THE DISPOSAL OF SPILLED OILS AND SORBENT MATERIALS

By

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THE DISPOSAL OF SPILLED OILS AND SORBANT MATERIALS

By

Michael T. Jones

May 2001

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This report is intended to provide guidance and methods for the proper disposal of spilled used oils, crude oils, their associated sorbant materials and oil soaked debris. The impact of an oil spill on the environment has far reaching consequences. The management of oil should be given the highest priority. Many steps have been taken in the development of oil management and disposal regulations and contingency planning, each of which greatly aides in the proper handling and disposal of oil.

It is imperative that all oil is disposed of properly, to avoid damaging the environment. Recycling and the reuse of oil are the preferred methods of disposal. However, it is often necessary to burn, deep well inject or landfill some oil. When this is the case, it is imperative that all

pertaining regulations are followed for the proper disposal. It is only through careful oil management and spill prevention that the true rewards of a clean environment can be achieved.

Chapter One

Introduction

Each year, millions of gallons of used oils are improperly disposed of in landfills, on land or dumped down storm drains. Each year, millions of gallons of oil are spilled into the United States waters or on the land. To clean up these spills, millions of pounds of sorbent materials are generated and must be disposed of properly. The improper disposal of used oils, spilled crude oils, and their associated sorbent materials is causing irreparable damage to the environment and can adversely affect human health (1).

Used oil is defined as, "any oil that has been refined from crude oil, or any synthetic oil that has been used and as a result of such use is contaminated by physical or chemical impurities."(2) To be a used oil, the oil must first be derived from crude oil or a manufactured synthetic oil. Second, the oil must have been used in some kind of process (i.e. used in an engine, or lubricant, etc). Finally, to be a used oil, the oil must be contaminated with some kind of impurities (i.e. soil, metals or chemicals, etc).

A crude oil is defined as a mixture of hydrocarbons that is in a liquid phase in natural underground reservoirs and has not been refined.(3) Crude oils are complex with variable mixtures of hydrocarbons which have different molecular weights and structures and can contain more that 300 different compounds.(4)

A sorbent is a material used to soak up liquids. Sorbents recover oil or other hazardous liquids on land or water. There are three basic typed of sorbents; natural organic, inorganic and synthetic. Sorbents are not the primary clean-up technique for large spills, but are used mainly for the final clean-up or for small spills. The overuse of sorbents can generate large disposal problems.

In the U.S., nearly 1.4 billion gallons of used oils are produced each year according to the Environmental Protection Agency. Only 925 million gallons of the 1.4 billion gallons produced, is recycled by commercial and Do-It-Yourself oil changers.(5) That leaves 475 million gallons or 34% of the used oil produced unaccounted for in the United States. Most of the unaccounted oil is improperly disposed of in landfills, dumped on the land or dumped into storm sewers! In 1999, over 7.1 million gallons of crude oil was spilled.(6) The majority of oil spilled is collected and recycled or burned. However, millions of pounds of sorbents and oil-soaked debris is generated for disposal!

When used oils, spilled oils or used sorbents are improperly disposed of or spilled on land, the oils eventually seep into the open waters or the groundwater and spread away from their initial contact site, making it harder to clean up the environment. It exposes plants and animals (including humans) to greater risks of pollution. The greatest danger from inland oil contamination is the pollution of our drinking waters. When oils or oil products are spilled or disposed of in the open seas, there is a very small environmental impact, because the oil is dispersed over a vast area quickly and the volatile hydrocarbons in oil, such as benzene and toluene, evaporate quickly.(1) This does not mean oil spills at sea need not be cleaned up. On the contrary, all oil spills, regardless of their location, must be contained and cleaned up to minimize the contamination and harm to the environment. Ultimately, oils spilled or disposed of at sea reach land where significant damage to marine life, waterfowl, aquatic food supplies, corals, beaches and drinking water supplies occur.

The proper management of used oils, recovered spilled crude oils and oil-contaminated sorbents is important for four reasons: 1) to protect the environment 2) to protect human health 3) to protect against the liability of damages to environment 4) to reuse, not waste, valuable resources.

Although most used oil and oil sorbents are not classified as hazardous wastes under the Resource Conservation Recovery Act (RCRA), they can harm the environment if disposed of improperly.(7) Just one gallon of oil can make one million gallons of fresh water unfit for human consumption.(2) It takes only 50 to 100 ppm of oil to foul the sewage treatment process if it is dumped down a sewer drain.(2) An oil film on a water surface prevents oxygen from entering the water and blocks sunlight, which makes it difficult for fish to breathe and for photosynthesis to take place in aquatic plants. Thus killing the plants and fish in the polluted water.

The improper disposal of oil or oil contaminated products can affect human health because most oil contains small amounts of carcinogens which could be inhaled or ingested.(2) Therefore, to prevent pollution of the air and drinking water sources, proper burning techniques coupled with recycling and landfill disposal practices must be utilized.

The Comprehensive Environmental Response Compensation and Liability Act (CERCLA), passed in 1980, allows the federal government to hold any party that creates or contributes to the creation of a hazardous waste site financially responsible for clean-up costs and possible fines.(8) As used oil is exempted as a hazardous waste only if it is being recycled, oil that is improperly disposed of would be considered hazardous and would then also fall under RCRA liability.(7)

The proper disposal of oil is important to limit liability costs and fines.

Used oil, recovered crude oil and oil-soaked sorbents are a very valuable resource because they have significant heat and lubricant values. Crude oils can even be used for their original intended processing, once water and deleterious materials are removed. Just two gallons of used oil can generate enough electricity to run a household for 24 hours.(9) It takes 50 to 85 percent less energy to re-refine used oil than to refine crude oil.(2) So we can see, the proper disposal of used oils, recovered spilled crude oils, and oil-contaminated sorbents is important and must be a primary concern for the protection of the environment and for human health.

Chapter Two

Federal Regulations

There are a number of Federal Regulations, along with State Regulations, which govern the recovery and disposal of used oils and spilled crude oils. A brief description and the effects of the applicable Federal Regulations are as follows:

- 40 Code of Federal Regulations (CFR) 279, "Standards for the Management of Used Oil", sets the standards to manage used oil and excludes used oil from being characterized as hazardous by 40 CFR 261, based on the presumption that the used oil is to be recycled. This section also sets forth constituent standards for the burning of used oils. The Used Oil Management Standards were set up to encourage the recycling of used oils. The regulations also prohibited the practice of road oiling and the mixing of hazardous wastes with used oils. However, if the oil is to be disposed of, not recycled, it falls under the Subtitle C RCRA regulations of a hazardous waste if it is determined to be hazardous. Some states, including Florida, have even more stringent regulations that require all used oil be treated as hazardous when being disposed and not recycled.(10)
- 33 United States Code (USC) 2702 to 2761, "Oil Pollution Act of 1990", streamlined and strengthened the EPA's

ability to prevent and respond to oil spills and required the development of Area Contingency Plans for oil spill response.(11)

- 40 CFR 110, "Discharge of Oil", describes discharges of oil which has been determined to be harmful to the public health or welfare of the environment.(12)
- 40 CFR 112, "Oil Pollution Prevention", establishes procedures, methods, equipment and other requirements to prevent the discharge of oil, including the requirement for all owners or operators of onshore or offshore facilities that could reasonably expect to discharge oils to prepare a Spill Prevention Control and Countermeasure Plan.(13)
- 40 CFR 261, "Hazardous Waste Identification", identifies contaminants which, when mixed with oils, may cause oils to be handled as hazardous materials.(14)
- 40 CFR 300, "National Oil and Hazardous Substances Pollution Contingency Plan", provides the organizational structure and procedures to be used in preparing for and responding to discharges of oil.(15)
- 40 CFR 307, "Comprehensive Environmental Response, Compensation and Liabilities Act (CERCLA) Claims Procedures", allows the Federal Government to hold any

Party who generates a hazardous waste responsible for the cleanup of a hazardous waste site.(8)

Chapter Three

Oil Disposal Evaluation Steps

The oil disposal evaluation steps are provided to assist in the determination of how to properly dispose of an oil. For the purpose of this evaluation, the term "oil" refers to a used oil, recovered spilled oil, used sorbents, oil-soaked debris, or oiled animal carcasses. Figure 1, provides a flow chart for the steps.

