United States
Environmental Protection
Agency

Municipal Environmental Research
Laboratory
Cincinnati OH 45268

Research and Development

EPA-600/S2-81-027 Mar. 1981

EPA

Project Summary

Evaluation of Powdered Activated Carbon for Removal of Trace Organics at New Orleans, Louisiana

Michael A. Epton and James F. Becnel

Several organic contaminants of interest to the U.S. Environmental Protection Agency (EPA) were found in New Orleans' finished drinking water. A bench-scale research program designed to determine the effectiveness of powdered activated carbon (PAC) for removing these organic contaminants was conducted at the City's Carrollton Purification Plant. This investigation consisted of the design and execution of bench-scale simulations of full-scale plant operations (100 million gallons per day conventional plant, utilizing lime and cationic polyelectrolyte for partial softening and coagulation of Mississippi River water). The feasibility of using PAC treatment to reduce the concentrations of the organics found in the drinking water was then evaluated. Control runs and full-scale plant profiles were included to compare PAC-treated and conventionally treated water. Additional studies attempted to evaluate the effects of changing the point of chlorine addition within the normal treatment scheme and to correlate nonspecific analytical parameters (fluorescence, ultraviolet absorption, and total organic carbon (TOC) concentration) with specific organics.

The effect of PAC treatment on the concentration reduction of volatile organic compounds, including trihalomethanes (THM); their precursors; and high molecular weight contaminants were evaluated. To select one PAC for further investigations, four commercially available PAC's were studied. At dosages of 5, 50, and 500 mg/L, the PAC added to coagulated settled water yielded average respective removals of 2%, 21%, and 65% of the 385 μg/L 5-day THM formation potential found in the controls. Even at the 500 mg/L dosage, only one of the four tested PAC's was able to reduce the formation potential to a level below the EPA promulgated maximum contaminant level of 0.10 mg/L in finished drinking water. The PAC's did not reduce the levels of the high molecular weight organic contaminants studied.

The effectiveness of the one selected PAC to reduce terminal THM concentrations was basically the same whether added to raw or to coagulated settled water. Its addition to raw water yielded 37% and 82% average reductions of terminal THM concentrations at respective dosages of 50 and 500 mg/L; the concentration of the controls ranged from 204 to 225 μg/L. The full-scale plant profiles demonstrated that conventional treatment alone effected a removal of 46% of the THM formation potential. Therefore, only the addition of 500 mg/L PAC effected more removal than conventional treatment.

This Project Summary was developed by EPA's Municipal Environmental Research Laboratory, Cincinnati, OH, to announce key findings of the research project that is fully documented in a separate report of the same title (see Project Report ordering information at back).

Plant Profiles

Two full-scale plant profiles were conducted, the first in September 1978 and the second in April 1979. The first corresponded to the annual low-flow period and the second to the peak-flow period for the Mississippi River at New Orleans. In each profile, sample collection sites and times were designed to enable a single portion of water to be monitored as it progressed through the plant process stream. With this sampling procedure, the influence of each treatment step on the levels of organic contaminants present in the water could be evaluated The profiles indicated that although TOC concentrations measured in the raw river water varied greatly, the THM formation potentials did not. Both profiles demonstrated overall removals of 46% of the approximately 700 μg/L THM formation potential that was found in the river each time.

In each profile, the largest portion of the 46% overall removal of THM formation potential occurred during coagulation and primary settling (27% to 40%). Rapid sand filtration, in both cases, provided the smallest portion of the overall removal (1% to 8% relative to the controls). Atrazine, a high molecular weight herbicide that was consistently found throughout the study, was removed by the overall plant treatment processes in nearly the same proportions (36% to 38%) during both profiles. Raw water concentrations of Atrazine were 1.36 and 0.67 μg/L in the first and second plant profiles, respectively.

