PROCEEDINGS OF THE AMOP TECHNICAL SEMINAR
MARCH 15-17, 1978

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ABSTRACT

Research has shown that burning can be an effective means to remove oil from the surface of the water. The combustion characteristics of crude oil have been measured in large laboratory tests using a nominal one meter diameter pool fire. This work reports on progress mid-way through a 2½ year research program. The objective of this research is to develop measurement equipment and calculations that can be used to characterize oil spill burning at operational scale during field trials of the technology. Field scale measurement techniques for fire radiation, smoke yield, particulate sampling, plume trajectory are described. Progress in the calculation of particulate deposition downwind of the burn site is presented.

INTRODUCTION

Response to oil spills includes considerations of oil containment, recovery, disposal and the logistics of delivering adequate response equipment quickly to the spill site. Particularly in remote areas, the use of burning as a oil spill response method is attractive. Burning requires a minimum of equipment, and because the oil is gasified during combustion, the need for physical collection, storage, and transport of recovered product is reduced to the few percent of the original spill volume that remains as residue after burning. The technology of oil spill burning and other response methods have been reviewed recently [1, 2, 3].

The technology of greatest interest is that designed to burn oil in-place. Present work is directed at burning spills under natural confinement such as within ice leads or with artificial confinement within fire-proof collection booms. Using the latter approach, approximately 15,000 gallons of oil from the recent Exxon Valdez spill were confined after nearly two days in the water and burned. The resulting fire lasting approximately 45 minutes consumed all but 300 gallons of residue that remained in the boom [4].

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OIL SPILL MODEL SHELL: WORLDWIDE APPLICATION

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ABSTRACT

The ASA oil spill model has evolved to standard model software and input and output procedures. An embedded geographic information system (GIS) is used to organize, display and manipulate the data necessary as input to the model and supplementary data that aids in understanding and evaluating model predictions. This system is referred to as a model shell. Applications to new areas are performed by defining geographically specific data sets. Model shell application to such diverse areas as the Arabian Gulf, Ligurian Sea, Gulf of Mexico and Block Island Sound are presented to illustrate the concept. Examples of trajectory and fate model predictions in stochastic and receptor modes are given to show the versatility of the shell in addressing a full range of applications.

1. INTRODUCTION

The development and application of oil spill trajectory and fate models has historically been fairly active and because of the recent number of large spill events (e.g., *Exxon Valdez*, Arabian Gulf spill, Cyprus *Haven* spill, etc.) has received increased attention. A review of the state-of-the-art over the last decade (Stolzenbach et al., 1979; Davidson and Lawrence, 1982; Huang and Monastero, 1982; Spaulding, 1988; Reed et al; 1988) indicates that at any one time 30 to 50 models are available through a variety of government agencies, academic institutions and private consulting firms. Typically two to five algorithms are available to describe any one fate or transport process depending on the process. It is interesting to note that the survivorship of a given model is not particularly long due to the advances in understanding of

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The Development and Use of Contemporary Oil Spill Models in the Preparation of a Response Plan for Cold Lake Bitumen.

by

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Calgary, Alberta
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Abstract

A new advanced contingency plan has recently been developed for the West Coast by Esso Resources, now Imperial Oil (Resources Division), using a combination of new mapping techniques, state of the art computer models and oil-specific laboratory measurements . This work was coordinated to satisfy the demands of the contingency planner, the operational needs of both local and national spill response groups and to meet the informational requirements of crisis management. Such a united approach means that the same basic and integrally consistent information is used by all groups. Thus, during an incident response situation, all groups will have available to them the same basic sets of information.

Introduction

Since 1975, Imperial Oil Limited has produced a heavy crude oil, known as bitumen, from its Cold Lake facility located in north eastern Alberta. The current production rates are between 14,000-16,000 m^3 per day. This bitumen is produced using a cyclic steam process. The reservoir is heated using steam injection in order to mobilize the flow of the bitumen, and after a suitable period of time, the oil is extracted. As produced the oil has an API gravity of 9-10, and a viscosity of about 200,000 cSt at 15°C.

In order to transport this material to market by pipeline, the produced oil is blended with a light condensate (up to 30% by volume) to produce a material with a viscosity of less than 250 cSt at temperatures as low as 0°C. This diluted material is called "dilbit" and has an API gravity of 26. Depending on market conditions, up to 15% of this production is transported by the Trans Mountain Pipe Line to Vancouver where it is loaded for shipment by sea. In recent years, approximately 10 tanker shipments of 70,000 m^3 each were made per year. In addition to the shipment overseas by tanker, there is one dilbit shipment per month to Tacoma using a 18,000 m^3 barge and tug combination.

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DRIFT CURRENT UNDER THE COMBINED ACTION OF WIND AND WAVES IN SHALLOW WATER

by
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ABSTRACT

In the present study the conservation of momentum and turbulent energy equations are solved using an implicit finite difference method to predict the vertical distribution of current, turbulent energy, and eddy viscosity at one point for shallow water. The model includes coupling between the wave and wind induced currents. Input energy from the atmosphere to the turbulent energy and current fields is represented through free surface boundary conditions.

The model was applied to predict the surface drift for water depths ranging from 20 to 1000 m for varying wind speeds. The predicted steady state drift factor decreases with decreasing water depth for a given wind speed. For depths greater than 400 m (deep water) or shallower than 100 m (shallow water), the drift factor is depth independent. In deep (shallow) water, the drift factor decreases (increases) with increasing wind speed. The deflection angle is relatively insensitive to variations in water depth, but decreases slightly as wind speed increases. Model results can be explained by studying the vertical eddy viscosity profiles and whether it is dominated by surface or bottom generated turbulence. Model results are consistent with observations and earlier theoretical studies and show drift factors/deflection angles typically varying from 1.5 to 4%, and 10 to 25°, respectively.

INTRODUCTION

Reliable, high quality predictions of the fate and transport of spilled oil requires an accurate procedure to estimate the wind and wave induced currents in a zone near the free surface. In addition to the traditional need to forecast the surface movement of oil, the current generation of oil spill models incorporate subsurface oil transport calculations as well (e.g. Kolluru et. al., 1994; Spaulding et. al., 1993) which require estimates of the current in the upper several meters of the water column. Strong shear flows in these regions and strong gradients of turbulent kinetic energy can dramatically influence both the surface and subsurface distribution of oil (Elliot, 1986; Spaulding et. al., 1993).

In a previous paper, Youssef and Spaulding (1993) presented the development, testing, and results of a wave current-interaction model. The model solved the conservation of momentum and turbulent kinetic energy equations at a single point assuming deep water conditions. The model further assumed that the principal source of turbulence was due to wave breaking activity at the sea surface and shear in the upper water column. The model results showed good comparison

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VOLUME 1

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June 14 - 16, 1995
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Dixhuitième Colloque technique de lutte contre les déversements d'hydrocarbures dans l'Arctique

du 14 au 16 juin 1995
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Oil tanker
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A CASE FOR SEPARATORS IN OIL SPILL RESPONSE

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ABSTRACT

The most pervasive problem in mechanical spill recovery is skimmers picking up too much water. In spite of a substantial research effort to correct this problem, high capacity skimmers tend to recover a high percent water.

Oil/water separators can solve skimmer efficiency problems because they operate most effectively when the incoming product has a very high percent water. The best of these can produce effluent oil with only a few percent water and water that is less than 50 ppm oil. Still separators are generally not used in spill response because of real and perceived problems. Recent tests indicate that many of these problems have been solved or are near solution. This paper reviews recent tests and comments on how these results may impact mechanical recovery operations. Further, the paper suggests areas in which additional development may improve separator performance to the extent that these devices become an important tool in the oil spill response effort.

