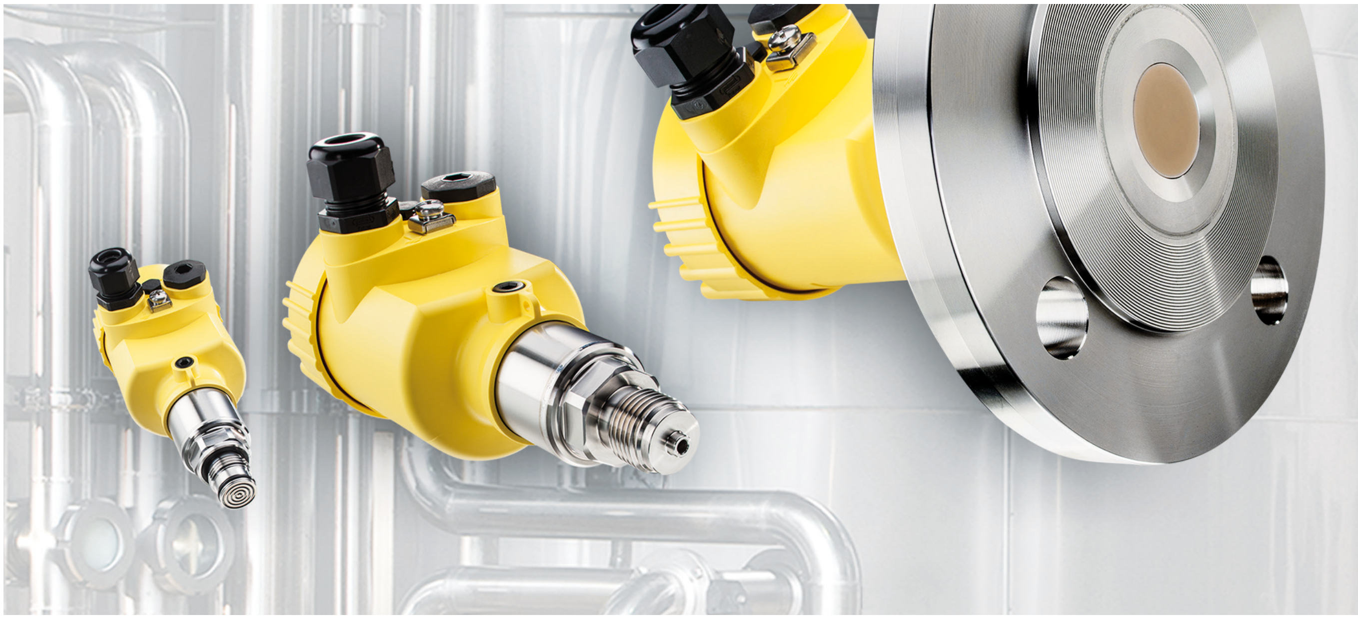


Making pressure sensors last in corrosive environments

Whether it's petrochemicals, industrial chemicals, or simple household cleaners, the chemical industry has been using pressure sensors to control their processes for a long time—and for good reason. Pressure is a tried and true measurement technology, and it works. Getting pressure sensors to last in the corrosive, volatile, and hazardous environments typically found in this industry is another challenge entirely.

This paper will focus on improvements in pressure technology, specifically ceramic cells and other safety features that make today's pressure sensors ideal for a broad range of applications across the chemical industry.

Metallic vs. ceramic measuring cells

Pressure sensors have traditionally used an oil-filled metallic diaphragm which separates the measuring cell from the process fluid. The filling oil acts as a transfer medium to move pressure on the diaphragm to the measuring cell. Unfortunately, these thin metal diaphragms are susceptible to general wear and tear as well as corrosion. The filling oil can be limiting in certain applications, and in worst case scenarios, the filling oil can even leak into the process itself. These issues can be avoided or minimized by using ceramic measuring cells.

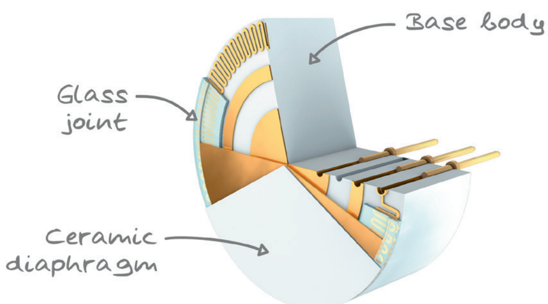
Ceramic, by nature, is a hard, abrasion-resistant material. Plus, ceramic is highly chemically stable, meaning it's less likely to break down, even when it comes in contact with many of the chemicals and compounds found in the chemical industry. Pressure sensors with ceramic measuring cells use a capacitive measurement at the point of pressure. This measurement is "dry," meaning they don't rely on filling oil like their counterparts with metallic diaphragms.

