



## **Kroff Facilities Services develops cost-effective, consistent way to remove selenium from wastewater**

### **Need/ Opportunity**

[A world-class refinery](#) in the Midwest has a throughput capacity of more than 160,000 barrels of crude oil a day. The product line includes gasoline, diesel, jet fuel, residual fuels and petrochemical feedstocks.

The refinery has a large wastewater treatment system that treats up to 4,500 gallons per minute of general wastewater from the refinery. It has a [National Pollutant Discharge Elimination System](#) (NPDES) permit with the Ohio Environmental Protection Agency.

Under the permit, discharged selenium levels into surface water must be less than 12 parts per billion (ppb). Despite a large, complex wastewater treatment system, the refinery was not consistently able to meet this standard. As an interim step, the company rented additional treatment equipment. The rental equipment was expensive to operate and inconsistent in meeting the discharge limit.

This situation presented a two-fold need: 1) to consistently meet the selenium level concentration of 12 ppb; and 2) to determine whether a selenium abatement process could be found that would reduce costs to operate the wastewater treatment system.

In May 2009, [Kroff Facilities Services](#) (KFS) along with Severn Trent Services (STS) began evaluating selenium removal technologies. STS is a provider of water and wastewater treatment technologies. KFS is a subsidiary of Kroff, Inc. It is a technical company that uses its own operators to operate and maintain water and wastewater treatment systems. The KFS programs enable plant managers to put the responsibility for water treatment and environmental compliance into the hands of KFS water treatment experts. In this case, KFS research uncovered a unique technology that could remove selenium via an absorption process and possibly eliminate or at least significantly minimize the use of treatment chemicals, thereby reducing operating costs.

### **Project Description**

KFS outlined a program to demonstrate the technology. If successful, the demonstration would lead to a concept, pricing and operating cost for a full-scale system.

The program was conducted in three phases.

1. Phase I: laboratory bench test
2. Phase II: on-site pilot study to determine the effectiveness of the treatment under refinery operating conditions

3. Phase III: Rapid Small Scale Column Test (RSCCT) to determine the life expectancy of the media.

#### *Phase 1*

KFS evaluated the general wastewater stream for selenium and reviewed various technologies to reduce selenium to acceptable concentrations that met effluent permit requirements. Samples of the wastewater were obtained and sent to Kroff's lab. Bench scale testing of a sorption media (Severn Trent's Bayoxide® E33G Media) was conducted.

#### *Phase 2*

A self-contained, two-column pilot skid with all necessary mechanical, electrical and ancillary equipment was used. One eight-inch diameter column contained media for solids removal and a four-inch diameter column contained Bayoxide sorbing media for the adsorption of selenium.

KFS provided a full-time operator to run the pilot test for approximately two months in September and October 2009.

#### *Phase 3*

Subsequent to the pilot test, KFS conducted a Rapid Small Scale Column Test (RSSCT) in Severn Trent's Tampa Tech Center, the purpose of which was to accelerate the adsorptive characteristics of Bayoxide and achieve breakthrough rapidly, thus determining the bed volume life of the media.

### **Results**

The Phase 1 laboratory bench test results indicated that selenium removal was adequate and on-site pilot testing would be appropriate. The Phase 2 test demonstrated that selenium removal was very effective to concentrations well below the discharge requirements and well below the current method. The refinery laboratory conducted the analytical testing to avoid any conflict in testing methods. As well, the RSSCT supported that selenium removal was very effective with the sorbing media.

Following three successful phases of testing, KFS was able to construct a cost-effective operating package that would ensure selenium concentrations in discharged water met acceptable EPA levels.