

10.WEEK

CHE 212 FLUID MECHANICS

Assoc.Prof. Dr. Ayşe Karakeçili

**Ankara University
Chemical Engineering Department**

Flow Past Immersed Objects

Fluid flow:

1. Inside conduits or pipes ✓
2. **Around solid, immersed bodies**

The flow of fluids outside immersed bodies occurs in many chemical applications such as: flow past spheres in settling, flow through packed beds in drying and filtration, flow past tubes in heat exchangers and so on.

Flow of fluid:

- ✓ The solid may be at rest; the fluid flowing past it (packed beds)
- ✓ The fluid may be at rest; the solid moving through it
- ✓ Both may be moving

Relative velocity

Flow Past Immersed Objects

Friction factor (f):

for flow through conduits

$$f = \frac{\text{wall shear}}{\text{density} \times \text{velocity head}}$$

$$f = \frac{\tau_w}{\rho(v^2/2)}$$

Drag coefficient (C_D):

for immersed solids

$$C_D = \frac{F_D / A_p}{\text{density} \times \text{velocity head}}$$

$$C_D = \frac{F_D / A_p}{\rho(v^2 / 2)}$$

Flow Past Immersed Objects

For $Re_p > 20$

Separation occurs

For high Re ($10^3 < Re_p < 3 \times 10^5$)

$C_D = 0.40-0.45$

Front boundary layer is still laminar

For high Re ($Re_p > 3 \times 10^5$)

$C_D = 0.10$

Front boundary layer becomes turbulent