

# THE FUTURE OF TURBIDITY MEASUREMENT IN DISTRIBUTION NETWORKS IS BRIGHT

**Solving the Water Industry's challenges through innovation is vital if the water industry is to achieve OFWAT's tough targets to improve the quality of drinking water and reduce the number of customer complaints.**

As the emphasis on reducing turbidity in potable water increases and customers become less tolerant of discolouration, water professionals have become more motivated to look for new, reliable and effective methods to address water quality as a priority.

Analytical Technology's Managing Director Europe, Dr Mike Strahand, discusses the important aspects of turbidity measurement that water plant operators must consider when selecting a turbidimeter to best suit their needs.

## What is Turbidity?

Turbidity is the cloudiness of a water sample. The cloudiness is caused by the scattering of light from undissolved particles suspended in the water. Turbidity is a general indicator of the optical clarity of water, and is defined as the amount of light



*Cloudy and Discoloured Tap Water Caused by Turbidity*

scattered by particles in solution. In practice, a light beam is directed into a water sample and a photo detector measures the light scattered at 90-degrees to the incident light beam. While other scatter angles are possible, the 90-degree measurement angle has become the standard for turbidity measurement in most water systems. It is used as a relative indicator of the amount of suspended solids in a solution, and is measured in virtually all drinking water systems. It is also used in industrial water treatment systems as an indicator of product water quality.

There are several optical arrangements that can be used for measuring turbidity. A flow through cell arrangement with the optics set up to make a 90-degree scattering measurement is very common. This type of arrangement has maintenance issues associated with optical surfaces becoming contaminated.

Another arrangement is to measure the turbidity in a falling stream of water with no flow cell. This eliminates the optical fouling issue, but introduces issues with vibration and air currents affecting measurement.

The turbidity sensor used in the ATi Q46 and M-Node turbidity monitors is a planar sensor with the light source and photo detector mounted on a flat face. Lenses in front of the light source direct the beam of light at a 45-degree angle into the sample. Another lens in front of the photo detector collects the 90-degree scattered light and directs it to the detector. The signal generated by the detector is amplified inside the sensor for transmission to the display unit. Periodic pulsing of the light source allows the sensor zero to be adjusted automatically for improved stability in low-range applications. A flow cell is required for very low measurements (0-2 NTU).

This type of sensor is particularly appropriate for use in distribution system, it is robust and can be made small and low powered enough for use in remote distribution network applications.

Discolouration formation in water distribution networks is a complex and not completely understood problem that can vary even between different parts of the same water distribution network, and yet is still similarly experienced throughout different countries regardless of the different varying factors between their water distribution systems.

A discolouration event occurs when a sufficient flow change mobilises solid matter and transports the accumulated



*MetriNet – Cutting Edge Smart Sensor Technology*



MetriNet Cutting Edge Turbidity Measurement

discolouration material through the network and produces discoloured water at the customer's tap. While large improvements have been made to reduce discolouration in distribution systems in recent years, water companies still mostly deal with discolouration in a reactive way. This is usually in the form of cleaning, (flushing, ice pigging and swabbing) once enough discolouration contacts have been reported in the area.

## Customer Complaint Targets

The UK water industry has been targeted over the quality of drinking water supplied to the public, with 27 measures, including turbidity, put into place to improve water quality. OFWAT has applied high financial penalties to water companies who fail to keep complaints of discolouration to a set limit – a fine of up to £1,000 per complaint if water companies exceed their target. Based on the number of complaints water companies received last year, this could see expected fines reaching between £2-3 million if they do not meet their targets. In addition, this could also affect their share price and positions in the quality league table. Under the new rules, although fines can be applied to water companies who 'fail' to hit their target, they can also be rewarded for an improvement to the quality of the water provided.

## The History of Turbidity Monitoring

Turbidity levels are traditionally difficult and time-consuming to measure, but they give a valuable insight into the performance and resilience of the network. Traditionally, obtaining turbidity data in networks was done via manual samples, which gives patchy information at best and the frequency of data isn't high enough to extract trends or meaning.

More recently, portable turbidity monitors have been used to help with flushing and improve efficacy. This technology offers a string of benefits to help water companies control their mains flushing, including continuous remote monitoring of turbidity; better accuracy at lower levels; fast connection to water mains via hydrants; huge savings when carrying out and planning flushing; along with wireless communications and alarms. If the portable turbidity monitors are permanently deployed, they can also allow water companies to track any issues, identify where any problems are occurring and forewarn when any problems are likely to reach the customers.

