Lab 2: Cylinder actuator

Objective
To study the flow rate / speed relationship of a cylinder actuator and to gain experience in using MATLAB for data analysis. Specifically, you will determine the major (cap-side) and minor (rod-side) areas of the cylinder actuator. You will also learn about least squares method of curve fitting.

Description
The directional valve is used to control the direction of motion of the piston. The needle valve can be used to control the fluid flow rate, and thus the piston velocity. Determine the areas, $A_1$ and $A_2$ of the cylinder using the flow rate ($Q_a$) and the speed of the cylinder-piston ($v$).

Pre-lab exercise – Due as a hardcopy at the beginning of lab
1. Study the schematic above and describe in a paragraph how a cylinder actuator operates.
2. Suppose that the cap-side area of the cylinder is $A_1$ (cm$^2$), and the measured flow rate is $Q_a$ (gpm). Write an equation for the extension speed of the piston, $v$, in both (in/s) and (cm/s).
3. Give a brief description of the least squares method and provide a simple equation to perform linear regression.

Procedure
1. Assemble the circuit shown above.
2. Develop a method for determining the cap-side and rod side areas. (Consider what dictates the velocity of the actuator and then decides what to vary and what to measure. You can consider the pump as providing a constant flow rate when the system pressure is below ~500psi.).
3. For accuracy, repeat your method for various “settings” of the circuit (at least 4-5). (Make sure to consider both directions of actuation).
4. Are there other aspects of the circuits that you can investigate? Investigate by 1) making a hypothesis; 2) designing additional experiments (what to do with the setup and what to measure) to test it.

Lab report
Your report should include the following
- Your hypothesis of how the cylinder works
- A brief description of the experiment for determining the cap-side and piston-side areas of the cylinder.
- Report the results, including concise and representative graphs of the data collected and the model fits obtained. Make sure that axes and curves are labeled appropriately. Least squares method should be used.
- Do your results make sense? If so explain, if not explain.
- Comment on how loads on the actuator would affect the relation that you obtained or on the system pressure.
- Report on your additional investigations.