VEX Pneumatics System

In addition to the instruction sheets found at https://content.vexrobotics.com/docs/instructions/VEX_PneumaticsKit-INST-0712.pdf , here is some supplemental pneumatics information.

Terminology and clarification of some of the parts:

This is a regulator. If you screw it in, you increase the pressure of the system. Normally installed just after the air tank, it reduces the system pressure and keeps the pressure steady, as long as the air tank's pressure is higher. The more you screw it in, the higher the pressure, up to that of the air tank. By using the lowest working pressure that will function in your particular application, you'll get the most cycles from your air cylinders. If you have multiple applications for air cylinders, where different pressures could be used, multiple regulators can be used. Just use a t-fitting between the air tank(s) and the regulators.

This is an exhaust flow control valve. If you screw it in, it will slow down (and eventually stop) the flow of air exiting the air cylinder. This provides speed control for your air cylinders. It doesn't actually affect the cylinder force, but on these small instrumentation cylinders that VEX uses, it sometimes seems like it does. While we use them in industry all the time on larger cylinders, most VEX robots don't need the speed control, and I would suggest just using regular fittings unless you actually need the speed control.

And by the way, this is an "air cylinder." I'd lose my job if I started calling this a "piston", and personally, I think students should be learning proper terminology for parts anyway.

Installing fittings onto air cylinders and solenoids:

The small M3 fittings seal with a gasket. Teflon tape, used to seal tapered pipe (NPT) connections, is not used on these fittings, and it can actually cause the fitting to leak if a bit of the tape were to get onto the gasket seating surface. Proper installation of all the fittings, both on the solenoids and air cylinders is as follows (this is from SMC Pneumatics): Ensure the gasket and the gasket mating surfaces are clean, then screw the fitting in finger tight, then using a metric hex key wrench ***inside the fitting***, tighten 1/3 additional turn (120°) to seat the gasket. Unfortunately, VEX does not provide enough instructions with the pneumatics—they say to use pliers (which could damage the parts).

Troubleshooting information (collected from answers I have given in the vexforum):

System leak (the most common problem of all)

In industry, we use a commercial leak detector (https://www.amazon.com/Leak-Detectors-snoop-leak-detector/dp/B00H895GH8) but you can make up some soap solution (a squirt of dishwashing soap in a cup of water). Put it in a little squirt bottle (or use a little brush) and apply it to your connections and you'll find your leak every time.

Most often leaks happen is where a hose plugs into a fitting. Carefully re-cut the hose as square as possible and reconnect it.

Next culprit is the fitting itself into the cylinder, solenoid, or air tank. The proper way to install these fittings is described above. Thread sealant or tape is not used on this type of fitting: proper tightening of the gasket is the key, using a metric hex key. I suggest getting a set of metric folding keys so the small key you need doesn't get lost.

The other problem can be pumping the tank up without losing air when you disconnect the tire chuck. There are several solutions, including adding a valve to the plumbing, use a high-quality press-on chuck, or practice a lot.

Leaking at the solenoid valve

Double-acting solenoids (like their double-acting cylinder counterparts) don't have a return spring. Consequently, the spool (the valve unit inside the solenoid that switches the air) can get knocked to a position between "side A" and "side B" when the pressure is off, which can cause the air to leak out the exhaust ports when you pump up the system. It takes about 25psi of pressure minimum for the pilots to push the spool back and forth: so, power up the cortex so the solenoid gets a signal to move to the A-side, then start pumping up, and as soon as the pressure gets high enough, the spool will move into position and the leak will stop.

If it doesn't stop leaking, you have a bad solenoid, which isn't too common, but I've seen a couple over the years.

Cylinder does not generate enough force, or two cylinders tee'd together are acting differently.

The force of a pneumatic cylinder is based solely on air pressure and cylinder bore, so check the following:

Is the air regulator turned up to the proper setting? Most teams will set the pressure a little less than the 100 psi of the initial air tank pressure so there will be some consistency in operation. To get the most operations, lower operating pressure uses less air. Are there any kinks or obstructions in the hoses which would inhibit the air flow?

Are you using exhaust flow control valves? These don't affect force, unless they are screwed closed. Most teams don't use them because they don't need to slow down the cylinder action. Generally it's better to just use the straight male connectors. (You'll need to buy extras, because the VEX kit only gives you one for each air cylinder.)

If you're operating the cylinder as single acting, is there anything impeding the exhaust port of the air cylinder? I'd even remove the fitting from the port.

Cylinder only moves at high pressures, or hard to move

You may have damaged the air cylinder by accidentally dropping or squeezing the cylinder casings, or bending the cylinder rod itself. Disconnect it and see if the rod and piston move freely in the air cylinder. These cylinders are called "non-repairable air cylinders" for a reason: they are welded shut and can't be repaired.

The most likely cause is a bad solenoid, especially if you are using a double-acting solenoid. The solenoid uses pilot air to push the spool valve back and forth inside the solenoid. Usually this takes about 15-20 psi, but if it is damaged, the spool might be sticking requiring the extra pressure to move it.

Using double-acting cylinders as single-acting

Double-acting cylinders consume air both extending and retracting. Single-acting cylinders use air to extend, and have an internal spring that retracts the cylinder. Double acting cylinders consume more air, while single acting cylinders use less air but reduce available force (because of the spring). A double-acting cylinder can be converted to a single-acting operation, however, with several benefits: you can chose which direction the pressure moves the cylinder, and if the mechanism itself retracts (perhaps due to gravity) you don't lose available force due to the spring.

To use a double-acting system for single acting, you must plug the extra output port on the double-acting solenoid. You can make a nice plug by taking a 6" length of tube, heating it carefully in the center with a heat gun (or BIC lighter). When it's beginning to melt, pull it gently and twist it, creating a sealed-off tube. Trim it and you have 2 air-tight plugs for converting double-acting solenoids. These are actually more reliable that the solid plastic plugs we buy for our controls applications. Connect the tube to one end or the other of the cylinder. Leave the other end open to the air, and don't try to use an exhaust flow valve either, they don't work correctly unless they are pressurized in a normal double-acting system.