INTRODUCTION

The basic problem with mechanical oil skimmers is that they pick up too much water. Further, as capacity goes up, efficiency, in terms of percent water in the recovered product, goes down. Some skimmers can recover a high percent oil, but this level of efficiency is almost always gained at the expense of capacity. This alternative is often acceptable if the oil is not spreading. For example, if a tank truck spills into an adjacent pond, the oil is contained so using a high efficiency low capacity skimmer over a long period of time is acceptable. This is also true in an industrial skimming situation in which the oil is confined. However, if the oil is spreading, which is true in most spill situations, sacrificing capacity for efficiency is not an acceptable alternative. Recovering the oil slowly permits additional spreading and the problem becomes worse. Clearly high capacity must achieved at any cost, and this cost is generally recovering a high percent water.

SEPARATORS FOR SPILL RESPONSE

At this point it becomes logical to add oil/water separators to the recovery system because they operate most effectively when the incoming product has a very high percent water. Although this seems to be the perfect solution to the problem, separators are not often used in spill response because of real and perceived problems. Typical problems include the following:

- o Low capacity

VOLUME 1

PROCEEDINGS

Nineteenth Arctic and Marine Oilspill Program Technical Seminar

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Hôtel Sandman
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Colloque commandité par

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Cover Photograph
Part of the Nipisi Spill, Northern Alberta - 23 years later.
Area showing no recovery
Remediation methods included rototilling

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Photographie de la couverture
Le déversement de Nipisi au nord de l'Alberta, il y a 23 ans.
Endroit démontrant aucune récupèration.
Les techniques de restauration incluent le labourage rotatoire.

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Part of the Nipisi Spill, Northern Alberta, 23 years later.
Area showing recovery.
Remediation methods unknown.

Photographie de la couverture
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Twentieth Arctic and Marine Oilspill Program Technical Seminar

June 11 to 13, 1997
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Vingtième colloque technique du programme de lutte contre les déversements d'hydrocarbures en mer et dans l'Arctique

du 11 au 13 juin 1997
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Cover Photograph
Oil slicks from clingage are clearly visible shortly after the IRVING WHALE oil barge is raised from the Gulf of St. Lawrence in 1996.

AVIS

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Photographie de la couverture
Les nappes d'hydrocarbures à la surface sont clairement visibles suite à la remontée de la barge du IRVING WHALE dans le golfe St-Laurent en 1996.

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The Evaporation of Oil Spills: Prediction of Equations Using Distillation Data

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Abstract

This work follows on extensive empirical studies on the evaporation of oil and petroleum products. A study of the evaporative characteristics of 19 different crude oils and petroleum products was conducted. Best-fit equation parameters were determined for both percentage loss by time and absolute weight loss. All oils except for three (diesel fuel, FCC Heavy Cycle and Bunker C light) were found to fit logarithmic curves. The exceptions noted, fit square root curves with time. The equation constants were correlated with oil distillation data. The equation constants correlated highly with the percentage distilled at 180 °C. Using this correlation, equations were developed by which the oil evaporation can be predicted using the distillation data alone.

Specifically, it has been found that the distillation percentage at 180 °C correlates well with the equation parameters. Regression coefficients (r^2) range from 0.74 to 0.98, depending on the type of equation and the selection of data. Relationships enabling calculation of evaporation equations directly from distillation data have been developed:

For oils that follow a logarithmic equation:

Percentage evaporated = $0.165(\%D)\ln(t)$ (1)

Weight evaporated = $0.0341(\%D)\ln(t)$ (2)

For oils that follow a square root equation:

Percentage evaporated = $0.0254(\%D)\sqrt{t}$ (3)

Weight evaporated = $0.00514(\%D)\sqrt{t}$ (4)

where the weight evaporated is in grams per 20 grams of oil exposed, %D is the percentage (by weight) distilled at 180°C and t is the time in minutes. These are relevant at 15°C.

These equations were combined with the equations generated to account for the temperature variations of the oil:

For oils that follow a logarithmic equation:

Percentage evaporated = $[0.165(\%D) + 0.045(T-15)]\ln(t)$ (5)

For oils that follow a square root equation:

Percentage evaporated = $[0.0254(\%D) + 0.01(T-15)]\sqrt{t}$ (6)

1.0 Introduction

The previous papers by this author presented results that showed that the evaporation rates of oils and petroleum products are largely governed by temperature and time (Fingas 1995a, 1995b, 1996). Equations were derived which correlated the temperature changes to the equations with both the empirical findings themselves, and with distillation data. This work still left the basic parameter of the evaporation rate at 15 °C to be determined empirically. The determination of these empirical

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Cover Photograph
After being raised from the Gulf of St. Lawrence, the IRVING WHALE oil barge is shown here on the submersible transporter barge, BOA 10.

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Suite à l'opération de renflouage dans le golfe St-Laurent la barge du IRVING WHALE est ici transportée par le submersible BOA 10.

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Cleanup of the M/V *Kuroshima* which ran aground at Dutch Harbor, Alaska

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Studies of Water-in-Oil Emulsions: Stability and Oil Properties

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ABSTRACT

This paper summarizes studies to determine the stability of water-in-oil emulsions resulting from asphaltene or resin content and viscosity stabilization.

These studies have confirmed that the stability of emulsions can be grouped into three categories: stable, unstable and meso-stable. Water can also reside in oil as 'entrained water', in which larger droplets of water are temporarily suspended by viscous forces. These have been distinguished by physical measures as well as visual differences. The viscosity of a stable emulsion at a shear rate of one reciprocal second, is at about three orders-of-magnitude greater than that of the starting oil. An unstable emulsion usually has a viscosity no more than about 20 times greater than that of the starting oil. A stable emulsion has a significant elasticity, whereas an unstable emulsion does not. A meso-stable emulsion has properties between stable and unstable, however breaks down after a few days of standing. The usual situation is that emulsions are obviously either stable, meso-stable or unstable. Entrained water, water suspended in oil by viscous forces alone, is also evident. Very few emulsions have questionable stability. Analytical techniques were developed to test these observations.

Studies in the past four years have shown that a class of 'very stable' emulsions exists, characterized by their persistence over several days to years. These stable emulsions actually undergo an increase in viscosity over time. Monitoring of all water-in-oil states resulting from oil/water mixtures prepared in this study, has been performed for at least one week. This shows that meso-stable emulsions, unstable emulsions and entrained water states clearly separate into oil and water layers. Stable emulsions increase in apparent viscosity and elasticity.

The stability of emulsions has been studied by examining the asphaltene and resin content and secondarily, the visco-elastic properties of eighty-two oils. Results are reported which show that these factors are responsible for the stability regimes noted.

1.0 Introduction

The most important characteristic of a water-in-oil emulsion is its "stability". The reason for this importance is that one must first characterize an emulsion as stable (or unstable) before one can characterize the properties. Properties change very

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Cover Photograph
Cleanup of the M/V *Kuroshima* which ran aground at Dutch Harbor, Alaska

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Photographie de la couverture
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Continued Development of a Test for Fire Booms in Waves and Flames

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Abstract

A near full-scale screening test protocol was developed in 1996 that evaluates a fire resistant boom's durability and its ability to contain oil during an *in situ* burn. Benchmarking the screening test protocol showed that it reproduced the correct stresses (both mechanical and heat) of an *in situ* burning operation, but that their intensity needed to be increased. This was accomplished in 1997, with the most significant change being the enhancement of the heat flux to the boom by increasing the flow of propane per unit surface area by a factor of three and injecting compressed air into the base of the flame.

The revised fire exposure portion of the test protocol was benchmarked in October 1997. These tests involved exposing a 15 m section of the NOBE fire boom to four one-hour cycles of enhanced propane flames and waves and four one-hour cycles of waves alone. The sustained average heat fluxes ranged from 110 to 130 kW/m^2 with some averages as high as 150 kW/m^2, a significant increase over earlier measured heat fluxes from propane fires and in line with heat fluxes from diesel and crude oil fires. Temperatures on top of the test section of boom ranged from 900 to 1100°C. After the second burn cycle, the boom was beginning to show signs of deterioration. By the end of the third burn cycle the boom fabric was obviously severely degraded and would not have contained oil at the vertical stiffeners exposed to flames. On completion of the fourth cycle there were large holes in the membrane at the vertical stiffeners and severe damage at the sides and the top of adjacent float sections. This is consistent with the damage observed at NOBE and in the same fire exposure time frame.