- Step 1) Oiled animal carcasses are to be turned over to the appropriate State Department of Fish and Game, or other designated representatives, who are responsible for wildlife rehabilitation and collection of carcasses.(9,16)

- Step 2) Is the oil known to have been mixed with a listed hazardous waste?

  Yes- treat as a hazardous waste regardless of halogen levels. Go to Federal Criteria Waste Evaluation Steps.

  No- go to step 3.

- Step 3) Used sorbents and oil-soaked debris.

  Used sorbents - remove the oil from the sorbent. Removed oils go to step 4. The sorbents, if reusable, can be reused. If not, sorbents go to step 5).

  Oil-soaked debris - if possible, remove the oil. Removed oils go to step 4. The debris goes to step 5.

- Step 4) If the oil is a crude oil, can it be shipped to and accepted by a refinery and refined?

  Yes- ship to refinery.

  No- treat as a used oil, go to step 5.

Note: Oil recovered at sea typically contains a lot of sea water. The U.S. Coast Guard can authorize the discharge of separated/decanted water back into the containing area of a boom or skimming system outside some state waters (three miles out). The exception to this is in NOAA Marine Sanctuary waters.(16)

- Step 5) Will the oil, sorbents or debris be recycled or burned?

  Recycled- go to step 6.

  Burned- go to step 7.

- Step 6) Is the used oil specification used oil or off-specification used oil for recycling (40 CFR 279.53)? Determine the total halogens using a total halogen test. If the total halogen is less that 1000 ppm, the oil is specification and can be recycled. If the total halogen is greater than 1000 ppm, go to Federal Criteria Waste Evaluation.(10)

- Step 7) To burn used oil is the used oil, specification used oil, or off-specification used oil? The objective test known as rebuttable presumption is used. A total halogen test is performed and the results compared to 40 CFR 279.11 table 1.(10)

- Specification used oil can be burned unrestricted.
- Off-specification used oil can only be burned if the facility is a licensed hazardous waste burner (40 CFR 279, subpart G) or disposed of as a hazardous waste, go to Federal Criteria Waste Evaluation.(10)

Constituent/Property	Allowable Level
Arsenic	5 ppm maximum
Cadmium	2 ppm maximum
Chromium	10 ppm maximum
Lead	100 ppm maximum
Flash Point	100 degrees F minimum
Total Halogens	4000 ppm maximum

Table 1. 40 CFR 279.11 Used Oil Specifications for Burning

The test of rebuttable presumption may be refuted by demonstrating, through analysis, that the used oil was not mixed with a listed hazardous waste. The EPA recommends that an analytical method from and EPA publication (EPA/SW-846) entitled "Test Methods for Evaluating Solid Waste", third edition, be used.(2)

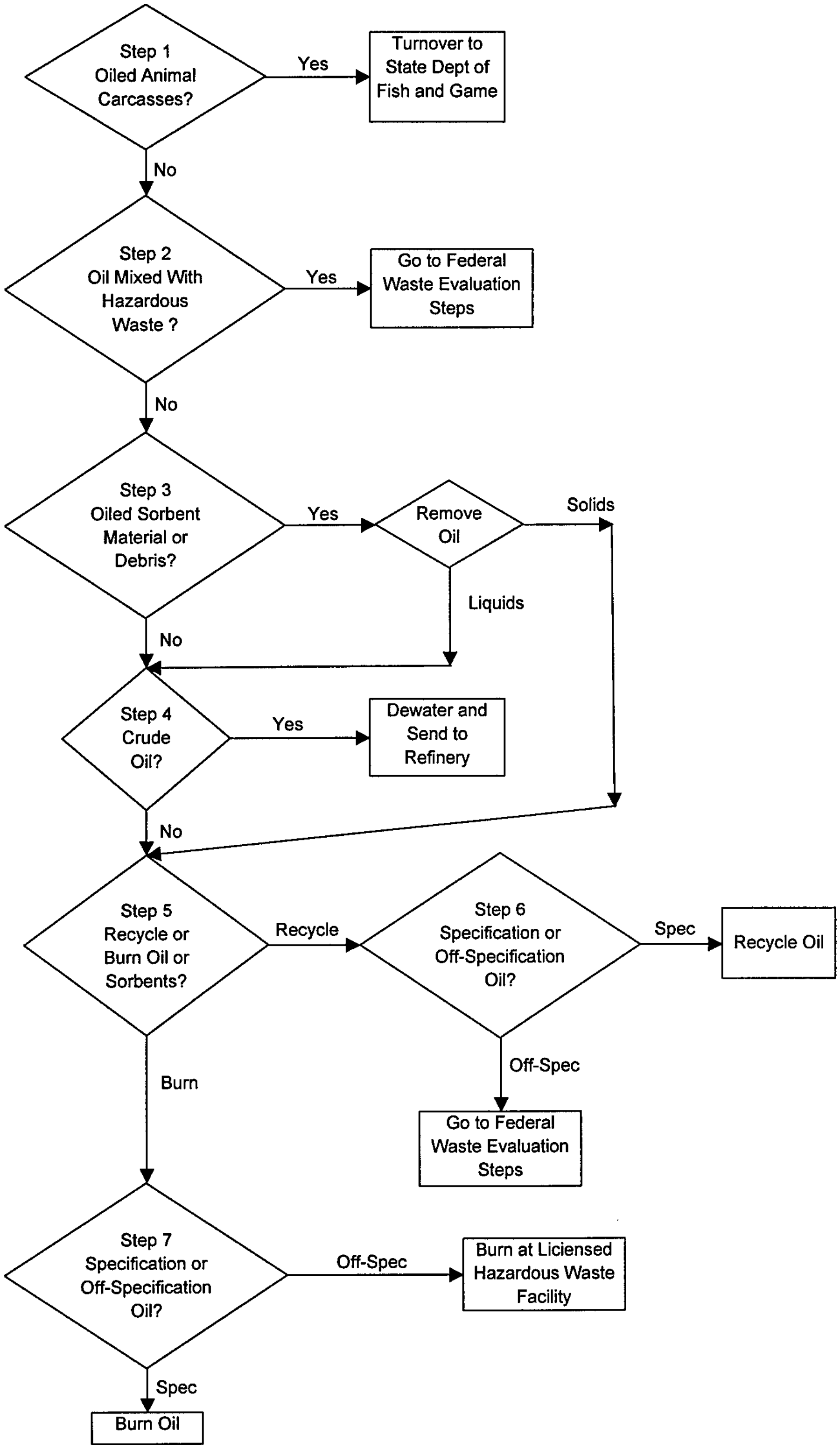


Figure 1. Oil Disposal Flow Chart

Chapter Four

Federal Criteria Waste Evaluation Steps

The Federal Criteria Waste Evaluation Steps are provided to assist in the determination of how to dispose of hazardous and non-hazardous solid wastes. A flow chart of the steps is provided as Figure 2.