Durability in any environment

Ceramic is made of a tight, dense matrix of atoms pieced together by covalent and ionic bonds. This structure on the atomic scale makes the material ten times harder than stainless steel, and the added strength makes ceramic better-suited for abrasive environments. In any application where liquids are used to move solids, process material slowly scratches, dents, and damages metal pressure cells, but this isn't an issue with ceramic. Ceramic cells continue to perform reliably long after their metallic counterparts have been replaced over and over.

The longevity of ceramic cells can also be attributed to its compatibility with the wide variety of materials used to create the things industries and consumers use. Ceramic is an inert material, meaning it doesn't react with chemicals the way metals do. Ceramic cells don't corrode or degrade over time like metal. This opens up applications measuring everything from salt water to acidic solutions, because the ceramic cell remains intact despite the corrosive properties of the process material. A longer lasting cell reduces the number of replacements and the amount of maintenance, and it may avoid using costly alternatives like corrosion-resistant tantalum.

Pressure cells made of ceramic are less expensive and more valuable than gold when it comes to combatting hydrogen permeation. Hydrogen molecules from certain chemicals will penetrate through metal diaphragms, then become trapped and react with the filling oil. This reaction causes an expansion, which falsely indicates increasing pressure. To minimize this effect, metal diaphragms are coated with gold or other dense, pliable material. This slows down the transfer of hydrogen molecules from the process to the oil filling behind the diaphragm, but it doesn't stop it completely. A ceramic cell also slows down the permeation of hydrogen molecules, but since there is no oil filling behind the diaphragm, it doesn't affect the pressure reading.



Eliminating filling oil all together and using a dry ceramic cell has other benefits. When a metal diaphragm eventually fails, the filling oil within the sensor can leak and contaminate the process. Plus, some chemicals are processed in vacuum conditions, which affects how the oil in a traditional pressure sensor performs. The vacuum conditions drop the temperature at which oil boils, so getting a pressure measurement in a vacuum significantly limits sensors using a metal diaphragm. With a dry ceramic cell, operators get a trustworthy measurement without any temperature limitations.

One cell type for every application

Every process material has different properties. Some are corrosive. Others may react with different materials. Some need to be pressurized or processed in a vacuum, and others need to be isolated from the atmosphere. In some cases, there may be a different pressure sensor for each of these materials to properly control the process. Ensuring the correct pressure sensor is matched up with the appropriate process is just another variable to track and check.

By taking advantage of the versatility of ceramic cells, this minimizes the inventory selection of instruments with one multiuse diaphragm material. Ceramic is hard enough to withstand the most difficult environments, and it's compatible with the majority of corrosive process materials because of its inert nature. And since pressure sensors with ceramic cells make a dry measurement, there is less of a limitation on measurements in a vacuum, and there are no concerns for filling oil accidentally getting into the process in the case of a failure.

Second line of defense

When handling exceptionally volatile and dangerous chemicals, safety is a top priority with no room for error. When the only thing between a volatile chemical and exposure is a single pressure sensor, operators need a second layer of safety. Just like pressure sensors can be configured with ceramic cells, they can also be built with a special process fitting to provide this extra layer of safety.

This special process fitting still puts the pressure cell in contact with the liquid or gas being measured, but there's an extra space between the pressure cell and the sensor electronics. This extra space is a gas-tight encapsulated process module completely sealed from the outside atmosphere and electronics within the housing. Its sole purpose is to provide a failure or electronic fault if a breach from the pressure cell occurs. Once an error is triggered, operators know they need to take precautions to isolate the breach and replace the sensor with a new one right away.

Pressure measurements that last

Pressure measurement technology continues to advance, and ceramic pressure cells and process fittings with extra layers of safety are just a couple of the features allowing these instruments to be more versatile and more widely used in the chemical industry. Having a single measurement cell material that's durable, resistant to corrosion, and makes a measurement without any filling oil simplifies the entire operation by minimizing the number of types of pressure sensors used and how often they need to be replaced.

Author: Jeff Brand
Product Manager | VEGA Americas, Inc.