

Creating Reliable Compressed Air Systems

A brief guide to compressors, header pipes, and water filtering and draining for production framing air lines

By Jim Burke

Compressed air systems are necessary in most production framing facilities. Saws are air operated, as are joining machines, staplers, fitting tools, computerized mat cutters, and blowers.

Regardless of your compressor size, you are also likely to have had some of the following types of problems:

- Your compressor only lasts a few years or you have to replace it too often.
- There is too much water in the air lines, especially during high-humidity days.
- The air cylinder in your saw didn't last as long as you expected.
- The air valves in your joiners stick occasionally and need replacing every two years or so.
- The foot pedal in your saw seems to leak all the time.

All of these problems are related to the compressor, air distribution system (or lack of one), and the inability to remove enough water from that compressed air system. Having an air distribution system that is the right size and is set up in the right way is important if you want your equipment to run well.

Air Lines

The first thing to look at in creating an efficient air system is eliminating air lines and hoses that are too small. When an air line is too small for the amount of flow you



Most production framers have single-stage compressors like this one, which is a 5 HP model that provides 14.2 CFM and 140 PSI and holds 60 or 80 gallons of air.

need, the air speed increases to the point where water cannot be separated from the air stream.

This velocity, which is measured in FPS (feet per second), is determined by pipe size and the CFM (cubic feet per minute) required by the equipment. For a compressor, the total CFM of all machines must be added together and a suitable header pipe size must be calculated if you want to deliver the required air volume at the correct velocity. When this is done properly, the velocity is reduced to 20 FPS or less, allowing water to be removed from the air with water drains and water filters. Velocities greater than 30 FPS create a condition in which water will not separate from the air stream. Instead, it travels right through water filters on the machinery and gets into the valves and cylinders. This causes hundreds or thousands of dollars in unnecessary repairs every year along with lost production time. Moisture washes the lubricating fluids from air tools and air cylinders and causes premature failure. Air valves in joiners get congested with the water/oil mixture, which eventually ruins their seals. Air blowers used to clean off glass in the fitting area turn into high-pressure water misters.

Start by checking the connection to the tank unit on your present compressor. If the first fitting attached to the tank is a quick-disconnect, you are already faced with the most common problem. The nipple that connects to that fitting is usually $\frac{3}{16}$ " inside diameter (i.d.). This area is so small that even 5 CFM has to accelerate to 181 FPS to travel through that nipple. By comparison, a $\frac{1}{2}$ " i.d. pipe at 5 CFM requires only a velocity of 25 FPS. Framing machinery doesn't need high-speed air. It needs dry, high-volume air at the correct pressure.

Solutions

Check the compressor's outlet threads in the tank. They will usually measure between $\frac{1}{8}$ " and $\frac{3}{4}$ " National Pipe Thread (NPT). The actual diameter of the threads will



A two-stage model like this 5 HP two-stage compressor, which provides air at 16.5 CFM and 175 PSI and holds 80 gallons, could save money and move air to equipment more efficiently.

be about 1/4" larger than the mentioned size because pipe thread is labeled by the i.d. of the pipe. Since most iron pipes have 1/8" wall, the actual thread is larger by twice that amount.

The solution is to install a stainless steel ball valve equivalent to the inside diameter of the pipe fitting on the compressor. If your fitting is 1/2" NPT, then use a 1/2" i.d. ball valve with the appropriate threads for your header pipe. (It is preferable to use threaded ball valves instead of soldered joints.) This will provide the instant shut off you want when repairing an air system or for shutting down for the night.

Next, you should have a header pipe system connecting your compressor to all of your machinery. Within this system should be water drains, water filters, drop lines for each area of production (or grouping of machines), and short hoses with quick-connects to attach the machinery to the drop lines.

If you have piped your entire factory with 1/2" or 3/8" rubber hose, you probably think that it's impractical to even consider a piping system. But you'll continue to have the water problems and all the other related costs if

you don't change it. It's not too late to correct the problem, and it will probably cost less than the repairs you'll need to make in any given year.

By using the included chart that lists CFM requirements and averages for various types of framing machines and equipment, you should be able to design a piping system that will serve your needs. Remember: size everything for future growth. That way, when you have to buy

a larger compressor to serve a new joiner or saw, the header pipe and attachments won't have to be redone and you can just connect to a new compressor.

