ARSENIC

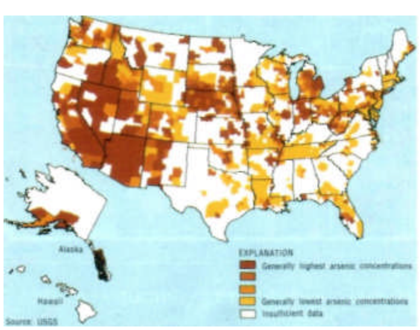
PART 1 OF 2

Impact of Proposed New Arsenic Standards on POU Carbon Filtration

By Mohammed Bayati and Mark Stouffer

Summary: *With the new proposed arsenic rule released in late May, it's anticipated that there will be more opportunity than ever for the point-of-use/point-of-entry (POU/POE) water treatment industry to offer homeowners assistance in assuring clean and safe drinking water. Following is the first in a two-part series on the effectiveness of water treatment technology in handling this contaminant.*

The current federal maximum contaminant level (MCL) for arsenic in drinking water is 50 micrograms per liter (mg/L) or 50 parts per billion (ppb), established by the U.S. Environmental Protection Agency (USEPA) in 1975 based on a standard initially set in 1942. In March 1999, a National Academy of Sciences report concluded the current standard doesn't achieve the agency's goal of protecting public health and recommended it be lowered as soon as possible. A final, more stringent arsenic rule was to be released in December 1999. The USEPA delayed its release, and sources indicated the MCL could be reduced to as low as 5-to-10 ppb. The current maximum concentration guideline set by the World Health Organization is 10 ppb, which was reduced from 50 ppb in 1993. On May 24,2000, the USEPA announced a new limit of 5 ppb, saying it would "provide additional protection to at least 22.5 million Americans from cancer and other health problems, including cardiovascular disease and diabetes, as well as developmental and neurological effects/[7] It applies to 54,000 community water systems, which serve about 254 million people. The agency estimated average annual household costs resulting from this action at $28 for those served by large municipal systems and $85 for those served by systems with less than 10,000 people. The new rule is to be promulgated by Jan. 1, 2001.



The USEPA said only 12 percent or 6,600 community water systems serving 22.5 million people would have to take corrective action to lower the current levels of arsenic in their drinking water. Of the affected systems, 94 percent serve fewer than 10,000 people. The agency had considered lowering the MCL to 3 ppb (the lowest technically feasible reduction level), but deferred to 5 ppb because the lower level didn't "justify the costs" required to meet it. The agency also set a public health goal of zero for arsenic, as it's a carcinogen for which no dose is considered safe. Public comment is being taken on other proposed arsenic levels.

Enter carbon

Since activated carbon, used in POU water filters, is produced from naturally occurring substances (coconut shells, wood or coal), it can contain trace amounts of arsenic. Coal contains varying levels of arsenic, depending on the geology of the coal seam. This arsenic is concentrated in the activation process, as volatile matter and carbon are removed. Coconut plants probably extract trace arsenic from groundwater. One supposition is that the use of arsenic-containing insecticides may have contributed to arsenic found in some coconut shell. Arsenic levels in the product carbon can be reduced by acid or water washing.

Testing was conducted to determine the potential for leaching arsenic from activated carbon into drinking water, an issue that was raised at the Water Quality Association convention in Long Beach in March 2000.

Testing protocol

Lot samples of various activated carbon products representing over one year of production were tested. A representative sample of carbon from each lot was collected. Multiple samples were taken from each sack in a lot using a thief sampling tube; these samples were then combined.

Testing was based on the methodology established by ANSI/NSF Standard 42 for drinking water treatment units. Carbon was tested in a column typical of a standard sized home water filter. The carbon column was contacted with a specific exposure water (per NSF *International* guidelines) for three 24-hour periods. The average concentration of arsenic in the three samples was determined by graphite furnace atomic adsorption spectroscopy.

Coconut shell activated carbon

The data in Figure 1 are for samples representing 280,000 pounds (lbs) of a specific coconut shell-based carbon product supplied for POU water filter manufacture. The coconut shell was activated in Southeast Asia using local coconut shell as a raw material. The producer maintains stringent control over raw material sources. All the carbon is activated in the same manufacturing plant there and water washed at a facility in the United States. Quality control and assurance is applied both at the activation site and in the United States, where the carbon is further processed and distributed.

As shown, all the carbon showed extractable arsenic levels below 5 ppb. Therefore, it would be acceptable under the new USEP A MCL rule. The mean extractable arsenic level of all samples was 0.40 ppb.

