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Project Summary

Biodegradation and Carbon Adsorption of Carcinogenic and Hazardous Organic Compounds

E. G. Fochtman

This research program was conducted to determine the capability of biological treatment and activated carbon adsorption to remove chemical carcinogens and other hazardous organic compounds from water and wastewater. All of the 11 compounds tested exhibited some degree of biological degradation. Carbon adsorption was also effective in removing the compounds from aqueous solution. Analytical methods were adapted to analyze the very insoluble polynuclear aromatic hydrocarbons that tenaciously adsorbed on the glass surfaces of sample bottles and analytical glassware.

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

The carbon adsorption isotherms and the ease of biodegradation were determined experimentally for 11 organic compounds selected from EPA's Priority Pollutant List and OSHA's List of Regulated Carcinogens. Because of the hazards presented by the compounds, special laboratory procedures were followed when handling them. In addition, the low solubility of the compounds and the tendency of some of them to adsorb on laboratory glassware required developing procedures for solution preparation and sampling handling.

The study was conducted in laboratory facilities designed for the handling of highly toxic or carcinogenic chemicals. All laboratory personnel were under medical surveillance.

Carbon adsorption isotherms were determined by treating an aqueous solution of known concentration and volume with a known weight of granular activated carbon that had been ball milled to less than 325 mesh. The low solubility of most of the compounds, generally less than 1 ppm, made it very difficult to prepare aqueous solutions free of undissolved chemical particles. In the procedure developed, water was pumped through a bed of beads coated with the chemical, then filtered to remove the particles of undissolved chemical.

Several of the chemicals rapidly and tenaciously adsorbed on the glass surfaces of sample bottles, glass fiber filters, filter flasks, and analytical glassware. Such adsorption was minimized by withdrawing the aqueous sample and mixing it with methyl alcohol to give 40 percent alcohol in the final sample. Only very small amounts of carbon were required, generally 1 mg/L of solution. The carbon was allowed to settle for 1

hour before a sample was withdrawn from the top of the container.

Biodegradation was determined using a static procedure. An approximately 1% solution of the chemical in an emulsifier was added to a bacterial suspension at concentration levels of 1 to 2 ppm. The suspension was analyzed twice: immediately after preparation and after a 7-day incubation period. Fresh bacterial suspension was prepared weekly using seed from the previous week. The procedure was continued for 28 days.

Analytical procedures varied depending upon the characteristics of the chemical and the type of sample. Neat samples were analyzed by ultraviolet absorption or fluorescence. Biological samples were extracted, concentrated, and analyzed by a liquid chromatograph equipped with a solvent programmer for gradient elution and an ultraviolet absorption detector.

Data have been presented as Freundlich adsorption isotherms expressed as:

$$\frac{X}{M} = KC_f^{1/n}$$

where

$X = C_o - C_f$

C_o = concentration of organic in untreated solution

C_f = concentration of organic in treated solution

M = concentration of carbon

K = empirical constant

1/n = empirical constant

K is the intercept of the plot of the isotherm at C_f = and 1/n is the slope of the line on logarithmic paper.

Data for the compounds studied are given in Table 1.

All of the compounds exhibited some degree of biological degradation. Typical values for percent removal during a 7-day incubation are given in Table 2.

More detailed information, including experimental data and laboratory procedures, can be found in the complete project report, available through the National Technical Information Service (NTIS). The full report was submitted in fulfillment of Contract No. 68-03-2834 by IIT Research Institute under the sponsorship of the U.S. Environmental Protection Agency.

Table 1. *Freundlich Parameters and Capacity of GAC*

Compound	Mol wt	pH	Freundlich Parameters K	Freundlich Parameters 1/n	Correl Coeff	No of Data Points	Calculated mg C/L to reduce 1 0 mg/L to 0 1 mg/L
Benzidine	184	9.1/7.1	215	0.16	0.966	16	6
3,3'-Dichlorobenzidine	253	7.2	308	0.19	0.968	8	5
Benzo(a)pyrene	252	7.1	34	0.44	0.905	6	0.4
2-Acetylaminofluorene	222	7.1	318	0.12	0.944	7	3.8
4-Aminobiphenyl	169	7.2	198	0.26	0.965	9	8
4-Dimethylaminoazobenzene	225	7.0	250	0.24	0.959	8	6.2
4-Nitrobiphenyl	199	7.0	370	0.27	0.978	6	4.5
Benzo(g,h,i)perylene	276	7.0	10	0.36	0.923	8	197
Dibenzo(a,h)anthracene	278	7.1	70	0.76	0.970	8	73
Benzo(k)fluoranthene	252	7.1	183	0.67	0.983	8	18
3, 4-Benzofluoranthene	252	7.0	56	0.37	0.946	8	0.5

Table 2. *Biological Degradation*

Compound	Percent Degraded
Benzo(a)pyrene	41
2-Acetylaminofluorene	14
4-Aminobiphenyl	50
4-Dimethylaminoazobenzene	99+
4-Nitrobiphenyl	99+
Benzo(g,h,i)perylene	60
Dibenzo(a,h)anthracene	60
Benzo(k)fluoranthene	54

E. G. Fochtman is with the IIT Research Institute, Chicago, IL 60616.
Richard A. Dobbs *is the EPA Project Officer (see below)*
The complete report, entitled "Biodegradation and Carbon Adsorption of Carcinogenic and Hazardous Organic Compounds," (Order No PB 81-171 852; Cost. $6 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 Officer can be contacted at:
Municipal Environmental Research Laboratory
U.S. Environmental Protection Agency
Cincinnati, OH 45268

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