- Step 1) Is the Material a Solid Waste (40 CFR 261.2)? A solid waste is an abandoned, recycled or inherently waste-like material (i.e. discarded). Note: Used oils and recovered spilled crude oils are covered by 40 CFR 279, go to Oil Disposal Evaluation Steps.(10)

  Yes- Go to Step 2

  No- Go to Step 6

- Step 2) Is the Waste Excluded from Being a Solid Waste (40 CFR 261.4)?(14)

  Yes- Go to Step 6

  No- Go to Step 3

- Step 3) Is the Waste a Listed Hazardous Waste (40 CFR 261.30-33)?(14)

  - Wastes from Non-Specific Sources (F list)
  - Wastes from Specific Sources (K list)
  - Discarded Commercial Chemical Products (P and U lists)

Yes- Dispose as hazardous solid waste (type C landfill, incineration, deep well injection).

No- Non-hazardous waste, go to Step 4.

- Step 4) Is the Waste a Characteristic Hazardous Waste (40 CFR 261.20-24)?(14)
  - ❑ Ignitability: Liquid (other than aqueous with <24% alcohol) with flashpoint <140 degree F; non-liquid which can cause fire and when ignited, burns persistently and vigorously; Flammable Compressed Gas (49 CFR 173.300(b)); Oxidizer (49 CFR 173.151)
  - ❑ Corrosivity: Aqueous liquid with pH <2 or >12.5; liquid that corrodes steel >6.35 mm/yr at 55 degrees F
  - ❑ Reactivity: Normally unstable; reacts violently; explosive mixtures; generates toxic gases; contains cyanides or sulfides; detonates or explodes
  - ❑ Toxicity: Forty contaminants are listed in table 1 of 40 CFR 261.(14) Samples are compared to the regulatory limits after a Toxicity Characteristic Leaching Procedure (TCLP) test is run.

  Yes- Hazardous Solid Waste, go to Step 5.

  No- Non-hazardous Solid Waste, go to Step 6.

- Step 5) Can the hazardous waste be de-characterized?

  Yes- De-characterize waste, then go to Step 6.

No- Dispose as hazardous solid waste (type C landfill, incineration, deep well injection).

- Step 6) Non-Hazardous Solid Waste-is it covered under a specific State or Federal rule (medical waste, radioactive waste, etc.)?

  Yes- manage according to appropriate rule, last option is to dispose of at a Class C Hazardous Waste Landfill.

  No- go to Step 7.

- Step 7) Recycle waste - Done.

  Landfill waste - go to Step 8.

- Step 8) Conduct Synthetic Precipitation Leaching Procedure (SPLP) test, will the waste leach?(14)

  Yes- Dispose in lined landfill, done.

  No- Possible disposal in unlined landfill, done.

Note: Governing states may have their own, more stringent regulations, concerning the handling of, and definitions of a hazardous waste.

