[**This is an interim report and the final report will be submitted in 2012**]

Predicting Performance of Almond Shells for Cleanup of Almond Soil Fumigants in Potable Water

Project No.: **10-WATER5-Ledbetter**

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Interpretive Summary:

Dibromochloropropane (DBCP) was an effective nematicide used in California orchards until the late 1970s. While over three decades have passed since it was last used, the compound persists at high levels in San Joaquin Valley groundwater. DBCP is regulated by the US Environmental Protection Agency under the National Primary Drinking Water Regulations, and activated carbons are considered the best technology treatment for removal of the compound from municipal waters. Activated carbon prepared from bituminous coal has been effective in reducing DBCP below the established maximum contaminant level. In laboratory studies, activated carbons made from almond shells are similarly effective in removing DBCP from water. Positive results with almond shell activated carbons in the lab led to this current project, undertaken in cooperation with the Fresno Department of Public Utilities' Water Division. A column filter study is being conducted at a DBCP-contaminated well site where the effectiveness and longevity of almond shell-based activated carbons can be compared to those based on bituminous coal.

Objectives:

1. Ascertain the effectiveness of using activated carbon made from almond shells to remove various concentrations of dibromochloropropane (DBCP), formerly a widely used soil fumigant, from municipal water systems.

2. Compare the effectiveness of almond shell-based activated carbon with that of the currently used standard form of activated carbon in terms of their ability to meet both USEPA and local contamination-reduction requirements.

Results and Discussion:

Increased almond acreage and utilization has led to similar increases in production by-products such as almond shells. Developing these by-products into value-added products requires annually reliable and uniform feedstocks that produce consistent results for a given process. In the case of activated carbons from almond shells, we have investigated the 'varietal' carbons produced from both soft shell (Nonpareil) and hard shell (Padre) varieties, as well as from a varietal mixture representative of what might be piled at an almond shelling facility. Regardless of the almond shell type, activated carbons produced from almond shells were able to adsorb DBCP significantly better than the bituminous coal-based carbon F-300 in DBCP-spiked distilled water samples.

In preparation for the activated carbon column study at a DBCP-contaminated well, a rapid analytical method (2 minute prep. time) has been developed to detect DBCP using a very small sample (1.5 ml) on the gas chromatograph. Sensitive to halogenated compounds, an electron capture detector will be used for detecting DBCP on the gas chromatograph.

Municipal water containing DBCP has been secured from a DBCP-contaminated well, and lab analysis indicates the sample contained approximately 0.38 µg/L DBCP. The sample was spiked with external DBCP to mg/L-levels and contacted with almond shell activated carbon. The results showed that the almond shell activated carbon successfully adsorbed the DBCP, with similar efficiency as in previous simulated distilled water experiments.

Clean Nonpareil almond shells have been pyrolized and steam activated under appropriate conditions to prepare sufficient almond shell activated carbon for a 2.5 cm X 60 cm column filter installation on a DBCP-contaminated well managed by Fresno Water Division. This filter is being compared directly with a similar filter filled with Calgon F-300, the bituminuous coal most commonly used at Fresno Water Division for DBCP-water treatment.

A representative sample of F-300 has been analyzed to determine particle size distribution. This distribution is important for the physical stability of the carbon filter, the mass transfer zone profile and maintaining carbon filter permeability. Accordingly, a particle size distribution of almond shell activated carbon has been determined so that the duplicate activated carbon filters can match with regard to particle sizes.

The two column filters will be maintained at the DBCP-contaminated well, and over a period of several months, water will be sampled periodically from filter outflows. The DBCP-contaminated water flow rate will be adjustetd in the experimental columns to match the water resistance time in the currently utilized full-scale activated carbon vessels. With these methods, data can be used to demonstrate whether or not USEPA and local clean-up requirements can be met on a consistent basis by almond shell-based activated carbons, as well as the longevity and carbon bed stability of almond shell-based activated carbon filters as compared to those filled with F-300.

In lab studies, almond shell-based activated carbons have demonstrated their effectiveness in DBCP adsorption. We have further demonstrated that the shell-based carbons are as physically strong as coal-based F-300, a property important for filter longevity. Our column filter study is meant to corroborate these results in a real-world setting on a municipal water stream. If the column study produces results comparable to those of the lab studies, almond shellers may soon realize additional revenue sources by supplying almond shells as feedstock for activated carbons.