Instantaneous THM concentrations were zero in all samples before the chlorine addition point. After chlorination, the instantaneous THM concentrations at all sample locations were significantly higher for the warm weather profile (September) than for the (April) cool weather profile (i e , 118 versus 108 μg/L on secondary settled water and 145 versus 113 μg/L on filter effluent).

Evaluation of Four PAC's

Bench-scale evaluations of four commercially available PAC products were conducted in an attempt to determine the most suitable one for further study. These efforts met with mixed success Because data on removal of TOC and high molecular weight compounds were very erratic, data on removal of THM formation potential became the principal consideration in selecting one PAC for further studies.

Effect of Adding PAC

With the use of the selected PAC, bench-scale studies were conducted to determine whether adding PAC to raw water would yield better removal of THM formation potential than adding PAC to coagulated settled water. A 500-gallon reserve of raw river water was constantly agitated in a stainless-steel tank, and portions were withdrawn, as needed, to test the various treatment alternatives Following PAC dosage, the percent removals for raw water and for coagulated settled water were similar (Table 1).

Table 1. *Removals of THM Formation Potential*

PAC Dosage (mg/L)	Average THM Formation Potential (μg/L)	Average Removal of THM Formation Potential (%)
Raw Water:		
Control	*213*	—
5	*196*	*10%*
50	*135*	*37%*
500	*38*	*82%*
Coagulated Settled Water:		
Control	*333*	—
5	*359*	*0%*
50	*206*	*38%*
500	*69*	*81%*

Effect of Altering Chlorination

Would instantaneous THM concentrations be reduced if the plant's chlorination scheme were changed from its present form of two doses (with one added after primary settling and the other after secondary settling) to a single dose after secondary settling (just prior to filtration)? Results from two bench-scale studies indicated that single-step chlorination yielded lower instantaneous THM concentrations This was expected since chlorine contact times were much shorter than those of the double-step chlorination (at both locations).

Confirmation of Analyses

In the course of the project, five analyses each of river and finished water were run by capillary column gas chromatography. Flame ionization detection and mass spectrometry were used for confirmation. Seven volatile compounds and two high molecular weight compounds of interest were identified in the plant finished water (Table 2).

Table 2. *Nine Organic Compounds and Their Concentration Ranges Found in Finished Water*

Compound	Concentration Range (μg/L)
Cloroform	*36.3 - 123*
Benzene	*0 - 0.45*
Bromodichloromethane	*3.1 - 29.0*
Dibromochloromethane	*0 - 6.1*
Toluene	*0 - 0.33*
Xylene	*0 - .38*
1, 2 - Dichloroethane	*0 - 1.5*
Atrazine	*0 14 - 5.02*
Di (2-ethylhexyl) Phthalate	*0.29 - 0.55*

The full report was submitted in fulfillment of Grant No R804404 by Roy F Weston, Inc , and the University of New Orleans under subcontract to the New Orleans Sewerage and Water Board under the sponsorship of the U.S. Environmental Protection Agency.

Michael A. Epton and James F. Becnel are with the Sewerage and Water Board of New Orleans, New Orleans, LA 70165.
***Benjamin Lykins** and **Jack DeMarco** are the EPA Project Officers (see below).*
The complete report, entitled "Evaluation of Powdered Activated Carbon for Removal of Trace Organics at New Orleans, Louisiana," (Order No. PB 81-161 853; Cost: $9.50, subject to change) will be available only from:
National Technical Information Service
5285 Port Royal Road
Springfield, VA 22161
Telephone. 703-487-4650
The EPA Project Officers can be contacted at:
Municipal Environmental Research Laboratory
U.S. Environmental Protection Agency
Cincinnati, OH 45268

* U.S. GOVERNMENT PRINTING OFFICE. 1981 - 757-012/7026

United States
Environmental Protection
Agency

Center for Environmental Research
Information
Cincinnati OH 45268

Postage and
Fees Paid
Environmental
Protection
Agency
EPA 335