

How to choose a pressure comparator

Application Note

Pressure calibrators don't need to be expensive or complicated. A common approach is to use a pressure comparator (also known as a comparison test pump) and a reference gauge. To make things easy, here are a few things you should consider to choose the right comparator for your application.

The basics

To perform a pressure calibration, you need to generate a stable pressure and measure it accurately. Here is how it works when you use a pressure comparator:

- A pressure comparator generates a stable pressure.
- A reference gauge accurately measures the pressure.
- The device under test (DUT) is compared to the reference gauge.

There are a number of different pressure comparators on the market. Each uses a different technology with unique advantages and disadvantages, depending on the application. For example, some comparators are designed to work in gas and others are designed to work in fluid. Let's look at the reasons you might choose one over the other.



P5510



P5515

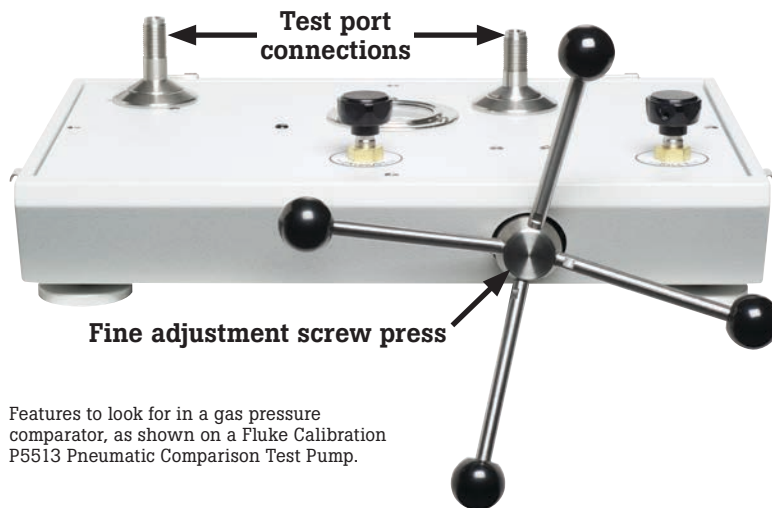
Gas pressure comparators

A gas pressure comparator is normally used for calibrating at relatively lower pressures. Its main benefit is cleanliness. If the device being tested is used in a process that doesn't tolerate liquid contaminants, then you'll probably want to use a gas pressure comparator. Most gas pressure comparators allow you to adjust and regulate the supply pressure, either through a pump or a needle valve.

Pump-based gas pressure comparators like the Fluke Calibration P5510 are best suited for pressures below 2 MPa (300 psi). A pump has the advantage of not requiring an external gas supply, allowing you to use the comparator in more applications. The drawback is that you have to pump harder to get higher pressures, and your hands and arms can get tired.

For pressures above 2 MPa (300 psi) that still require gas media, many users find it easier to use a pressure comparator that meters in pressure from an external supply. To enable the supplied gas to be metered precisely, fine needle valves control both the gas supply into the system and the gas exhaust out of the system.

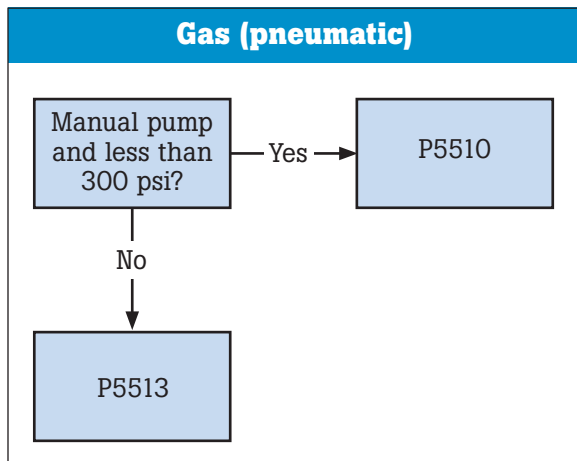
The pressure comparator may also use a variable volume to allow for small changes in pressure. This can be used to make fine adjustments so that either the reference gauge or device under test are reading on the cardinal point. The Fluke Calibration P5513 is a good example of this type of pressure comparator. Whereas a pump based gas pressure comparator is limited by the force the operator can apply, this type of comparator is limited only by the maximum working pressure of the internal components and the pressure of the supply gas.



