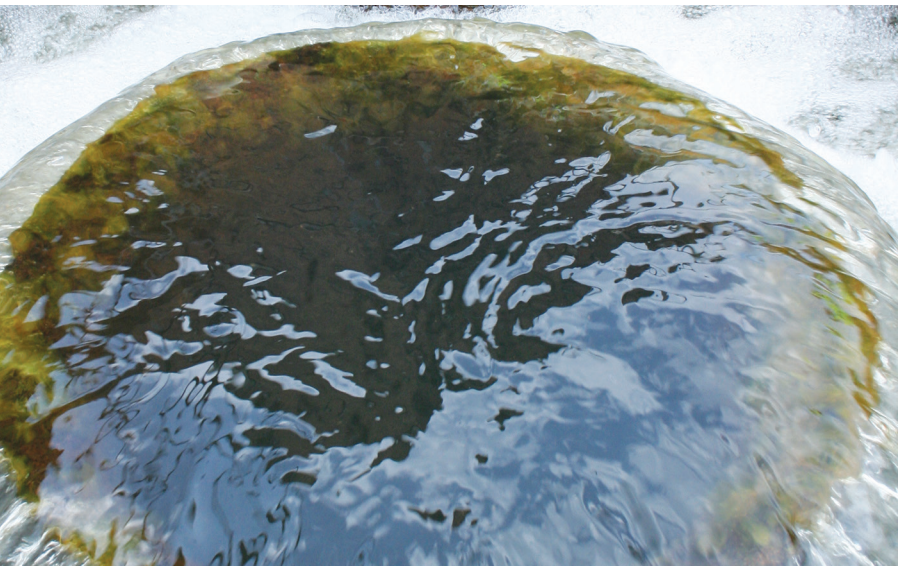
ABB MEASUREMENT & ANALYTICS | APPLICATION DESCRIPTION

Optimizing final water quality through manganese monitoring

Using ABB's Aztec 600 Manganese analyzer to improve manganese removal efficiency



Accurate monitoring of manganese levels in final water improves dosing control and final water quality, minimizes deposition on pipeline surfaces and reduces customer complaints

Measurement made easy

On-line manganese monitoring

Introduction

The task of managing the quantity and quality of potable water is unimaginable without on-line instrumentation to help water utilities to measure, treat and deliver drinking water to consumers. ABB's Aztec 600 colorimetric and ion-selective electrode (ISE) analyzers have been designed to measure the key parameters that affect water quality – aluminium, iron, manganese, phosphate, color, ammonia and fluoride.

This publication looks at the issues associated with monitoring manganese concentrations in potable water supplies, including how it affects water quality, why it must be removed and how to minimize its presence to acceptable limits.

Manganese occurs naturally in many sources of water. Although it has not been proven to pose a risk to human health, it can have a negative impact on the appearance of drinking water if not properly treated. Failure to control manganese levels results in black deposits collecting in pipe networks that may turn potable water black if disturbed.

Most complaints about manganese in potable water relate to staining of laundry or vegetables becoming discolored during washing or cooking.

Other common problems associated with manganese include:

- deposition of manganese oxides on pipeline surfaces
- reduced chlorine levels in the distribution system
- restriction of water flow
- break off, resulting in poor water quality
- growth of bacteria in the water distribution system

The World Health Organization (WHO) has set a maximum permitted level for manganese in potable water of <0.05 mg/l. Many water operators actually aim for a level of below 0.02 mg/l.

Monitoring manganese levels in water can be problematic, depending on whether it is present either in its soluble (Mn_2+) or insoluble (Mn_4+) form. Solubility increases under acidic or anaerobic conditions.

Waters that are well oxygenated tend to contain mostly insoluble manganese. Soluble manganese is found deeper and closer to sedimentary levels in rivers and other water sources.

The application

Although particulate manganese can be removed easily through filtration, it is less straightforward to remove it in its soluble form. For this to occur, a chemical oxidant, such as chlorine, ozone, chlorine dioxide or potassium permanganate must be added to treatment processes to assist in its removal. Of these, the most commonly used is potassium permanganate; a crystalline salt used in water treatment processes worldwide to help remove dissolved manganese.

The challenge

For water treatment plant operators, the challenge is to ensure that the correct amount of potassium permanganate is added. The accepted dosage of potassium permanganate needed to oxidize 1 ppm of soluble manganese is 1.92 ppm.

$$3Mn^{2+} + 2KMnO_4 + 2H_2O \rightarrow 5MnO_{2(s)} + 2K^+ + 4H^+$$

In conventional water treatment plants, potassium permanganate solution is added either to the raw water intake at the rapid mix tank together with coagulants, or at clarifiers upstream of the filters.

Potassium permanganate dosing must be carefully controlled, as overdosing can cause the treated water to turn pink, requiring further treatment. It is therefore important to ensure that all of the potassium permanganate is reduced, forming MnO_2 solids, and removed.

