Solenoid valves – tubing and assembly

What you will learn: Basics of solenoid valve operation, testing, and assembly

Introduction

A solenoid valve is an electromechanical device in which the solenoid uses an electric current to generate a magnetic field and thereby regulate fluid flow using a valve. Essentially the magnetic field created by solenoids are what drive the valves on and off. Then what are solenoids? **A solenoid is a cylindrical coil of wire acting as a magnet when carrying electric current.** Solenoids are actually easily confused with electromagnets, but the key difference is that the solenoids don't have a metal core in the center. If there was a magnetic core, then it would be an electromagnet and the strength of the magnetic field would be proportional to the electric current. Without the magnetic core, the wires would be called a solenoid and exist only in binary on and off states. This is why solenoids are used as simple switches in electrical systems.

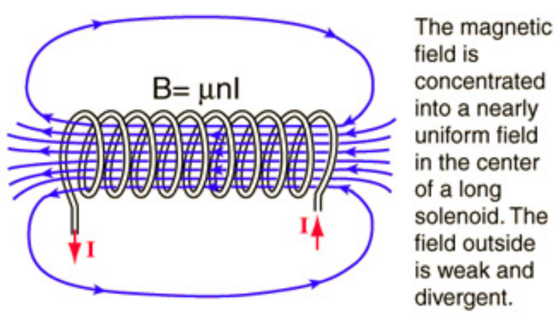

Figure 2: Example of a solenoid. Note the absence of a magnetic core

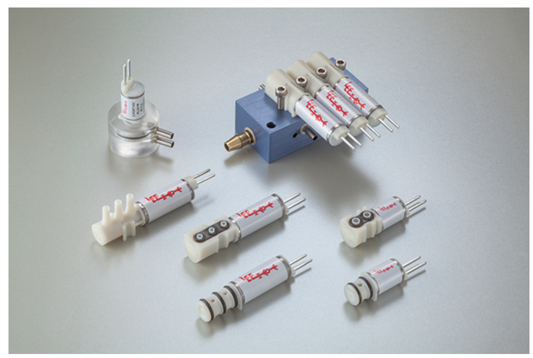

Figure 1: Different types of solenoid valves

In the lab we use the solenoid valves to control the flow of reward. There are a lot of different types of solenoid valves out there and you should explore the different types that best fit your own needs. In our lab, we use LHDA0531115H (3-port ported solenoid valves) because they are compact, and we are able to attach appropriate tubing to effectively lengthen the distance of reward action.

Solenoid Valve LHDA0531115H

The following is the solenoid valve we use in the lab. As you can notice, it is very small.

Figure 2: Close-up picture of solenoid valve used in the lab

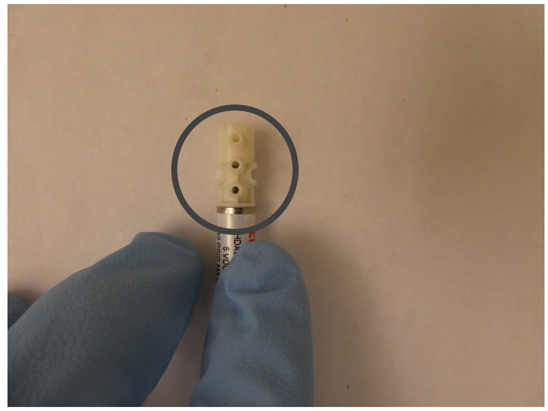

Figure 3: Notice that the tip port is closed off and the bottom two are open

You might also notice from Figure 3 that the top port is closed off and the bottom two are open. I won't go into the details of how solenoid valves work, but basically the solenoids control the opening and closing of the valves that are inside the component. And with electrical current, we can control how long the valves stay open or closed. That's how solenoid valves can dispense water (or any liquid or gas). So the opened up and closed off ports you see in Figure 2 are the mini-valves inside the component. We can confirm this using the official diagram from the specification sheet. Note that the top port is "normally closed", the middle port is "common", and the bottom port is "normally open".