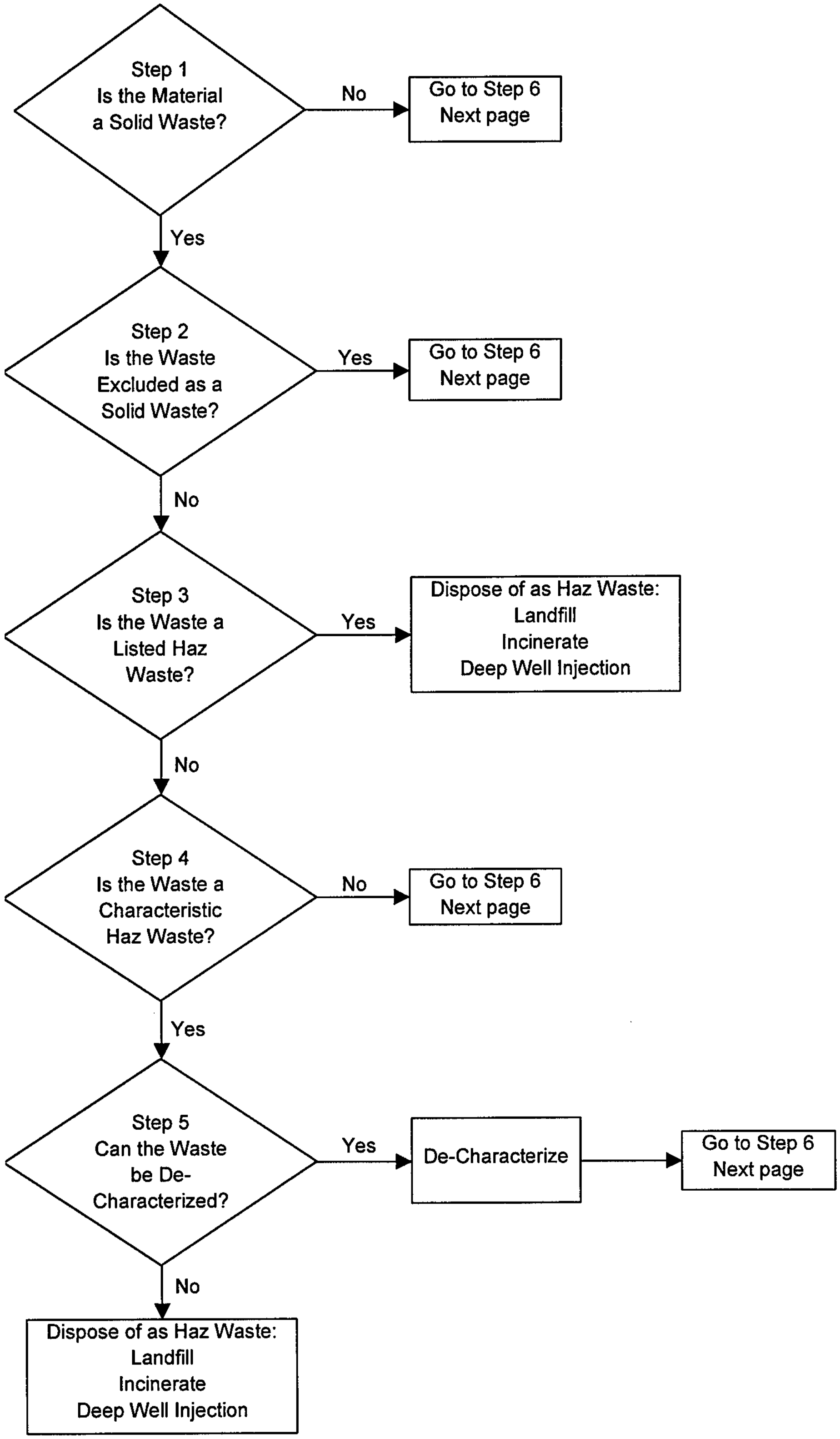


Figure 2. Federal Criteria Waste Evaluation Flow Chart

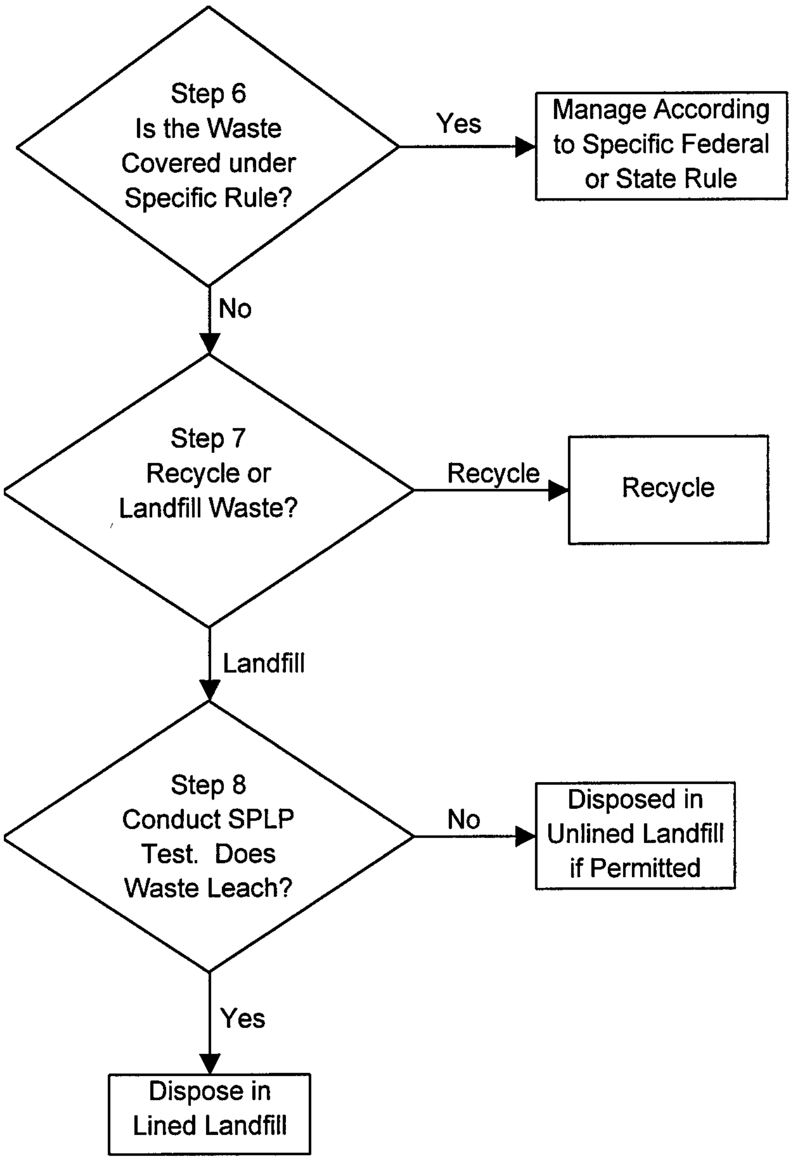


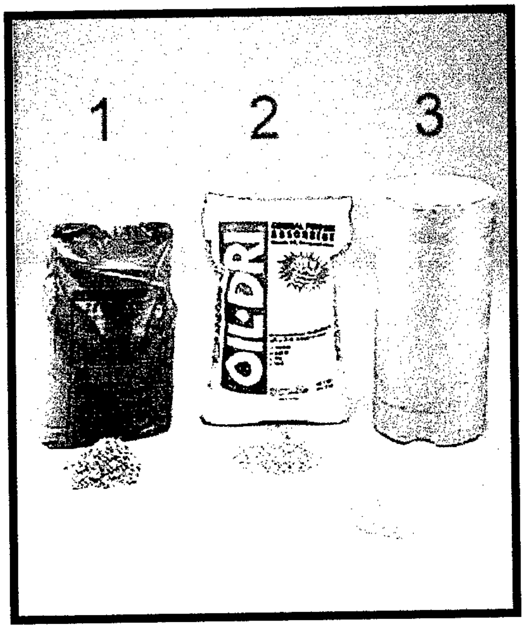
Figure 2 (Cont). Federal Criteria Waste Evaluation Flow Chart

Chapter Five

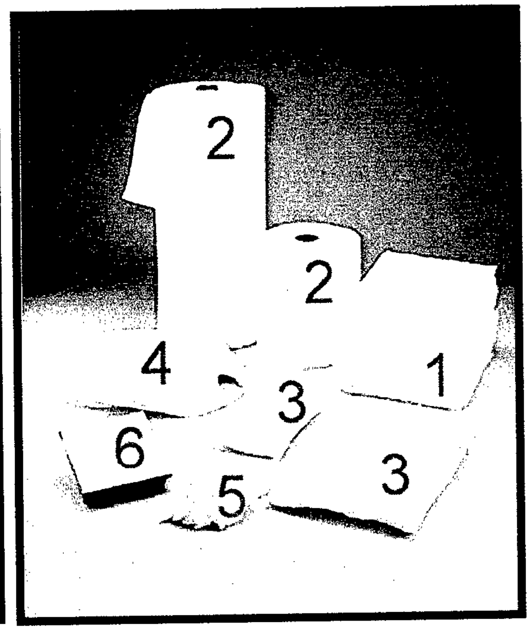
Sorbent Materials

Sorbent materials are used to soak up liquids. Sorbents are normally used for the final clean-up measures on large oil spills or for small spills. All used sorbents will eventually need to be properly disposed of, therefore, care should be taken not to overuse sorbents and to use recyclable sorbents to minimize the volume generated. Sorbent materials are categorized by composition: organic, inorganic or synthetic, and by their performance: selective, chemical or specialty. The American Society for Testing and Materials (ASTM) has developed standard testing methods and sets performance factors for sorbents. Sorbent effectiveness is measured in terms of a percent of efficiency.(18) ASTM also recognizes three types of absorbent product configurations which are as follows:(4,18)

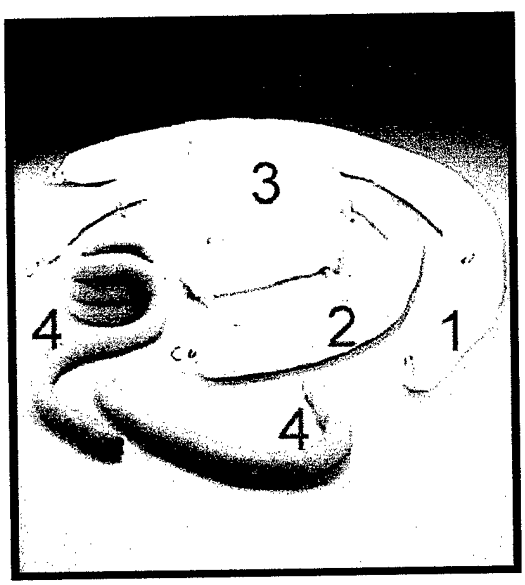
- Type I: the sorbents consist of loose particles or granules. An example would be clay granules, sometimes referred to as kitty litter, or floor dry.
- Type II: the sorbents are in the form of sheets, rolls, pads, blankets, or pillows and have sufficient strength to be lifted and handled without tearing when saturated.



