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Project Summary

Automotive Crankcase Oil: Detection in a Coastal Wetlands Environment

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The marine environment has become the primary disposal ground for an increasing quantity of petroleum wastes. Although a continuous, low-level discharge of waste petroleum hydrocarbons into the marine environment may not be as dramatic as a major oil spill, the consequences could be more devastating over an extended period. Continued addition of these hydrocarbons can only lead to a further deterioration of this ecosystem. Tidal wetland areas provide food and shelter for a variety of indigenous and migratory wildlife and thus provide critical support to marine food chains reaching all the way to man.

The analytical results of this study suggest that appreciable quantities of hydrocarbons attributable to waste automotive petroleum products are present in treated wastewater effluents entering Jamaica Bay. The discharge of petroleum hydrocarbons in the effluent is chronic. Significant quantities of detectable hydrocarbons remain in solution in the surface waters of the Bay while aromatic hydrocarbons from waste petroleum are found in tissue extracts of marine benthic organisms collected in the Bay.

This Project Summary was developed by EPA's Municipal Environmental Research Laboratory, Cincinnati, 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).

Introduction

Of the estimated 0.3 mil m^3 (994 mil gal) of automotive and industrial waste petroleum purchased annually in the New York metropolitan area, only 40% is being reprocessed. The sources of this petroleum in municipal wastewater systems and their receiving waters range from individuals who change the oil in their automobiles and indiscriminately dump the wasted crankcase oil into a nearby sewer to large establishments that sporadically discard accumulated stocks of waste oils. On many occasions, especially during periods of plant by-pass, large "oil slicks" pass through water pollution control facilities undetected and untreated.

This study attempted to determine:

1. whether waste automotive petroleum hydrocarbons are present in the treated effluents discharged by water pollution control facilities into Jamaica Bay,
2. whether the quantity of petroleum-derived hydrocarbons present in the Jamaica Bay waters is sufficient to warrant immedicate attention,
3. whether a significant portion of this waste petroleum persists in the surface waters of the Bay and causes a chronic exposure of the ecosystem to petroleum derived hydrocarbons, and
4. whether petroleum hydrocarbons are being incorporated in biological tissue of a Bay marine organism, *Mya arenaria*.

Methodology

Because of the complex chemistry of the oil, each oil sample lends itself to differentiation from others. This passive-tagging approach establishes specific qualitative parameters for oil samples in the form of "fingerprints" that can be compared with a "standard profile." Thus, positive correlations for environmental samples are either established or not established with standards depending on those portions of the petrochemical waste that exhibit themselves in fingerprints and remain stable under environmental conditions.

Jamaica Bay was chosen as the study site because its unique hydrological characteristics afford a long residence time for treated or untreated effluents. The sampling scheme involved final effluent samples from the four major water pollution control facilities emptying into the Bay, surface water samples of the Bay, and marine organism samples, *Mya arenaria* Three analytical methods were used for sample analyses: gas chromatography, UV-spectroscopy, and GC-MS.

GC retention times and relative peak heights were used to identify petroleum hydrocarbons in environmental samples. A "spike" was added to samples after noting the original samples' profiles and retention times for resolved peaks. Increases in peak heights of previously noted sample components indicated its presence in the sample extract.

For all fluorescence analyses, a UV-fluorescence spectrophotometer with two independent monochromators and a constant temperature cell bath were used. A fluorescence technique was also used to excite each sample at successive excitation wavelengths from 240 mu to 440 mu while scanning for the maximum fluorescence emission. Correlation was determined by visually comparing the maxima profile plots of known oil standards to the maxima profile plots of environmental samples. When these maxima profiles fit, in addition to exhibiting the other qualitative characteristics established by standards, detection was established for the particular sample.

A computerized GC/MS combination with 1.52 M X 2 mm ID glass, packed with 3% OV-1 on a Chromsorb W column was used. Only organism subfractions were analyzed for specific petroleum-derived aromatic compounds by this method.

