



Project Summary

Response of Crude Oil Slicks to Dispersant Treatment at Sea

A series of ocean studies was conducted in 1978 and 1979 to develop quantitative data on the effectiveness of dispersants at sea and on the behavior of dispersant-treated oil. Test spills were made in the outer New York Bight some 80 km southeast of New York Harbor. Ambient conditions were consistent for both years of testing, but other factors such as spill volume, time of dispersant application, and dispersant dose were varied. Oils used were Murban and La Rosa crude.

Reasonably effective treatment was achieved when dispersant was sprayed 30 min or less after the oil was spilled. Little oil was found in the subsurface water after spraying dispersant on oil that had been on the sea surface for 2 hr.

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).

Introduction

Information about spilled oil behavior is needed for effective responses to oil spills at sea. If a response includes possible treatment with chemical dispersants, quantitative data are needed on the behavior of dispersant-treated oil to determine its chemical and physical fate and the advisability of using dispersants. Though considerable laboratory and field tests of dispersants were conducted in many countries in 1977, few quantitative data were developed on the effectiveness of dispersants at sea or on the behavior of dispersant-treated oil. In response to this information need, the American Petroleum Institute (API) and the U.S. Environmental Protection Agency (EPA) jointly sponsored the 1978-1979 series of ocean experiments described here.

Experimental Program

Research oil spills were made in the outer New York Bight approximately 80 km southeast of New York Harbor. Four spills were made in November 1978 and four in October 1979. Some experimental factors were common to all tests. These included:

- taking background samples of ocean water before the spill,
- recording oceanographic and meteorological data before and during each test,
- collecting large numbers of seawater samples at various depths in the spill area,
- repeatedly having the principal research vessel move slowly through the oil on sampling transects that were perpendicular to each other so that a three-dimensional view of the oil in the water would be obtained,
- applying a commercially available dispersant from a helicopter to spills that were to be dispersed, and
- guiding the helicopter and all sampling from a spotter plane that also conducted vertical photographic observations.

Other experimental conditions varied between 1978 and 1979 (Table 1).

As Table 1 indicates, the 1979 tests were intended to refine and augment the data generated during 1978. Note that one important difference in 1979 was the use of control spills (untreated) on the same day as treated spills. During 1978, the approach had been to treat all spills to maximize the information generated on treated oil. Comparisons could be made with earlier untreated spills of the same oil under similar ambient conditions, but rigorous experimental control was absent until the 1979 tests.

All test spills during 1978 and 1979 were made in an area of the outer New York Bight that was approved for this purpose by EPA under Permit No. II-MA-143-Research. Ambient conditions for the test were consistent

Table 1. Principal Differences Between the 1978 and 1979 Test Series

Item	1978	1979	Reason for Difference
Volume of each spill	1.67 m ³	3.55 m ³	Desire to minimize effect of scale on accuracy of simulation.
Biological testing	Minimal	Extensive	Ship mechanical failures in 1978.
Time of dispersant application after oil spill	Within 10 min or after 2 hr	None or 30 min	Need to assess effect of weathering.
Dose (gal dispersant/acre of slick)	Approximately 10	Approximately 20	Desire to assure sufficient dose.
Use of control spills	No	Yes	Need for rigorous experimental control.

for both years of testing, so weather and sea conditions are not considered a factor in differentiating one test from another. These conditions were as follows:

Condition:	Description
Air temperature, °C	12 - 21
Water temperature, °C	13 - 16 (constant throughout sampled depth within each test)
Wind speed, m/sec	0 - 7.5
Wave height, m	0.3 - 1.6

The oils used were Murban crude (Abu Dhabi) and La Rosa crude (Venezuela). The primary difference between these is the higher concentration of volatiles in Murban crude.

Dispersant application was similar for all treated spills. A commercially available dispersant product (same for all tests) was sprayed from a helicopter at an altitude of approximately 6 m and a speed of approximately 80 km/hr. Mean droplet diameter was approximately 1 mm.

Sampling of subsurface water was conducted with a specially designed apparatus and procedure used to avoid contamination by surface oil. All samples were preserved to avoid biological degradation before analysis. Analyses were conducted by API member laboratories using gas chromatographic and infrared techniques.

Findings

The behavior of dispersed oil is generally quite different from that of untreated oil. The chief cause of this difference is the fact that dispersed droplets, while still positively buoyant, are often small enough to be kept in suspension below the water surface by the turbulence near the sea surface.

Figure 1 shows a typical pattern of oil-in-water concentrations for the crossed transects of a sampling run through dispersed oil. With plots such as this, volumes of oil in the water were computed. These

computations were approximate and used the concentration and the geometric shape represented by each concentration isopleth to arrive at values for total dispersed oil (Table 2).

Reasonably effective treatment was achieved when dispersant was sprayed 30 min or less after the oil was spilled (Table 2). Little oil was found in the subsurface water after spraying dispersant on oil that had been on the sea surface for 2 hr.

Other conclusions are briefly summarized as follows:

- Early in the tracking of spills that were effectively dispersed, extractable organics in the upper meter of the water column ranged typically from 1 to 3 mg/l.
- Little oil was found in water samples at the 9-m depth; this result is not caused by stratification, because the water density was found constant throughout the sampling depth.
- Murban was more effectively dispersed than La Rosa crudes when other factors were held constant. Murban is lighter and less viscous.
- One physical effect of dispersant treatment was that thin films were spread over larger areas of the sea surface than when an equal amount of the same oil was spilled and not treated.
- Within 3 to 5 hr of spills this size, water samples from under the oil approach background concentrations because of dilution, evaporation, and perhaps other factors.

