OIL SPILL PREVENTION AND REMOVAL HANDBOOK

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FOREWORD

By the very nature of the subject matter covered in this book, its categorization spills over into three fields. Since it deals with cleaning up a dirtied marine environment, it naturally falls into Pollution Technology Review and because it deals with our major energy source among the fossil fuels it most certainly can be considered an Energy Technology Review. It also quite literally spills over into Ocean Technology since the mishaps discussed occur both on ships at sea and at offshore drilling sites.

The book is based mostly on authoritative government reports and U.S. patents. We are fortunate in the United States to be receiving direct help not only from the numerous surveys but also from active research and development programs which are being supported by the Federal government. The book attempts to organize and clarify the many ways and means made available in this literature for the removal of the contaminating oil from both the ocean's surfaces and its beaches.

Here are condensed vital data from government sources of information that are scattered and difficult to pull together. Important processes are interpreted and explained by examples from 320 U.S. patents and 5 foreign patents. One should have to go no further than this condensed information to establish a sound background for action against oil spills.

Advanced composition and production methods developed by Noyes Data are employed to bring new durably bound books to the reader in a minimum of time. Special techniques are used to close the gap between "manuscript" and "completed book." Industrial technology is progressing so rapidly that time-honored, conventional typesetting, binding and shipping methods are no longer suitable. Delays in the conventional book publishing cycle have been bypassed to provide the user with an effective and convenient means of reviewing up-to-date information in depth.

The Table of Contents is organized in such a way as to serve as a subject index and provides easy access to the information contained in this book. Special attention is called to the list of companies producing materials and equipment useful in cleaning up oil spills and contaminated beaches.

15 Reasons Why the U.S. Patent Office Literature Is Important to You —

1. The U.S. patent literature is the largest and most comprehensive collection of technical information in the world. There is more practical commercial process information assembled here than is available from any other source.

2. The technical information obtained from the patent literature is extremely comprehensive; sufficient information must be included to avoid rejection for "insufficient disclosure."

3. The patent literature is a prime source of basic commercially utilizable information. This information is overlooked by those who rely primarily on the periodical journal literature.

4. An important feature of the patent literature is that it can serve to avoid duplication of research and development.

5. Patents, unlike periodical literature, are bound by definition to contain new information, data and ideas.

6. It can serve as a source of new ideas in a different but related field, and may be outside the patent protection offered the original invention.

7. Since claims are narrowly defined, much valuable information is included that may be outside the legal protection afforded by the claims.

8. Patents discuss the difficulties associated with previous research, development or production techniques, and offer a specific method of overcoming problems. This gives clues to current process information that has not been published in periodicals or books.

9. Can aid in process design by providing a selection of alternate techniques. A powerful research and engineering tool.

10. Obtain licenses — many U.S. chemical patents have not been developed commercially.

11. Patents provide an excellent starting point for the next investigator.

12. Frequently, innovations derived from research are first disclosed in the patent literature, prior to coverage in the periodical literature.

13. Patents offer a most valuable method of keeping abreast of latest technologies, serving an individual's own "current awareness" program.

14. Copies of U.S. patents are easily obtained from the U.S. Patent Office at 50¢ a copy.

15. It is a creative source of ideas for those with imagination.

CONTENTS AND SUBJECT INDEX

INTRODUCTION

Oil spills, which have been in the public eye in a big way since the Torrey Canyon accident in 1967 and the Santa Barbara Channel incident of 1969 threaten to be much bigger news. In early 1974, the U.S. Government was considering offering oil leases on the outer continental shelf (OCS) off the Atlantic Coast as part of a ten-fold increase in offshore land open to oil exploration. The expansion from 1 million acres of OCS oil leases to 10 million acres in areas ranging from the U.S. East Coast to the Gulf of Alaska means that much more potential for oil spills from wells and tankers exists.