1.0 Introduction

A near full-scale test protocol was developed in 1996 that evaluates a fire resistant boom's durability and its ability to contain oil during an *in situ* burn without the environmental problems of burning crude oil or the costs of testing offshore. The screening test was comprised of four discrete stages:

1. The pre-burn wave stress stage, where the test boom was flexed under tension in waves to simulate deployment of the boom and transit to the spill site.
2. The burn in waves stage, where the test boom was exposed to waves and repeated one hour cycles of a propane gas fire to simulate oil burning operations.
3. The post-burn wave stress stage, where the test boom was again flexed under tension in waves to simulate retrieval of the boom.

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PROCEEDINGS

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June 2 to 4, 1999
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Vingt-deuxième colloque technique du programme de lutte contre les déversements d'hydrocarbures en mer et dans l'Arctique

du 2 au 4 juin 1999
Hôtel Westin
Calgary, Alberta
Canada

Colloque commandité par

Service de la Protection de l'environnement
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Cover Photograph
The deliberate burning of the remaining cargo aboard the M/V *New Carissa.*
Oregon, 1999

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Le brûlage volontaire des restes de la cargaison de M/V *New Carissa.*
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Cover Photograph
Cleanup of oil from the *Gordon C Leetch* after hitting a pier in the port of Hâvre St-Pierre (Quebec).
March 1999

Photo courtesy of: Environment Canada, Quebec Region

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Photographie de la couverture
Nettoyage d'hydrocarbures venant de *Gordon C Leetch* après avoir frappé la jetée à Hâvre St-Pierre (Quebec).
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Aerial view of the M/V*Bovec* after running aground in Prince Rupert harbour on March 21, 2000.

Photo courtesy of: Empire Grain Ltd.
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Mass Balance Constraints on the Sources of the Petrogenic Hydrocarbon Background in Offshore Sediments of Prince William Sound and the Gulf of Alaska

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Abstract

Many natural sources of petrogenic hydrocarbons contribute to the background observed in offshore sediments of Prince William Sound and the Gulf of Alaska (PWS/GOA) (Page *et al.* 1995; Page *et al.* 1996; Page *et al.* 1998a; Page *et al.* 1998b). Hydrocarbon fingerprinting, least-squares analysis (Burns *et al.* 1997; Page *et al.* 1999) and mass balance constraints indicate that eroding Tertiary petroleum source rocks and residues of associated seep oils are the dominant sources of the hydrocarbon background rather than area coals or residues from the *Exxon Valdez* oil. Mass balance constraints are imposed by total organic carbon (TOC), polycyclic aromatic hydrocarbons (PAH), and saturate and aromatic biomarker concentrations. Inputs of the natural background predate the 1989 oil spill (Page *et al.* 1995; Page *et al.* 1996). Results of this analysis indicate that recent claims (Short *et al.* 1999; Hostettler, *et al.* 1999) that area coals are the major source of the background are incorrect.

1.0 Study Plan and Methods

Sixty-nine field samples of coal, seep oil, offshore sediments, stream and river sediments and petroleum source rocks from locations ranging from Yakutat in the east to PWS in the west were taken in 1999. Table 1 summarizes the locations and features of these 1999 samples (see also Figure 1). In addition, subsets of 20 stream-sediment and seep-oil samples taken in 1993 and 1994 (see Bence, *et al.*, 1996) and 32 benthic sediment samples from the GOA and PWS taken in 1991 (see Page, *et al.*, 1996) were quantitatively re-analyzed for a large set of PAH and chemical biomarkers. Three Bering River coal samples plus 10 archived source-rock and 3 archived GOA seep and field oil samples from exploration activities in the 1960s and 1970s were analyzed to complete the data set.

PAH and biomarker concentrations were quantified by GC/MS-SIM techniques previously reported (Page, *et al.* 1996; Bence, *et al.* 1996). Included were thirty-six 2-6 ring PAH analytes and 44 C_{19}-C_{35} hopanes (tri- tetra- and pentacyclic terpanes) and demethylated hopanes (m/z 191), 14 C_{21}-C_{29} regular steranes (m/z 217, 218), eight C_{27}-C_{29} diasteranes (m/z 259), and 7 C_{20}-C_{28} triaromatic steranes (m/z 231). Sample size ranged from 30 to 50 g dry weight. Before solvent extraction, source rock and coal samples were finely pulverized to produce a grain size approximating that of PWS benthic sediments. This was done to minimize grain size effects on extraction efficiency. TOC was determined by standard combustion methods. The thermal maturities of the shale and coal samples and of the particulate kerogens in shoreline, stream and subtidal sediment samples were determined by reflectance (Ro) measurements, a standard technique.

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Cover Photograph
Lightering operations begin, March 25, 2000. M/V *Bovec*, Prince Rupert harbour

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Abstract

The Hazmat Division of the National Oceanic and Atmospheric Administration has recently completed a major upgrade to its widely used oil spill behavior model, ADIOS. Based on new research results and analysis since the release of the first version of the model, the algorithms for evaporation, spreading, dispersion, and emulsification have been modified. Evaporation now utilizes a pseudo-component approach, dispersion includes the effects of sedimentation and new estimates for wave breaking, emulsification considers droplet size distribution as well as water content, and spreading uses new numerical techniques that allow non-uniformity in slick thickness. New sub-models calculate the inhalation hazard due to evaporating benzene from the slick surface, record the effects of cleanup, and allow several options with regard to the initial release. The user is allowed to input ranges for selected input variables with the resulting uncertainty displayed in the model output. Along with the standard library of over a thousand oils and refined products, a custom library option is available. Documentation for the software is provided as an accompanying HTML document.

1.0 Introduction

The National Oceanic and Atmospheric Administration Hazmat Division (NOAA/HAZMAT) oil weathering program, ADIOS (Automated Data Inquiry for Oil Spills) was introduced at the Fifteenth Arctic and Marine Oil Spill Program (AMOP) and has been widely used throughout the world as a standard modeling tool at oil spill incidents. The model was deliberately designed to be capable of operating easily on the relatively less powerful desktop computers of 1992. As a result, many simplifying assumptions had to be made with regard to weathering algorithms employed in the model. However, in the intervening years, personal computers have become more powerful and our understanding of the underlying physics and chemistry of oil slicks has advanced. Therefore, NOAA/HAZMAT has revised the existing algorithms in ADIOS and introduced new ones which model additional weathering processes and cleanup strategies.

This paper is divided into three parts. The first part outlines the changes in the existing algorithms implemented in the new version. The second part discusses the new algorithms for additional weathering processes and cleanup activities. The third part describes the new interface, which is the result of NOAA/HAZMAT research in software usability and uncertainty.

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Cover Photograph
The tanker Jessica lies aground and leaking fuel oil off the coast of the Galapagos Islands in January, 2001. (Photo courtesy of Ron Goodman)

Photographie de la couverture
Échoué au large des Galápagos, en janvier 2001, le pétrolier Jessica laisse échapper du mazout (cl. Ron Goodman).

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Reassessment of the hydrocarbons in Prince William Sound and the Gulf of Alaska: identifying the source using Partial Least Squares

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Abstract

The multivariate statistical methodology of Partial Least Squares (PLS) has been used to reassess the percentage contribution of coal, seep oil, shales and rivers to the hydrocarbon loading in the Gulf of Alaska. Data have kindly been provided by Short (NOAA) and Page (Bowdoin College, for Exxon) and have been analysed using selected sites as sources in order to develop signatures. These signatures are based on 40 and 136 compounds respectively and include the PAH and terpane biomarkers in the case of the Exxon data. The principal components describing these sources are then fitted to the data for other sites around the Gulf of Alaska (GoA) to determine the proportion of the variability described by each source. Using the Exxon data, the coal, seep oil, eroding shales and rivers (1 & 2) sources described ~13, 18, 24, 26 and 20% respectively of the variance in the Prince William Sound (PWS) and GoA data. With the NOAA data, spatial plots of the explained variance indicate regions where *Exxon Valdez* oil dominates and others where the pre-spill background dominates. As with the Exxon data, there is considerable overlap in the signatures and Cooman's Plots identify those compounds which are the most diagnostic: for the seep oil signature, naphthalene, methyl and dimethyl naphthalene are the best markers whereas the pre-spill background, coals and shales are best defined by the larger PAHs such as perylene and benzo(ghi)perylene. The evidence suggests mixed sources whose contributions vary across the sampling area.

