
- **Oversize**

  e.g. (-10+14) Tyler Mesh

- **Screen aperture**

  e.g. 0.0015 in, 0.0017 in, 0.0021 in

- **Screen interval**

  e.g. $2^{1/2}$, $2^{1/4}$

Screening terminology

- **Diameter of a sieve fraction**

e.g.

Size Range (Tyler Mesh)	Diameter (in)
-10+14	0.0555

Methods of Graphic Presentation of Data

- Histogram
- Fractional Distribution
- Cumulative Distribution

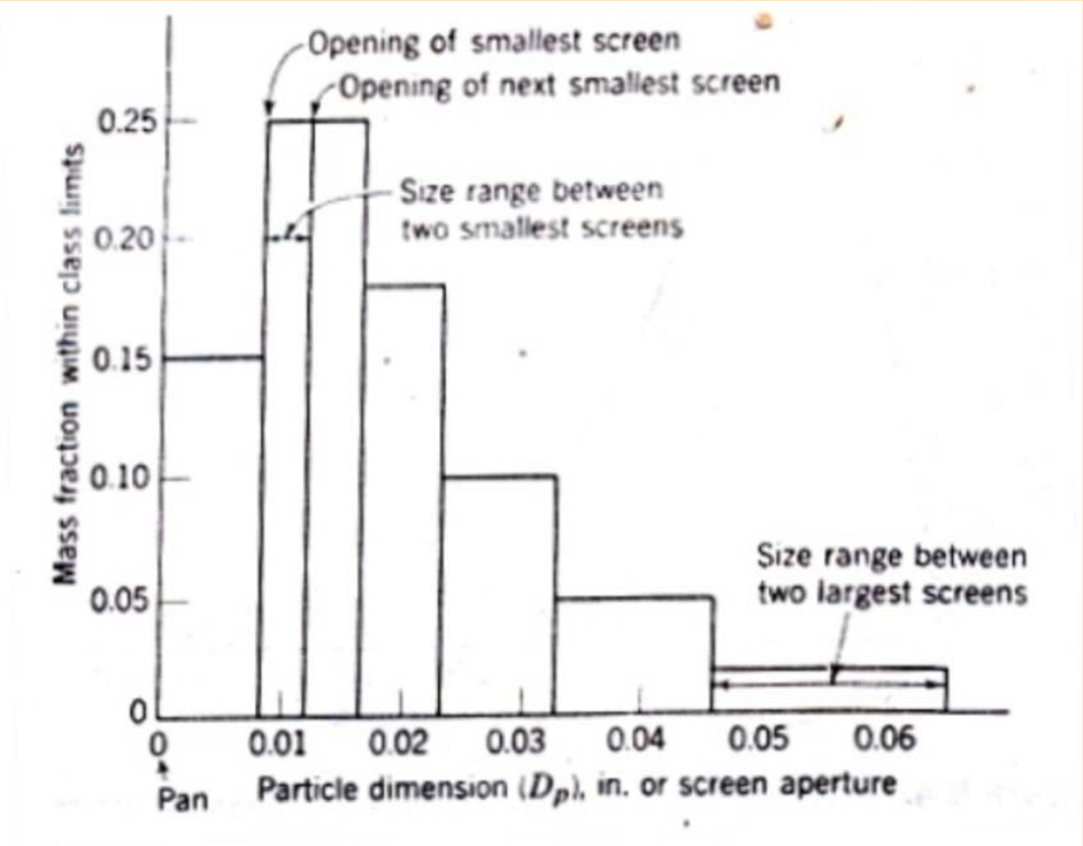
Typical Screen Analysis Data

Size Range	Mass Fraction Retained, wt%
-10+14	2
-14+20	5
-20+28	10
-28+35	18
-35+48	25
-48+65	25
-65	15

Calculated Data

Size Range	Avg Particle Dia, in	Mass Fraction
-0.065+0.046	0.0555	0.02
-0.046+0.0328	0.0394	0.05
-0.0328+0.0232	0.0280	0.1
-0.0232+0.0164	0.0198	0.18
-0.0164+0.0116	0.0140	0.25
-0.0116+0.0082	0.0099	0.25
-0.0082		0.15