Features to look for in a gas pressure comparator, as shown on a Fluke Calibration P5513 Pneumatic Comparison Test Pump.

Features to look for in a gas pressure comparator

- **Test port connections.** Using a pressure comparator to calibrate a device requires that both a reference gauge and a device under test to be connected to the comparator. If your normal workload includes gauges with a wide variety of pressure ranges and connection types, then choose a type of connection that allows you to quickly switch out the reference gauge, and one that can easily handle the types of connections you normally see in your lab.
- **Pressure pump.** Pressure pumps are ideal for pressures of 2 MPa (300 psi) and below. If you are working with higher pressures, you probably should consider another pressure generation method.
- **Fine adjustment.** If your procedure requires fine adjustment of the pressure at the test point, then make sure the comparator has the ability to provide fine adjustment and is sufficient for your application.
- **Pressure supply connection.** For higher pressure applications where a connection to supply pressure is feasible, consider pressure comparators that can make use of that supply pressure versus manual pumps. Your technicians will thank you for it.



Liquid pressure comparators

Liquid pressure comparators are normally used for calibrating higher pressures. Since liquid does not compress, a liquid pressure comparator can generate higher pressures more easily than a gas pressure comparator can. Liquid comparators are also inherently less dangerous at higher pressures, compared with the potential energy stored in highly compressed gasses.

A liquid pressure comparator works by changing the volume in the system. This is normally done with a screw-press variable volume controller and a liquid reservoir. You fill the system with liquid from the reservoir, and then isolate the reservoir from the actual pressure system. Then you turn the handle on the screw press, causing a piston to move in or out of the system. Depending upon the system's design, you might be able to reach pressures as great as 140 MPa (20,000 psi).

Any gas bubbles trapped in a hydraulic system need to be removed. Bubbles tend to migrate upwards and collect at the highest point in the system. To get the bubbles out, you prime the system.

A priming pump draws liquid from the reservoir and pushes it throughout the pressure system. If the reservoir valve is open, then the liquid is drawn in from the reservoir, pushed through the system and then back into the reservoir. If the reservoir is a relatively high point in the system, then the air in the system will also be pushed into the reservoir and bubbles will appear.

If there are higher points on the system than the reservoir, you might need to open the system to atmosphere at a higher point by loosening ("cracking") a fitting. You would continue to use the priming pump until liquid flowed continuously through the opening in the fitting.

The ideal design for the priming pump includes a displacement that allows for a large amount of fluid to be pushed through the system at one time and check valves to ensure that it is always drawing fluid from the reservoir and pushing it into the system.

With the check valve setup, the priming pump can be easily used to also generate the first bit of pressure. With the reservoir valve closed, the priming pump draws liquid in from the reservoir and pushes it into the closed system, causing the pressure to go up. The screw pump can then be used to generate large pressures with no lag caused by air in the system. You will see this type of setup on the Fluke Calibration P5515 Pressure Comparator.

Media selection

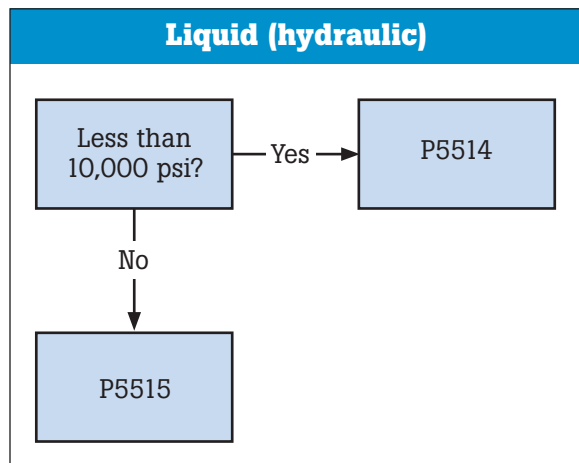
Once you have chosen to use a liquid pressure comparator, what liquid should you choose to fill it? Your choice will determine what materials are required for seals and wetted components in the comparator and will potentially impact the overall performance of the comparator over its lifespan.

