A new fluid pressure sensor for process control and validation in critical dispensing and dosing applications

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Introduction

There are many applications for precision automated fluid dispensing, dosing or filling where the accuracy and repeatability of the dispensed amount is critical. These include procedures in medical device manufacture, pharmaceutical formulation or packaging, semiconductor fabrication and many high reliability dosing processes up to about 100ml/minute flow rate and 1,600kPa pressure.

One method to help verify the dispensed amount of fluid or liquid is to monitor the system pressure; all other factors being the same, the pressure is directly related to the flow rate. Analysis of pressure against time can be used to give assurance that the correct amount of liquid or fluid has been dispensed.

Pressure monitoring and analysis can reveal the presence of issues which may impede or otherwise affect the material flow. These include the presence of unwanted air bubbles in the medium, obstructions caused by contamination, clogging caused by agglomeration of fillers, variable feed pressure or simply that the material reservoir is empty.

These issues can result in inconsistent and inaccurate application leading to, for example, over- or under-filling, or insufficient or excessive material (such as adhesive or lubricant) being applied to a substrate. Clearly, the consequences vary according to application and industry sector, but include reduced end-product integrity/performance, poor standards compliance and even, in pharmaceutical applications for example, risks to health.

However, the limited availability of accurate, efficient in-line fluid pressure sensing technology has restricted the ability to utilise this approach in these applications.

Conventional Pressure Sensors

Typical fluid pressure sensors used in this type of application (e.g. flush-mounted pressure sensors) require the insertion of an adaptor into the line carrying the material whose flow is to be measured. A drawback to this design is that it can cause ‘dead space’ or undercuts, potentially distorting pressure readings and making cleaning difficult.

Most also incorporate a stainless steel diaphragm or membrane (sometimes ceramic). Because the surface of the sensing diaphragm is in constant contact with the material being dispensed/dosed, it is important to determine potential incompatibilities between the two. Many liquids – including anaerobic adhesives, organic compounds and body fluids such as blood – are either damaged or begin to react when they come into contact with metal. In the case of anaerobic adhesives, for example, contact with metal ions will initiate cure, meaning that all metallic components in the sensor will require special treatment to preclude the reactive surface in order to be usable.

flowplus[16] Fluid Pressure Sensing Technology[1]

Market demands to overcome these issues – as well as the need to achieve ever greater and more stable process reliability – has led to the development of a new kind of liquid pressure sensor designed specifically for small-shot dispensing, precision dosing, filling and metering applications.

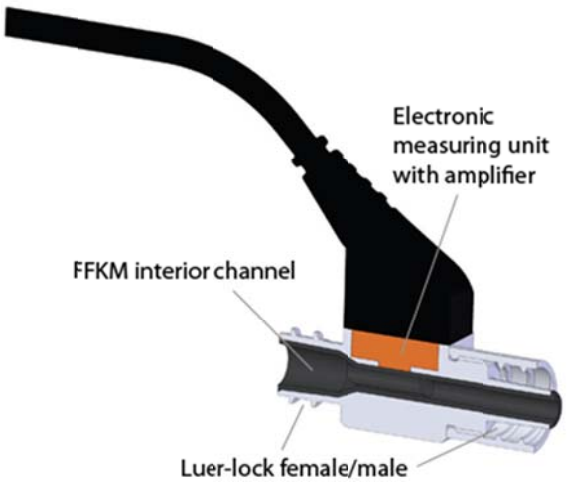

Figure 1 – A schematic of the flowplus fluid pressure sensor

This compact, in-line, piezoresistive sensor incorporates an elastomer which transfers the force (pressure) to the measuring cell. Challenges which were overcome included the vulcanising of the thin elastomer diaphragm within the very narrow tolerance range required, integrating the elastomer into small geometry of the sensor housing, and connecting the elastomer to the measuring cell (many other pressure sensors transfer the force via an oil or similar medium). The fluid channel within the sensor has been completely coated with a FFKM perfluoroelastomer, which provides both an inert and impervious internal seal, and transmission of the internal pressure. This fluid channel design has no dead space or undercuts which would impede material flow, cause pressure variations or make cleaning difficult.

Installation into the fluid path

The new sensor is of in-line design and utilises the industry standard Luer lock type connection on both sides, simplifying integration into many systems. Its compact dimensions also make it easy to install into existing production lines, where space might be at a premium.

