APPLICATION BRIEF

City of Alamosa Evaluates SafeGuard™ H2O Arsenic Removal Technology to Replace Bulk Ferric

Since 2008, the City of Alamosa in Colorado has been operating an arsenic removal system based on the use of bulk ferric chloride as a coagulant. With a maximum flow rate capacity of 5.25 million-gallons-per-day (mgd), the city's water treatment plant blends source water obtained from five wells across the region to meet drinking water needs.

Source water contains naturally occurring arsenate [As(V)] and other inorganic contaminants. The city's treatment process involves a bulk ferric reagent, which is dosed into raw water at a rate of 17-19 milligrams per liter (mg/L). Following coagulation, the treated water is passed through an ultrafiltration (UF) membrane to remove the ferric-arsenic coagulant. The filters are backwashed periodically, and the backwash is discharged into the city's sewerage system. The process reduces arsenic from an influent value of ≥ 35 parts per billion (ppb) to an effluent below the U.S. EPA's current maximum contaminant level (MCL) of 10 ppb; however, it is dependent on bulk chemicals and presents a number of associated operational issues.

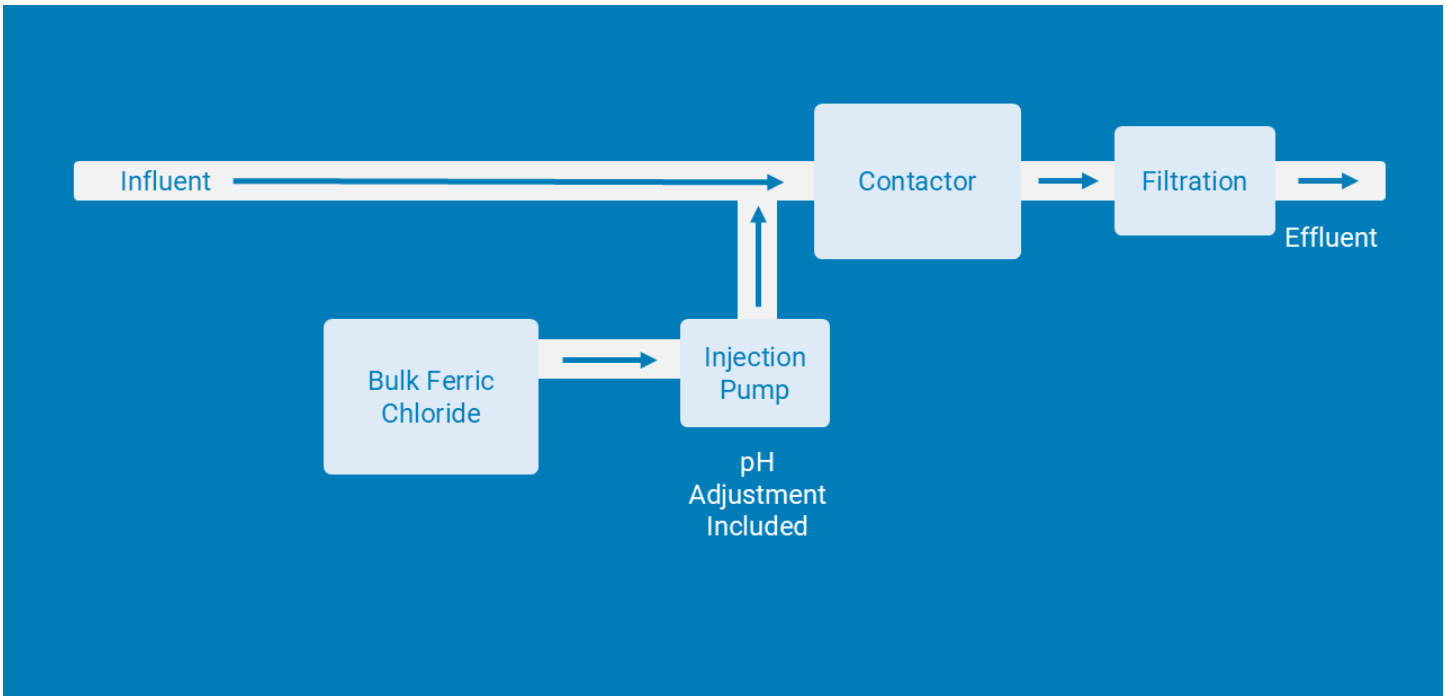
Concerned with its reliance on bulk chemicals to meet the current or future arsenic MCL, the City of Alamosa evaluated the SafeGuard™ H2O arsenic removal treatment system, manufactured by AMS, to replace the use of bulk ferric chloride. The evaluation was completed in 2022 via bench-scale testing and subsequent pilot demonstration of the SafeGuard H2O system was conducted in 2023.