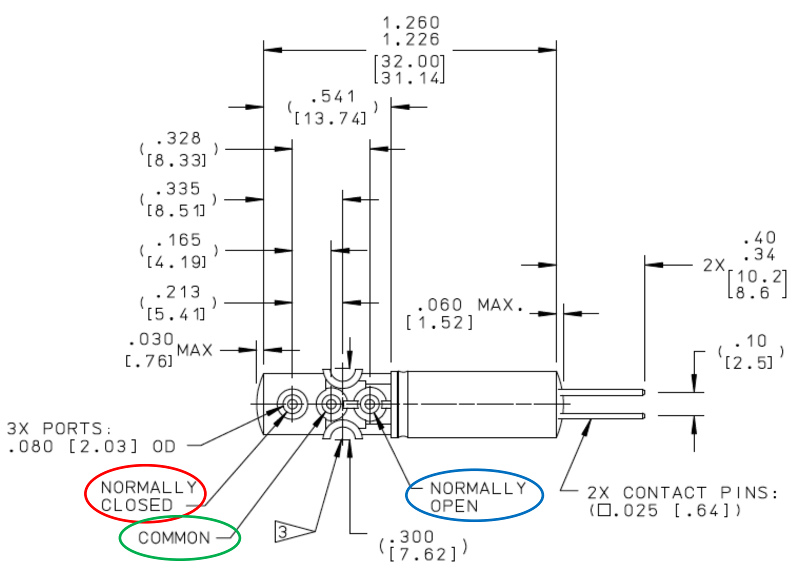

Figure 4: Diagram of the ports in solenoid LHDA0531115H. Note that the ports are either 'normally closed', 'common', or 'normally open' / Source: Lee Company

What this means is that we will be regulating the fluid flow using the middle and top ports when the solenoid valve is powered up. Since the bottom port is “normally open” we want to cap it so that the fluid doesn’t leak. To make the cap, I’ve just burned the same tubing to close off one end.

Figure 5: Tubing has been burned at one end to be used as caps for the solenoid valves

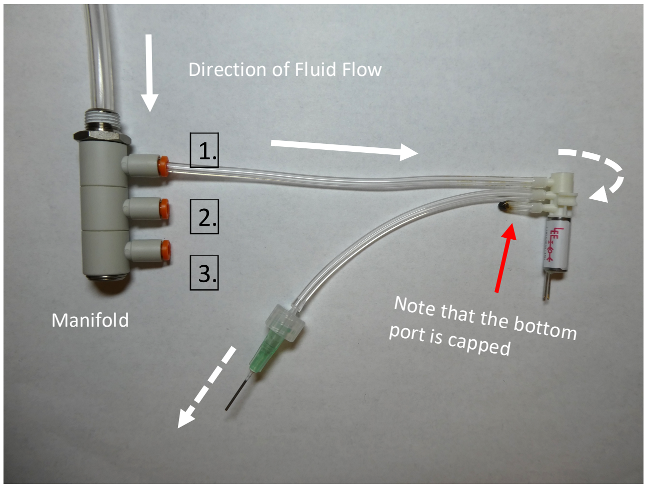

Figure 6: Diagram of how the fluid will flow in the system. White arrows denote the direction of fluid flow. The dashed arrows signify that it wil flow only when solenoid valve is powered up.

Manifolds

From the above figure, you might have been wondering what a manifold is. Manifolds are chambers that branch into several openings, just like the above manifold branches out into 3 different ports or outlets (see the numberings 1, 2 and 3 in Figure 5). Our lab picked this particular manifold because it would allow fluid control to 3 different solenoid valves using just one syringe as an inlet source. These are also push-to-connect manifolds meaning that you can just push in the appropriate tubing into the orange outlet and the “claws” within the port will clamp down on the tubing and hold it down. Just make sure that the tubing end is cut evenly since a slanted cut will affect the level of the clamp. When inserting the tubing, make sure to pull out the orange ring completely, insert tubing, and push in the orange rings again.