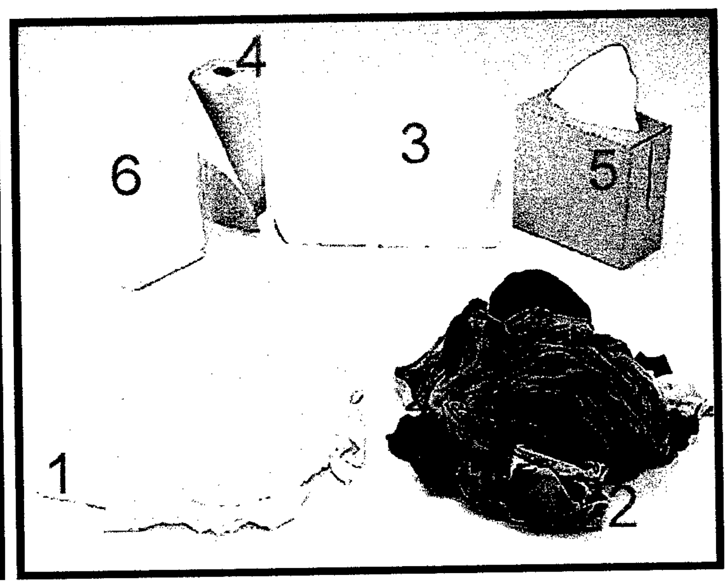
a.Type I, Sorbents: Loose Particles and Granules



b.Type II, Sorbents: Rolls, Sheets, Pads and Pillows



c.Type III, Sorbents: Booms



d.Other Common Sorbents :Rags, Towels and Wipes

Figure 3. Sorbent Types (www.chemtex-inc.com)

- Type III: the sorbents are booms, which come in long lengths and can be connected together to encircle any size oil spill.(18)
- Common sorbents such as rags, towels and wipes can be found almost any place oils are used

There are three classes of sorbents: natural organic, inorganic and synthetic: (4,18)

Natural organic sorbent materials include sawdust, hay, straw, peat moss, feathers, ground corncobs, and other carbon based products. They can generally pick up 3 to 15 times their weight in oil and are used frequently because they are inexpensive and are easily available, as they are generally waste products. There are three problems with natural organic sorbents. First, they also pick up water along with the oil and tend to sink. Second, because they are normally used in their loose form, their use is generally limited to use on land. In their loose form, collection is more difficult to accomplish. The development of mesh or netting to encase natural organic sorbents is helping to solve collection difficulties. However, they are not easily recyclable or reusable.

Inorganic sorbent materials include clay, vermiculite, perlite, wool, sand, glass wool, volcanic ash or other mineral based products. They can generally pick up 4 to 20 times their weight in oil and because they are available in large quantities and are inexpensive, they are commonly used. Inorganic sorbents are often treated with silicones to give them oil attracting and water repelling properties. The problem with inorganic sorbents is that they are not biodegradable and must be completely recovered after use. The second problem is that when they are landfilled, they easily leach their contained oils. Finally, they are not easily recyclable or reusable.

Synthetic sorbent materials include man-made organic polymeric materials such as polyurethane, polyethylene, polypylene, nylon fibers, crossed-linked polymers and urea formaldehyde foam. They can generally pick up 70 times or more their weight in oil and because they can be reused several times, they are a very popular sorbent. Synthetic sorbents are also highly oleophilic (oil attracting) and hydrophobic (water repelling), making them very effective in cleaning up oil spills. The problem with synthetic sorbents can be that once they are removed from water, the oil tends to seep out of the sorbent naturally. However it is this same property that also helps make it easier to remove the oil and then reuse the sorbent.

When selecting sorbents, there are many characteristics that should be considered to make the sorbents as effective as possible for the anticipated oil spill it will be used for. The characteristics are: (4,18)

- Oil Retention - The capability of the sorbent to soak up and retain liquid oils. The viscosity of the absorbed oil greatly affects the sorbents ability to retain the oil. The lower the oil's viscosity, the less the retention capability of the sorbent. It is the mass of the recovered oil contained within the sorbent that causes the sorbent to sag and deform when being recovered, thus releasing some of the recovered oils.
- Buoyancy - The capability of the sorbent to float on top of the water, even when saturated with oil and water. For used on land, this characteristic is not important.
- Rate of Sorption - The capability of the sorbent to quickly absorb oil. The rate of sorption is dependent on the viscosity of the oil. Low viscosity oil absorbs faster that high viscosity oils. The sorption rate becomes important in cold temperatures, because the cold increases oil viscosity. Also, the sorption rate is critical in recovering oils that weather quickly (form an emulsion composed of oil and 50-80% water) or for high viscosity oils.

- Oleophilic and Hydrophobic properties - An oleophilic property is the sorbents ability to attract oil for absorption. A hydrophobic property is the sorbents ability to repel and not absorb water along with oil. The best sorbents will contain both properties and ensure that considerably more oil is absorbed than water.
- Surface Area - The more surface area a sorbent has, the greater its capability and the higher its rate of absorption.
- Reusability - The ability for a sorbent to be reused minimizes the total amount of waste generated for disposal and decreases the cost of cleaning up an oil spill. Many sorbents pick up oil more efficiently after being used once, because they are primed for reuse. In order to reuse sorbents, a mechanical process must be used to remove the oil from the sorbents. Rollers are the most common process used, however, they can be labor intensive and the equipment must be easily transportable for on-site use.
- Disposal - The sorbents must be composed of non-hazardous materials, biodegradable, or burnable materials, as all used sorbents must ultimately be disposed of. The most common methods of disposal are incineration and landfilling.

Once a sorbent has absorbed a used oil, it is then regulated as a used oil under 40 CFR 279, as long as the sorbent is intended to be recycled.(10) The recycling process most commonly used is incineration in waste-to-fuel processes, to recover the contained energy. Unfortunately, landfilling is currently the most common method of disposal.(4) In order to landfill a sorbent that contains non-hazardous oils, the sorbent must be mechanically processed to remove all free liquids.(3) The picture below shows two typical sorbent wringers.

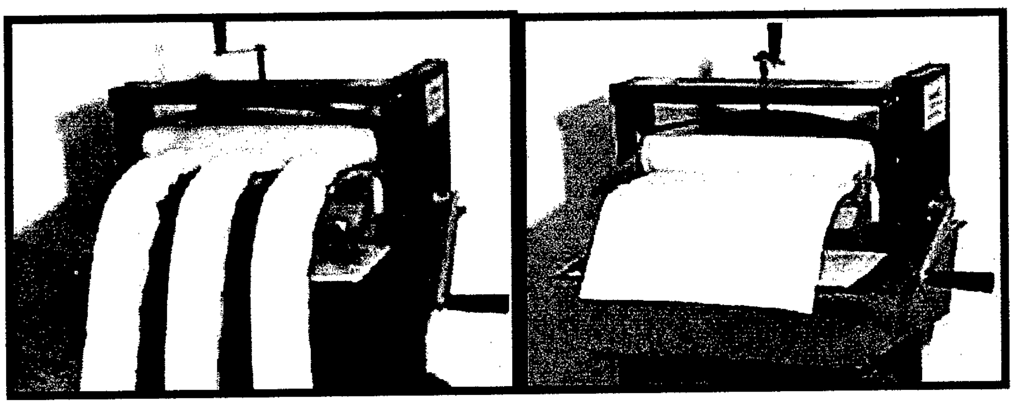


Figure 4. Sorbent Wringers

Chapter Six

EPA Waste Management System

The EPA has established a four-tier waste management program, which begins with waste minimization.(19) Waste minimization is the first step and is the best way to minimize waste disposal. The second step is to reuse/recycle. The 40 CFR 279 standards for the management of used oil is a good example of the government's attempts to encourage recycling. The third step is to treat hazardous materials and make them non-hazardous. 40 CFR 268 universal treatment standards for hazardous wastes set forth some guidelines and treatments for some specific hazardous waste treatments. The final and least desirable disposal step is landfill of wastes, either hazardous or non-hazardous. The rest of this report will be dedicated to the disposal methods of oils, concentrating on recycling and reuse procedures.

Recycling and reusing oils keeps them out of our land waters, groundwater, and drinking water supplies. Oil does not wear out, it only gets dirty as it is used. When contaminates are removed from oils, they can be reused for many things, sometimes even for their original use. By recycling and reusing oils, we are conserving energy for future generations, protecting the environment, and minimizing wastes for disposal. The following disposal methods will be discussed in detail: recycling, in-situ burning and landfilling.

