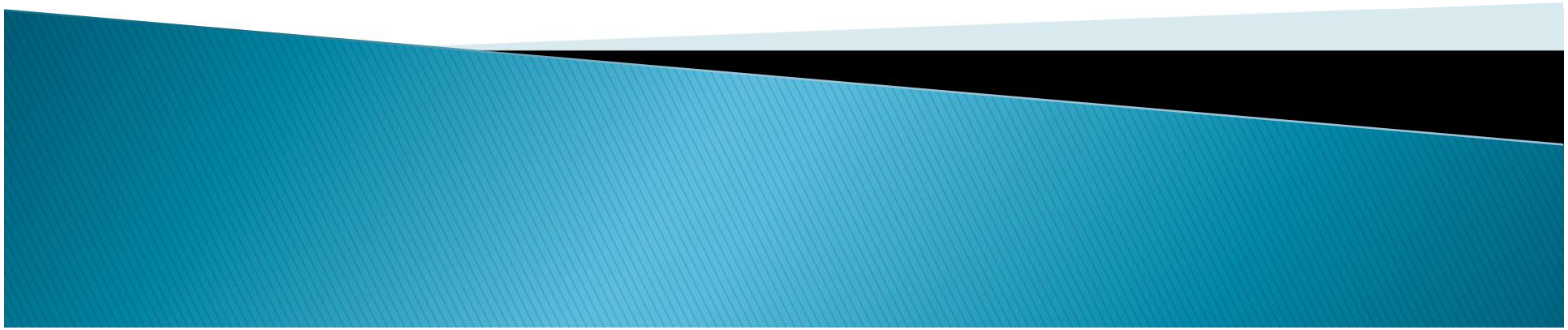
FDE 205 Fluid Mechanics

4.10.2012



TYPES OF FLUID FLOW AND REYNOLDS NUMBER

- There are two types of fluid flow in fluid mechanics
- Laminar flow (laminer akış)
- Turbulent flow (türbülanslı akış)
- Reynolds number is used to characterize the type of the flow.

- In other words, to determine if the fluid is laminar or turbulent we calculate Reynolds Number.

- Laminar Flow: The first type of flow, at low velocities, where the layers of fluid seem to slide by one another without eddies or swirls being present.

- (Akım hatları birbiri üzerinde kayan ince tabakalar halindedir ve bu tabakalar arasında karışma yoktur. Düşük akış hızlarında görülür.)

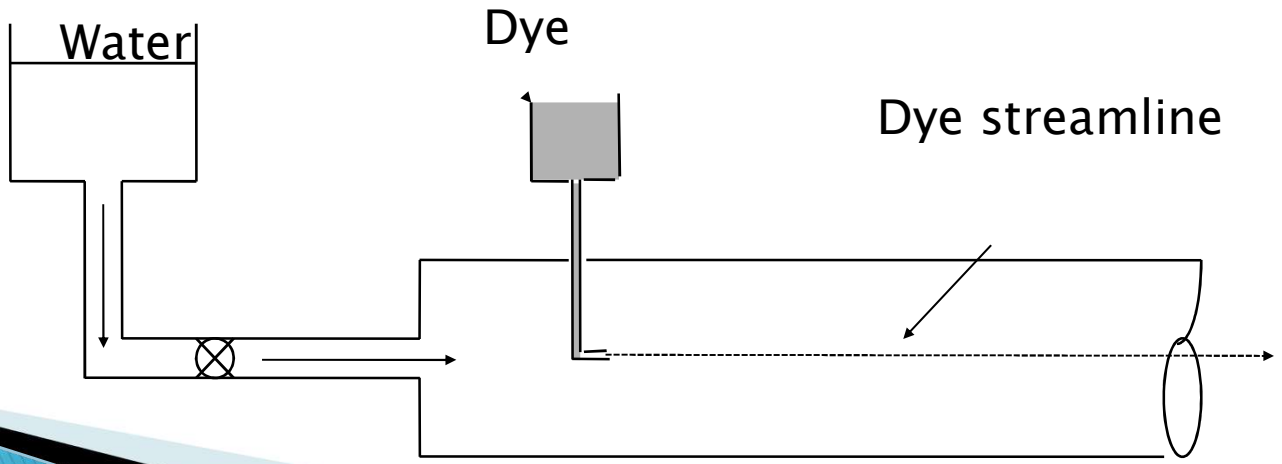
- Turbulent Flow: The second type of flow, at higher velocities, where eddies are present giving the fluid a fluctuating nature.

- (Türbülanslı Akış: Yüksek akış hızlarında görülür. Akım hatları düzensiz, tabakalar arasında karışmalar ve girdaplar görünür.)