As one expert in the compressed-air business says, "There is no such thing as too large a compressed air line." Installing pipe now that's larger than needed won't hurt a bit and will just add a little storage capacity to the system. All water-related problems arise from using pipes and hoses that are too small, not too large. When you



This higher-capacity, two-stage 7.5 HP compressor provides 175 PSI and holds 80 gallons, but at 24 CPF provides a greater volume of air to power more pieces of equipment.

slow down the air to a speed of 20 FPS, it will ensure water removal, volume delivery, and no turbulence or backups in the system that can overwork a compressor and eventually ruin it.

Equipment Requirements (CFM)

Here is a list of common machines and tools used in picture framing factories and their relative CFM needs. Note that rotary tools like air drills or sanders require the most air volume as do computerized joiners.

Computerized Joiners	6.0 - 7.0 CFM
Semi Auto Joiners	5.0 - 5.5 CFM
Computer Mat Cutters	1.0 - 2.0 CFM
Air Staplers	0.5 - 1.0 CFM
Air Blowers	2.0 - 6.0 CFM
Air Drills	6.0 - 9.0 CFM

Compressors

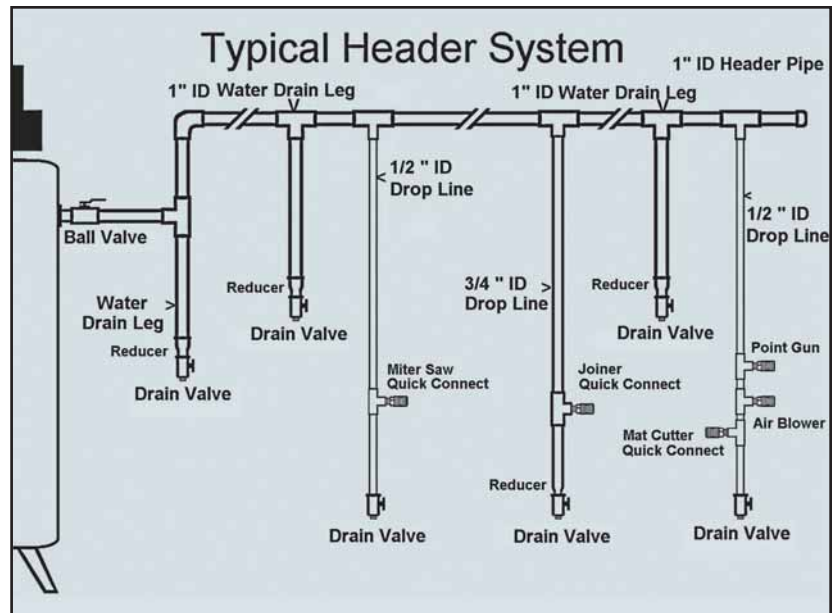
Compressors fall into three categories: reciprocating, rotary screw, and centrifugal. Most compressors under 100 HP are reciprocating (piston-driven) and are available as single- or two-stage.

- Single-stage compressors take air into their cylinders and compress it with a single stroke of the piston directly to the tank. This type is generally used where operating pressures are below 150 PSI.
- Two-stage compressors recycle the first compression stroke and re-compress it to a higher value. These compressors under 50 HP usually peak at 175 PSI.
- Single-stage compressors operate at 55 to 70 percent efficiency while two-stage compressors operate at 75 to

80 percent efficiency.

- The advantage of higher pressure is that more air volume can be stored in a compressor's tank. (A regulator is used with the compressor to reduce the PSI in your air system to the needed operating range.)
- Compressors with 220/440-volt, three-phase motors operate with less amperage than 220-volt single-phase motors or 115-volt motors.
- Tank sizes for stationary compressors range from 40 to 120 gallons. Since one cubic foot equals 7.48 gallons at atmospheric pressure, an 80-gallon tank holds 10.8 cubic feet of air. The greater the PSI, the more air a tank will hold. For example, at 100 PSI an 80-gallon tank holds 84 cubic feet while at 150 PSI the same tank holds 121 cubic feet of compressed air. This is the advantage of higher tank pressures (although it still doesn't justify operating a single-stage unit above 130 PSI).

