Case Study - Arsenic Treatment Technologies
Fairbanks, AK

Background: Water Quality Characteristics

Fairbanks, Alaska has unique water needs due to its remote geographical location and cold climate. Fairbanks is in an area of discontinuous permafrost, where most of the moisture in the soil occurs as ground ice, rendering it difficult to drill wells and lay pipe. There are a number of work camps and native villages surrounding Fairbanks that cannot easily access the public water system (PWS).

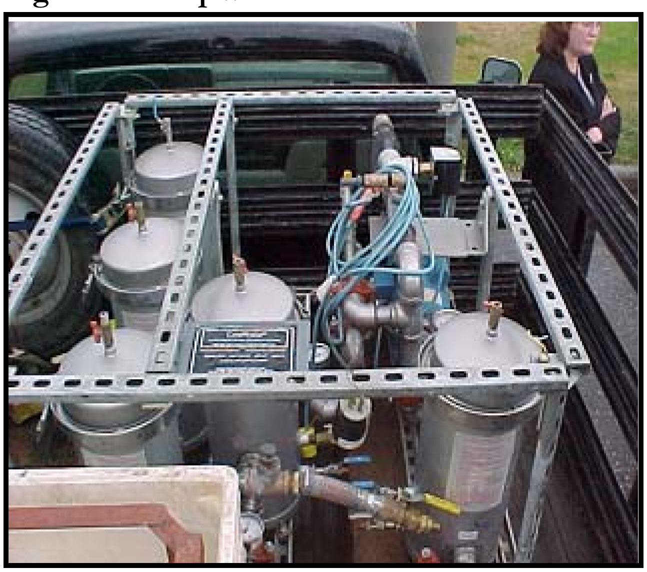
To help provide water, Northern Testing Laboratories, Inc. and Delta Industrial Services, Inc. developed a 5 gallon per minute (gpm) portable water treatment system and tested it on the Taiga Woodlands well located outside of Fairbanks. The well serves a community of 14 homes.

The raw water in the Taiga Woodlands well has an arsenic content of 0.237 mg/L and an iron content of approximately 9.43 mg/L. According to the Safe Drinking Water Information System (SDWIS), the system has incurred monthly total coliform and antimony maximum contaminant level (MCL) violations and a number of total coliform rule monitoring/reporting violations.

Pilot Testing

The CampWater™ Porta-5, a portable system that can be mounted on a truck and transported to areas where connecting to the PWS is not possible, was pilot tested from February, 2001 to May, 2001 at the Taiga Woodlands well. The pilot consisted of several initial "run-in" trials, 14 days of performance testing, and complete evaluation of the raw and treated water.

Figure 2: CampWater™ Porta-5



The CampWater™ Porta-5 uses ozonation and cartridge filtration to reduce arsenic content. The system relies on co-precipitation, which occurs when ozone oxidizes both iron and arsenic. The iron and arsenic adsorb to each other and are deposited on the filter media.

The adsorption rate of arsenic to iron depends upon a number of factors; higher pH decreases adsorption and higher iron concentration increases adsorption.[1]

In the chemical process of oxidation, 1.5 mg/L of ozone is necessary per 1 mg/L of total organic carbon (TOC). This relationship determines the size of the ozone generator necessary for the system. The ozone generator used in Fairbanks had a capacity of 4.5 grams per hour (gph) at approximately seven standard cubic feet per hour (SCFH) when ambient air was drawn into it. By feeding concentrated oxygen into the generator, ozone output was increased to 10 gph. The ozone was then drawn into the system by a vacuum. At a flow rate of five gpm, the 54.5 gallon stainless steel tank allowed 5.45 minutes of contact time for the ozone to react with the water.

Conclusions

The Oxidation Reduction Potential (ORP) is highly influenced by the production rate of the ozone generator. In the eight tests where the ORP was between 471 and 849 millivolts (mV), the finished water arsenic level was below the revised arsenic MCL of 0.010 mg/L and below the secondary MCL (SMCL) for iron of 0.3 mg/L. The iron present in the raw water was sufficient to adsorb and remove 0.237 mg/L of arsenic. The system also successfully reduced manganese levels to below the SMCL of 0.05 mg/L in the nine tests where the ozone generator produced 10 gph.

Figure 3: Truck mounted CampWater™ Porta-5

The costs associated with the installation and operation of the CampWater™ Porta-5 system are variable. The unit itself costs about $15,000, but if mass-produced in the future, that cost may decrease.

The CampWater™ Porta-5 needs a source of raw water (preferably a flooded suction), a source of power (30 amp 220 volt breaker), and about 40 square feet of floor space (4'x10'). The system was recently added onto an existing system at a cost of approximately $200 for parts and 8 hours of labor. If additional floor space, forwarding pump, or electrical service were necessary, the price would be higher.

Since there are no chemicals to purchase, filter replacement is the predominant maintenance cost. The particulate filters cost $70.00 (12 each) and if used by the system, the carbon filters cost $48.00 (4 each). While the frequency of replacement will depend on the contaminant load, an 800 hour run

[1] Jon Dufendach. "Arsenic Removal from Groundwater by Coprecipitation: A Field Test in Fairbanks, Alaska."

time is anticipated. Other costs include the air filter and dessicant in the ozone generator ($20.00 per year), a pump replacement every 5-years ($750.00), and electricity costs.[2]

For example, if a system runs 12 hours per day, filters would last approximately two months. The cost of replacing the particulate filters would be $35.00 a month (replacement six times a year at a total cost of $420.00) and the cost of replacing the carbon filters would be $24.00 a month (replacement six times a year at a total cost of $288.00). Adding in the monthly ozone generator cost of $1.70 and a monthly pump replacement cost of $12.50 ($750.00 spread across 60 months), the costs for maintaining the CampWater™ Porta-5 is approximately $73.50 a month.

The CampWater™ Porta-5 conservatively produces 5 gpm. Using the example above, if the system is running 12 hours a day (720 minutes) at the 5 gpm estimate, the system will produce 3,600 gallons in the 12 hour day. At the monthly maintenance of $73.50 a month (or $2.45 a day), the operating costs are approximately 0.07 cents per gallon. In addition, the CampWater™ Porta-5 is estimated to need 288 kwh per month. Estimating $ 0.07 per kilowatt hour (kwh), the operating cost per gallon increases slightly to 0.09 cents per gallon.[3]

The portable nature of the CampWater™ Porta-5 system could allow water to be delivered to a number of work camps and native villages and would work well in areas like Fairbanks. However, the system requires more maintenance than a stand-alone system where weight and volume are less critical and the success of this system is linked to a number of water quality factors such as the level of iron in the raw water, the amount of ozone produced, TOC levels, and the pH of the raw water.

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[2] Email correspondence Jon Dufendach to Joe Steiner, November 20, 2002.

[3] This per gallon cost does not take into account purchase and installation costs.