Oil can be recycled in a number of various ways to produce usable oils or for energy production and heat use. Unfortunately, the price of crude (virgin) oils dramatically affects recycling efforts. In today's market place, recycled oils must compete with the crude oil market. When crude oil prices are high, companies can afford to invest money in developing and operating recycling facilities. As crude oil prices rise and fall, recycling plants either pay for used

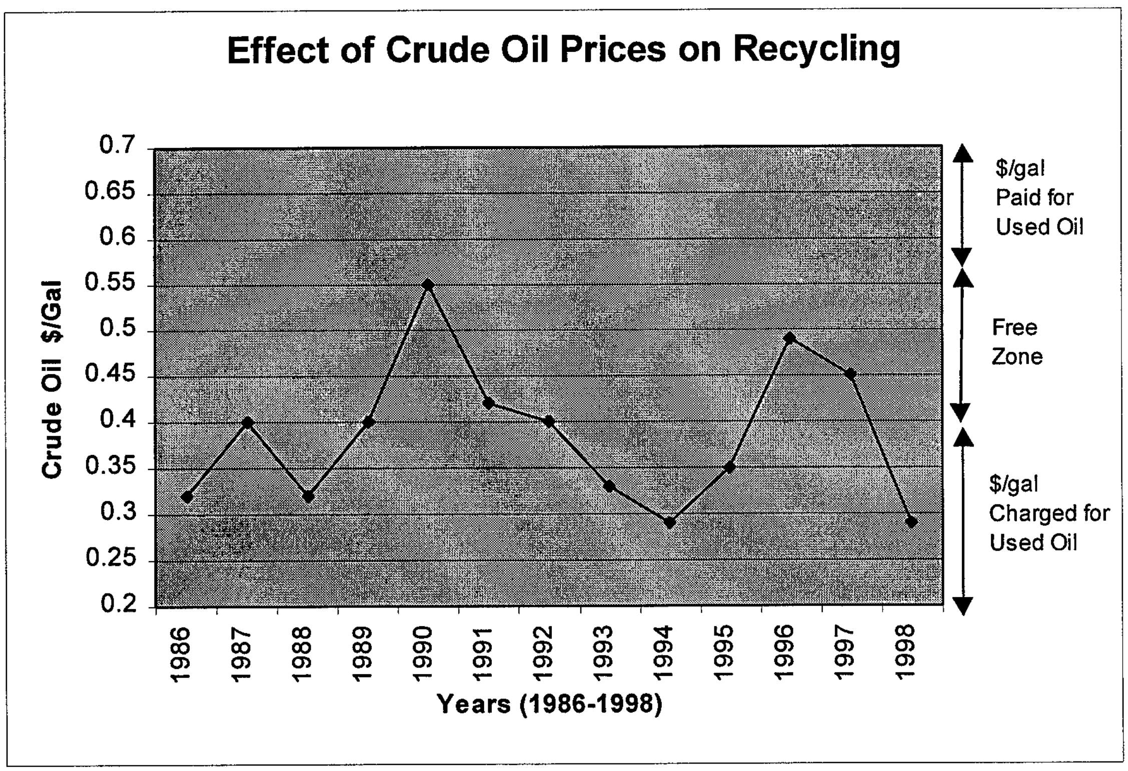


Figure 5. The Effect of Crude Oil Pricing on Recycling and the Payments Made to Generators for Used Oils.

oils, accept used oils (no payment, no charge), or charge the generators to recycle their used oils.(2,20) Figure 5, shows the effects of crude oil prices on recycling.

In order to recycle or reuse an oil, it must first be collected in quantities large enough to make the transportation and recycling/reuse economically feasible. The following flow chart, provided by figure 6, demonstrates the basic used oil collection and management system. (21)

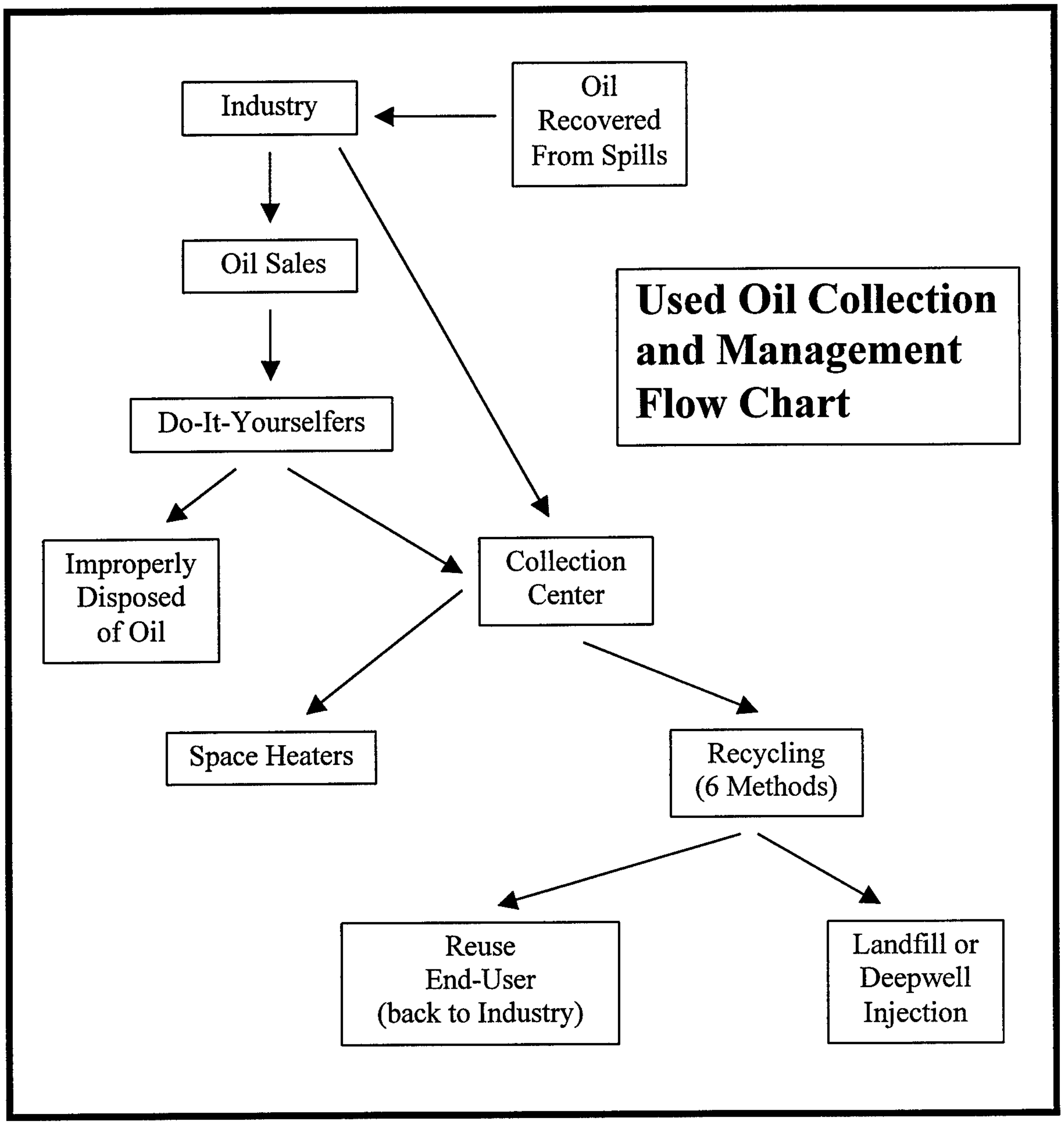


Figure 6. Used Oil Collection and Management System

Chapter Seven

Recycling/Reuse

Recycling/Reuse of oils has many benefits:

- It reduces the liability from environmental regulations.
- It reduces the disposal costs of contaminated oils.
- It reduces the demand for industrial oils.
- It reduces the consumption of crude oils.
- It reduces the energy required to manufacture and refine new oils.
- It decreases the demand on both class C and D landfills.
- It protects the environment and human health.

