

## SNS COLLEGE OF TECHNOLOGY



(An Autonomous Institution)
19ASE304/ Heat Transfer

Unit -2/ Flow across tube banks, Turbulent flow over flat plate and flow through pipes

## **Flow Across Tube Banks**

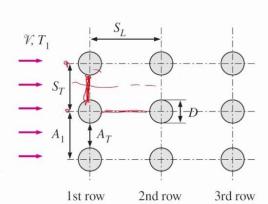
- For in-line arrangement
  - The conservation of mass can be expressed as

$$\rho \mathcal{V} A_1 = \rho \mathcal{V}_{\text{max}} A_T$$

$$\mathcal{V} S_T = \mathcal{V}_{\text{max}} (S_T - D)$$

Then the maximum velocity becomes

$$\mathcal{V}_{\text{max}} = \frac{S_T}{S_T - D} \mathcal{V}$$



$$A_1 = S_T L$$

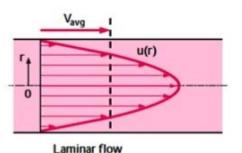
$$A_T = (S_T - D)L$$

$$A_D = (S_D - D)I$$

## Turbulent Flow in Pipes

## **Turbulent Velocity Profile**

- The velocity profile is parabolic in laminar flow but is much fuller in turbulent flow, with a sharp drop near the pipe wall.
- Turbulent flow along a wall can be considered to consist of four regions, characterized by the distance from the wall. The very thin layer next to the wall where viscous effects are dominant is the viscous (or laminar or linear or wall) sublayer.



Turbulent layer
Overlap layer

Buffer layer
Viscous sublayer