Resistance in the Fluid System

Overview
Resistance in the Fluid System

1. What causes resistance in the fluid system?
   
   - there are two sources of resistance
   
   - 1. Friction between outer layer of fluid and the walls of a pipe or duct

   - 2. Friction between fluid layers within the fluid itself
2. What effect does friction have on the fluid?

- It causes both the flow rate and pressure to drop along the pipe.
- Remember from Rate in FS – longer hoses result in slower flow rates and lower pressure.
Resistance in the Fluid System

- There are 2 main forms of fluid flow:
  
  - Turbulent
  
  - Laminar
Resistance in the Fluid System

3. What is a smooth flow fluid?
- fluid where the layers of the fluid are not mixing together
- the fluid flows smoothly, creating very little friction between the layers
- also known as “laminar flow”
Resistance in the Fluid System

4. Why do the layers in the middle of laminar flow fluids travel faster?
- they are not affected by the friction between the fluid and the pipe
Resistance in the Fluid System

5. What is a turbulent flow fluid?
- the layers of the fluid are moving in a disordered pattern that creates eddies and swirls
Resistance in the Fluid System

6. **What is the effect of the turbulent flow?**
   - there is more resistance for the fluid to overcome
   - the fluid moves slower and at lower pressure

7. **Are most fluids laminar flow or turbulent flow?**
   - fluids are assumed to be laminar flow unless it is specified to be turbulent flow
Resistance in the Fluid System

8. When *comparing pressure in a pipe*, where is the pressure the greatest?
- the pressure is always higher at the inlet than the outlet

9. *Why is this the case?*
- due to resistance along the pipe, the pressure drops as the fluid travels through the pipe
10. How can the fluid resistance be defined?

Fluid Resistance = \[ \text{Pressure Drop} \]

\[ R_F = \frac{\Delta p}{Q_v} \]

** pressure drop is used rather than pressure difference, but it is the same thing**
Resistance in the Fluid System

- How do you read a fluid resistance graph?

\[ \text{Slope} = \text{flow resistance} \quad R_F \]
11. What are the units of fluid resistance?
- unit of pressure / unit of flow rate
  - English – lb/in$^2$
  - SI – N/m$^2$
- gal/min
- m$^3$/sec
12. Example – Fluid flows through a length of pipe at a flow rate of 0.05 m³/sec. It undergoes a pressure drop of 1000 N/m². What is the fluid resistance ($R_F$) of the pipe?

- $R_F = \Delta p = 1000 \text{ N/m}^2 = 20,000 \text{ N/m}^2$
- $Q_V = 0.05 \text{ m}^3/\text{sec}$
Resistance in the Fluid System

Practice: A length of hose has a flow rate of 5 gal/min when the pressure drop from one end of the hose to the other is 20 lb/sq in. What is the fluid resistance of the hose?

Solution:
- \( R_F = \frac{\Delta p}{Q_v} \)
- \( R_F = \frac{20}{5} = 4 \text{ lb/sq in/(gal/min)} \)
Resistance in the Fluid System

13. What three factors affect fluid resistance?
   1. area and length of the pipe
   2. type of fluid flowing
   3. inside finish of the pipe
Resistance in the Fluid System

14. What is the affect of pipe area and length on fluid resistance?

- pipes with larger area have less resistance than pipes with smaller areas
- longer pipes have more resistance than shorter pipes
Resistance in the Fluid System

15. **What is the affect of the type of fluid on fluid resistance?**
- fluids with lower viscosity have less resistance than fluids with high viscosity

16. **What is viscosity?**
- how thick or thin a fluid is
- alcohol has very low viscosity; syrup has very high viscosity
Resistance in the Fluid System

17. What is the affect of the inside of the pipe on fluid resistance?

- smoother pipes have less resistance than a rough pipe
- clean pipes have less resistance than a pipe with scale buildup
18. What are two sources of resistance in air ducts?
- constriction and a filter

19. What is constriction and what is its affect?
- constriction is the blockage of a duct
- it increases resistance
20. What affect does a filter have on fluid resistance?

- a filter reduces the amount of air that flows, increasing resistance
- a dirty filter has a greater resistance
- a clogged filter can almost stop airflow; can damage equipment
21. If pipes are adding together in a series, what is the affect?

- the resistance is added to together, so it is increased

22. If pipes are connected in parallel, what is the affect?

- this increases the area, so resistance is reduced and flow rate increased