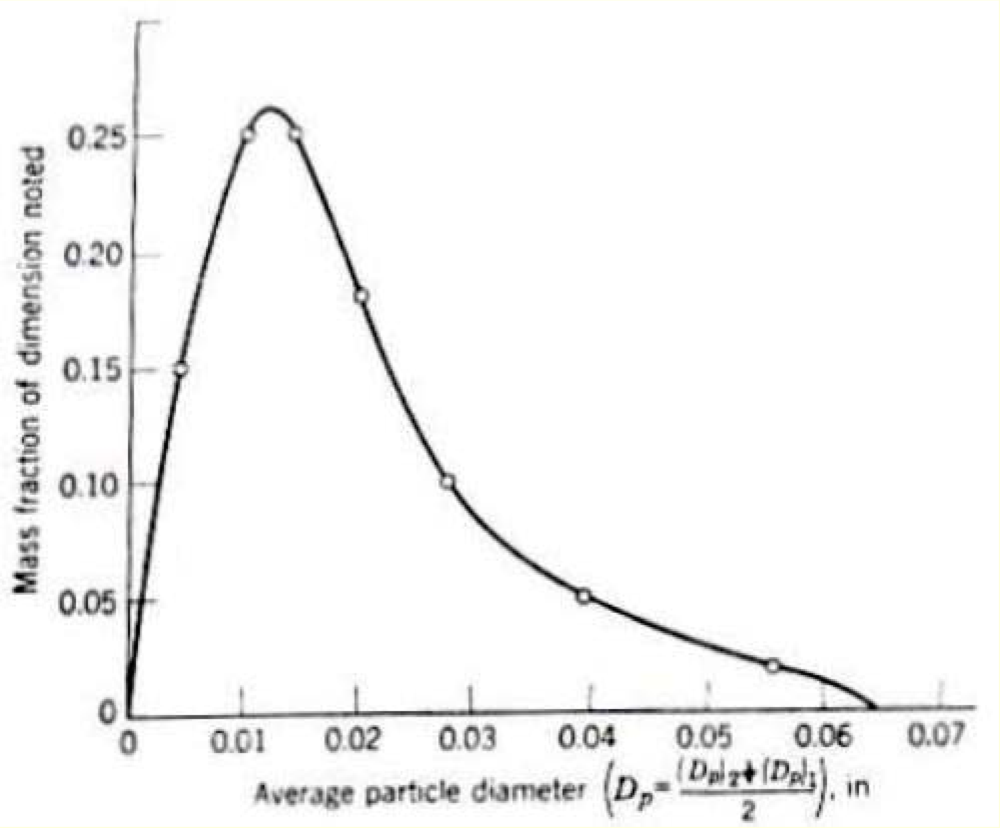
Histogram


Opening of smallest screen
Opening of next smallest screen
Size range between two smallest screens
Size range between two largest screens
Mass fraction within class limits
0.25
0.20
0.15
0.10
0.05
0
0
0.01
0.02
0.03
0.04
0.05
0.06
Pan
Particle dimension (D_p), in. or screen aperture

Histogram

- A bar graph
- Good pictorial method
- Shape greatly effected by sieve interval
- Grain size parameters (skewness, kurtosis) cannot be computed from histogram