1. Introduction

Following the grounding and loss of oil from the *Exxon Valdez* tanker in PWS, Alaska, there has been much work published on the clean-up and potential long term fate of the oil (see Wells et al., 1995; Rice et al., 1996). However, an outstanding issue does exist with regard to the origin of the background hydrocarbons present within Prince William Sound (PWS) and the GoA generally. There are two school's of thought on this matter; Short and co-workers from the NOAA Auke Bay Laboratory cite evidence based on the presence of coal on nearby beaches and the coal measures between the Bering River and Ice Bay that these background (pre-spill) hydrocarbons come from such deposits (Short et al., 1999). In contrast, Page and co-workers believe they originate from natural oil seeps and eroding source rocks in the same regions around the eastern shores of the GoA (Page et al., 1999; Boehm et al., 2001). Several papers have been published presenting evidence for each hypothesis which have then been challenged in replies. Much of the work revolves around the biomarkers, PAHs, ratios between selected PAHs, their refractory index and TOC considerations. Recently Page and co-workers have used

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Cover Photograph
The fishing vessel Katsheshuk *burns while being towed through pack ice north of St. John's, Newfoundland. The* Katsheshuk *sank a few days later on March 30, 2002, releasing part of the 400,000 L of diesel fuel on board.* (Photo courtesy of the Canadian Coast Guard)

Photographie de la couverture
Remorqué dans la banquise, le navire de pêche Katsheshuk *brûle au nord de St-Jean, Terre-Neuve. Il coulera quelques jours plus tard, le 30 mars 2002, en libérant une partie de ses 400 000 L de carburant diesel.* (Photo Garde côtière canadienne)

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The Fate of Stranded Oil at the BIOS Site Twenty Years after the Experiment

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Abstract

A beach at Cape Hatt, northern Baffin Island, Canada was oiled as part of the 1981 BIOS experiment. The distribution, natural weathering and character of the oil have been monitored over time by periodic site visits. The oil has been exposed to weathering processes for a total of approximately 40 months during ice-free periods over the 20 years of the study. The majority of the stranded oil was removed in the first few months of open water following the experiment; however, small surface patches still remain in 2001. There has been relatively little change in the overall distribution or in the observed physical condition of the oil patches between two site visits in 1993 and 2001. Geochemical analyses show that some samples remain essentially unaltered despite their 20 years (~40 months) of exposure to the elements, whereas, others show that biodegradation and photo-oxidation can play important roles in removing the majority of the components of the oil in this low-energy arctic environment. The most biodegraded sample has lost more than 87% of the hydrocarbons that were initially present.

1 Introduction

One component of the Baffin Island Oil Spill (BIOS) Project involved a nearshore release of 15 m^3 of aged crude oil that was allowed to strand on the nearby shoreline (Sergy and Blackall, 1987). The oiling took place in 1981; the experimental beach (designated as Bay 11:Figure 1) was left to weather naturally and was monitored over time. Another component of the BIOS Project, carried out in 1980 and 1982, involved the creation of intertidal and backshore control and test plots in an area known as Z Lagoon. These plots were oiled directly and were used to evaluate various treatment techniques (Owens *et al.*, 1987; Owens and Robson, 1987). Field studies were conducted in July/August 1981 and during August in each of the years 1982, 1983, 1985, 1987, 1989, 1993 and 2001 to systematically document changes in the distribution, quantity, and character of the oil though time. Even in the last visit of 2001(~20 years later), oil residues were found on the Bay 11 beach and in Z Lagoon where two 1980 control plots of weathered crude and emulsion (plots T1 and T2 respectively) had been oiled above the normal limit of wave action. Small amounts of oil residues were also found on a 1982 weathered crude plot that had been treated by *in situ* mixing (plot IMC).

The results of chemical analyses on the samples collected in 1993 and 2001 are reported elsewhere (Prince *et al.*, submitted; Wang *et al.*, 1995) and this discussion focuses on the changes in the observed distribution and character of the oil residues in the context of the long-term fate of the stranded oil.

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Abstract

An experiment on dispersant effectiveness was conducted at a wave-tank facility in Corpus Christi TX (USA). The tank was setup to simulate a shallow embayment with wave conditions similar to those found in Corpus Christi Bay. A known volume of weathered Arabian medium crude oil was applied to the water surface and the dispersant was systematically applied to the slick in an aerosolized form (dispersant-to-oil ratio of 1:10). The effectiveness was quantified by conducting a mass balance on the oil where the compartments for oil accumulation were the water column, the water surface (as a resurfacing slick), and the tank walls. Samples were periodically collected from each compartment during the 24-hour experiment (t = pre-oiled baseline, 0.5 hours, 2 hours, 4, hours, 24 hours). Samples were extracted and analyzed via GC-MS. Data analysis indicates that during the 4-hour sampling event, more than two-thirds of the applied oil was determined to be in the water column. This result suggests that the dispersant was effective in dispersing the crude oil under these wave energy conditions. After 24 hours, a large portion of the oil had resurfaced. Fuller et al. (2002) had similar results in the lab scale version of this experiment.

1 Introduction

The anthropogenic introduction of petroleum into the marine environment is largely due to the production and transport of crude oil and refined products. Sudden large inputs of oil into marine ecosystems can have an enormous impact, both environmentally and economically. Chemical countermeasures are one tactic for oil spill cleanup. Dispersants, one type of countermeasure, are designed to disperse the oil into the water column. Currently, dispersants are not pre-approved for near-shore use in some parts of the United States. Consequently, if an oil spill occurs in these shallow marine waters, oil-spill response teams cannot utilize dispersants in the most-timely fashion, thus increasing the chances of onshore movement of the oil.

Although the majority of marine oil spills occur close to land, dispersant use in coastal marine ecosystems has been approached cautiously. Many of these concerns are in response to the high toxicity of the first-generation dispersants, although the newer dispersant formulations are considered more effective and much less toxic (NRC, 1989).

Although numerous toxicological studies have been conducted on these newer dispersants, the effectiveness of the dispersant application process is difficult to

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Le vingt-sixième Colloque technique du programme de lutte contre les déversements d'hydrocarbures en mer et dans l'Arctique
Le vingtième Session sur les déversements de produits chimiques (TSOCS)
Le cinquième Session de Solutions en biotechnologie lors de déve[illegible] (BIOSS)

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Cover Photograph
Workers load recovered oil into a large container during cleanup operations in response to the Prestige-Nassau *oil spill off the coast of Spain in November/December, 2002.* (Photo courtesy of the National Oceanic and Atmospheric Administration/NOAA, Seattle, Washington)

Photo couverture
Des travailleurs chargent, dans de larges contenants, les hydrocarbures récupérés lors de l'intervention suite au déversement d'hydrocarbures de la Prestige-Nassau *au large de l'Espagne en novembre/décembre 2002.* (photo fournie par la National Oceanic and Atmospheric Administration/NOAA, Seattle, Washington)

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Studies of Water-in-Oil Emulsions: Formation of Water-in-Oil States from Heavy Oils

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Abstract

This paper summarizes studies of the formation of water-in-oil states from heavy oils. In previous studies, viscosity has been identified as a significant factor influencing the formation and stability of water-in-oil emulsions. A viscosity "window" has been postulated as necessary for the formation of stable emulsions. Further, the viscosity was necessary for an oil to produce an entrained water state. Heavy oils were rarely found to produce a stable or meso-stable emulsion and in most cases, an entrained water-in-oil state result. However, it was found that the entrained water-in-oil states would persevere for a much longer time (days) than with lighter oils. This is due to the lower migration rate of water droplets out of a heavy oil compared to that of a crude oil.