When looking at new compressors, you should be less concerned about the initial price and more about CFM capacity, electrical operating expense, and overall duty rating. Buying a compressor that's too



This illustration shows a header pipe and drop lines. Note that the drop lines extend beyond the takeoff tee for the machinery and end with a drain valve at the bottom of the leg. This helps eliminate more water before it gets to the hoses and machines. The tee is about 2' from the bottom of the drop line to connect to the hoses. Water drain legs can be installed as needed in the header or for every 25 feet of pipe. The drain valves can be 1/2" NPT ball valves at \$7 to \$8 each—the same type you would use under a sink with pipe threads on the inlet side. The best pipe is hard copper type M. The next best is galvanized pipe. The cheapest but least desirable is black iron pipe. Although it works, over time it will rust. PVC pipe is generally not recommended by the experts because of the degradation of its seams and pipes from synthetic oils used in many compressors, although this applies more to large systems with rotary screw compressors than to systems typically used by production framing operations. PVC is also not acceptable under the codes of some states or cities, so check first before considering it.

Pipe Sizes for CFM Volumes

Here is a recommended pipe size chart for headers based on CFM for the compressor or for a drop line feeding more than one piece of machinery.

5 CFM - use 1/2" pipe minimum	(25 FPS velocity) 3/4" pipe would drop it to 11.3 FPS velocity
7 CFM - use 3/4" pipe minimum	(15.8 FPS)
10 CFM - use 3/4" pipe minimum	(22.6 FPS) 1" pipe would drop it to 12.8 FPS velocity
15 CFM - use 1" pipe minimum	(19.1 FPS)
20 CFM - use 1 1/4" pipe minimum	(16.3 FPS)
25 CFM - use 1 1/4" pipe minimum	(20.4 FPS)
30 CFM - use 1 1/4" pipe minimum	(24.4 FPS) 1 1/2" pipe would drop it to 17 FPS velocity
40 CFM - use 1 1/2" pipe minimum	(22.6 FPS)
50 CFM - use 1 1/2" pipe minimum	(28.3 FPS) 2" pipe would drop it to 15.9 FPS velocity

Drop lines from the header can have velocities at or near 30 FPS without harm. Air hoses running to machinery should not exceed 50 FPS. The simple formula is $V = \text{CFM}/\text{area}$. There are more complicated ways to get exact numbers using more intricate formulas, but this one works. Also remember that two joiners on a drop line will require 12 to 13 CFM if they are working at the same time. While a 1" pipe would be best for that application, a 3/4" pipe will work.



Most framing companies have compressors that are too small, which they run too much and have to be replaced every couple of years. Instead, they should use more efficient compressors like this 10 HP two-stage model that holds 120 gallons of air and provides 34.8 CFM at 175 PSI.

small is like throwing money away. A compressor that's suited to future expansion or one that's rated higher than what you need right now is the best bargain in the long run.

If you are not sure what compressor is right for you, ask your supplier to help—but only after you have the necessary data from your facility. Add up all of the CFM required by all your air equipment. Decide if you want 220/440 three-phase motors or 220 single-phase. How many shifts a day will a compressor work? Do you want a vertical tank to save space? Armed with this information, you should be able to pick the type of compressor you need.

Maintenance

Whether you're buying a new compressor or staying with your present one, maintenance is critically important. Someone must be designated to check the oil level

in the pump unit. At first, it should be done daily then weekly or monthly depending on oil usage. Develop a schedule based on your findings. Keep a handy supply of the correct oil in a convenient place. Check the inlet filter and keep it clean or replace it. Keep extra filters on hand. Drain water from the tank, daily at first then weekly until a schedule is developed. Do this more often in months with high humidity. Even a 5 HP compressor can produce a gallon of water a day and up to five times that much on hot, humid days.

Drain the water only; don't drain all the air from a tank at night because that wastes electricity. Turn the ball valve to the off position each night to eliminate losing tank pressure from air line leaks. If you have installed a good header system with water drains, open those periodically as designated by your maintenance schedule. Also check and drain any water filters on the equipment at some standard interval. Each operator can be in charge of draining his or her equipment at the end of the day. ■

Pipe Size I.D. vs. Area

Inside Diameter	Square Inches
3/16"	0.0276
1/4"	0.0491
3/8"	0.1104
1/2"	0.1964
3/4"	0.4418
1"	0.7854
1 1/4"	1.2272
1 1/2"	1.7672
2"	3.1416

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