Figure 2 – The sensor is simple to integrate into existing lines with Luer fittings on both ends

Electrical output

The sensor provides a standard, calibrated, linear 0 - 10V output signal via an integral cable and standard M8 connector. The millivolt signal generated at the source is converted to this signal by an integrated amplifier, obviating the need for an external transducer or booster, and it is internally stabilised within the operating temperature range of 15°C – 45°C. The 0-10V output is a standard control signal, readily utilised by PLC-based automation or test & measurement systems.

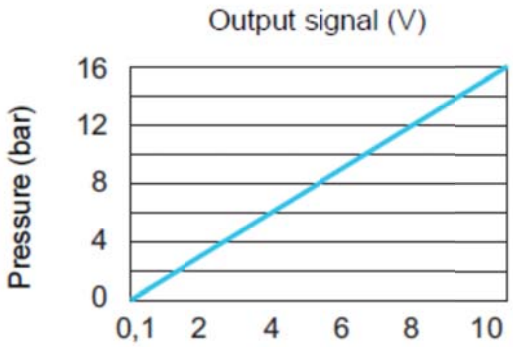

Figure 3 – Output signal vs. pressure

Material compatibility

The sensor's flow channel is fully coated with FFKM (a fully fluorinated elastomer). This provides optimal resistance to many aggressive chemicals including hydrocarbons and highly corrosive fluids, which combined with high temperature resistance make it sufficiently robust to be used in a wide range of applications. The FFKM formulation used in the sensor has FDA compliance, and therefore can be considered for use in food preparation, biochemical work, pharmaceuticals or genetic engineering, for example.

Maintenance and Cleaning

The new sensor is maintenance-free and requires no calibration. Cleaning is straightforward, achieved by thoroughly flushing the interior flow channel with a solvent such as isopropyl alcohol and allowing it to dry.

Applications

In the laboratory, the flowplus will deliver pressure and flow information, and can analyse static and dynamic application flow mechanics using the output and appropriate software.

This information is useful in many analytical and lab situations, but also has real value in production environments where, for example, it can detect irregularities caused by air bubbles in adhesives which would disrupt tight tolerance dispensing on medical devices or visual displays, or identify a blockage building up in filled fluids, so enabling corrective action to be taken.

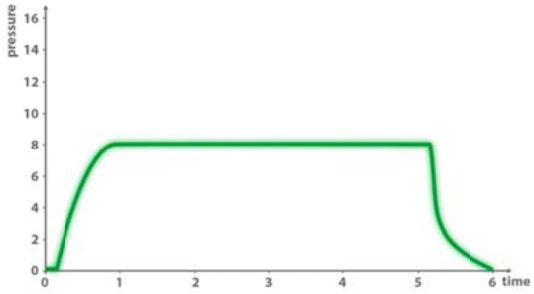

Figure 4 – Signal from an in tolerance dispensing or dosing event

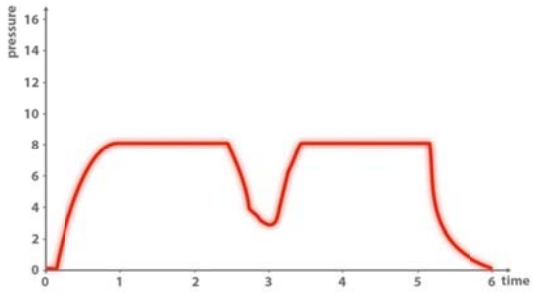

Figure 5 – Signal from an out of tolerance dispensing or dosing event

Connected to a PLC or other control system as part of an automated process, the sensor output can instigate a warning message or error signal which might alert an operator to investigate or shut down the process, or do so automatically. For process validation, the output signal can be kept in a log as part of the quality assurance.

Conclusion

The flowplus pressure sensor is very simple to install into production and laboratory environments, and its standard output signal readily integrates into automation and analytical equipment. The in-line design means there is no “dead space”, and it is easy to clean and to set up with new fluids. The fluorinated elastomer fluid channel is compatible with a large number of liquids and fluids across many uses, including enzymes, drugs and medicines, critical ingredients, inks and adhesives. The new sensor has found applications in a range of sectors including laboratory, pharmaceutical, research & development, electronics & microelectronics, photonics, process engineering, and across industry.

When you absolutely have to know your process is right every time, the flowplus provides assurance, process reliability and reduced downtime.

References

1) ® ViscoTec Pumpen- und Dosiertechnik GmbH, www.flowplus.de

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