Oil Spill Optimized Contingency and Recovery Techniques Using ADIOS2

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Abstract—The methodology adopted was performed by carrying out a review of existing literature, contacting companies previously involved in recovering oil from water worldwide, holding discussions with operators, this is then applied to ADIOS2 the Automated Data Inquiry for Oil Weathering Model to develop the ideal s Contingency and Recovery Techniques. It is not possible to derive simple generic relationships between petroleum mass loadings and ambient concentrations that can be applied universally. The “fate” (where it goes) and “persistence” (how long it remains in the system) of petroleum in water are controlled by processes that vary considerably in space and time. In a completion of this study we extrapolate that, Most of the existing mechanical recovery equipment was designed to collect oil using its property to adhere to the surface material of the recovery unit. This equipment can efficiently collect oil with certain physicochemical properties at standard conditions and cannot be used with equal competence both in warm and cold waters and on variable oil types and properties. The recovery efficiency significantly changes with time due to the oil slick property changes and emulsion formation. Therefore, multiphase interactions between oil, water, material of recovery unit need to be studied thoroughly due to their strong influence on the oil recovery process.

Index Terms—ADIOS2, oil weathering model, oil spill in water, oil budget.

I. INTRODUCTION

With respect to the appropriate recovery strategies. Failure to consider the properties of the oil, and the specific local environment condition can dramatically reduce the recovery effectiveness and ultimately the success of the most economical and environmental option. All factors must be carefully considered when developing an oil recovery plan.

This study discusses the way to the paramount Oil recovery Options of oil mix in water particularly in waste water facilities in Kuwait and provides environmentally and economically recovery and re-cycle solutions.

II. OFFSHORE ENVIRONMENTAL IMPACT

A number of methods have been used to detect subjection effects of hydrocarbons and other contaminants. In laboratory experiments, exposure of fish to hydrocarbons leads to an elevation of levels of an enzyme, ethoxyresorufin-O-diethylase, (EROD), which breaks down complex organic molecules. This has been used with varying

success to assess the extent to which field populations have been exposed to hydrocarbon contamination [1].

The elevation of EROD concentrations in fish is a response to environmental exposure to hydrocarbons, indicating they are present in concentrations capable of exerting biological effects, but is not in itself indicative of ecological effects. Rather closer to ecological effects are the measurement called ‘Scope for Growth’ [1].

For example, if individual mussels are exposed to contaminants, they may increase their respiration rate and/or decrease their feeding rate, leading to a reduction in surplus energy available for growth. This parameter can be readily measured in the laboratory and if scope for growth is depressed in a field population for a period of time it will be reflected in reduced individual growth rates and therefore in ecological effects. Studies have shown that ‘Scope for Growth’ is reduced throughout much of the southern North Sea, and hydrocarbons have tentatively been identified as one of the causes of this reduction [2].

III. ONSHORE ENVIRONMENTAL IMPACT

The environmental impacts considered on shore from the oil spill are mainly the atmospheric emissions .The main source of emissions onshore will be from the processing.

Biological and chemical processes in landfill sites may cause releases of organic material and nutrient salts to the leach ate. If a failure occurs, such releases may be transported with the (seepage) water to ground water, river systems and fiords. The content of contamination of the leachate varies strongly due to waste content, landfill site age, and management and degradation rate [3].

Three key areas need to be investigated to develop a better understanding of the cause/effect relationship between hydrocarbons and ecological effects in any oil field:

- 1) The actual cause and effects of hydrocarbons environmental impact.
- 2) The relationship between the concentration in sediment and exposure to organisms.
- 3) Oil spill discharges contain a mixture of contaminants and could also have an impact on ecology through physical effects such as smothering and change in sediment grain size.

It is obvious that the Environment impact strongly dependent on the physical and chemical properties of the spilled oil [2].

IV. PHYSICAL PROPERTIES OF OIL

THE TERM OIL describes a broad range of

hydrocarbon-based substances. Hydrocarbons are chemical compounds composed of the elements hydrogen and carbon. This includes substances that are commonly thought of as oils, such as crude oil and refined petroleum products, but it also includes animal fats, vegetable oils, and other non-petroleum oils. Each type of oil has distinct physical and chemical properties. These properties affect the way oil will spread and break down, the hazard it may pose to aquatic and human life, and the likelihood that it will pose a threat to natural and man-made resources [2].

