AN OVERVIEW OF US AND INTERNATIONAL REGULATIONS REGARDING HYDROCARBONS IN WATER EFFLUENTS

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ABSTRACT

The amount of hydrocarbons allowed in industrial and stormwater effluents varies greatly from one locality to another or from one country to another. Some countries mandate hardware solutions to the effluent problem, while others stipulate a specific allowable concentration.

This paper will present the regulations governing effluents in many countries and states and localities within the US, as well as offer discussions of some of the hardware systems required by various jurisdictions.

Comments are also included concerning the possible future course of these regulations.

Keywords: US, International, regulations, hydrocarbons, water, effluent

INTRODUCTION

Natural hydrocarbons have been seeping into water for millennia. The Greek historian Herodotus reported petroleum and tar as early as 450 BC (Nelson). Laws noted that natural gas from the Kirkuk oil field in Iraq has been burning since biblical days, and that reports of oil seeps in the ocean off Coal Oil Point in California were noted as early as 1629.

Kerosene distilled from coal was patented in the US in 1854 as an inexpensive alternative to whale oil (Fuel Ethanol), and it was subsequently found that it could more easily be refined from crude oil. Hydrocarbons in the environment did not present much of a problem until the advent of the automobile as a major mode of transportation because petroleum was of little use, except as a lubricant and a replacement for whale oil in oil lamps. Eventually, kerosene, lubricating oils, and gasoline from petroleum became major industrial products and subsequently began entering the environment in larger quantities. Today, many freshwater systems are polluted with hydrocarbons. The largest single source of hydrocarbon discharge to the oceans is river runoff (Laws).

Because there are differing engineering and legal opinions about the effects of oil in the environment, substantially different legal requirements have been enacted in different countries. Local conditions and environmental conditions can also have an effect on legal requirements within countries.

WHAT IS OIL AND WHY IS IT A PROBLEM?

Crude oil is a variety of complex hydrocarbon substances composed of thousands of different kinds of molecules. Crude oil from different fields can have varying properties. Some light crudes have specific gravities as low as 0.85, while others have specific gravities up to 1.15 (Nelson). Crudes may contain mostly alkanes, alkenes, aromatic compounds, or asphaltic compounds. Most contain mixtures of one or more of these types. Refined products have an even greater range of properties than crude oils because many have molecular structures not commonly found in nature.

Gasolines are composed mainly of aliphatic compounds and aromatic compounds (Nelson). Oxygenates, such as methyltertiarybutyl ether (MTBE) and ethanol in percentages of up to fifteen percent (15%), are also used. Aliphatics also predominate in kerosene, diesel fuel, and jet fuel.

In addition to the petroleum related compounds, vegetable oils and animal fats are also considered to be oils (Romano). Since these are generally biodegradable, they are usually not considered a problem unless they are present in very large quantities (a substantial vegetable oil spill in Vancouver, Canada harbor in 1999 killed about 2000 waterfowl (Environmental News Service)). For purposes of this discussion, the term oil will be taken to mean petroleum-based hydrocarbons.

Toxic effects of oil fall into two categories (Laws):

1) Effects due to smothering or coating of an animal or plant with the oil. These coating effects are most often associated with crude oil and primarily impact sea birds and some sea animals, such as sea otters, seals, etc. Coating effects are most noticeable when large amounts of free oil are present, as in an oil spill. Coating effects are not usually found when only parts per million (ppm) are present, as is the case in an industrial plant effluent.

2) Disruption of the animal or plant's metabolism due to the ingestion of the oil and incorporation of the oil into the organism's fatty tissues. It is now thought that aromatic hydrocarbons are the most toxic, followed by cycloalkanes, olefins (alkenes), and lastly alkanes (Laws).

Benzene, one of the aromatic components of gasoline, is known to be carcinogenic. Some other gasoline components, notably toluene, ethyl benzene, and xylenes are also aromatic compounds. Some other hydrocarbon based chemicals, notably Polychlorinated Biphenyls (PCBs), are aromatics and also known to be carcinogenic. Generally, hydrocarbons are not soluble in water. Some hydrocarbons do have a small solubility in water and unfortunately the lighter, more water soluble hydrocarbons have a tendency to be more toxic than the heavier, less soluble ones (Laws).

THE POTENTIAL SOURCES OF OIL IN WATER

Many possible sources of oil in water exist. Ignoring natural seeps, these can be divided into five general categories (Laws):

1) Industrial continuous sources
2) Industrial spills
3) Oil spills
4) Urban runoff
5) Domestic/Miscellaneous sources

Industrial continuous sources are the easiest to deal with as they are generally "point sources", have generally constant flow, and constant oil content. These sources, such as refinery water outfalls, are often large sources of hydrocarbons. Point sources can be dealt with either by installation of oil-water separators or by elimination of individual sources of oil within the refinery or other industrial plant. From a regulatory standpoint, "oil and grease" content of these sources are regulated in the US under the National Pollutant Discharge Elimination System (NPDES) program. Industrial spills are likewise a problem that is relatively easy to deal with because it is possible to predict where spills may originate, and to take preventative measures to capture spills before they enter the environment.