A secondary use of the results was to evaluate the representative basis for using the "Stability Index", devised to quantitatively characterize the stability of an emulsion, under varying formation regimes. The results show that the stability factor previously defined as the complex modulus of the water-in-oil state after emulsion formation divided by the starting oil viscosity, is still a robust indicator, however, is less predictive for heavy oils. A new or alternative stability scale was developed and yield similar values for water-in-oil states produced from either light or heavy oils. However, the alternative stability scale is complex and has no improved discriminating power over the old simple stability scale.

1 Introduction

Emulsification is the process whereby water-in-oil emulsions are formed. These emulsions are often called "chocolate mousse" or "mousse" by oil spill workers. When emulsions form, the properties and characteristics of oil spills change to a very large degree. For example, stable emulsions contain from 60 to 80% water, thus expanding the spilled material from 2 to 5 times the original volume. The density of the resulting emulsion can be as great as 1.03 g/mL compared to a starting density as low as 0.80 g/mL. Most significantly, the viscosity of the oil typically changes from a few hundred mPa.s to about 100,000 mPa.s, a typical increase of 1,000. A liquid product is thereby changed to a heavy, semi-solid material.

Many researchers feel that emulsification is the second most important behavioural characteristic of oil after evaporation. Emulsification has a significant effect on the behaviour of oil spills at sea. As a result of emulsification, evaporation of oil spills slows by orders-of-magnitude, spreading slows by similar rates, and the oil rides lower in the water column, showing different drag with respect to the wind. Emulsification also significantly affects other aspects of a spill, such as cleanup

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June 8 to 10, 2004
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Le vingt-septième Colloque technique du programme de lutte contre les déversements d'hydrocarbures en mer et dans l'Arctique (AMOP) incluant la vingt et unième Session sur les déversements de produits chimiques (TSOCS)

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Cover Photograph
The Tasman Spirit *ran aground off the Arabian Sea port of Karachi on July 27, 2003. The tanker, which was carrying 67,000 tons of light crude oil, eventually broke in two, dumping thousands of tons of oil into the sea and along the coastline.* (Photo courtesy of the International Tanker Owners Pollution Federation, ITOPF, London, UK)

Photo couverture
Le 27 juillet 2003, le Tasman Spirit *s'échoue au large du port de Karachi, en mer d'Oman. Chargé de 67 000 t de brut léger, le pétrolier finit par se casser en deux, en déversant des milliers de tonnes dans la mer et sur le littoral.* (Cl. International Tanker Owners Pollution Federation [ITOPF], Londres)

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Energy and Work Input in Laboratory Vessels

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Abstract

Turbulent and total energy are known be a very important part of the measurement of oil spill processes. For example, the energy spectrum is thought to be the single most-important variable in relation to chemical dispersion.

Two techniques have been used to measure energy and work input. One measurement technique chosen to do this is Particle Image Velocimetry or PIV. In this method, seed particles - which could be oil droplets, are put into the fluid and the fluid is illuminated with a laser at one of 4 chosen wavelengths. The movement of a particle in a given cell is measured as a function of time. This can occur as fast as 30 Hz. Energy can be calculated from at least 2 successive frames. Turbulent energy can be calculated at each point in the image frame. The other method is the method of using hot wire anemometry. This method can yield data similar to PIV measurements, however requires the intrusion of a probe into the area.

Energy and work are calculated or estimated in several laboratory vessels and compared to estimates of energy/work at sea. Some measurements completed by PIV and anemometry are compared to these calculated values. The initial measurements and estimates indicate that the energy in several laboratory vessels is similar and that it may be equivalent to those encountered at sea under moderate wind and wave conditions.

1 Introduction

An important aspect of oil spill processes is the energy applied to the oil on the water surface. The energy and work applied is known to effect the kinetics of water-in-oil emulsion (Fingas et al., 2001). Further, it has been found that energy is critical in understanding the effectiveness of chemical dispersion of oil (Fingas et al., 1996). This paper reports on initial measurements of energy and work using modern techniques. In the past year, initial studies on this problem were reported (Fingas, 2003). Emphasis has been placed on studying the kinetic energy and turbulence in small laboratory apparatuses. It is important to note that turbulent energy is felt to be the most important form of energy related to emulsion formation.

Turbulence is the fluctuation of velocity (Tennekes and Lumley, 1972; Zhou et al., 2000). If a velocity assemblage is viewed, the description of the overall velocity is given as:

$$U = \overline{U} + u' \qquad (1)$$

where U is the overall velocity component

$\overline{U}$ is the average or constant velocity

u' is the fluctuating component or turbulence.

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Volume 1
Proceedings

Twenty-eighth Arctic and Marine Oilspill Program (AMOP) Technical Seminar including sessions for the Twenty-second Technical Seminar on Chemical Spills (TSOCS)

June 7 to 9, 2005
Fairmont Palliser Hotel
Calgary, Alberta
Canada

The Technical Seminar is sponsored by the Emergencies Science and Technology Division, Environmental Technology Centre, Environmental Protection Service of Environment Canada.

Volume 1
Compte Rendu

Le vingt-huitième Colloque technique du programme de lutte contre les déversements d'hydrocarbures en mer et dans l'Arctique (AMOP) incluant la vingt-deuxième Session sur les déversements de produits chimiques (TSOCS)

du 7 au 9 juin 2005
Hôtel Fairmont Palliser
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Canada

Le Colloque technique est commandité par le Division les urgences - science et technologie, Centre de technologie environnementale, Service de la protection de l'environnement, Environnement Canada.

Cover Photograph
On December 8, 2004, the Selendang Ayu, *a 738-foot cargo vessel, went aground between Skan Bay and Spray Cape on the northwest corner of Unalaska Island, Alaska. The vessel was loaded with 132 million pounds of soybeans and carrying approximately 470,000 gallons of heavy bunker fuel oil (IFO 380) and 21,000 gallons of diesel fuel. High seas pounded the vessel, which subsequently broke in two, spilling at least 40,000 gallons of oil. This photo was taken about a week later.* (Photo courtesy of the International Tanker Owners Pollution Federation, ITOPF, London, UK)

Photo couverture
Le 8 décembre 2004, le Selendang Ayu, *cargo de 738 pieds de longueur, s'échoue entre la baie Skan et le cap Spray, à l'angle nord-ouest de l'île d'Unalaska, en Alaska. Il transportait 132 millions de livres de fèves de soja, 470 000 gallons de mazout lourd (IFO 380) et 21 000 gallons de carburant diesel. Sous les coups de boutoir de la mer grosse, sa coque se brise en deux, laissant fuir au moins 40 000 gallons de mazout. Cette photo a été prise environ une semaine plus tard.* (Photo reproduite avec l'aimable autorisation de l'International Tanker Owners Pollution Federation [ITOPF], Londres)

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Measurement of Energy in Laboratory Vessels-III

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Abstract

Energy and work are calculated or estimated in several laboratory vessels and compared to estimates of energy/work at sea. Some measurements completed by PIV and anemometry are compared to these calculated values. The initial measurements and estimates indicate that the energy in several laboratory vessels is similar and that it may be equivalent to those encountered at sea under moderate wind and wave conditions.

Two techniques have been initiated to measure energy. The measurement technique chosen to do this is Particle Image Velocimetry or PIV. In this method, seed particles - which could be oil droplets, are put into the fluid and the fluid is illuminated with a laser at one of 4 chosen wavelengths. The movement of a particle in a given cell is measured as a function of time. This can occur as fast as 30 Hz. Turbulent energy can be calculated at each point in the image frame. The other method used is the method of using hot wire anemometry. This method can yield data similar to PIV, however requires the intrusion of a probe into the area.