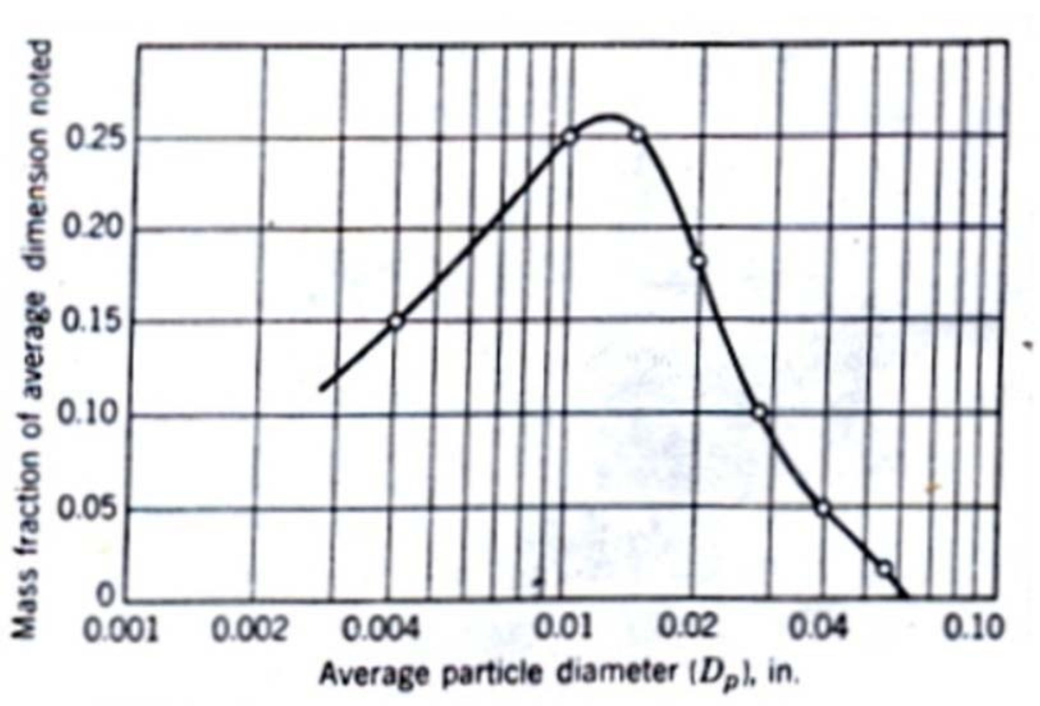
Fractional Distribution



Fractional Distribution

- A “smoothed-out” histogram
- Good pictorial method
- Independent of sieve interval
- Grain size parameters cannot be computed from this curve