When this increase in offshore drilling and transport from offshore locations to shore terminals is coupled with the increases in sizes of supertankers and potential disastrous spills from supertanker accidents, one has a problem of monumental proportions. As applied to water quality considerations, the pollutant "oil" can cover a number of types of materials: Petroleum (crude oil), petroleum products (gasoline, diesel fuel, lubricating oils, fuel oils, etc.) and, to a lesser degree, edible materials such as vegetable oils and animal fats. These diverse substances are distinguished by the following characteristics: Mostly organic chemical in composition, mixtures of molecules, mostly insoluble in water, generally lighter than water and liquid or fluid semisolid. Any type of material fulfilling all of these characteristics will certainly be characterized as oil pollution when encountered in the aquatic environment. However, without question, the problem of oil pollution is predominantly petroleum-oriented.

Effective oil spill prevention is the best method for reducing the problem of oil spills. Thorough training programs, properly maintained equipment, adequate alarm systems, strict adherence to industry and governmental codes and regulations, all make essential contributions to the prevention of spills. If despite these preventive measures a spill does occur, it follows that the less oil spilled, the easier the cleanup job and the better for all. In most cases, the action necessary to limit the spill is obvious: close the valve that has been accidentally opened; cease pumping through the ruptured oil line; or repair the leak. If petroleum is escaping from a shoreside facility, use sandbags or throw up a temporary dike to prevent drainage into the water. In the case of a grounded tanker or barge, transfer the oil to another vessel. The proper corrective action is most often obvious, but if not taken promptly, what should be a minor spill may escalate into a major headache.

On May 26, 1967, the President of the United States, Lyndon B. Johnson, directed the Secretary of the Interior and the Secretary of Transportation to examine how the resources of the Nation could best be mobilized against the pollution of water by spills of oil and other hazardous substances. Referring to the Torrey Canyon and Cape Cod incidents earlier that year, the President considered it "imperative that we take prompt action to

prevent similar catastrophes in the future and to insure that the Nation is fully equipped to minimize the threat from such accidents to health, safety, and our natural resources." He asked for a thorough assessment of existing technical and legal resources, and for recommendations toward an effective national and international program. A report was prepared by the Secretary of the Interior and the Secretary of Transportation entitled *Oil Pollution – A Report to the President* which marked a significant point in the attempt to prevent and control oil spills.

The report dealt primarily with water pollution by oil, but where appropriate addressed itself to other hazardous substances as well. It reflected a conviction that the problem of oil pollution must be faced and solved as part of the current general effort to improve the quality of life. Just as the world cannot afford to accept the slow poisoning of its air, or the fouling of its cities and countryside, it cannot abandon to pollution the treasure of its waters and shorelines. Oil in its many forms, oil in vast quantities, is one of the necessities of modern industrial society. Under control, serving its intended purpose, oil is efficient, versatile, productive. Out of control, it can be one of the most devastating substances in the environment. Spilled into water it spreads havoc for miles around.

The destructive characteristics of oil out of control, and the inadequacy of current measures for dealing with it, have never been better illustrated than when the Torrey Canyon, with 119,000 tons of crude oil in her tanks, ran aground and broke up off the Southern coast of England in March 1967. The desperate efforts of the British and French to cope with the tragedy captured the attention and sympathy of people all over the world. Oil spills, large and small, as well as the careless or accidental release of other hazardous materials into the environment, have long been of concern to pollution control authorities. Once an area has been contaminated by oil, the whole character of the environment is changed. Afloat, even a relatively small quantity of oil goes where the water goes. By its nature, oil on water is a seeker. Once it has encountered something solid to cling to, whether it be a beach, a rock, a piling, the feathers of a duck or gull, or a bather's hair, it does not readily let go.

Cleaning up an oil-contaminated area is time-consuming, difficult, costly. To the costs of the cleanup must be added the costs of the oil invasion itself, the destruction of fish and other wildlife, damage to property, contamination of public water supplies, and any number of other material and esthetic losses. Depending on the quantities and kinds of oil involved, these losses may extend for months or years, sometimes for decades, with correspondingly heavy costs of restoring the area to its prior condition. The risks of contamination by oil and other hazardous substances are as numerous and varied as the uses made of the many materials involved and the means of transporting them. These risks involve terminals, waterside chemical and other industrial plants, loading docks, refineries, tankers, freighters, barges, pipelines, tank cars, trucks, filling stations, everywhere that oil is used, stored, or moved. All are subject to mechanical failures compounded by human carelessness and mistakes. There are countless opportunities for oil to get out of control.