The methods are compared in several laboratory vessels under several energy conditions. This year's work includes new measurements in several apparatuses.

1 Introduction

An important aspect of oil spill processes is the energy applied to the oil on the water surface. The energy and work applied is known to effect the kinetics of water-in-oil emulsion (Fingas et al., 2001). Further, it has been found that energy is critical in understanding the effectiveness of chemical dispersion of oil (Fingas et al., 1996). This paper reports on initial measurements of energy and work using modern techniques. Emphasis has been placed on studying the kinetic energy and turbulence in small laboratory apparatuses because that turbulent energy is felt to be the most important form of energy related to emulsion formation and dispersion.

Turbulence is the fluctuation of velocity (Tennekes and Lumley, 1972). If a velocity assemblage is viewed, the description of the overall velocity is given as:

$$U = \overline{U} + u' \qquad (1)$$

where U is the overall velocity component

$\overline{U}$ is the average or constant velocity

u' is the fluctuating component or turbulence.

The intensity of turbulence is given by:

$$I = (u^2 + v^2 + w^2)^{1/2} \qquad (2)$$

Where I is the turbulence intensity

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The Restoration Project: Decontamination of Facilities from Chemical, Biological and Radiological Contamination after Terrorist Actions

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Abstract

A multi-agency project on site restoration after a terrorist attack is reviewed. The objective of the project is to gather and compile information on and subsequently test and validate all known procedures for restoration of areas including interiors and exteriors of buildings, the interior contents of buildings, and areas adjacent to buildings, such as parking lots, lawn, vehicles, etc. This includes the air inside the building and the surfaces contaminated. The restoration includes pickup, neutralization, decontamination, removal and final destruction/deposition of the contaminant, cleaning/neutralization material and contaminated waste from decontamination. resulting from the act. Further, the project is intended test existing concepts and to develop new ideas for application to restoration.

The laboratory scale experiments consist of testing, using standard laboratory techniques, the efficacy of some of the proposed concepts. Radiation decontamination is a two-step proposal consisting of removal and concentration/removal of the radioisotopes from the removal fluid. An important part of the project is the testing of the remaining candidate procedures on a small scale. NATO and DRDC-Suffield have developed 'standard' tests with a small surface token. The testing of target chemicals is being conducted at the Environment Canada facility in Ottawa, the biological agents at the Health Canada facility in Winnipeg and Ottawa, and the radiological agents at the radiological facility at DRDC-Ottawa. The fourth phase is the preparation of

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Volume 1
Proceedings

Twenty-ninth Arctic and Marine Oilspill Program (AMOP) Technical Seminar, including sessions for the Twenty-third Technical Seminar on Chemical Spills (TSOCS) and the Seventh Biological Solutions for Site Remediation, Restoration and Rehabilitation (BISLOR^3) Symposium

June 6 to 8, 2006
Coast Plaza Hotel
Vancouver, British Columbia, Canada

The Technical Seminar is sponsored by the Emergencies Science and Technology Division, Science and Technology Branch of Environment Canada.

Volume 1
Compte Rendu

Le vingt-neuvième Colloque technique du programme de lutte contre les déversements d'hydrocarbures en mer et dans l'Arctique (AMOP), incluant la vingt-troisième Session sur les déversements de produits chimiques (TSOCS) et le septième Colloque sur les solutions biologiques pour la dépollution, la restauration et la réhabilitation (BIOSLOR^3).

du 6 au 8 juin 2006
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Vancouver (Colombie Britannique) Canada

Le Colloque technique est commandité par le Division les urgences - science et technologie, Direction générale des sciences et de la technologie d'Environnement Canada.

Cover Photograph
On December 10, 2005, the Bahamain-registered container vessel CP Valour *(15,145 GT) went aground off Faial Island in the Azores. Fuel oil leaked into the bay from the vessel's damaged bunker tanks, but contamination was confined to the bay by the prevailing onshore wind. The sandy beach was cleaned by local labour. The remaining bunker fuel was pumped off the vessel and the containers of hazardous cargo were removed by helicopter. The vessel is being dismantled on site which should be completed by August 2006.* (Photo courtesy of the International Tanker Owners Pollution Federation, ITOPF, London, UK.)

Photo couverture
Le 10 décembre 2005, le porte-conteneurs CP Valour *enregistré aux Bahamas (jauge brute, 15 145 tx) s'échoue au large de l'île de Faial, dans les Açores. De ses soutes endommagées le fioul s'échappe dans la baie, mais, grâce au vent du large, la pollution n'ira pas plus loin. Une main-d'œuvre locale nettoie la plage de sable. Le reste du fioul est récupéré par pompage, et on transporte par hélicoptère la cargaison de conteneurs en péril. La démolition du navire sur place sera terminée en août 2006.* (Photo reproduite avec l'aimable autorisation de l'International Tanker Owners Pollution Federation [ITOPF], Londres)

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A Review of Knowledge on Water-in-Oil Emulsions

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Abstract

Fifteen years of studies have yielded extensive data on water-in-oil emulsions. Studies have been conducted at laboratory, test tank and field scale. Good correlation between results have been achieved between the studies. Test results on about 400 oils and petroleum products are reported. Literature corroborates these studies.

It has been found that emulsions can be grouped into three categories: stable, unstable and meso-stable. Each of these has distinct physical properties. For example, the viscosity of a stable emulsion at a shear rate of one reciprocal second is at least three orders-of-magnitude greater than that of the starting oil. An unstable emulsion usually has a viscosity no more than two orders-of-magnitude greater than that of the starting oil. The zero-shear-rate viscosity is at least six orders-of-magnitude greater than the starting oil for a stable emulsion. For an unstable emulsion, it is usually less than two or three orders-of-magnitude greater than the viscosity of the starting oil. And finally, a stable emulsion has a significant elasticity, whereas an unstable emulsion does not.

The stability of emulsions has been studied by examining their asphaltene content and secondarily, their resin content. Results are reported showing that asphaltenes and resins are responsible for stability. Asphaltenes by themselves can stabilize emulsions and are primarily responsible for water-in-oil emulsion formation. It is also shown that the content of other materials such as waxes is irrelevant to the basic formation process. The stability of any emulsion created from an oil can be predicted by its asphaltene content and, to a secondary degree, by its viscosity. It is noted that given the correct chemical composition, primarily asphaltenes, a minimum of sea energy is needed. It was found that emulsion formation occurs at a threshold energy, however this energy has been defined only in terms of relative sea state.

A new numerical modelling scheme was proposed recently. This model was based on empirical data and the corresponding physical knowledge of emulsion formation. The density, viscosity, saturate, asphaltene and resin contents were used to compute a class index which yields either an unstable or entrained water-in-oil state or a meso-stable or stable emulsion.

1. Introduction

Emulsification is the process whereby water-in-oil emulsions are formed. These emulsions are often called "chocolate mousse" or "mousse" by oil spill workers. When emulsions form, the physical properties and characteristics of oil spills change extensively. For example, stable emulsions contain from 60 to 80% water, thus expanding the spilled material from 2 to 5 times the original volume. The density of the resulting emulsion can be as great as 1.03 g/mL compared to a starting

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Proceedings

Thirtieth Arctic and Marine Oilspill Program (AMOP) Technical Seminar, including sessions for the Twenty-fourth Technical Seminar on Chemical Spills (TSOCS) and the Eighth Biological Solutions for Site Remediation, Restoration and Rehabilitation (BIOSOLR^3) Symposium

June 5 to 7, 2007
Fantasyland Hotel
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Volume 1
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Trentième Colloque technique du Programme de lutte contre les déversements d'hydrocarbures en mer et dans l'Arctique (AMOP), incluant la vingt-quatrième Session sur les déversements de produits chimiques (TSOCS) et le huitième Colloque sur les solutions biologiques pour la dépollution, la restauration et la réhabilitation (BIOSOLR^3)