Potassium permanganate dosing is further complicated by the fact that manganese levels in water are never constant. Both the form (soluble and/or non-soluble) and concentration of manganese can vary greatly. This problem is particularly pronounced during hot months and periods of water scarcity, when water levels fall and temperatures increase, with more soluble manganese likely to be present.

With manganese concentrations capable of changing suddenly over even a short period of time, operators must have a system that can respond quickly to likely variations to ensure the correct dosing of oxidizing chemicals. Traditional off-line, laboratory-based methods are unable to detect these sudden changes, even when conducted on a regular weekly or bi-weekly basis. Failing to provide the correct information for dosing processes can result in higher levels of manganese in final water.

As a further challenge, water operators are also increasingly under an obligation to reduce the level of chemical dosing in water treatment processes to help reduce the potential formation of harmful dis-infection by-products (DBPs) such as trihalomethanes and haloacetic acids.

The solution

ABB's Aztec 600 Manganese analyzers provide accurate on-line monitoring of manganese concentrations from surface and ground waters. Available in both low and high range versions, the Aztec 600 Manganese offers reliable, accurate, on-line analysis of manganese, enabling immediate process decisions to be made without the delays associated with off-line monitoring techniques.

The low range sensitivity version offers a very low limit of detection from just 0.001 ppm up to 0.10 ppm. This level of sensitivity is particularly important when analyzing treated water for Mn concentrations below 0.02 mg/l. As further protection against post-treatment breakthrough of manganese, the Aztec 600 Manganese low range analyzer enables accurate post filtration measurement of low concentrations of manganese found in final waters at levels of typically <0.050 ppm Mn.

The high range version is available specifically for the measurement of manganese concentrations up to 10 ppm, making it ideal for ground, surface and potable water applications.

How does the Aztec 600 Manganese work?

The Aztec 600 Manganese is an on-line colorimetric analyzer. It has been designed for ease-of-use and maintenance simplicity, while offering the benefits of flexible communication and advanced data acquisition.

The Aztec 600 Manganese can measure up to six samples per hour. ABB has developed two different methods for the analysis of manganese levels. The low range method is based on leucomalachite chemistry and is extremely sensitive for final water measurements. The high range method uses industry standard formaldoxime chemical method, and is suitable for measuring higher concentrations typically found in source waters. A fully-programmable multi-stream option is available, providing up to 3-stream capability with user-programmable stream sequencing.

Fluid handling

A single piston pump provides all the sample and chemical fluid handling for measurement, mixing and disposal. The pump is stepper motor controlled for repeatability and precision. This 'motorized syringe' approach has the added benefit of wiping the optical cell on every movement of the piston, resulting in a highly efficient automatic cleaning process. This is particularly important when measuring waters where optical contamination can be a real issue without having stringent automatic cleaning.

Measurement technique

The optical cell is rinsed thoroughly with sample before measurement, eliminating dead zones and enabling multi-stream measurement across different samples without cross contamination.

To correct for any natural coloration of the sample, the background absorbance of the sample is measured prior to the addition of any color-forming reagents to provide a sample blank. Instead of using a mechanical stirring system, the piston and optical sensor is utilized further by drawing in air after the sample and reagents are introduced. This provides turbulence and efficient mixing without any of the cost and maintenance drawbacks of mechanical and electrical mixing systems.

The Aztec 600 Manganese analyzer includes an automated chemical cleaning routine. This programmable rinse routine enables a separate acid/alkali or biocide to be drawn through the sample tubing and optical cell.

Aztec 600 Manganese (low range)

Aztec 600 Manganese (high range)

Key features and benefits

The Aztec 600 Manganese analyzers offer a range of benefits, providing users with a powerful, accurate and reliable tool for efficient control of manganese concentrations:

- **Improved process control**
  Enables operational decisions to be made in near real-time.
- **Improved process reliability**
  Detect process failures before they affect the quality of the water leaving the plant.
- **Process optimization for water quality**
  Increased plant efficiency.
- **Potential capital and operating cost reductions**
  Reduced chemical and energy usage.
- **Continual monitoring of remote or un-staffed sites**
  Improved response times and reduced visits saving money and time whilst lowering carbon footprint.
- **Improved reporting**
  Analyzer audit trail data can be used to assure customers and regulators of process efficiency and consistent product quality.

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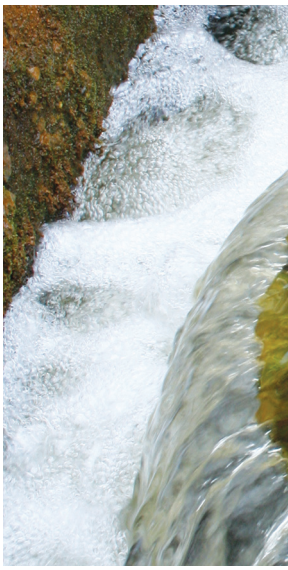

AD/ANAINST/013-EN Rev. A 10.2018