## Research and Development

In order to improve SIM scores and increase compliance, water companies need to look at how they can reduce the number of complaints from the public. The main causes of discolouration is the release of biofilm and entrapped inorganic material, such as iron and manganese being released from pipe walls, typically by changes in the flow and/or pressure in the system and air trapped in the network. This gives a 'cloudy' appearance. Discolouration can be caused in many ways: sudden changes in pressure when the fire brigade connects to a hydrant; council staff with high pressure cleaning; valve operations when dealing with 'dead-legs' in the network; and leaks that can affect sudden changes in pressure. This alters the level of shear stress, hence releasing bio-film. Once the bio-film reaches the consumer, a complaint is made and logged.

With all this in mind, the main challenges for specialist sensor manufacturers have been to produce low powered, continuous sensors that are as accurate as fixed systems.

## Continuous, On-line Measurement

In order to protect against contamination risks, turbidity must be measured continuously, as the turbidity value can change very rapidly, turbidity events with values going from 0.05NTU to >20NTU in a matter of seconds have been seen. The key to a successful water quality system in today's environment is using the latest in monitoring technologies together to measure changes in the water system and then take action based on the interpretation of the measured values. Changes in turbidity must be monitored very carefully to immediately detect abnormal conditions take action to reduce the risk to customers.

Access to this newly acquired continuous, accurate data have 'opened the eyes' of many water companies, who have previously struggled to understand the overall condition of their networks. In many cases, network engineers simply do not know enough about the the water quality of their network. As only spot checks were available, there was a lack of information on why water quality differs so much within an area and with time. Now that changes in water quality can be identified and tracked via new technology action can be taken (e.g the supply could be diverted to a service reservoir) and crucially, warnings can be sent out to customers to prevent complaints filtering through. If this new technology is permanently deployed in multiple locations, it can also allow water companies to start to manage their networks in a predictive rather than a reactive fashion.



Biofilm on Water Mains, the Cause of Turbidity

Many water companies are now starting to invest in the latest cutting-edge technology, which has seen them permanently deploying ground-breaking multiparameter monitors. For the first time, these water companies are now able to organise, plan and manage their distribution networks rather than react. One example of such on-line turbidity monitoring systems is the new state-of-the-art MetriNet, which is a brand-new approach to smart sensor technology that helps to improve compliance, reduce complaints and increase their SIM scores. This patented technology provides a flexible method for delivering information from remote locations, is designed specifically for applications in water distribution networks and allows 'no compromise' continuous measurement of all the main water quality parameters, including turbidity, residual chlorine, pH, Conductivity, Dissolved oxygen, temperature and many more.

## Network Monitoring Solutions

At the heart of the new MetriNet system are a series of smart digital sensors, the industry-leading M-Nodes, that come complete with all the communications protocols needed and expected in today's digital age, as well as a good old-fashioned analogue output.

The M-Nodes are connected to the water supply using a purpose

designed 'click-connect' flow cell arrangement. Sensors are connected in series to minimise water usage and can run at pressures up to 6 bar. This means that MetriNet systems can be used in closed bypass arrangement to completely eliminate water loss.

M-Nodes are ultra low-powered and run autonomously for years at a time on small batteries. Alternatively they can be powered from a local plc or telemetry system. Flexibility really is the name of the game with M-Node sensors, they can be connected to any data gathering system.

For those looking for a complete solution, M-Nodes can be connected to the MetriNet User Interface (MUI). The MUI connects to up to 8 M-Node sensors and connects to the outside world in via any 'ftp' based system. The MUI also has on board data -logging with massive data storage capabilities.

M-Nodes are available for a variety of measurement in water systems. All nodes plug directly into MetriNet systems and are powered directly from the communications bus. Nodes may be added or removed as needed and removal of a node will not affect system measurements.

M-Nodes are complete water quality monitors equivalent in most respects to full function instruments. Electronic assemblies are galvanically isolated from both the power supply and communication link.

## Conclusion

Innovation plays a vital part in providing solutions to the challenges faced by the Water Industry. Advances in robust, high-precision and reliable network monitors is revolutionising water quality management in water distribution systems.

Understanding network behaviour by using these smart monitors allows operators to condition mains for resilience purposes, or long-term maintenance to reduce customer complaints and safeguard against water quality failures.

It is imperative that water companies choose a turbidity monitor that offers a sustainable solution to meet the complex challenges currently facing the industry. It will ultimately help drive down complaints, increase water companies' credit ratings and result in pro-active network management to safeguard water quality for customer use.

There may be other multi-parameter monitoring systems on the market, however the difference with the MetriNet is that ATI are sensor people adding data handling and not the other way around, hence the phrase 'no compromise'. Other similar multi-parameter monitors may have good data handling, but the quality of the sensors are compromised. The MetriNet is unique because it combines the best of everything for the first time.

The MetriNet offers a sustainable solution to meet the complex challenges currently facing the water sector. It will ultimately help drive down complaints, increase water companies' SIM scores and result in pro-active network management to safeguard water quality for customer use.



MetriNet Turbidity Sensor

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