Technical Note 34

Bubbles in Turbidity Measurements

Introduction

Bubbles are a common source of interference in turbidity measurements. The presence of bubbles, either in the water or on the surfaces of the light source or the detectors, will generally cause a positive interference as they will cause additional scatter of light. When making measurements in samples with low turbidities this additional scatter can represent a significant error in the measurement.

Bubbles occur at the sensor due to the presence of dissolved air within the water. A higher pressure water can carry higher levels of dissolved gases than a lower pressure solution. This means that if the pressure is lowered, gases will start to come out of the solution. Similarly, a lower temperature solution can carry a higher level of dissolved gases than a warmer solution so raising the temperature of the solution will also cause these gases to come out of solution as bubbles. When the gas comes out of solution it can form either entrained bubbles or nucleated bubbles.

Entrained Bubbles

Entrained bubbles move within the solution and can be removed using a debubbler. The TurbSense flow cell contains a series of baffles for this purpose. As the liquid passes through the baffles, entrained bubbles rise to the surface, burst on the surface and do not reach the sensor chamber.

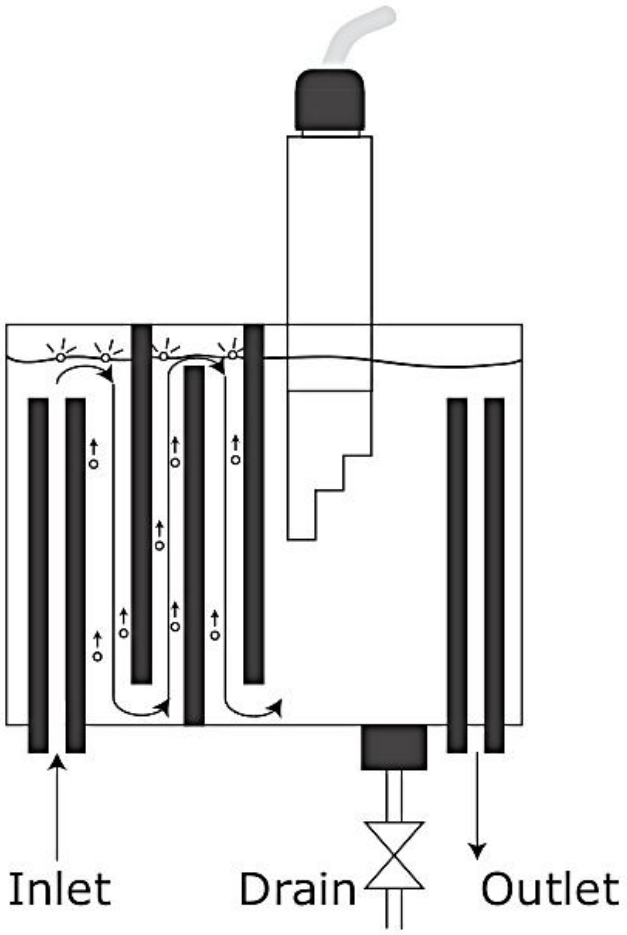

Fig. 1 Debubbling in the TurbSense flow cell.

Nucleated Bubbles

When water is put under pressure (eg. when pumped) the water is able to hold more dissolved air than when it isn't under pressure. When the pressure is released the bubbles come out of the solution and build up at nucleation sites such as miniscule surface defects (like CO_2 comes out the solution when champagne is uncorked). Nucleated bubbles grow with time and can become detached and become entrained bubbles. If nucleating bubbles form on sensor surfaces they can cause large errors in readings. Pi deals with nucleating bubbles in one of two ways depending on the installation. For pole mounted installations in tanks and channels, installation of the Pi autoclean means that bubbles can be removed from a TurbSense sensor by carrying out an Autoclean operation and firing a jet of water over the sensor surface. In flow cell installations the bubbles can be forced to burst by fitting a solenoid valve to the flow cell drain and dropping the liquid level in the sensor chamber below the sensor surface. These operations can both be scheduled to be carried out periodically at a frequency that prevents interference from nucleated bubbles.

The effect of nucleated bubbles growing on the optical surfaces of the sensor is shown in Fig. 2 and Fig. 3. In Fig. 2, no bubble removal was employed leading to erratic readings due to growth of nucleated bubbles.