The world today is not fully prepared to deal effectively with spills of oil or other hazardous materials, large or small, and much less with a Torrey Canyon type disaster. Because sizable spills are not uncommon, and major spills are an ever-present danger, effective steps must be taken to reduce this vulnerability. All preventive measures cost money. The cost of preventive measures which might be incorporated in ships or industrial establishments or operating equipment must be weighed agains the costs, both tangible and intangible, that arise from disastrous spills. Such cost evaluations may be expected to guide the development of ships and industrial facilities, with effects on their future size and operating characteristics. On the whole, economics and good sense commend an effort to prevent pollution rather than accept the costs of its occurring. For this reason, preventive action is stressed.

In spite of preventive efforts there will still be spills, either due to human carelessness or to calamities beyond human control. For those reasons, attention must always be paid to improved cleanup measures. Present cleanup procedures leave much to be desired and

are often too expensive, too tardy, too ineffective, and too destructive of the marine and land environment. There is room for a great deal of improvement in present techniques, and there is a need for the development of better ones. As suggested by the New England Interstate Water Pollution Control Commission, in the event of any oil spill, the responsible vessel shall be held until responsibility for such a spill is determined, the oil adequately removed and the vessel operator has provided evidence of financial responsibility for such environmental damage as may have occurred.

The oil pollution problem has significant international aspects. First, accidental or deliberate spills which threaten one country's coasts may occur outside the territorial waters of that country. Despite this fact, each country must be able to act quickly against a threat that develops in international waters so that it may take whatever immediate preventive or remedial steps are necessary. Secondly, vessels which discharge oil may be outside the registry of an affected coastal nation and thus not be within the direct and simple application of the nation's laws. For this reason, attention has been given for some years to international cooperation in control of oil pollution. As an example, the Subcommittee on Oil Pollution of the Intergovernmental Maritime Consultative Organization (IMCO) has done continuing work in this field. Through this Subcommittee, IMCO is presently examining a series of proposals which might be adopted internationally to minimize the threat of future spills. Further efforts to reduce oil pollution should include seeking expanded use of international regulation because any other solution would be incomplete. For these reasons, there is need for rapid international action, as well as urgent steps to be taken domestically.

An important factor in any oil spill is the potential fire hazard. Light petroleum products, such as gasoline, benzene, and naphtha, are the most flammable. These lighter petroleum products spread rapidly on water and, because of their high volatility, evaporate quickly. In open water, where no fire hazard is involved, wind and water action are sufficient to disperse the products naturally. Near a tanker, pier, terminal, or other location where the fire danger is serious, spills should be confined and fire-preventive foam spread on the surface of the oil. When the fire hazard no longer exists, the foam and gasoline mixture should be pumped into a suitable container and disposed of in the most appropriate manner. Heavier oil products present a less serious fire hazard, since their higher ignition point makes them difficult to set ablaze. The volatile fractions of crude evaporate and dissolve quickly, and the remaining crude is difficult to ignite. Attempts to burn off crude oil on the open sea, therefore, are usually unsuccessful.

In the course of the preparation of this volume, major dependence has been placed on the report entitled *Control of Oil and Other Hazardous Materials,* a publication of the training program of the Office of Water Programs of the Environmental Protection Agency, published as report PB 213,880 by National Technical Information Services, Springfield, Virginia (December 1971).

