2021Q23 (HYDRAULICS)

Here at One Energy, we use hydraulics for a multitude of things. Importantly, hydraulics are used to power many components of the machinery that we use to construct wind turbines. From the lifts to the steering and braking, hydraulics allow the machines to perform functions vital to their roles. But how do these hydraulics work?

A hydraulic system applies force to certain areas via pressurized incompressible fluids inside a container. An incompressible fluid is one that cannot be compressed at all; it cannot be made denser by pushing it together. In the real world, this container is usually a cylinder, and the fluid is always a liquid. Hydraulics help systems do work which means the systems enact a force on objects across a certain distance. The work done at both ends of the container must be the same. We can simplify the work equation to the following where F stands for force, d stands for distance, and W stands for work. The numbers one and two refer to the two sides of the container that work is being measured at.

$$W_1 = W_2 \rightarrow F_1 d_1 = F_2 d_2$$

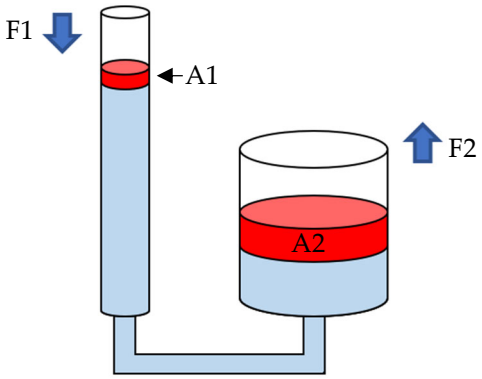
The unit of work is joules. The force being applied is measured in newtons, and the distance is measured in meters. The sides are arbitrary since they are equal regardless.

Another property of hydraulic systems is that pressure is equal at both ends. As we have shown above, we can simplify this formula into its individual components; using Pascal's Law, which states that pressure is equal to force over area, we get:

$$P_1 = P_2 \rightarrow \frac{F_1}{A_1} = \frac{F_2}{A_2}$$

The unit of pressure is Pascals or PSI (pounds per square inch) or pounds per square foot. This means that if we keep force constant and decrease the area on one side, one of two things will happen on the other side. Either the force increases, or the area decreases. That is the basics of hydraulics. We can apply a small force to a large area and get a much larger force if we decrease the area at the other end of a container hosting a fluid.

This is a diagram of a system that uses hydraulics. Because A1 is smaller than A2, F2 will be smaller than F1!



WIND STUDY

Wind Study is intended for grades 5-8 and 8-11
Questions posted on: Monday Answers posted on: Friday
Find downloadable one pagers at www.oneenergy.com/one-energy-feed

Level 1: A mechanic at One Energy uses hydraulic jacks to lift cars. If the mechanic applies a force of 735 lb to an area of 0.75 ft^2, what force will the other side of the cylinder exert on the car if it has an area of 3.5 ft^2? What is the pressure throughout the hydraulic container? You will need the following equation.

$$F_2 = A_2 \frac{F_1}{A_1}$$

This equation is a rearranged version of Pascal's Law.

Level 2: A hydraulic system has two sides: side A and side B. If you keep the force on side A constant, keep the area of side B constant, and increase the area on side A by a factor of 3, how much would you have to decrease the force on side B to maintain an equal pressure?

Lots of our equipment utilizes hydraulics. This mini-excavator uses hydraulics to help it control its arm.