Fall 13 - Homework Assignment #1 – Due: Wed., 4 September

* List five everyday examples of the application of fluid mechanics. Please provide comprehensive details of how fluid mechanics is involved and list appropriate references.
  1. **Water Tower**
     1. The purpose of a water tower is to provide water pressure to maintain the safe supply of water to an entire town or one building. The water tanks are usually placed at very high elevations because that will provide the most pressure [1]. This is because Concepts from fluid statics state that the pressure is directly proportional to change in height. So an increase in elevation means an increase in pressure [2].
  2. **Race Car**
     1. The design of a race car applies concepts from both fluid mechanics and Computational Fluid Dynamics (CFD). Fluid dynamics is used in the design of the chassis and the front and rear wings. CFD is used to model the airflow over the car. This model is needed for figuring out the aerodynamic efficiency and achieve the most effective race car design [3].
  3. **Hydraulic machines**
     1. A basic hydraulic machine consists of a two cylindrical pistons with a fluid inside of it, typically oil. Fundamentally hydraulic machines operate on something known as “hydraulic multiplication”. In terms of the piston machine, hydraulic multiplication involves two pistons of unequal sizes and the forces exerted on both on them. Applying a force on one piston will cause a greater force to the other piston. This happens because of Pascal’s principal, which states that “Pressure is transmitted undiminished in an enclosed static fluid”. Since the fluid inside a hydraulic machine is at rest, this means that the pressure inside the machine can be assumed to be constant. So applying a force to a smaller piston produces the larger force on a larger piston [4].
  4. **Submarine**
     1. Submarines use laws from fluid statics in everyday operation. As the submarine transitions from going below sea level to the surface or vice versa, it experiences a lot of pressure and forces on its exterior walls. One of the most important forces that a submarine encounters is the buoyant force. This force prevents the submarine from sinking all the way down to the ocean floor. When diving down underwater the ballast and trim tanks are filled with water to increase the submarine’s density. This increases its weight to counter the buoyant force and thus it sinks [5].
  5. **Airplanes**
     1. Fluid dynamics has widespread applications in airplane flight. One way that fluid dynamics is applied is in the study of drag on an airplane while it is in flight. Drag is an aerodynamic force that opposes the airplane’s motion and it is caused by a difference in the speed of the airplane and the speed of the air. The value of drags depends on the viscosity of the air and the viscous forces opposing the flow of the air. These factors are used to calculate the Reynolds Number for the air. The Reynolds number determines whether the airflow is laminar or turbulent. A low Reynolds Number means the flow is more laminar because the viscous forces are higher, while a high Reynolds number means the flow is more turbulent, because the viscous forces are smaller. Turbulent airflow is what causes the airplane to jolt back and forth and this is the phenomenon known as “turbulence”.

References

[1] Marshall, B., n.d., “How Water Towers Work” from <http://www.howstuffworks.com/water.htm>

[2] TutorVista.com, "Pascal's Law.", n.d., from <http://www.tutorvista.com/physics/pascal-s-law-for-kids>

[3] Quora, “How are Thermodynamics and Fluid mechanics involved in an F1 racecar”, n.d. from

<http://www.quora.com/Formula-1-1/How-are-Thermodynamics-and-Fluid-mechanics-involved-in-an-F1-racecar>

[4] Marshall B., n.d., “How Hydraulic Machines Work”, from <http://science.howstuffworks.com/transport/engines-equipment/hydraulic.htm>

[5] from <http://hyperphysics.phy-astr.gsu.edu/hbase/pasc.html>

[6] Marshall B. and Freudenrich C. Ph.D, n.d., “How Submarines Work”, from

<http://science.howstuffworks.com/transport/engines-equipment/submarine.htm>

[7] National Aeronautics and Space Administration, n.d., “What is Drag”, from <http://www.grc.nasa.gov/WWW/k-12/airplane/drag1.html>

[8] National Aeronautics and Space Administration, n.d., “Reynolds Number”, from <http://www.grc.nasa.gov/WWW/k-12/airplane/reynolds.html>

[9] from <http://www.efm.leeds.ac.uk/CIVE/CIVE1400/Section4/laminar_turbulent.htm>

* Solve the problems below that relate to the conversion of units from one system to another. Please show details of your work.

1.20, 1.21, and 1.22

**Problem 1.20:**

Part a:

Part b:

Part c:

Part d:

Part e:

**Problem 1.21:**

Part a:

Part b:

Part c:

Part d:

Part e:

**Problem 1.22:**

Part a:

Part b:

Part c:

Part d:

Part e: