DigiVac
Home of Vacuum Engineering Excellence
Precise Practical Personal

DESIGNING INNOVATIVE VACUUM GAUGES AND CONTROLLERS FOR OVER 30 YEARS

APPLICATION NOTE \ ANSWERING THE PRESSURE & VACUUM TIGHTROPE WITH VAC|MAC

ABSTRACT: One challenge that some engineers have to deal with is precise measurement of both vacuum and pressure when the application demands it. There are specific challenges in accomplishing precise measurement of both vacuum and pressure. Use the wrong tool to measure and you totally miss the target, or fail to isolate the vacuum and run the risk of loss of accuracy, failure and leaks in your vacuum process.

We recently helped a customer gain greater control of their process through more accurate readings at a vacuum near 2 Torr, or 29.88 inches of mercury. Previously they were using a compound gauge that scaled from a vacuum of "30" inches of mercury to 100 PSI.

The problem with this is that they had very little resolution and very little accuracy at vacuum with this gauge. This gauge had graduations of 2 inches of mercury complete with parallax error, which was equal to 50 Torr. Fifty Torr is a huge vacuum difference, and almost undetectable with inches of mercury gauges. Given these issues a repeatable process was difficult to assess. A vacuum controller that offers both a pressure sensor and a highly accurate isolated vacuum sensor was devised to solve this problem.

DIFFERENCE BETWEEN PRESSURE AND VACUUM:

Pressure is the measure of the quantity of molecules in a given space. At sea level we have 14.7 PSI pushing down on us, and in our car tire we have 32 PSI. We typically see a flat tire or a deflated balloon and say that it has no pressure in it. When people think of pressure they think of that pressure above atmospheric pressure. Vacuum is that pressure below atmospheric and

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is treated as a special case of pressure. Often low pressure or very rough vacuum is expressed as a negative number in gauge pressure, such as -20 inches of mercury that you might see in a clogged fuel filter.

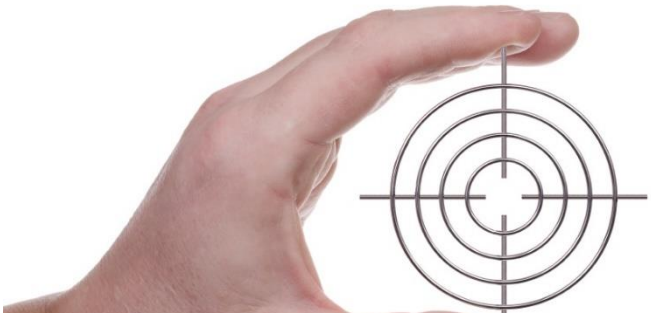
Pressure is used more than vacuum to do a variety of things like push oil through pipes, gas to our injectors and water to our sinks. Vacuum pressure is often used for suction like in a vacuum cleaner or sewage movement, and in many industrial applications to make things clean and free of water. Many industrial applications involve evacuating a vessel full of material, then backfilling with some more desirable gas like nitrogen. This evacuation/purge cycle is often used to remove water and air bubbles.

Vacuum has a relatively small pressure range where a lot of things happen. Since the range is so tight, accuracy is your friend.

HERE IS THE PROBLEM: The whole world of vacuum is comprised in that 14.7 PSI, whereas the whole world of pressure extends to several thousand PSI. In fact vacuum is a relatively small pressure range where a lot of things happen. For example at 17.5 Torr and 20C (chilly room temperature) water evaporates. At 20 Torr it doesn't. This is an important vacuum level for anyone that is using vacuum to dry or remove water. A standard inches of mercury dial gauge won't tell you this.

The unit of measure used depends on where in the pressure spectrum your particular measurements are most meaningful. For accurate measurement at low pressures, absolute measurement is used and expressed in units like Torr, mbar and Pascals. For less accurate measurements, an inches of mercury dial gauge is typically used. For a small pressure differential very close to Atmosphere, inches of water units are typically used.

The next problem comes in the form of accuracy. Typically sensors are expressed in % of full scale. For example, a gauge that has +/-5% accuracy for 100 PSI means its reading will be +/- 5 PSI. If this is a compound gauge, that means there will be a huge error in the vacuum reading. Consider the example, if the actual pressure measurement is known to be a vacuum pressure of -10 PSI; that means the reading would range from -15PSI to -5 PSI. *Not good if you care about vacuum.*



Did you know that the last inch of pressure indicated on the compound gauge represents 25,400 microns?

Resolving vacuum around the vapor pressure of water with a compound gauge is like using a fork to pick up a grain of sand!

One other significant challenge is that highly accurate vacuum sensors tend to be more sensitive to over pressurization. Typical over pressure ratings for sensors and transducers is 2x highest pressure. For vacuum sensors, that might mean 15 PSIG to 30 PSIG.

Many vacuum sensors advise against using them in a pressure at all.

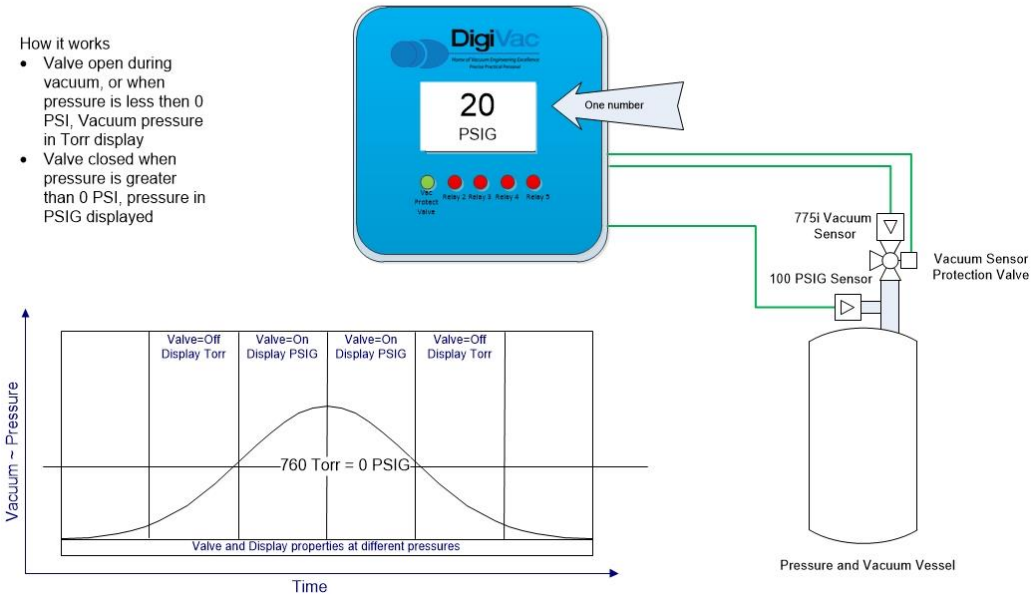
Therefore if you need to measure both pressure and vacuum, it is important to isolate the vacuum sensor to avoid **loss of accuracy**, **failure** and **leaks**.

To solve both of these problems, DigiVac created a solution that employs both a vacuum sensor and a pressure sensor. This approach has the effect of giving accurate readings near 2 Torr and accurate readings near 90 PSI all while protecting the vacuum sensor, and providing a single intelligible pressure/vacuum reading.

SOLUTION DESIGN: The Vac|MAC is designed with a vacuum controller that closes a valve in response to positive pressure indicated by a pressure sensor. This 3-way valve isolation valve keeps the sensor from being over pressurized during the pressure portion of the process.

Once the pressure falls to atmospheric pressure, the vacuum sensor protection valve is opened, exposing the vacuum transducer to the vessel. The exposed vacuum transducer can then obtain accurate pressure measurements down to its lower useful range, which in this case is 1 Torr.

Vac|MAC solution to achieve Vacuum and Pressure indication while protecting vacuum sensor



The Vac|MAC controller was designed to Measure, Automate, and Control your toughest industrial processes and is immune to the most dirty applications with its isolated sensor. It is rugged with robust control functions in a simple and easy to use package for vacuum process control.

Vacuum Process Controller

Vac|MAC —Measure| Automate| Control

The Vac|Mac indicates the pressure in Torr, mbar kPa and other units for a total of 12 units of measure.

It can have up to 2 sensors and 5 relay controls for more complex installations. Every vacuum controller is tested under actual vacuum using a NIST standard.

The standard configuration comes with:

o Vacuum controller with display mounted in an IP67 case intended for wall mounting

o 1-775 Torr ~ 15 PSIA IP66 Isolated Sensor with 10' sensor cable

o A single 7A 250V relay with type "C" contacts for turning on and user set-point between 2 and 760 Torr

Summary

- Vacuum has a relatively small pressure range where a lot of things happen. Since the range is so tight, accuracy is your friend
- Using a vacuum controller like Vac|MAC helps you navigate the tightrope of measuring pressure and vacuum and helps you avoid loss of accuracy, failure and leaks in your vacuum process due to an over pressurized sensor.

We would love to hear how you are utilizing one of our products. How can we serve your needs?

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