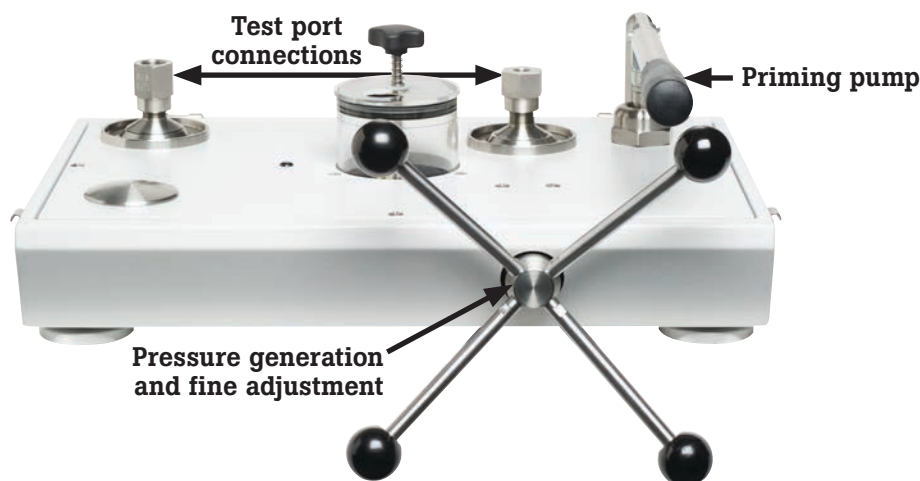
A basic mineral oil or silicon oil like Sebacate provides lubrication for moving parts and is compatible with seal materials like Viton. If your primary objective is good performance of the comparator and extending its life span, this type of fluid is ideal.

Unfortunately, oil is not acceptable in all applications, especially those that need to be hydrocarbon free. In those situations, you may prefer to use distilled water or a water/alcohol mix. However, some materials may rust if exposed to water, so be absolutely sure that all wetted parts in the comparator are compatible with water before using it as the fluid.

Overall, water is not as good of a lubricant as oil, and oil is normally preferred when allowed. The Fluke Calibration P5514 and P5515 standard units are compatible with oil (mineral oil or Sebacate) and water.

Certain applications may require that the calibration be performed in the exact same fluid as what the device is normally operated in. An example of this would be phosphate ester based fluids used as fire resistant brake fluids in the aerospace industry. These fluids can be extremely aggressive, and many shops have a segregated set of tools for use with these fluids. The P5514-70M-EP and the P5515-140M-EP are specifically designed for use with these types of fluids.





Features to look for in a liquid pressure comparator, as shown on a Fluke Calibration P5515 Comparison Test Pump.

Features to look for in a liquid pressure comparator

- **Test port connections.** Using a pressure comparator to calibrate a device requires that both a reference gauge and a device under test to be connected to the comparator. If your normal workload includes gauges with a wide variety of pressure ranges and connection types, then make sure that the type of connection enables you to change reference gauges easily and also handle a wide variety of connection types.
- **Media compatibility.** You must ensure that the pressure comparator you choose is compatible with the media you intend to use. Most pressure comparator manufacturers provide a list of all of the wetted materials so that users can determine whether the comparator is compatible with a given fluid.
- **Pressure generation.** The pressure comparator needs to have some system (normally a screw press) capable of generating the full scale pressures you need.
- **Priming system.** If your application includes a potentially large volume that may have quite a bit of gas in it, then you'll generally want to have a method for priming the system. Ideally, the priming system should be able to displace a large amount of fluid quickly.
- **Fine adjustment.** The fine adjustment of pressure on a liquid system can be done in a number of ways. If the system has a well-designed priming system, then the main screw press can have a smaller overall displacement and finer thread forms. This allows you to use the screw press for both major pressure generation and fine adjustment, like what is found in the Fluke Calibration P5515.

- **Platform stability.** The turning of a screw press at high pressures often requires quite a bit of force. While not always necessary, you might want to clamp or semi-permanently attach the pressure comparator to a bench. If you do, you'll need to choose a comparator whose design makes that easy to do.

Conclusion

Pressure comparators can provide an easy-to-use, low cost solution for basic pressure calibration. There are a number of different types of pressure comparators available, each with different advantages and disadvantages depending upon the application. The P5500 Pressure Comparator product line is a complete product line that can be combined with one of the Fluke Calibration 2700G Series Reference Pressure Gauges to provide a complete pressure calibration solution for both gas and liquid pressures.

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