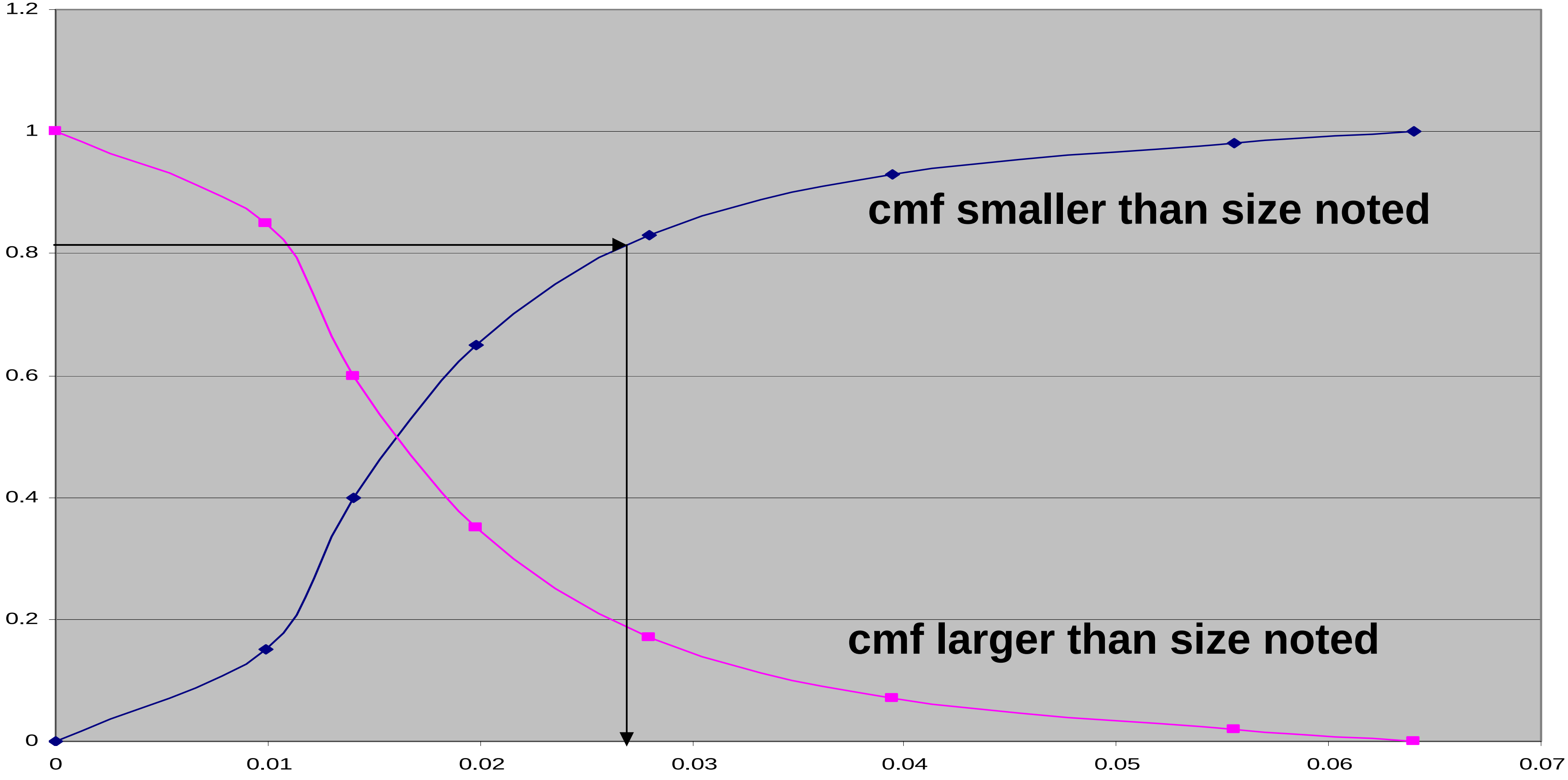
Semi logarithmic Coordinate



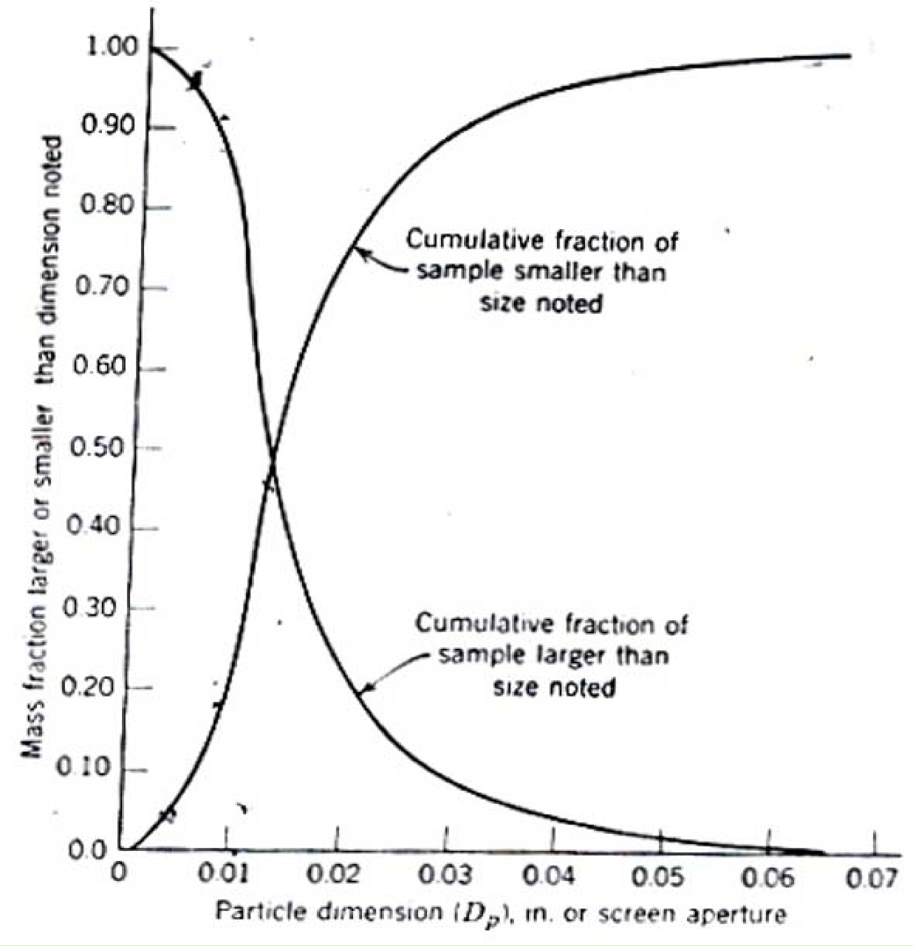
Cumulative Distribution

Avg Particle Dia, in	Mass Fraction x_i	Cumulative MF smaller than size noted	Cumulative MF larger than size noted
		1	0
0.0555	0.02	0.98	0.02
0.0394	0.05	0.93	0.07
0.0280	0.1	0.83	0.17
0.0198	0.18	0.65	0.35
0.0140	0.25	0.4	0.6
0.0099	0.25	0.15	0.85
	0.15	0	1

Cumulative Distribution



Cumulative Distribution



Cumulative Distribution

- More difficult than histogram or frequency curve to interpret at a glance
- Independent of sieve interval
- Grain size parameters can be computed from this curve

Summary of the Lecture

- Sieving
- Different screening terminology
  - Undersize & Oversize
  - Screen aperture & Wire mesh etc.
- Graphic presentation of data
  - Histogram
  - Frequency curve
  - Cumulative distribution curve

Reference

- Foust *et al*: **Principles of Unit Operations**, second edition, John Wiley & Sons, Page#699-703