Figure 1. Arsenic levels (NSF 42) for coconut shell carbon

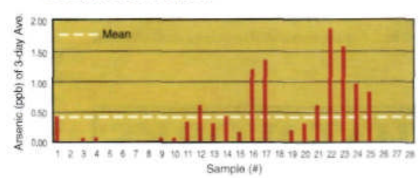


Figure 2. Arsenic levels for alternate coconut carbon source

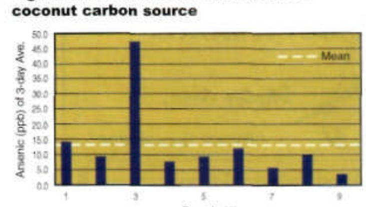
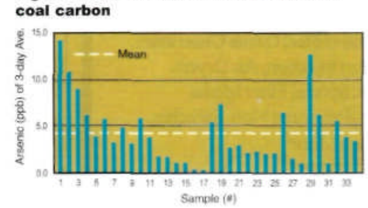


Figure 3. Arsenic levels for acid-washed coal carbon



Carbon source is critical

Figure 2 illustrates data for a coconut-shell-based activated carbon from another source, which was evaluated as an alternative supply. The carbon was produced in a Pacific Rim country. The manufacturer doesn't maintain stringent control over raw material suppliers. Quality control is applied in the United States before further processing and distribution.

As shown, the carbon didn't meet a 5-ppb arsenic standard. The carbon couldn't even routinely meet a 10-ppb standard. Variability in arsenic levels between lots of carbon was high.

The above results demonstrate that meeting a stringent standard consistently with coconut shell activated carbon will require a well-defined raw material source and a rigorous testing and quality assurance (QA) program.

Coal-based carbon

In Figure 3, we find data for samples representing 340,000 lbs of acid-washed, coal-based carbon supplied for POU water filter manufacture. The carbon was produced in the same manufacturing plant, and the coal was derived from a defined source and hot acid washed to reduce arsenic. As shown, all the carbon showed extractable arsenic levels below the current MCL of 50 ppb. However, a substantial fraction of the carbon wouldn't meet the proposed standard of 5 ppb.

The above results indicate that an acid-washed, coal-based product can meet an arsenic standard of 10 ppb or 5 ppb. However, lot selection will likely be required. This will necessitate a stringent QA program, including NSF extraction testing for each lot of carbon. Further investigation of the variability within lots will be required to define the lot size for testing that assures consistent product.

NSF Standards

NSF Standard 42 applies to complete drinking water treatment units; Standard 61 applies to individual components of a drinking water treatment unit. Generally, if a carbon passes Standard 42 testing, it will also pass Standard 61 testing. This is because the latter standard allows more latitude in specifying pre-treatment of the component. However, the opposite is not necessarily true— passing Standard 61 doesn't mean it will pass Standard 42— which is a situation that must be recognized in the industry to assure proper use of NSF testing methodologies are being applied.

Conclusions

Activated carbon can be provided to POU applications and comply with a revised arsenic MCL of 5 or 10 ppb. Meeting this stringent requirement will require a well-defined carbon source, special processing (acid or water washing) and stringent QA testing by the carbon supplier. The cost of coal-based carbon for POU applications would undoubtedly increase due to increased QA costs and to rejection of some material. This will make coconut shell-based carbon more attractive for POU applications. Coconut carbon has its additional advantages of higher capacity for removal of trace organics (such as disinfection byproducts or ABPs like trihalo-methanes, the oxygenated fuel additive MTBE and pesticides), lower dust levels and higher hardness levels. For those reasons, coconut shell is the preferred source of activated carbon for drinking water treatment applications to meet stricter arsenic standards. □

About the authors

Mohammed Bayati is Western regional manager for Barnebey Sutcliffe Corp., a division ofWaterlinkInc, of Canton, Ohio. Based in Santa Fe Springs, Calif, Bayati is the former technical director of the company and holds a bachelor's degree in chemical engineering from the University of Southern California. He can be reached at (562) 802-3400, (562) 802-3480 (fax) or email: mbayati@waterlink.com

Mark Stouffer is the technical director for Barnebey Sutcliffe and is based in Columbus, Ohio. Stouffer holds a bachelor's degree in chemical engineering from the Virginia Polytechnic Institute. He can be reached at (614) 258-9501, (614) 258-3464 (fax) or email: mstouffer@waterlink.com

WATER FACTOID

Carbon filtration has been around for years. Early sailors knew that water tasted better when it was stored in charred wooden barrels.