Spills from oil tanker accidents, such as the *Exxon Valdez* disaster, have the potential of being very damaging and various plans have been advanced to safeguard against such problems. Spills from oil wells, especially onshore ones, have become infrequent due to increased efforts to alleviate this problem (Green).

Urban runoff water is primarily caused by stormwater from streets and highways. Hydrocarbons in this water include primarily gasoline fractions, diesel fuel, and automotive and truck crankcase oil leaks. Of these, crankcase lubricating oil predominates in runoff water (Romano). A study has shown (Hunter), that runoff water from highways can contain an order of magnitude more hydrocarbons than runoff from other urban areas. Most of the hydrocarbons in runoff are associated with particulate matter. This indicates that separators designed to deal with stormwater should also be designed to handle the associated solids, and that the design of the separator should be based on the composite specific gravity of the oily solids. Hunter, et al. indicated that roughly 30% of the hydrocarbons in runoff are aromatic, while the balance is aliphatic.

Domestic/Miscellaneous sources are much harder to eliminate as they are so diverse. These sources of oil include (Romano), (Green), and (Stenstrom):

1) Non-highway leaks from vehicles, especially crankcase oils
2) Illicit dumping of used motor oil into storm drains
3) Discharges from motorboat exhaust and leaks from boats
4) Industrial wash downs - machine wash downs

US LAWS AND REGULATIONS

Oil in water discharges from industrial and other facilities are governed by a variety of federal, state and local laws. Included are the Clean Water Act (CWA) and its amendments, the Oil Pollution Act of 1990, the Coastal Zone Management Act and others (Laws).

In 1965, a United States District Court found that an accidental discharge of aviation gasoline into navigable waters did not constitute a violation of the Rivers and Harbors Act of 1899 because gasoline “was not such as to impede navigation”. A few years later, in 1973, the United States Supreme Court ruled that the Congress did intend the regulation of pollutants under both the Rivers and Harbors Act and the Clean Water Act (United States Supreme Court).

The basic law covering discharges is now the CWA. It was originally enacted as the Federal Water Pollution Control Act of 1972, but was amended extensively in 1977. The 1977 amendments, in conjunction with the earlier legislation, became known as the Clean Water Act. Under the terms of this Act, amended Section 402 created the National Pollutant Discharge Elimination System (NPDES) permit system. Permits for point sources under this system are granted by the United States Environmental Protection Agency (EPA) or by states with EPA approved programs. Any discharges other than those allowed by permit are illegal.

Although the Clean Water Act was enacted primarily to control discharges from sanitary sewer plants and toxic discharges from industrial plants, it also governs other discharges of water containing petroleum and other hydrocarbons into the waters of the United States.

Administration of permits granted under the NPDES program is generally by the various

state environmental agencies under the supervision of the EPA. Most states and localities require discharges to contain 15 ppm or less oil and grease, based on a 24-hour composite sample. This requirement is based on the CWA requirement for “no sheen” and an EPA study defining sheen (Horenstein). Oil and grease may include petroleum hydrocarbons, as well as animal and vegetable oils. Some localities have established lower discharge limits. King County, Washington, which includes the Seattle area, requires discharges to be less than 10 ppm (Romano).

In addition to the regulating outfalls from the process sewers, the Clean Water Act required the EPA to set up a stormwater management program to manage the stormwater discharge from industrial and construction sites under NPDES permits. This includes sites that have any rainwater effluent from outdoor storage of either raw materials or finished goods. Included in individual permit applications are quantitative requirements for “Oil and Grease”, TSS, COD, pH, BOD, total phosphorous, TKN, and nitrate, plus nitrite nitrogen. Sampling for contaminants is mandated, and samples must be collected from the discharge resulting from a storm greater than 0.1 inch, and at least 72 hours from the latest measurable storm event (Chieu). All US refineries and chemical plants have NPDES permit requirements they must meet to remain in operation.

In 1990, the EPA published a set of stormwater management rules (US Environmental Protection Agency). The reasoning behind stringent regulation of stormwater is included in the "National Water Quality Inventory, 1988 Report to Congress", as discussed in the Federal Register (US Environmental Protection Agency). This report concludes that "pollution from diffuse sources, such as runoff from agricultural, urban areas, construction sites, land disposal, and resource extraction is cited by the States as the leading cause of water quality impairment." These diffuse sources are becoming comparatively more important as discharges of industrial process wastewater and municipal sewage plants are decreased by additional controls.

Stormwater discharges were covered under the CWA but not required to have permits under the NPDES system until the final rules were published in the Federal Register, November 16, 1990. "Stormwater discharges" refer to discharges consisting entirely of rainwater runoff, snowmelt runoff, or surface runoff and drainage. Waters that do not meet this definition are not covered by these regulations. The new rules specify that facilities with stormwater discharges from "areas containing raw materials, intermediate products, finished products, by-product, or waste product located on site" will require a NPDES permit. Several different facilities are specifically exempt from these regulations, notably stormwater runoff from mining operations, oil and gas exploration, production, processing, or treatment operations, and parking lots, whose rainwater sewers are not interconnected with manufacturing facility sewers.