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Cover Photograph
The MSC Napoli *is shown beached in Lyme Bay off the Dorset coast of England on January 20, 2007. This occurred while the 62,000-tonne container ship was being towed to safe haven after being damaged during a storm at sea. The Napoli carried approximately 3,500 tonnes of heavy fuel oil which were safely transferred off the ship.*
Photo courtesy of the Maritime and Coastguard Agency (MSA)

Photographie de couverture
Le MSC Napoli *s'est échoué en baie de Lyme au large des côtes du Dorset, en Angleterre, le 20 janvier 2007. Ceci a eu lieu alors que le porte-conteneurs de 62 000 tonnes se faisait remorquer à bon port après avoir été endommagé par une tempête en mer. Le* Napoli *transportait approximativement 3 500 tonnes de mazout lourd qui ont été transférées du bateau en toute sécurité.*
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Estimation of Oil Spill Behaviour Parameters from Readily-Available Oil Properties

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Abstract

Oils are very complex mixtures of hydrocarbons resulting in somewhat unique oil properties for every oil. Some of this uniqueness may be bourne out in the simple properties such as density and viscosity, others not. The solution to this uniqueness in the past has been to model oils on typical characteristics such as light crude oil, medium crude oil, etc. Another method has been to use very specific crude oil data. When an oil or petroleum product is spilled there often is a need to be able to predict oil behaviour with only simple data such as density or viscosity, until more comprehensive data can be found,.

Often oil behaviour parameters such as for evaporation, emulsification and chemical dispersion, are needed and specific behavioural data are not available. Despite the growth of oil property data bases, and initially at least, little data on some spilled oils are available. Often only basic data such as density, and viscosity are available. This paper presents a series of simple schemes to provide prediction for oil evaporation, emulsification and chemical dispersion given readily-available data. Schemes for prediction are given using only density and viscosity and then adding SARA and other composition data. As the input data amount is increased, more accuracy in the estimations are achieved.

The estimation schemes are compared to the measured data available and also to the use of generic oil types sometimes used in models such as 'light or heavy crude oil'. It was found that the accuracy of these estimation schemes are more accurate than the traditional predictions based on generic oil types.

1 Introduction

An important tool in oil spill planning and response is oil spill modeling. Oil spill modeling relies on algorithms that require a number of oil property inputs. Sometimes these inputs are not readily available, especially at the time of a spill. It is the focus of this paper to report on the development of simple estimators to predict oil evaporation, emulsification and chemical dispersion, using only density and viscosity. Density and viscosity are often the only data available at the time of the spill. The algorithm development will be described with the background of the significance of spill processes and more detailed behaviour prediction algorithms, sometimes using more sophisticated chemical data inputs.

The behaviour of oil in the environment is largely dictated by its chemical composition. Oil composition data that are relatively available include the SARA or Saturates, Aromatics, Resin and Asphaltene contents. As will be shown later, sometimes these data are not sufficient to yield a truly accurate prediction. More detailed compositional data are available for only a few oils (Oil Catalogue, 2007).

The most important behavioural aspect is felt to be evaporation. Evaporation

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Compte rendu du Trente-et-unième Colloque technique de l'AMOP - Contamination de l'environnement et intervention

Du 3 au 5 juin 2008
Hôtel Fairmont Palliser
Calgary (Alberta) Canada

Le Colloque technique est commandité par la Division des urgences - Science et technologie, Direction générale des sciences et de la technologie d'Environnement Canada.

Cover Photograph
This photo shows a barge used to remove wastes from an inaccessible beach after a large oil spill along the coast of South Korea. On December 7 2007, a South Korean crane barge crashed into the 147,000-ton Chinese oil tanker, the Hebei Spirit, *ripping three holes in the tanker's hull and spilling 10,000 tonnes of crude oil into South Korean waters. The spill triggered a huge cleanup effort along 200 kilometres of beaches. Experts from Environment Canada and the Canadian Coast Guard responded to South Korea's call for help by providing technical support and expertise to aid in the disaster assessment and cleanup efforts.* (Photo courtesy of Roger Percy, Environment Canada)

Photographie de la couverture
Cette photo montre une barge utilisée pour enlever les déchets d'une plage inaccessible après un important déversement de pétrole le long des côtes de Corée du Sud. Le 7 décembre 2007, une barge-grue sud-coréenne est entrée en collision avec le Hebei Spirit, *un pétrolier chinois de 147 000 tonnes, déchirant la coque du pétrolier en trois endroits et provoquant le déversement le 10 000 tonnes de pétrole brut dans les eaux sud-coréennes. En a résulté un énorme travail de nettoyage sur 200 kilomètres de plage. Des spécialistes d'Environnement Canada et de la Garde côtière canadienne ont répondu à l'appel de la Corée du Sud en apportant soutien technique et expertise aux travaux d'évaluation du désastre et de dépollution.* (Photo reproduite avec l'aimable autorisation de Roger Percy, Environnement Canada)

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Experimental Approaches to Assessing the Impact of a Cesium Chloride Radiological Dispersal Device

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Abstract

The US EPA, as a part of the Chemical, Biological, Radiological-Nuclear, and Explosives (CBRNE) Research and Technology Initiative (CRTI) project team, is currently working to assess the impacts of an urban radiological dispersion device (RDD) and to develop containment and decontamination strategies. Three efforts in this area are currently underway: development of a laboratory-scale cesium chloride deposition method to mimic a RDD; assessment of cesium (Cs) penetration depth and pathways in urban materials using two dimensional (2-D) mapping laser ablation inductively coupled plasma mass spectrometry (LA-ICP-MS); and experimental determination of distribution coefficients (k_d) for Cs in water-building material systems. It is critical that, when performing laboratory-scale experiments to assess the fate of Cs from an RDD, the Cs particle deposition method mimics the RDD deposition. Once Cs particles are deposited onto urban surfaces, 2-D mapping of Cs concentrations using LA-ICP-MS is a critical tool for determining Cs transport pathways through these materials. Lastly, distribution coefficients are critical for understanding the transport of Cs in urban settings when direct measurements of its penetration depth are unavailable. An assessment of the newly developed deposition method along with preliminary results from the penetration experiments are presented in this paper.

1 Introduction

The US Environmental Protection Agency (EPA), as a part of the CRTI project team, is currently working to assess the impact of an urban radiological dispersion device (RDD) and to develop containment and decontamination strategies for the recovery process. The physical impact of an RDD in a given area is a function of the explosive design, the radioactive material type, and weather (e.g. rain and wind). The size and shape of the contaminated area is dependent upon the geometry of the area, the device geometry, the size distribution of the RDD particles and the wind conditions after the explosion. Cleanup after an RDD will likely occur weeks to months after the event; therefore the contaminated area will be exposed to a variety of weather conditions (rain,

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Cover Photograph
The M/V Westwood Anette *is shown here at the docks in Squamish, British Columbia after approximately 29,000 L of Bunker C oil leaked from one of the ship's fuel tanks in August 2006. The tank was punctured by a metal piling while the tanker was being towed from the docks. High winds carried the oil into the estuary of the Squamish River. The high sediment content of the water promoted natural cleaning of both the oiled shorelines and marsh grasses.* (Photo: Environment Canada)

Volume 1
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Trente-deuxième Colloque technique de l'AMOP - Contamination de l'environnement et intervention

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Le Colloque technique est commandité par la Section des urgences - Science et technologie, Division des urgences, des laboratories d'analyses opérationnelles et du soutien à la recherche, Direction de la science et de la technologie de l'eau, Direction générale des sciences et de la technologie d'Environnement Canada.

