Hydraulics Problems

Set 1 -- Three main formula

These formula help you determine the:

a. Pressure (PSI)
b. Force (lbs.)
c. Area (sq in)

To determine anyone of these you must know the other two.
The formula for each is:

a. Pressure = Force / Area  \quad P = \text{PSI}
b. Force = Pressure X Area  \quad F = \text{lb.}
c. Area = Force / Pressure  \quad A = \text{square inches}

To determine piston diameter you will need the following formula.

Area of the piston is \( = 0.7854 \times d^2 \) (d = Diameter)

Example Problems:

1. A piston with a 6 inch diameter has how many square inches?

   6 squared \( \times 0.7854 = 28.274 \text{ sq inches} \)

2. How many pounds could be lifted by a driven piston with 10 sq. inches if it was driven by a piston that had 50 pounds of force on it and the area of the drive piston is 2 sq. in.? Formula to use is --- \( F = P \times A \)

   Ask yourself these questions:
   1. What is the PSI of the drive piston? \( \_\_\_\_\_\_\_\_ \)
      50 lbs on 2 sq inches would = 25 psi

   2. Pounds to lift? \( \_\_\_\_\_\_\_ \) 25 PSI X 10 sq inches (driven piston)\( \_\_\_\_\_\_\_\_ \)

   3. Answer = 250 pounds could be lifted

3. What size driven piston would be required to lift 800 pounds if you had a drive piston that had 100 PSI?
   Formula to use is --- \( A = F/P \)

   800 lbs. / 100 PSI = 8 sq inches
**2nd SET** of formulas deal with speed of travel, area of piston and vol of fluid for a given time period.

The following formula help you determine the

a. Speed of travel

b. Volume of fluid displaced in a given time

c. Area of a piston head

Note: Displacement = Distance traveled of drive (or driven piston) X Area of the piston

Ex. = 4 inches X 2 sq. inches = 8 cubic inches

To determine anyone of these you must know the other two.

The formula for each is:

a. Speed = Vol/time / Area (inches/minutes)
b. Vol/time = Speed X Area (cubic inches/minute)
c. Area = Vol/time / Speed (square inches -- area of piston head)

Example problems:

First all times have to be convert to the measurement of a minute.

1. If a drive cylinder with 2 sq. inches moves 10 inches in 20 seconds how many cubic inches does it move in one minute? Which formula to use? Answer is "b"

   2 sq inches X 30 inches/minute = 60 cubic inches

2. If a cylinder displaces 800 cubic inches of fluid/minute and has an area of 4 sq inches what is the speed of travel of the cylinder? Which formula to use? Answer is "a"

   800 cubic inches/minute / 4 sq inches = 200 inches/minute

3. If a cylinder displaces 1200 cubic inches of fluid/minute and moves 30 inches in 20 seconds, what is the area of the piston? Which formula to use? Answer is "c"

   1200 cubic inches / 90 inches/minute = 13.33 Square inches

Most pumps and motors are not rated in cubic inches / minute. they are rated in Gallon/ minute. to covert Cubic inches/ minute to gallons / minute you divide by 231.

Example: in the problem above the 1200 cubic inches would be divided by 231 which would = 5.194 GPM
Part 3

3rd Set The last thing that you might need to know how to do is to select a pump with a given output or given horsepower. The horsepower would be that of the electric motor which drives the pump.

Using the Formula $hp = Gpm \times PSI \times .0007$ you can determine the horsepower of the electric motor need that is used to drive the pump. In most cases you will have to solve for GPM and PSI.

Example problem:

If you had to select a pump that would lift 10,000 pounds, a distance of 10 inches in 20 seconds what size cylinder would you select? The area of the piston is 8 square inches

What is the pump output in PSI? $\frac{10000}{8} = 1250$ PSI

$\frac{PSI}{F/A}$

What must be the flow rate in GPM? $1.39$ $\frac{10 \text{ in/20 sec} = 30 \times 8 = 320 \text{ Cubic inches / min}}{320/231 = 1.39}$

Using the Formula $hp = Gpm \times PSI \times .0007$ how many horsepower would the motor need? $1.21$

Check your answer with the chart at the bottom.

Note: If you are going to figure horsepower using this formula then you must have the GPM and PSI given or you must calculate it as stated in the previous formular.