Results

To see if detection parameters established for standard oils would be appreciably affected by weathering, standard oils were weathered in filtered sea water for 32 days. Profiles generated indicated no significant changes in fluorescence detection criteria even though some profiles exhibited decreases in intensity because of concentration factors.

Treated Wastewater Samples

Thirty-nine treated effluent samples were analyzed for total CCl_4 extractable hydrocarbons (Table 1).

Surface Water Samples

Average background levels of petroleum hydrocarbons in oceanic water have been established at approximately 2 μg/L; greater than average or excessively high levels ranged between 20 and 10 μg/L. The values obtained for the Jamaica Bay surface waters are significantly above normal background oceanic levels of hydrocarbon concentrations (Table 2).

Organism Samples

Results of analyses clearly demonstrate that the presence of petroleum-derived hydrocarbons from *Mya arenaria* tissue extracts are considered to be of high pollution or contamination potential.

Discussion

Chromatograms generated by waste automotive lubricating oil and refined petroleum have been shown to be characteristic and differentiable from chromatograms of other petroleum entities. Once a waste oil enters the environment, it seems that weathering phenomena such as evaporation and bacterial degradation will have little effect on the less soluble aromatic and higher molecular weight components. Thus, detection parameters are preserved. The wide-boiling range, variety of substituents separated, and unresolved envelope portions of chromatograms indicate the presence of crankcase oil, although they are not conclusive. Though the specific sources of the detected waste petroleum could not be established, the accumulated evidence from all analyses strongly indicates a crankcase oil origin.

Gas chromatograms of a pollution control plant extracts did show a wide range of hydrocarbon compounds above C_{20}, a characteristic of lube oils. The chromatograms generated by organism extracts strongly exhibited the presence of aromatic compounds in body tissue. Tentative GC/MS identification of organism subfractions indicated the presence of alkyl-substituted benzene structures, which are highly toxic substances indicative of petroleum contamination. UV-fluorescence analysis furnished dramatic evidence for the presence of crankcase oil in environmental samples and greatly strengthened the other analytical results obtained. Emission spectra of environmental samples consistently demonstrated the presence of polynuclear aromatics, compounds that could only be attributable to petroleum pollution.

Table 1. *IR Quantification of Total Extractable Hydrocarbons from Treated Effluents*[a]

Water Pollution	*Date*										
Plant	*9-10*	*9-15*	*9-17*	*9-24*	*9-29*	*10-1*	*10-8*	*10-15*	*10-22*	*10-29*	*11-5*
Coney Island	*1.50*	*16.4*	*7.1*	*2.0*	*3.5*	*15.6*	*3.0*	*39.8*[b]	*10.5*	*416*	*8.6*
26th Ward	*29.7*	*20.0*	*34.9*	*28.9*[b]	*22.9*	*12.3*	*19.2*	*19.1*	*9.3*	—	—
Jamaica	—	*10.7*	*12.0*[b]	*7.2*	*5.3*	*4.7*	*9.6*	*4.6*	*9.4*	*14.2*	*18.8*
Rockaway	—	—	*4.9*	*1.3*	*4.7*	*0.5*	*10.0*[b]	*13.8*	*8.5*	*7.7*	*3.2*

[a] *All values in mg/1.*
[b] *Gas chromatographic analysis.*

The results presented give a strong indication that hydrocarbons that are discharged with treated wastewater into Jamaica Bay and that ultimately accumulate in biological tissue are of a waste automative petroleum origin.

Table 2. *Jamaica Bay Surface Water Total Extractable Hydrocarbons*[a]

Sample Site	*11-7*	*1-8*
NYN16	*0.94*	*1.13*
NYN09A	*1.20*	*0.88*
NYJ01	*2.10*	*2.16*
NYJ02	*1.17*	*2.20*
NYJ03	*3.10*	*5.10*
NYJ05	*0.50*	*1.50*
NYJ07	*1.08*	*1.40*

[a]*All values in mg/L.*

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Uwe Frank *is the EPA Project Officer (see below).*
The complete report, entitled "Automotive Crankcase Oil: Detection in a Coastal Wetlands Environment," (Order No. PB 81-171 662; 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 Officer can be contacted at:

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