The bench-scale test characterized the efficacy of the technology and the coagulation filtration requirements. The demonstration was initiated to show the ability of SafeGuard H2O to provide effective and reliable arsenic removal below the MCL, evaluate the purity of the in-situ generated ferrous reagent compared to bulk ferric chloride (Table 1), and study the impact of both reagents on UF membrane health.

Overview of SafeGuard™ H2O Arsenic Removal Technology

The SafeGuard H2O technology uses a non-toxic, certified reagent precursor material (low carbon steel) and an in-situ electrolytic generator to create a ferrous reagent onsite and on-demand. SafeGuard H2O features automatic dosing and incorporates proprietary continuous, real-time monitoring of contaminant levels at the influent and effluent to ensure optimal treatment and compliance with regulatory and operational targets 24/7/365. As with any water treatment system, high frequency continuous water quality monitoring of contaminants such as arsenic and iron at critical treatment process steps supports process automation, optimization, reliability, and can give remote visibility of system performance for the utility and their customers.

SafeGuard H2O Arsenic Removal System Control Panel



SafeGuard H2O Arsenic Removal Technology Schematic

Demonstration Results

The bench scale testing demonstrated that the SafeGuard H2O in-situ generated ferrous reagent can achieve arsenic removal below 10 ppb, proving the efficacy of the technology. The electrogenerated ferrous reagent was shown to achieve reliable arsenic removal below 5 ppb with a ferrous dose of 6.5-8 mg/L.

For the SafeGuard H2O demonstration, a treatment system with a capacity of 100 milliliters per minute (ml/min) [0.016 gal/sq ft/min] that uses all the essential components for a full-scale installation was designed to mimic key plant conditions and parameters including treatment reagent (coagulant) dose, water/coagulant contact time, coagulation pH, the flowrate through UF module and UF membrane backwashing schedule.

The SafeGuard H2O demonstration system consisted of two treatment trains, one for the electrolytic ferrous reagent and another for bulk ferric chloride, that were run in parallel to ensure a side-by-side comparison of the two treatment approaches. Each treatment train shared a similar process flow and identical arsenic coagulation/filtration modules, they differed only in the reagent used.

Parameter	Bulk Ferric Chloride Reagent (mg/L)	Electrogenerated Ferrous Reagent (mg/L)
Antimony	0.378	0.0008
Beryllium	0.002	< 0.0006
Copper	112.91	2.56
Iron	> 140,000	2,865.35
Lead	< 0.001	< 0.001
Manganese	951.48	5.789
Molybdenum	8.092	1.159
Nickel	21.546	0.841
Selenium	0.094	0.004
Silver	0.122	0.006
Thallium	< 0.0002	< 0.0002
Zinc	28.8	0.97
Source: Analytical Results conducted by SDC Laboratory located at Tierra Del Sol Industrial Park, 2329 Lava Lane, P.O. Box 642, Alamosa, CO 81101		

Table 1. Laboratory Analysis Results of 39% Bulk Ferric Chloride Reagent and Electrogenerated Ferrous Reagent

During the operation period of Jan. 14 to Feb. 3, 2023, the influent arsenic levels, specifically As(V), were ≥ 35 ppb. Total arsenic levels in the permeate obtained from the electrolytic ferrous reagent were consistently lower than that in the permeate obtained from the bulk ferric chloride (Figure 1). These findings were confirmed by laboratory and field tests.