Crude oils can be divided into three broad groups of compounds, which help the responder assess the initial impact and fate of the oil. These groups are very simple.

Based on all the properties of spilled oil, there are three types for which a general assessment of behavior and fate can be made:

- 1) Light-weight components
- 2) Medium-weight components
- 3) Heavy-weight components

We use compositional data on crude oils to characterize them as to the amounts of each group present in the oil, and thus predict the behaviors of the oil and the risk the oil poses to natural resources.

To observe the environment and economical risk we have to understand how oil behaves and act when spill intended for our study spill in water [2].

The rate at which an oil spill spreads will determine its effect on the environment. Most oils tend to spread horizontally into a smooth and slippery surface, called a slick, on top of the water. Factors, which affect the ability of oil spill to spread, include surface tension, specific gravity, and viscosity.

V. PROCESSES THAT AFFECT THE IMPACT OF OIL RELEASES

Oil is a complicated mixture of many components, and when it mix with water the water surface will largely be effected, and this will depends on the initial properties of the oil and composition as well as on specific local environmental conditions. Spreading, evaporation, dispersion, and emulsification can rapidly alter oil properties within several hours, leading to formation of water in oil emulsion. The same type of oil released under different environmental conditions disperses in dramatically different patterns due to the influence of air and sea temperature, wind speed, and weather. Oil dispersal and deterioration can have significant ramifications

A. Weathering

Following an oil spill or any other event that releases crude oil or crude oil products into the marine environment, weathering processes begin immediately to transform the materials into substances with physical and chemical characteristics that differ from the original source material [4].

B. Emulsification

Emulsification is the process of formation of various states of water in oil, often called “chocolate mousse” or “mousse” among oil spill workers [5].

C. Dissolution

Dissolution is the chemical stabilization of oil components in water. Dissolution accounts for only a small portion of oil loss, but it is still considered an important behavior parameter because the soluble components of oil, particularly the smaller aromatic compounds, are more toxic to aquatic species than the aliphatic components. Modeling interest in dissolution is directed at predicting the concentrations of dissolved components in the water column. Most models in existence do not separate the dissolution component. The entrainment model is sometimes used but fails to distinguish between dispersion and dissolution.

D. Oxidation

Oxidation occurs when oil contacts the water and oxygen combines with the oil hydrocarbons to produce water-soluble compounds. This process affects oil slicks mostly around their edges. Thick slicks may only partially oxidize, forming tar balls. These dense, sticky black spheres may linger in the environment, washing up on shorelines long after a spill.

E. Evaporation

Evaporation occurs when the lighter or more volatile substances within the oil mixture become vapors and leave the surface of the water. This process leaves behind the heavier components of the oil, which may undergo further weathering or may sink to the bottom of the ocean floor. Spills of lighter refined products, such as kerosene and gasoline, contain a high proportion of flammable components known as light ends. These may evaporate within a few hours, causing minimal harm to the aquatic environment. Heavier oils, vegetable oils, and animal fats leave a thicker, more viscous residue. These types of oils are less likely to evaporate.

Environmental factors that affect the rate of evaporation are:

- 1) Area of slick exposed, which changes rapidly
- 2) Wind speed and water surface roughness
- 3) Air temperature and solar radiation
- 4) Formation of emulsions, which dramatically slows evaporation

All these factors must be carefully considered when developing an oil spill response plan [2], [6].

VI. OIL WEATHERING MODEL ADIOS2

Clearly, planners and responders need a tool to help estimate realistic release scenarios. In response to this need, a simple model has been developed to estimate the amount of product spilled and the leak rate based on easily obtainable information. The KOC lagoon model is included as a module within the oil-weathering model, ADIOS2.

ADIOS2 is an oil spill response tool to assist oil spill responders and contingency planners in making decisions on potential response strategies. It integrates a library of approximately one thousand oils with a short-term oil weathering and clean-up model to help in developing clean-up strategies based on estimates of the amount of time that spilled oil will remain in the marine environment.

The ADIOS2 oil library was compiled from a number of

different sources, including Environment Canada, the U.S. Department of Energy, and the International Oil Companies [7].

Fig. 1. Waste water facility scenario.

VII. WASTE WATER FACILITY SCENARIO

It was noted that the oil/water separator was feeding wastewater and oil to a small lagoon nearby. This lagoon feeds a larger lagoon. Both lagoons contain crude oil; the initial smaller lagoon contains the highest concentration of crude oil Fig. 1 demonstrates our case.