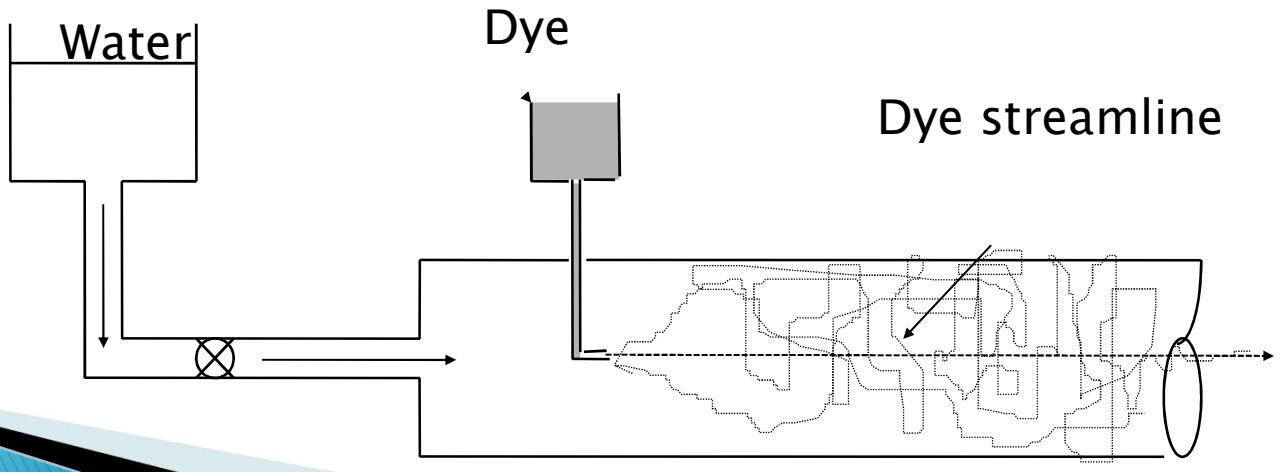
- The existance of laminar and turbulent flow is most easily visulized by the experiemnts of Reynolds.

- He allowed water to flow at steady state through a transparent pipe with the flow rate controlled by a valve. A fine, steady stream of dyed water was introduced from a fine jet and its flow pattern was observed.

- At low rates of water flow, the dye pattern was regular and formed a single line or stream similar to a thread. There was no lateral mixing of the fluid, and it flowed in streamlines down the tube. (Laminar Flow)



- As the velocity of the water was increased, it was found that at a definite velocity the thread of dye became dispersed and the pattern was very erratic. (Turbulent flow)



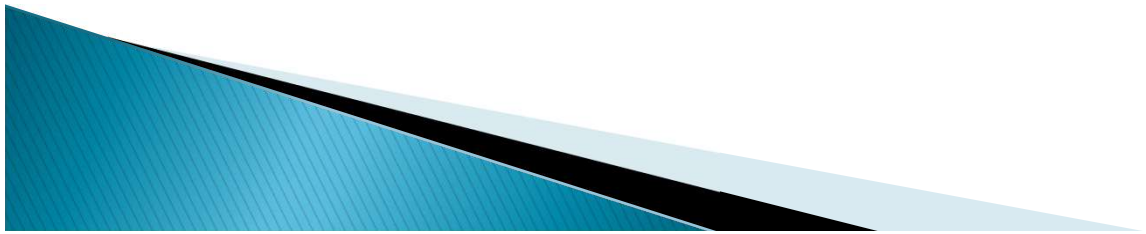
- The velocity at which the flow changes is known as **critical velocity.**

- Reynolds found that the transition from laminar to turbulent flow in tubes is not only a function of velocity but also of density and viscosity of the fluid and the tube diameter.

$$\mathrm{Re} = \frac{D < v > \rho}{\mu}$$

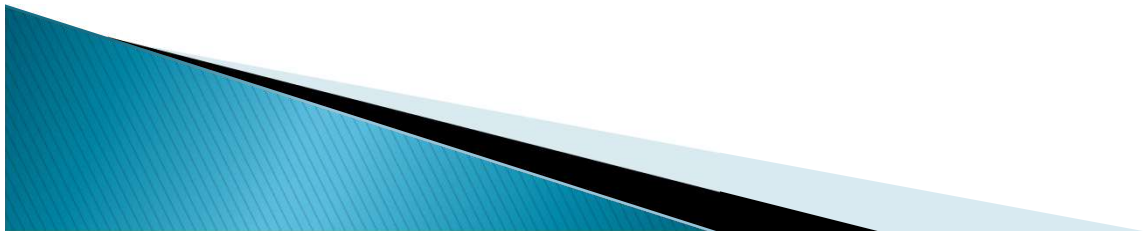
- Reynolds number is a dimensionless number.

- Re<2100 Laminar Flow
- 2100<Re<4000 Transition Region
- Re>4000 Turbulent Flow



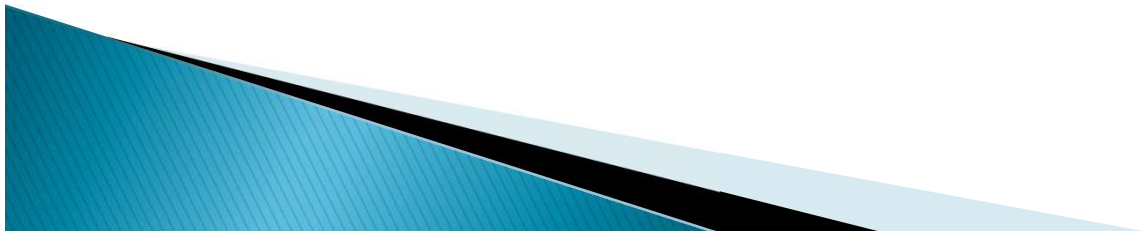
Example 1)

- Oil with a density of 850 kg/m^3 and viscosity of 0.03 Pa.s is flowing inside a pipe that has a dimater of 50 mm. If the average velocity of the oil is 0.75 m/s, what would be the type of the flow?



Example 2

- Water at 30°C is flowing at a rate of 0.01 m^3 /min in a pipe having an inside dimater of 0.05m. Re=?



Example3)

- You are working as a Food Engineering in Dairy Factory. Your boss wants you determine the maximum diameter of the pipe that you can use to transfer the milk with a laminar regime inside the plant.
- Temperature of the milk:293K
- Viscosity of the milk: 2.12cp
- Density of the milk: 1030 kg/m^3
- Milk flow rate: 0.605 kg/s