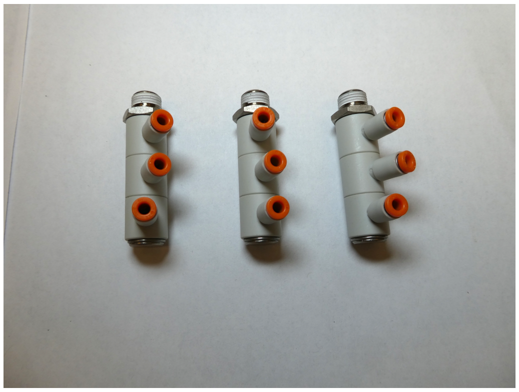

Figure 7: Push-to-connect manifolds side by side. The orange ring is where the tubing goes in and can slide in and out.

The tubing that goes into the manifold will connect to the top port of the solenoid (refer to Figure 6). When the manifold is fitted onto the manifold encasing, the length required for the tubing to reach the solenoid is about ~13cm. However, you can't extend the length of the tubing, so give yourself some extra length and cut about 15cm. You'll probably need to trim some off since these push-to-connect manifolds are prone to leaks and might need to readjust (pull out and re-insert) often.

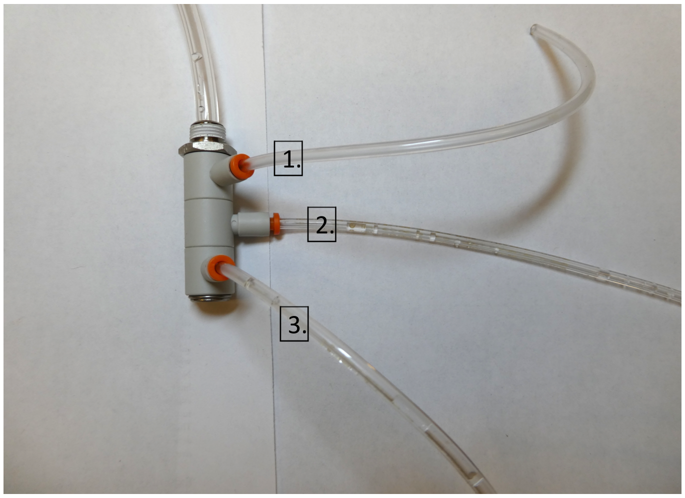

Figure 8: Manifold fitted with appropriate tubing. The numbers represent the outlets

The manifolds are also more prone to leakage when placed vertically. They will be lying horizontally on the encasings in the finished product however, so as long as the manifolds don't leak when laid horizontally, you don't need to worry about the leak. If they keep leaking after multiple adjustments however, try to identify the source and glue it in with Loctite 401. Personally, I found that the juncture between the body and the orange slider turns out to be the source of the leak 90% of the time, so that's where I would use Loctite (Figure 9). Going forward however, I believe a new manifold is needed since more than half of the outlets have been leaking with the normal push-to-connect mechanism.

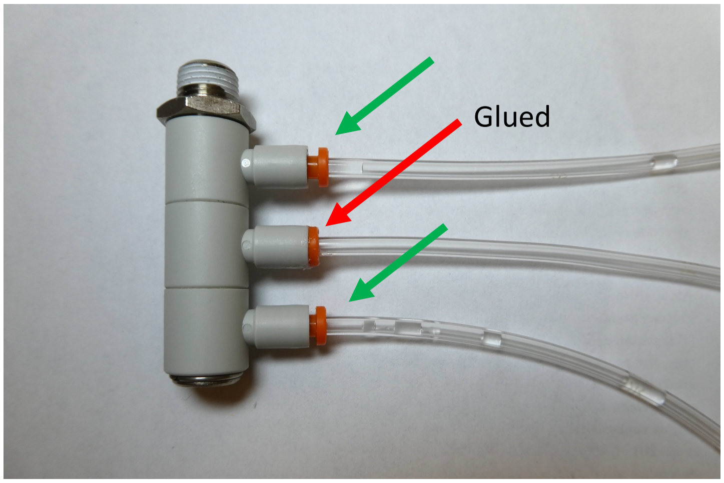

Figure 9: Red arrow represents where I have glued the orange slider to the body. Green arrows indicate that no glue was used.