HISTORICAL ASPECTS

Petroleum (rock oil) has been known to man for at least six millenia. Earliest known usage was in the vicinity of the oil seeps in the Black and Caspian seas, where oil was employed for some of the same uses it is put to now, viz., cooking, heating, lubrication, road-building, etc. These seepages were regarded as obnoxious by the local populace, suggesting that the concept of aquatic oil pollution is not new. Natural seepages are found throughout the world and are believed to constitute an environmental insult. When compared to the volume of oil contamination resulting from current technological exploitation of petroleum, the estimated quantity of oil introduced into the aquatic environment as a result of natural seepages is relatively minor, however, as outlined in Report LBL-1, Vol 2, *Instrumentation for Environmental Monitoring: Water,* Berkeley, University of California (February 1, 1973).

Early recorded comment on inland oil pollution characterized the Caspian Sea in 1754 as

greatly spoiled due to leakage of oil carried in wooden-hulled ships. Similar problems existed with oil barges on the Volga until stone ballast was added to increase the draft and hence the hydrostatic pressure outside the hull. Contamination of water resources by oily matter, primarily petroleum and its products, is a natural consequence of the exponential growth of the petroleum industry. For example, in 1860, one year after the first successful domestic producing well was established, world petroleum production ran around 0.5 million barrels. A century later it had grown to 7 billion barrels. It has more than doubled in the decade since.

One of the early major domestic oil-spill incidents involved the tanker Santa Rita in San Francisco Bay in 1907. A sizeable spillage of fuel oil cargo was ignited by sparks from a dock locomotive, and the resulting fire endangered nearby shipping. The steady climb in oil pollution levels in the decades to follow appeared not to crystallize public concern until the tanker sinkings along the coast during World War II resulted in beach pollution too serious to ignore. As noted by D.E. Kash et al in *Energy Under the Oceans,* Norman, Oklahoma, The University of Oklahoma Press (1973), the trend is to some combination of imports and drilling on the outer continental shelf (OCS) which will in any event give rise to the vastly increased possibility of oil spills over what would be the case for primarily domestic production.

In 1970, imports provided 12% of U.S. energy supply. The possible range of imports in 1985 is extreme. In the lowest demand-highest domestic production situation, imports would represent only 3 to 4% of supply. In the highest demand-lowest domestic production situation, imports would supply approximately 40% of domestic energy. The most likely situation is that imports will supply between 20 and 28% of U.S. total energy. This is between 9 and 14 million barrels of oil per day and between 3.2 and 3.9 trillion cubic feet of gas per year.

Although state-controlled offshore lands hold promise for increased production, their percentage of 1985 domestic production is much less significant than the OCS. Development in these areas may be difficult also because of local opposition. The OCS is likely to contribute the major portion of the oil and gas produced offshore in 1985. Thus considerable emphasis has been placed in this volume on prevention and control of oil spills from offshore production.

Continued development of OCS oil and gas will thus take place within the context of continuing demands for environmental quality. OCS oil and gas operations appear to be identified in the minds of many citizens with the environmental concerns generated in the late sixties and early seventies. Union's blowout at Santa Barbara is repeatedly mentioned as a major catalyst for the environmental movement and therefore as a major turning point for public policy. (Although referred to as "Union's blowout," Union Oil Company had three partners: Gulf, Mobil, and Texaco.) In California, for example, the moratorium on leasing state offshore lands imposed after Santa Barbara is still in effect; and on November 7, 1972, California voters passed Proposition 20, the Coastal Zone Conservation Act. This Act established a statewide Coastal Zone Conservation Commission and six regional Commissions to oversee a state plan for the preservation, protection, restoration, and enhancement of the environment and ecology of the coastal zone.

However, plans for OCS operations all along the Atlantic Coast from Maine to Florida and in the Gulf of Alaska are proceeding as described in a comprehensive report by the Council on Environmental Quality entitled *OCS Oil and Gas – An Environmental Appraisal,* Washington, D.C. (April 18, 1974).

THE MAGNITUDE OF THE PROBLEM

Petroleum in its many forms has been on the move in the United States since 1859 when the first commercially successful oil well was developed in Pennsylvania. First transported by wagon and log raft, oil is now en route from the oil field to refinery to consumer by pipe, water, rail and highway. During 1970 more than 4.5 billion barrels of petroleum