Technical Note 153

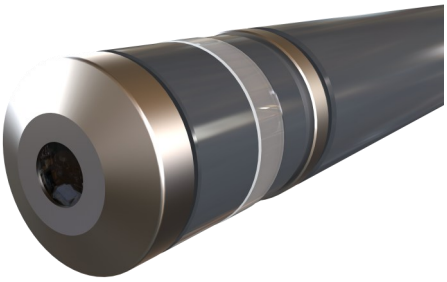
Using Open and Closed Flow Cells with Membraned Sensors

Introduction

Membraned sensors come with many advantages over non-membraned sensors such as better resolution, fewer interferents and a greatly reduced effect of flow rate changes. These advantages can make a huge difference to the bottom line, particularly if the cost of the chemical being dosed is quite high. For free chlorine sensors, using a membrane can make your measurement much less dependent on pH (if you are using sensors from Pi), meaning your measurement is a more accurate reflection of chlorine residual.

As such, membraned sensors are now largely the norm in residual chlorine measurement and are also prevalent for chlorine dioxide and ozone monitoring, but membraned sensors are:

- **sensitive to changes in pressure**
- **open flow cells can be difficult when the outlet does not go to drain**
- **flow cell outlets can airlock even when water is flowing through them**



Membraned free chlorine sensor

This technical note looks at Pi's solutions to this potential issue.

Sensitivity to pressure

Membraned sensors do have one property that needs to be carefully managed; they are sensitive to pressure. Pi was an early adopter of membrane technology, so we know that the installation of these sensors is just as important as the sensor itself. In fact, the same sensors in different flow cells can give very different results.

In order to prevent pressure variations affecting the probe, Pi typically uses open flow cells which eliminate variability in pressure before it reaches the probe. With Pi's open flow cell, variations in pressure on the inlet are removed before they get to the sensor.

Open Flow Cells

Whether the sample to the cell is pumped, gravity fed, or comes from a pressurised line an open flow cell where the sample is open to atmosphere and maintains a constant ___ removes any pressure fluctuations. It is important, however, that the flow is controlled to within a range of 350-1000ml per minute, to ensure that sufficient flow is reaching the sensor and to prevent the flow cell overflowing.

If the flow to the cell is variable outside the range, Pi can provide a dole valve which controls the flow to approximately 500ml per minute, which prevents the cell from overflowing when pressure variations mean more flow than the cell can handle, whilst also ensuring adequate flow when the sample line flow/pressure reduces.

Open flow cell

Airlocks

The outlet of the flow cell needs to be open to atmosphere, and completely unobstructed. Any system with a long outlet line (particularly flexible pipe) is prone to get airlocks, which will cause the cell to overflow. Outlets which are visually clear and even have water flowing through them, can be partially airlocked which causes backpressure to overflow the cell. This is very easy to diagnose as if you see the cell overflowing and remove the outlet pipe, you will see the cell go back to normal operations within approximately 10 seconds. If this is a persistent problem, consider putting in an air break using a commercially available tundish.

An open flow cell with a commercially available tundish.

Outlets that do not go to drain

The water from an open flow cell doesn't have to go to drain. For processes where saving water is a high priority, a simple tank and pump system that will pump sample water back into your main process line will allow water losses to be reduced to almost zero. Pi's CRIUS®4.0 controller can be used to control this return process and ensure that this tank never overflows.

What if things go wrong?

As any water engineer can tell you, no matter how well a system is designed, lines can clog, pumps can break and someone on site could fiddle with the settings. Pi recognises these challenges and has engineered solutions into our systems. All Pi flow cells have an integral flow switch and options to:

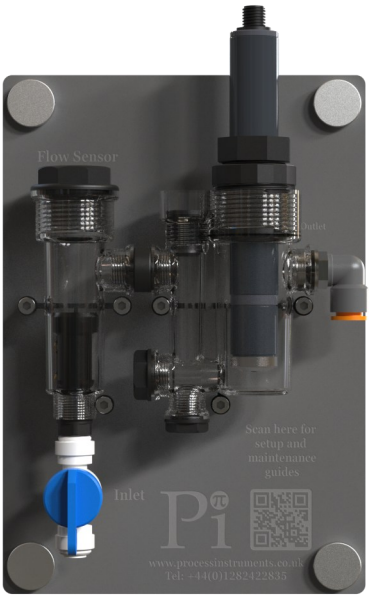
- **Use dosing overfeed protection to protect against clogged dosing lines or pump failure.**
- **Have remote access for SMS or email alarms.**
- **Use relays to trigger beacons or sirens for alarms or control valves and pumps.**
- **Customise user security levels to control who can change what settings.**
- **Use status logs that show what happened to the system and when.**

Closed flow cells

For membraned sensors, the best technical way of housing a membraned sensor is with an open flow cell. There are some occasions where this solution just isn't practicable and in those instances the flow cells from Pi can be sealed to provide closed flow cells, which can take an overpressure of up to 3 bar, are the best solution. As long as there is a sufficient pressure differential between the inlet and the outlet, and the total pressure is less than 3 bar, the closed flow cells from Pi allow for these applications where an open flow cell is not practicable.

In order of "getting the best results" a membraned sensor should be installed in:

1) An open flow cell to drain or to a return tank
2) A closed flow cell to drain or to a return tank
3) A closed flow cell to a lower pressure than the inlet to the flow cell sufficient to ensure >350ml per minute.



Closed flow cell