The six most common used-oil recycling methods are; re-refining, slip streaming, reprocessing, supplementing diesel fuel, oil/water separation, and direct burning. Each of these recycling methods will be briefly discussed.(2)

Re-refining. Currently, about 14% of all used oils collected are sent to re-refiners.(21) With re-refining, used oil is put through extensive physical and chemical treatments to remove impurities. Re-refined oils can be as high of a quality as virgin products. The re-refined oils are sold back to the producers of lubricating oils, who use the re-refined oils as a base stock and blend it with additives to make new lubricating oils. The re-refining companies in the U.S. today use a vacuum distillation/hydrotreating process. Figure 7, shows this process.(2)

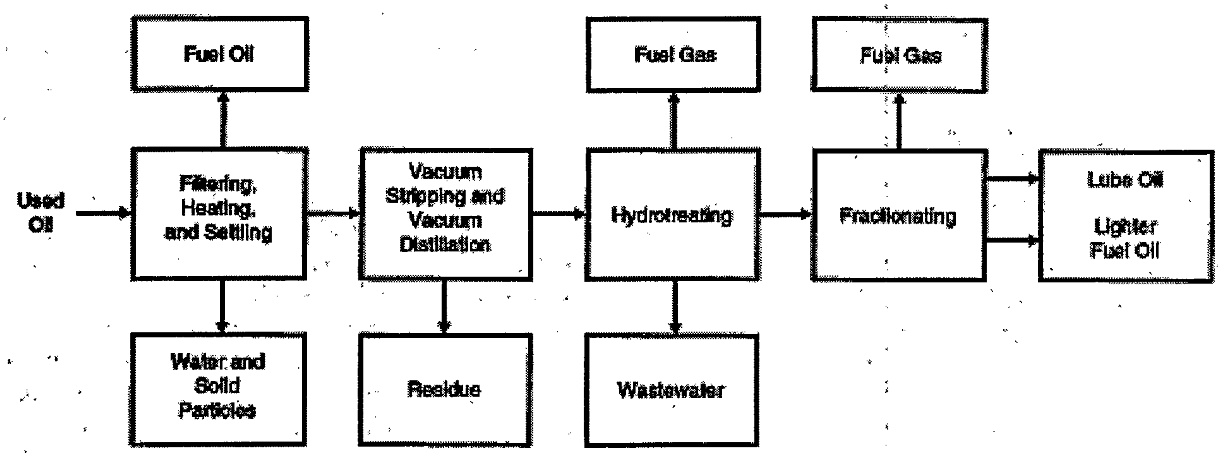


Figure 7. Vacuum Distillation/Hydrotreating Re-refining System

In vacuum distillation/hydrotreating processes, the first step is where filtering, heating and settling processes are used to remove water and large solid particles from the oil. In the second step, oil then goes to a vacuum stripping and vacuum distillation process where additional contaminants are removed. In the third step, the oil is treated with hydrogen, which bonds to the remaining contaminants which are then settled out of the process. The final step is fractionating, where heavy lubricating oils are separated from lighter fuel oils.

Re-refining has three advantages(2):

- The production of hazardous wastes is minimized or eliminated, along with the other residuals, which are burned as fuel or used in the production of asphalt products.
- Used oil can be re-refined over and over again and can be subject to the same performance standards as virgin oils.
- Re-refining takes 50-85% less energy than it takes to refine crude oils into lubricating oils.

A disadvantage of re-refining is that it is more complex and expensive than other recycling options. However, re-refining is a less expensive process than refining crude oil. Another disadvantage is that there are not very many re-refiners in the U.S. and transportation costs are sometimes not economical.(6)

Slipstreaming. In slipstreaming, used oil is introduced into a refining process in small amounts. Because small amounts are inserted into the refining process, no pre-processing of the used oil is necessary. Slipstreaming can be used in the production of gasoline, heating oil, or feedstocks for other petrochemical products. The major advantage to slipstreaming is that as long as specification used oil is used, it is exempt from the EPA's used oil management standards. This exemption should increase the use of slipstreaming.(2)

Supplementing Diesel Fuel. In the supplementing diesel fuel, specification used oil can be mixed with diesel fuel once it has been filtered to remove large solids. The used oil can be mixed with diesel fuels up to a ratio of one part used oil to nine parts diesel fuel.(2)

Re-processing. Re-processing used oil is simply treating the used oil to remove contaminates so that it becomes a better fuel. The simplest processing treatment is oil/water separation, so the used oil can be burned more efficiently. Today, approximately 75% of the recycled used oil in the U.S. is being reprocessed and marketed to the following markets:(21)

- Asphalt plants (43%)
- Industrial boilers (14%)
- Electric power plants (12%)
- Steel mills (12%)
- Cement/lime kilns (5%)
- Marine boilers (5%)
- Pulp and paper mills (4%)

- Commercial boilers (<1%)
- Other (5%)

Figure 8, shows a typical used oil reprocessing system.(2) The first step in the reprocessing system is filtration, where

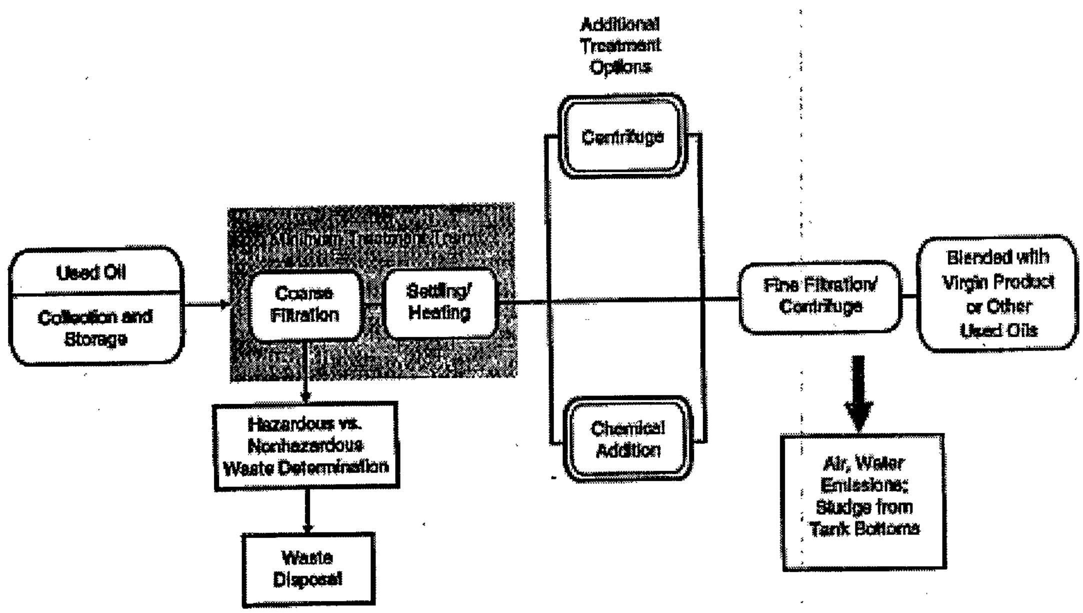


Figure 8. Used Oil Reprocessing System

large contaminate particles are removed. The second step is settling and heating, where the used oil is held in settling tanks for a long time to allow heavy contaminates to settle to the bottom. The third step is centrifuging, where the oil is spun, causing density separation of oil, water and contaminants. A chemical treatment step may be added to remove chemical contaminants and improve burning. The final steps can include another filtration and centrifuging process to further remove contaminants. Finally, virgin oils can be blended to improve viscosity or improve burning quality.