VIII. SPILL SCENARIO

We will use the information available from tank farm Waste water Facility area in Kuwait, and then we will feed ADIOS2 with all this information. The model will display the predicted property changes and estimated oil budget for a given time as Table I below. All sizes and measurements are given as a guide as know data was taken off site during the visit.

Below we listed our inputs for the above lagoon scenario:

- 1) Oil Type
BURGAN, OIL & GAS
Location = DIVIDED ZONE
Synonyms = none listed
Product Type = Crude
API = 23.3
Pour Point = .20 deg C
Flash Point = unknown
Viscosity = 28.1 cSt at 50 deg C
Adhesion = unknown
Aromatics = unknown
- 2) Wind and Wave Conditions
Wind Speed = 20 mph from 0 degrees

3) Water Properties

Temperature = 35 deg C
Salinity = 15 ppt
Sediment Load = 5 g/m3 (ocean)
Current = 0 mph

4) Release Information

Continuous Release
Time of Release = May 30, 1500 hours
Amount Spilled = 567 bbl
Duration of Release = 4 days

The program provides us with a “best” answer and also calculates possible ranges in the values of estimated spill properties.

5) Spill Scenario – Oil Budget Table

Oil Name = BURGAN, OIL & GAS
API = 23.3 Pour Point = -20 deg C
Wind Speed = constant at 20 mph Wave Height = computed from winds
Water temperature = 35 deg C
Time of Initial Release = May 30, 1500 hours
Total amount of Oil Released = 567 bbl

TABLE I: OIL BUDGET

Hours Into Spill	Released (bbl)	Evaporated (percent)	Dispersed (percent)	Remaining (percent)
1	6	20	1	79
8	47	23	3	74
12	71	25	3	72
16	94	26	3	71
20	118	26	3	71
24	142	27	3	70
28	165	27	3	70
32	189	28	3	69
36	213	28	3	69
40	236	28	3	69
44	260	29	3	68
48	284	29	3	68
52	307	29	3	68
56	331	29	3	67
60	354	30	3	67
64	378	30	3	67
68	402	30	3	66
72	425	31	3	66
76	449	31	3	66
80	473	31	3	66
84	496	31	3	66
88	520	31	3	65
92	543	32	3	65
96	567	32	3	65
100	567	32	3	65
104	567	32	3	64

IX. CONCLUSIONS AND RECOMMENDATIONS

We conclude that, full understanding of the impact of petroleum loadings into the water requires an accurate assessment of the magnitude, spatial extent, and duration of exposure. Because of the incredible diversity of physical environments within the lagoons each case has different assumptions and conclusions for example wind directional changes, variances in crude oil concentrations in the lagoon, oil layer thickness, evaporation etc all have to be taken into account when trying to establish a recovery rate. That's way each lagoon has various recovery coordination. it is not possible to derive simple generic relationships between

petroleum mass loadings and ambient concentrations that can be applied universally. The “fate” (where it goes) and “persistence” (how long it remains in the system) of petroleum in water are controlled by processes that vary considerably in space and time.

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REFERENCES

- [1] J. M. Rotchell, D. J. Bird, and L. C. Newton, *Marine Ecology Progress series*, 1999, vol. 190, pp. 263-270.
- [2] P. Stanislav and E. Cascio, “Environmental impact of the offshore oil and gas industry,” *EcoMonitor Pub*, East North Port, N.Y., 1999.
- [3] D. M. Alongi, *Coastal Ecosystem Processes*, Boca Raton: CRC Press, 1998, pp. 419.
- [4] D. Mackay, “Formation and stability of water in oil emulsions,” Environment Canada Manuscript Report EE-93, Ottawa, Ontario, 1987, pp. 97-99.
- [5] Q.-F. Wei, R. R. Mather, A. M. Fotheringham, R. D. Yang, “Characterization of water-in-crude oil emulsions in oil spill response,” *Journal of Environmental Sciences*, vol. 15, no. 4, pp. 506-509, 2003.
- [6] M. Fingas and B. Fieldhouse, *Studies of Formation Process of Water-in-Oil Emulsions*, Marine pollution bulletin, 2003, vol. 47, no. 9-12, pp. 369-396.
- [7] ADIOS2. Automated data inquiry for oil spills, from NOAA's response and restoration. [Online]. Available: <http://response.restoration.noaa.gov/oil-and-chemical-spills/oil-spills/response-tools/adios.html>

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