Photographie de couverture
Cette photo montre le M/V Westwood Anette *au port de Squamish en Colombie-Britannique après qu'environ 29 000 L de fioul de propulsion (Bunker C) se sont échappés de l'un de ses réservoirs en août 2006. Une barre de métal a perforé le réservoir alors que le pétrolier se faisait remorquer des quais. Les vents violents ont poussé le fioul jusque dans l'estuaire du fleuve Squamish. La forte teneur en sédiments de l'eau a accéléré le nettoyage naturel des côtes touchées et des foins des marais.* (Photo : Environnement Canada)

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Emergency Response Monitoring of a Benzene Release using the Ministry's Mobile TAGA Unit in Southwestern Ontario

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Abstract

On March 14, 2008 the Ontario Ministry of the Environment (MOE) was notified of an accidental chemical release at a petroleum refinery's distribution centre in Southwestern Ontario. A feed tank containing a benzene mixture suffered a floating roof failure resulting in a direct exposure of benzene to the environment. The specialized services of the Ministry's Environmental Monitoring and Reporting Branch (EMRB) were requested to measure airborne pollutant concentrations while the benzene mixture was transferred to another tank. This paper highlights the services of EMRB during response efforts from March 14 to April 1, 2008. The role of EMRB was to model the relative impact from the benzene release, acquire real-time airborne pollutant concentration data, and provide a geographical representation of benzene levels downwind of the feed tank. The Ministry's mobile trace atmospheric gas analyzer (TAGA) unit performed chemical fingerprints and measured 192 half-hour averages of benzene at 21 different locations downwind of the spill site. The data collected by the mobile TAGA unit was regularly conveyed to the Ministry's Spill Action Centre (SAC), the Ministry's Southwestern Region staff, the community leaders, Environment Canada, Health Canada, and the Medical Officer of Health to support decision making based on the benzene levels observed.

1 Introduction

On March 14, 2008 the MOE received notification of a benzene release at a petroleum refinery's bulk distribution centre in Sarnia, Ontario. The tank containing 3,130 cubic metres (m^3) of a benzene mixture experienced a floating roof failure resulting in a direct exposure to the environment. On March 15th, Ministry staff were notified that the roof had sunk near the bottom of the tank, and a layer of firefighting foam was applied to the surface to mitigate environmental exposure. The tank was located within 2 kilometres (km) of a residential area and a First Nations Reserve, situated in a complex of industries along the St. Clair River bordering Ontario, Canada and Michigan, U.S.A. Benzene, the major component of the mixture, is a highly flammable, volatile hydrocarbon, that is liquid at room temperature (Merck, 2001), and considered a human carcinogen. Due to the highly flammable properties of benzene, Ministry staff had grave concerns of igniting the tank's contents by producing a spark as the tank was drained and the roof lowered to the bottom. Effects of a benzene fire could result in damage to human health and the environment locally, as well as impact the United States due to potential transboundary flow. Rapid response monitoring for benzene was needed to monitor the effectiveness of the foam as the contents were lowered, and if needed, monitor levels of benzene during a worst-case scenario of a chemical fire or explosion. In such cases, the best approach is to bring a mobile air monitoring unit to the areas of concern and conduct real-time air quality analysis and monitoring (Karellas, 2003). Local Ministry staff

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Cover Photograph
Forty years ago in February 1970, the Liberian tanker Arrow *ran aground on Cerberus Rock in Chedabucto Bay, Nova Scotia in heavy rain and high winds. Within days, the* Arrow *broke in half and an estimated 8,000 tonnes of Bunker C oil was released from the tanker. The spill contaminated many kilometres of the Nova Scotia coastline and had long-lasting effects on marine life and local wildlife, as well as the ground fishery and tourist trade on both sides of the bay.*
(Photo: Task Force - Operation Oil)

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Photographie de couverture
Il y a quarante ans, en février 1970, le pétrolier libérien Arrow *s'échoue sur le rocher du Cerbère dans la baie Chédabouctou, en Nouvelle-Écosse, sous une pluie torrentielle et des vents violents. Au bout de quelques jours, l'*Arrow *se rompt en deux et environ 8 000 tonnes de mazout brut se déverse du pétrolier. Ce déversement a contaminé la côte de la Nouvelle-Écosse sur plusieurs kilomètres et a eu des effets à long terme sur la vie marine et la faune de la région ainsi que sur l'industrie de la pêche et du tourisme des deux côtés de la baie.* (Photo : Task Force – Operation Oil)

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Fingerprinting of Oil Hydrocarbons and Biogenic Organic Compounds in Canadian "Background" Soil and Plant Samples (Phase I of the PERD Project: "*Distinguishing and Quantifying Petrogenic and Biogenic Hydrocarbons in Contaminated and Background Soils*")

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Abstract

The ultimate objective of this PERD (Program of Energy Research and Development) project, "*Distinguishing and Quantifying Petrogenic and Biogenic Hydrocarbons in Contaminated and Background Soils*" is to correct the misconception that all detectable hydrocarbons should be regulated as toxic petroleum hydrocarbons (PHCs). This can only be accomplished through improvements to the existing CCME (*Canadian Council of Ministers of the Environment*) PHC protocols and Tier 1 Soil Quality Levels. Our goal is to provide the scientific rationale that would be necessary for creating this significant degree of change.

In the summer of 2008, a total of 34 background soil and 34 plant samples were collected by the Geological Survey of Canada along the Trans-Canada Trail as part of the Tri-national soil chemistry survey program. The samples were collected from the following three provinces: (1) Alberta (AB) – 15 sites; (2) British Columbia (BC) – 10 sites; and (3) Newfoundland (NF) – 9 sites. The Newfoundland samples were collected primarily from peatland habitats that were heavily vegetated by mosses. Most of the Alberta and B.C. samples were collected from silty/sandy fields and forests that were dominated by grasses and shrubs.

Twenty representative samples among these samples were extracted by ALS Laboratory in accordance with the CCME Method and analyzed in the ESTS Oil Research Lab during 2009. A reliable GC-MS method in combination with the derivatization technique developed in this lab was used for identification, characterization, and quantification of various biogenic organic compounds (BOCs), including sterols, fatty acids, and alcohols, and others in these background samples. Both PHCs and BOCs in these samples were quantitatively determined and the quantitation data will be used for assessment of the contamination sites and toxicity risks associated with the CCME Fraction 3 hydrocarbons. The characterization results indicate the following.

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Proceedings
Thirty-fourth AMOP Technical Seminar
on Environmental Contamination and Response

October 4 to 6, 2011
Banff Park Lodge Resort Hotel and Conference Centre
Banff, Alberta, Canada

The Technical Seminar is sponsored by the Emergencies Science and Technology Section, Emergencies, Operational Analytical Laboratories and Research Support Division, Water Science and Technology Directorate, Science and Technology Branch of Environment Canada.

Photographs
On April 20, 2010 the semi-submersible offshore oil drilling rig, the Deepwater Horizon, experienced a deep-sea blowout. The resulting fire could not be extinguished and on April 22 the rig sank into the Gulf of Mexico.
(photo: US Coast Guard)

On July 26, 2010, an estimated 819, 000 gallons of crude oil spilled from the ruptured Enbridge pipeline into Michigan's Talmadge Creek and flowed into the Kalamzoo River.
(photo: Environment Canada)

Compte rendu
Trente-quartrième Colloque technique de l'AMOP -
Contamination de l'environnement et intervention

Du 4 au 6 octobre 2011
Banff Park Lodge Resort Hôtel et Centre de congrès
Banff (Alberta) Canada

Le Colloque technique est commandité par la Section des urgences - Science et technologie, Division des urgences, des laboratoires d'analyses opérationnelles et du soutien à la recherche, Direction de la science et de la technologie de l'eau, Direction générale des sciences et de la technologie d'Environnement Canada.

Photographies
Le 20 avril 2010, la plate-forme pétrolière extracôtière semi-submersible, Deepwater Horizon , a connu une rupture en eaux profondes. L'incendie qui en a résulté n'a pu être éteint et le 22 avril, l'appareil de forage a coulé dans le golfe du Mexique.
(photo : US Coast Guard)
Le 26 juillet 2010, une quantité de pétrole brut évaluée à 819 000 gallons a fui du pipeline rompu d'Enbridge dans le Michigan's Talmadge Creek et a pénétré dans la rivière Kalamazoo. (photo : Environnement Canada)

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