In the US, some organizations, such as the American Society for Testing and Materials (ASTM) and Underwriters’ Laboratories (UL), which do not have the force of law, have proposed testing standards for the performance of separators processing stormwater flows. These standards are not yet in general use, but some testing for performance certification has been done to the preliminary standards. The California state Environmental Protection Agency is also considering a certification program for this

type equipment.

INTERNATIONAL MARINE LAW – THE INTERNATIONAL MARINE ORGANIZATION

The International Marine Organization (IMO) regulations govern the discharge of bilge water from ships in international waters. These regulations require all ships over 400 tons, gross tonnage, to be equipped with a bilge water separator that has passed the IMO mandated performance test and approved by one or more of the world's regulatory authorities (International Marine Organization, 1992). In many countries, including the US and Canada, the regulatory body is the Coast Guard. In other countries, it may be the maritime administration or Navy.

The IMO performance test is detailed in IMO Resolution MEPC.60 (33), adopted in 1992. Separators must be tested with test oils of two specific gravities: either 0.83 and 0.94 or 0.83 and 0.98. If the separator is not tested with the 0.98 oil, it may not be used on ships utilizing heavy fuel oils. The inlet oil concentration is varied from 0% to 100% and nine effluent samples are taken during the course of each test run. All samples must be analyzed and all effluent analyses must be equal to or less than 15 mg/L. The test must be witnessed by an independent certifying body. The US Coast Guard issues Certificates of Approval based on the test results. In the US, the independent certifying body is usually the National Sanitary Foundation (NSF). Other certifying bodies are Germanischer Lloyd and Bureau Veritas.

Ships equipped with bilge water separators must also be able to operate them properly. In 1998 and 1999, Royal Caribbean Cruises was fined a total of $27 Million by the US Coast Guard for pumping bilges without the use of a separator, and falsifying logs to conceal the illegal acts (Environmental News Service).

EUROPEAN REGULATIONS

The various governments of the European community have enacted different legal requirements for discharge of oil in water over the years, but recently the European Committee for Standardization (CEN) has been working on a unified standard for separator systems for oil and petrol (European Committee for Standardization Draft Pren). This standard, in two parts, EN 858-1 and EN 858-2, is currently (early 2000) in draft form.

Two classes of separators are recognized by this standard:

I) Separators for processing rainwater where discharge is to surface water. This class requires an effluent quality of 5 mg/L or less. These may also be used for some industrial discharges to sewer systems.

II) Separators for processing industrial streams or rainwater to sewer systems. This class requires an effluent quality of 100 mg/L or less.

The EN 858 regulation requires maintenance at least every 6 months, including measurement of sludge volume and accumulated light liquids, and removal as required.

CANDADIAN REGULATIONS

No federal regulations concerning hydrocarbon discharges from land-based equipment into Canadian waters are in force, but the Fisheries act is often referenced concerning these discharges because it states that “no one shall throw overboard ballast, coal ashes, stones or other prejudicial or deleterious substances in any river, harbor, or roadstead, or in any water where fishing is carried on (Government of Canada 1978). This means that almost all waters are considered frequented by fish, because to avoid this designation, it must be proved that “at all times material to the proceedings the water is not, has not been, and is not likely to be frequented in fact by fish.” (Government of Canada 1978) These Fisheries act statements are often interpreted to mean a hydrocarbon discharge of less than 10 mg/L.

The Canadian Council of Ministers of the Environment does offer a recommended practice (Canadian Council of Ministers of the Environment), which requires stormwater runoff water to be treated to 15 mg/L or less.

For shipping, Canadian marine regulations are similar to other countries for ocean-going ships, requiring the discharges to meet the IMO 15 mg/L or less regulation. For inland waters of Canada, however, the discharges must meet 5 mg/L or less (Government of Canada 1993).

SOUTH AMERICAN REGULATIONS

In many of the countries in South America, environmental regulations are becoming more stringent and enforcement is becoming stricter. In Ecuador, the environmental law concerning oil operations (MTBE in Gasoline) limits the discharge of oil and grease in water to a maximum of 15 mg/L for exploration, production, refineries, and transportation facilities. In Colombia, the regulations are similar, with discharges also limited to 10 mg/L or less for effluent to the ocean (Baldwin).

SUMMARY AND CONCLUSIONS

Governments around the world have been working to protect the environment by enacting and enforcing laws regarding hydrocarbon discharges. Substantial progress has been made in the prevention of spills on land, as well as avoiding tanker spills. Studies are being conducted to determine how much oil is present in stormwater and in characterizing the types of oil present, as well as in determining the damage done by the oil to the environment.

Progress is also being made in defining the performance of equipment designed to remove hydrocarbons from water streams before disposal, and in setting standards for performance.

Enforcement actions are getting stronger as well, as evidenced by the Royal Caribbean Cruises fines.

It seems likely that in the future there will be more agreement on the requirements for hydrocarbon content allowable in industrial wastewater and stormwater, and that equipment to remove the hydrocarbons will be tested and certified by either governmental or other approving bodies, such as UL. This combination should lead to better protection of the bodies of water of the planet from contamination by hydrocarbons.

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