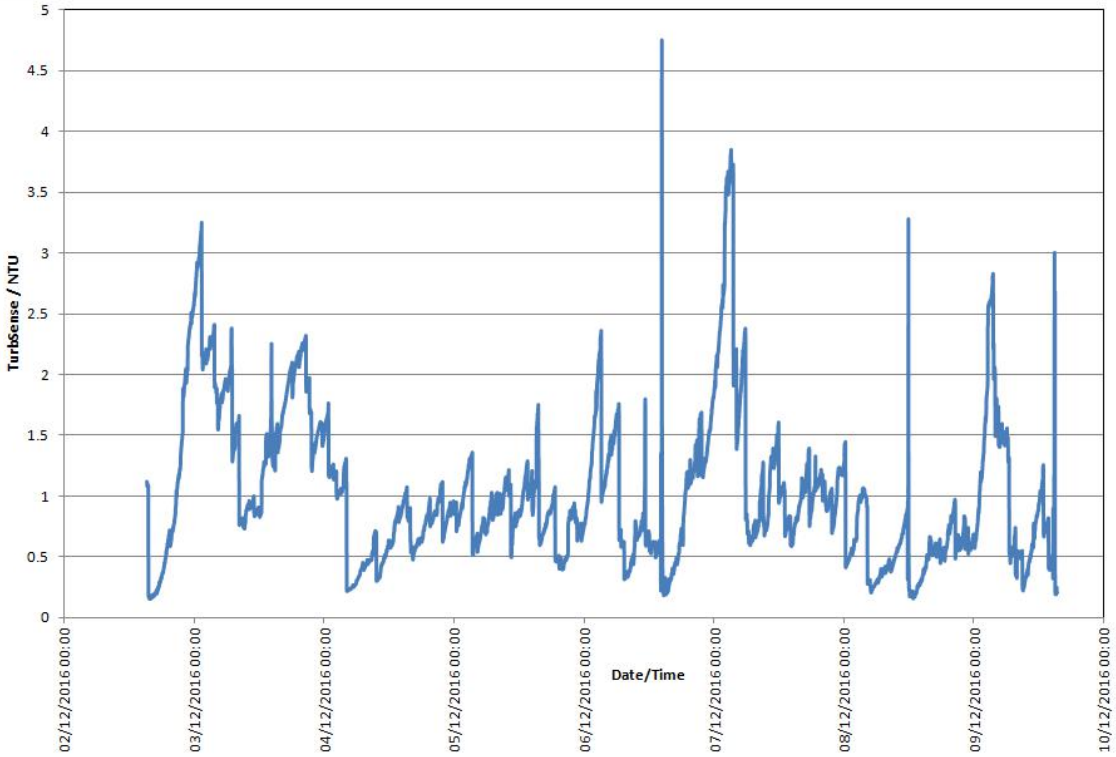

Fig. 2 Turbidity readings with no bubble removal.

In Fig. 3, the liquid level was dropped every hour forcing nucleated bubbles on the sensor surfaces to burst and no build-up of bubbles is seen. The small peaks visible in the trace are due to variations in the process stream being monitored and are also seen in the results of other probes monitoring the stream such as pH and free chlorine.

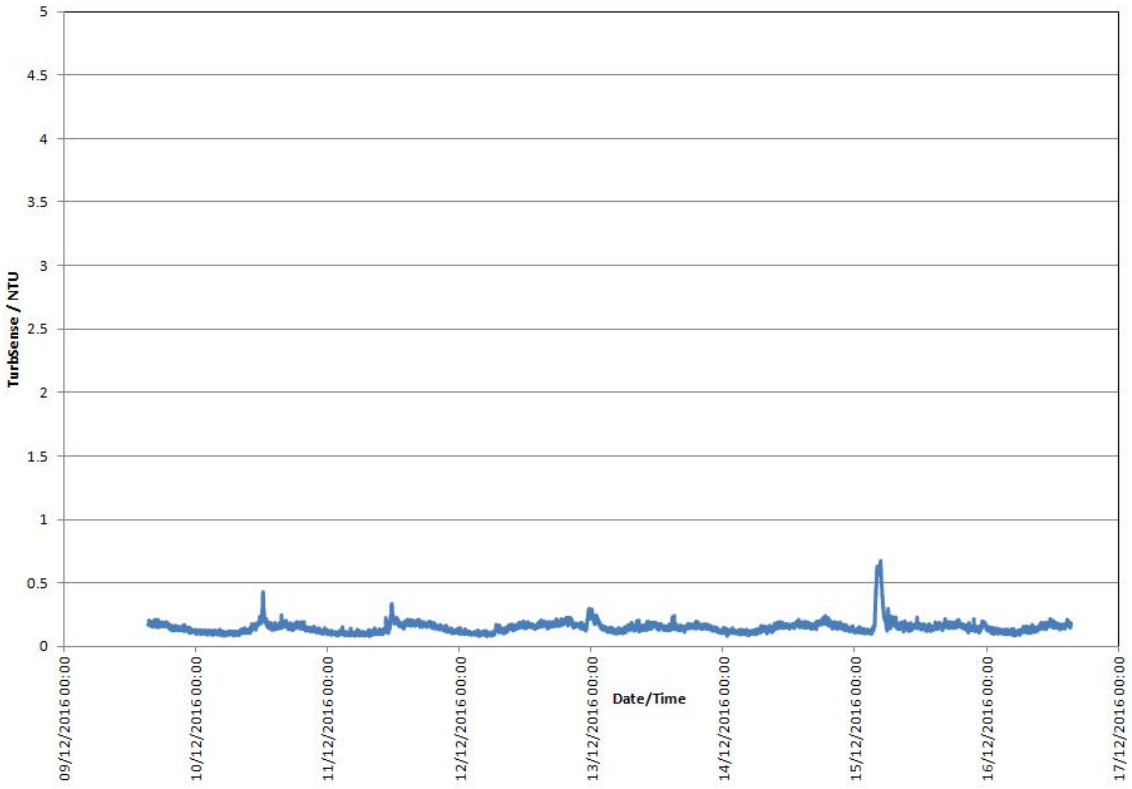

Fig. 3 Turbidity readings with bubble removal by dropping the sensor chamber liquid level.

Conclusion

Whilst bubbles do interfere with turbidity measurements Pi has developed simple, robust methods of removing that potential interference.