Chemical Engineering (Thermodynamics I) (UCH305)

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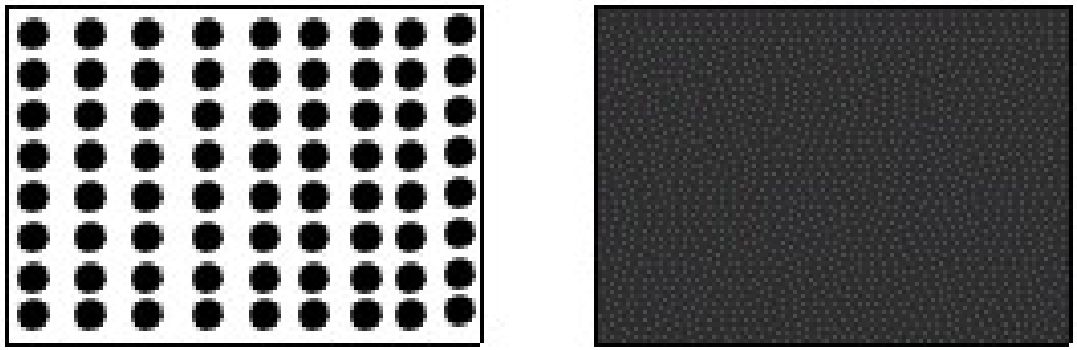
Lecture 2

Concept of Continuum

Concept of Continuum

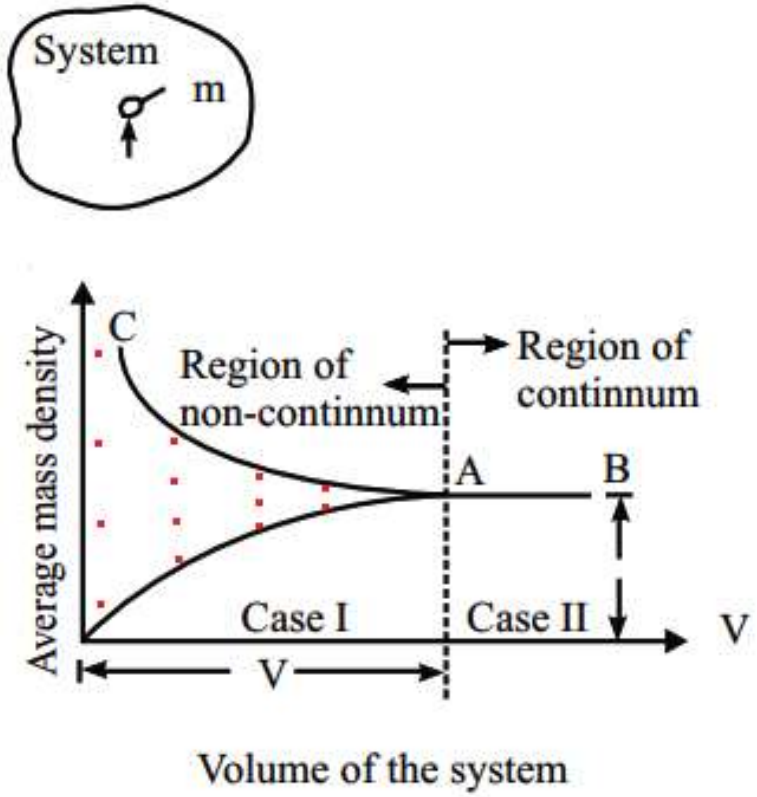
Matter is made up of atoms that are widely spaced in the gas phase. If we disregard the atomic nature of a substance and view it as a continuous, homogeneous matter with no holes, that is, called continuum hypothesis.



(a) (b)

- Concept of continuum gives the criteria to apply the *macroscopic viewpoint*.
- This idealization allows us to treat properties as *point functions* and to assume the properties vary continually in space with no jump discontinuities.

Concept of Continuum…..



- Concept of continuum gives the *minimum volume which must be considered* so the system should be continuous and averaging is meaningful.

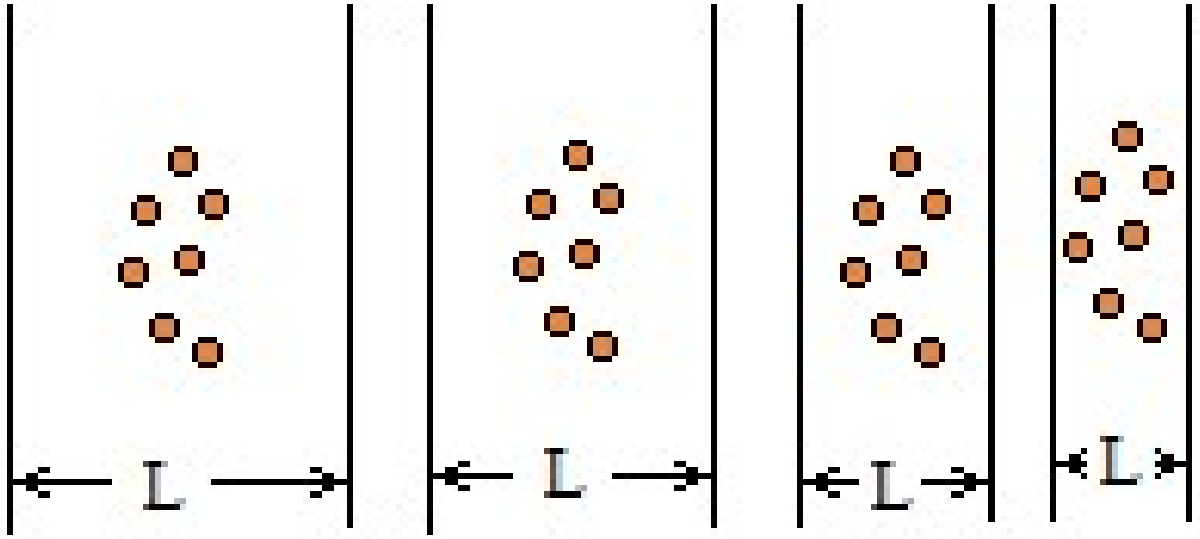
Quantification of range of validity of Continuum hypothesis

$$Knudsen\ Number, Kn = \frac{\lambda}{L} = \frac{mean\ free\ path}{Characteristic\ length};\ limit\ of\ 0.01$$

This idealization is valid as long as the size of the system we deal with is large relative to the *space between the molecules* (mean free path of the molecule).

Effect of characteristic length on continuum hypothesis

At atmospheric pressure for Nitrogen, $\lambda = 59$ nm



L	100 mm	1 mm	10 micron	1 micron
λ/L	5.9×10^{-7}	0.000059	0.0059	0.059

References

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3. *Nag, P.K., Engineering Thermodynamics, Tata McGraw Hill (2008) 3rd ed.*
4. *Cengel, Y. A. and Boles, M., Thermodynamics: An Engineeing Approach, Tata McGraw Hill (2008).*

Thank you for your Patience