Conclusions from the demonstration of the SafeGuard H2O technology include:

- The SafeGuard H2O arsenic removal technology demonstrated the ability to remove high levels of influent arsenic to below 5 ppb under tightly controlled treatment process conditions.
- The electrolytically generated ferrous reagent provides a higher efficiency in arsenic removal compared to bulk ferric chloride. The SafeGuard H2O electrolytically generated reagent demonstrated high arsenic treatment performance using a ferric coagulant dose 27% lower than that with a bulk ferric chloride reagent.
- The purity of the in-situ ferrous reagent precursor is of a higher quality than bulk ferric chloride.
- The high purity of the in-situ ferrous reagent resulted in lower manganese levels in the treatment reagent as well as in the treated water and waste. The low manganese content in the electrolytic ferric reagent relative to the bulk ferric reagent caused minimal impact on the treated water quality.

The validation of the SafeGuard H2O technology to generate a ferrous reagent in-situ via an electrolytic process shows great promise for the many utilities across the U.S. looking for an affordable and effective arsenic remediation solution to meet current and future MCLs while eliminating reliance on hazardous bulk chemicals.

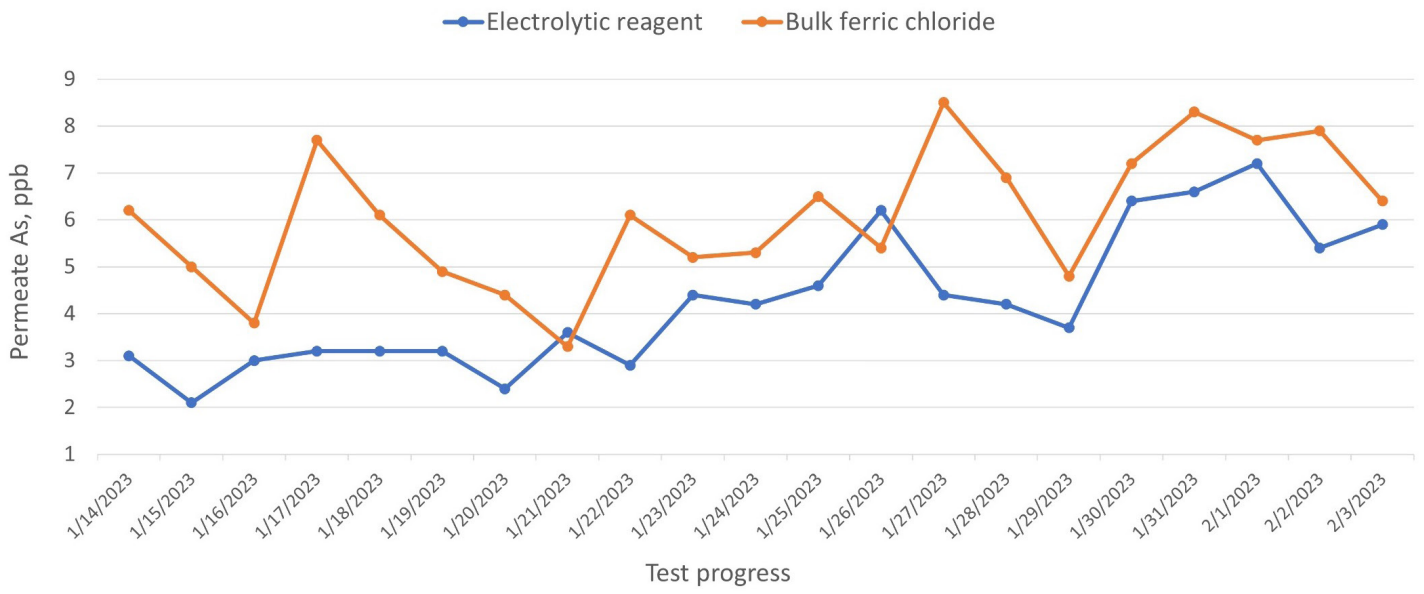


Figure 1. Total Arsenic in Train 1 (Bulk Ferric Chloride) and Train 2 (Electrolytic Ferrous Reagent) Permeates

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