The full report, prepared by JBF Scientific Corporation, was submitted in fulfillment of Grant No. R806056 with the American Petroleum Institute under the sponsorship of the U.S. Environmental Protection Agency.

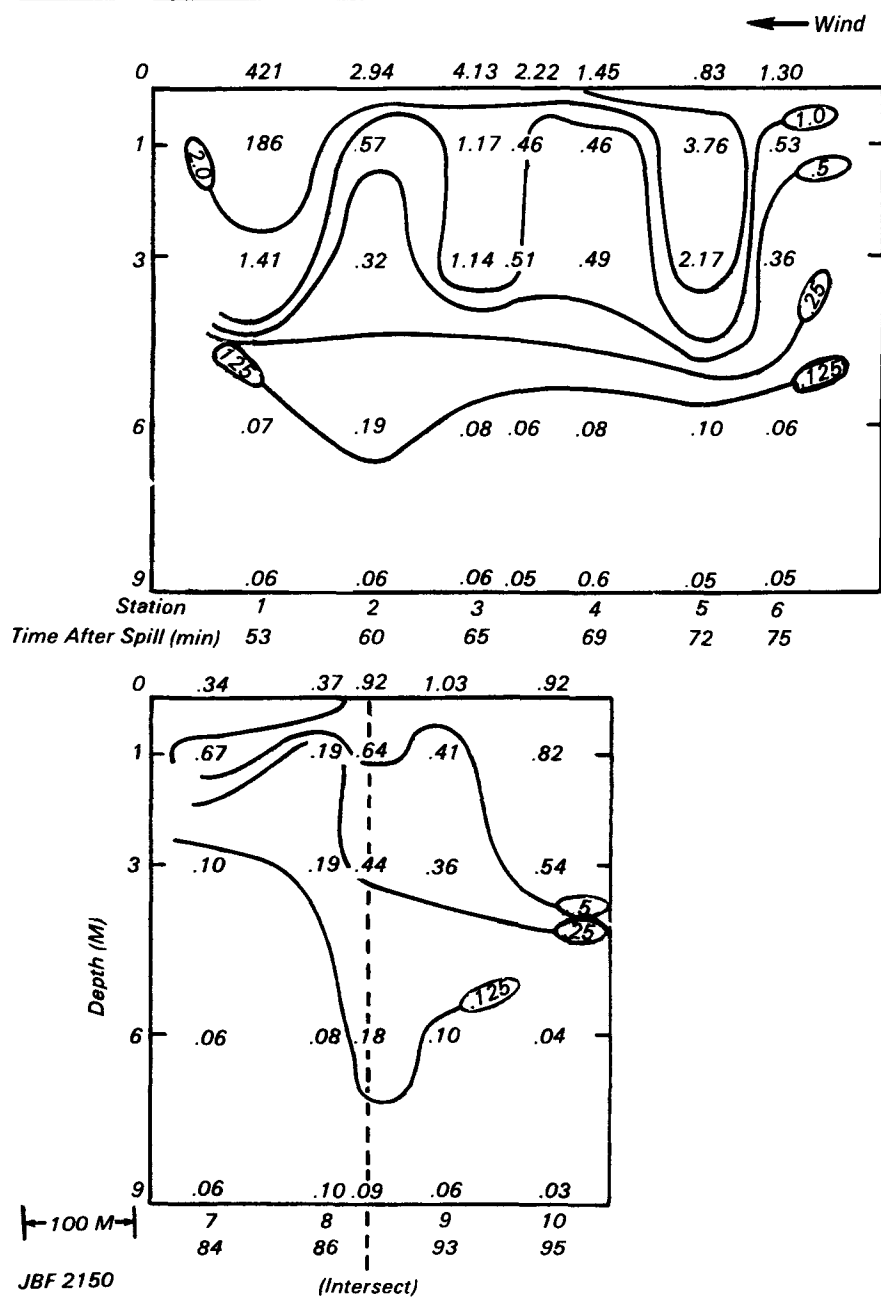


Figure 1. Total extractable organic matter (mg/l) in water samples collected during first sample run through treated Murban crude oil spill. Vertical exaggeration about 45 X.

Table 2. Approximate Percent of Spill Oil Accounted for in Water Samples

Crude Oil Type	Untreated	Immediate Dispersant Spray	Dispersant Spray after 30 min	Dispersant Spray after 2 hr
Murban	<5	40	70	2
La Rosa	<1	20	60	2

This Project Summary was prepared by staff of JBF Scientific Corporation, Wilmington, MA 01887.

Leo T. Mc Carthy, Jr. is the EPA Project Officer (see below).

The complete report consists of two volumes:

"Volume I. Response of Crude Oil Slicks to Dispersant Treatment at Sea: 1978 Tests," (Order No. PB 84-164 144; Cost: \$11.50, subject to change).

"Volume II. Response of Crude Oil Slicks to Dispersant Treatment at Sea: 1979 Tests," (Order No. PB 84-164 151; Cost: \$10.00, subject to change).

The above reports 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:

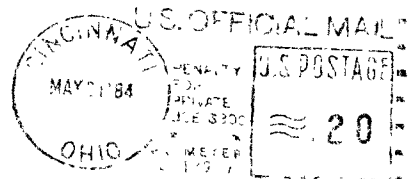
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