The advantage of reprocessing is that it improves the burning quality of used oil. Reprocessing can also upgrade off-specification used oils to specification used oils, which has fewer burning restrictions. With over 200 reprocessing factories throughout the U.S., this is a readily available recycling/reuse option.(2)

Oil/Water Separation. Oil/water separation is used extensively in recovering spilled oils. Generally spilled crude oils must be run through an oil/water separator before they will be accepted by the oil refinery. Oil/water separation is typically conducted at the spill site, if allowable by Federal and State regulations, in order to reduce the transportation requirements. For used oils, the simple removal of water may be all that is necessary for the used oil to be burned efficiently.(2,16)

Direct Burning. Direct burning is divided into two areas: specification used oil and off-specification used oil burning. Direct burning is the burning of used oil without any processing, not even water removal. Under 40 CFR 279, used oil generators may burn their used oil, as long as the following requirements are met:(2,10)

- The used oil was generated on-site, or collected from "do-it-yourself" individual home and vehicle use.
- Their space heater has a maximum capacity of 500,000 BTU per hour.
- The exhaust from their space heater is vented outside.

Generators may also burn their used oil in other burners if they follow the applicable burner regulations.

Specification used oil can be burned for fuel in heaters, boilers and furnaces without being subjected to burning requirements. Burning specification used oils in heaters is a very common recycling method with over 75,000 heaters burning more than 120 million gallons of used oil per year, approximately 11% of the used oil recycled.(21)

Off-specification used oil can only be used for fuel in industrial furnaces or boilers (like cement kilns or asphalt plants) that are approved hazardous waste incinerators. Hazardous waste incinerators burn hotter than other incinerators and have pollution control equipment to reduce emissions.

The advantages of direct burning is that it allows for the heat value to be recovered without the expense of processing. Another advantage is there are a large number of facilities across the U.S. that can burn off-specification used oil.(2)

Chapter Eight

Disposal

This covers the most common methods of recycling/reusing used oils. Now we will look at the last resort options for disposal: in-situ burning, deep well injection and landfilling.

In-situ burning. In-situ burning is a technique used by the on-site commander of an oil spill to control a spill and remove large quantities of spilled oil. In-situ burning is a controlled burning of the spilled oil. When conducted properly, 90-95% of the oil on the surface can be removed.(22) This technique is one of the most effective in handling and removing a very large oil spill at sea before it come ashore and causes great environmental damage. Under the Nation Contingency Plan (section 300.910) and the Federal Water Pollution control Act (section 311), the on-site commander of an oil spill, on a case-by-case basis, has the authority to authorize in-situ burning to control an oil spill and minimize the damage to the environment by the oil spill.(16,23) The general guidelines for in-situ burning on bodies of water are as follows: (3,24)

- Wind speed less than 23 mph
- Waves less than 3 ft high
- Minimum slick thickness of 2-3 mm, (depends on oil type)

- Less than 30% evaporation loss
- Emulsification of less than 25% water content

Air quality is carefully monitored during burning and if air quality standards are exceeded, the burn is terminated. Portable forced air incinerators can also be moved to a spill site and be used to burn oil, oil contaminated debris and used sorbents on-site.(3,24) The main issue for in-situ burning on land is the proximity to people. In-situ burning cannot take place within 3 miles of populated areas.

The advantages of in-situ burning are that it can remove 90-95% of the surface oil in a large spill and volatile compounds that would evaporate are burned.(22) The disadvantage is that the oil is burned without receiving any economical benefit. In some situations where access to the oil is limited, in-situ burning may be the only effective clean-up method.

Deep Well Injection. Deep well injection is a process in which hazardous liquid materials are injected deep into the earth in confining formations. Deep injection wells range in depth from 300-12,000 feet, depending on subsurface geologic formations.(25) 40 CFR 144, 146 and 147 allow for the permitting of Class I hazardous waste injection wells. It is estimated that 59% (290 million tons) of hazardous waste generated in the U.S. is disposed of annually by deep well injection.(25)

Landfill. When used oils, used sorbents or contaminated solids, and especially hazardous used oils can not be economically recycled/reused or incinerated, they are sent to landfills for disposal. Only used oils that contain less that 1000 ppm total halogens can be sent to Subtitle D (non-hazardous) lined landfills.(2) Subtitle D landfills will generally only accept solid materials and sorbents that contain no free-flowing oils.(3) Oils can sometimes be treated with chemicals, such as calcium oxide ("quicklime")(24). This mixture can stabilize an oil and make it less likely to seep into the soil or ground water when landfilled. Depending on State regulations, only some subtitle D landfills can accept these mixtures. "Quicklime" is more commonly use to treat hazardous oils before they are disposed of in subtitle C (hazardous material) landfills. The use of Subtitle C landfills, is the last option for disposal in many areas.

Chapter Nine

Conclusion

The impact of an oil spill on the environment has far reaching consequences, which eventually affects humans. Therefore, the management of oil must be given the highest priority. Many steps have been taken in the development of oil management and disposal regulations and contingency planning in the United States, each of which aides in the proper handling and disposal of oil. As long as we are dependent on oil and oil products, oil spills are inevitable. Which creates the need to dispose of spilled oils, used sorbent materials and oil soaked debris. It is imperative that all oils are disposed of properly, to avoid damaging the environment. Only through careful oil management and spill prevention can the true economic and environmental rewards be achieved.

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Lieutenant Jones was born 12 March 1965 in Chico, CA and raised in Bozeman, MT. He graduated with department distinction from Northern Montana College in Havre, MT with an Associate of Applied Science Architectural Drafting in June 1985. He received a Civil Engineer Corps Collegiate Scholarship in June 1990. He graduated from Montana State University in Bozeman, MT with a Bachelor of Science Civil Engineering in May 1992. He then reported to Officer Candidate School, graduating on September 25, 1992. After commissioning, he reported to the Civil Engineer Corps Officer School (CECOS), Port Hueneme, CA graduating in December 1992.

LT Jones's first assignment was with the Resident Officer in Charge of Construction (ROICC) at Naval Air Station, Key West, FL, where he served as an Assistant Resident Officer in Charge of Construction from January 1992 to April 1995. He then transferred to Naval Air Facility, Misawa, Japan, where he served as Public Works Officer and ROICC from June 1995 to June 1998.

In July 1988, LT Jones reported for duty with Naval Mobile Construction Battalion FORTY making one full deployment to Rota, Spain serving as Training and Weapons Officer. He completed his tour and second deployment with NMCB 40 as the OIC of Det San Diego, July 2000.

LT Jones is currently attending postgraduate school at the University of Florida, where he will receive his Master's Degree in Civil Engineering in August 2001.

LT Jones earned the title of Seabee Combat Warfare Officer while on deployment to Rota. He is a certified DAWIA Level I Construction Contracting Officer. He is a registered Civil Engineer in Training in the State of Montana. His awards include the Navy Commendation Medal (two awards), Navy Achievement Medal (two awards), Air Force Achievement Medal, National Defense Medal, Armed Forces Expeditionary Medal, Expert Rifle Medal and Expert Pistol Medal.

LT Jones is married to Kimberly Sue Briggs of Livingston, Montana. They have a daughter, Michaela (9) and a son, Tyler (6).