PETROLEUM PRODUCTS

Petroleum is a term that includes a wide variety of liquid hydrocarbons. Many scientists also include natural gas in their definition of petroleum. The most familiar types of petroleum are tar, oil, and natural gas. Petroleum forms through the accumulation, burial, and transformation of organic material, such as the remains of plants and animals, by chemical reactions over long periods of time. After petroleum has been generated, it migrates upward through the earth, seeping out at the surface of the earth if it is not trapped below the surface. Petroleum accumulates when it migrates into a porous rock called a reservoir that has a non-porous seal or cap rock that prevents the oil from migrating further. To fully understand how petroleum forms and accumulates requires considerable knowledge of geology, including sedimentary rocks, geological structures (faults and domes, for example), and forms of life that have been fossilized or transformed into petroleum throughout the earth's long history.

http://science.jrank.org/pages/5126/Petroleum.html

TYPES OF REFINED PETROLEUM PRODUCTS

Gasoline, a lightweight material that flows easily, spreads quickly, and may evaporate completely in a few hours under temperate conditions. It poses a risk of fire and explosion because of its high volatility and flammability, and is more toxic than crude oil. Gasoline is amenable to biodegradation, but the use of dispersants is not appropriate unless the vapors pose a significant human health or safety hazard.

Kerosene, a lightweight material that flows easily, spreads rapidly, and evaporates quickly. Kerosene is easily dispersed, but is also relatively persistent in the environment.

No. 2 Fuel Oil, a lightweight material that flows easily, spreads quickly, and is easily dispersed. This fuel oil is neither volatile nor likely to form emulsions, and is relatively non-persistent in the environment.

No. 4 Fuel Oil, a medium-weight material that flows easily, and is easily dispersed if treated promptly. This fuel oil has a low volatility and moderate flash point, and is fairly persistent in the environment.

No. 5 Fuel Oil (Bunker B), a medium-weight to heavyweight material with a low volatility and moderate flash point. Preheating may be necessary in cold climates, and this fuel oil is difficult, if not impossible, to disperse.

No. 6 Fuel Oil (Bunker C), a heavyweight material that is difficult to pump and requires preheating for use. This fuel oil may be heavier than water, is not likely to dissolve, is difficult or impossible to disperse, and is likely to form tar balls, lumps, and emulsions. It has a low volatility and moderate flash point.

Lubricating Oil, a medium-weight material that flows easily and is easily dispersed if treated promptly. This oil has a low volatility and moderate flash point, but is fairly persistent in the environment.

http://www.epa.gov/osweroe1/content/learning/refined.htm

USES OF PETROLEUM PRODUCTS

- Credit cards
- American flags
- Eyelashes
- Aspirin
- No-wax floors
- Permanent-press
- Clothes
- Oxygen masks
- Golf balls
- Ink
- Lighter fluid
- Heart valves
- Hair spray
- Attache cases
- Crayons
- Steering wheels
- Wet suits
- Disposable diapers

http://www.texasalliance.org/admin/assets/pdfs/the_many_uses_of_petroleum.pdf

HOW SHOULD PETROLEUM PRODUCTS STORED AND TRANSPORTED

Marine Tankers and Barges

The majority of the world's crude oil is transported by tankers from producing areas such as the Middle East and Africa to refineries in consumer areas such as Europe, Japan and the United States. Oil products were originally transported in large barrels on cargo ships. The first tanker ship, which was built in 1886, carried about 2,300 SDWT (2,240 pounds per ton) of oil. Today's supertankers can be over 300 m long and carry almost 200 times as much oil (see figure 102.15). Gathering and feeder pipelines often end at marine terminals or offshore platform loading facilities, where the crude oil is loaded into tankers or barges for transport to crude trunk pipelines or refineries. Petroleum products also are transported from refineries to distribution terminals by tanker and barge. After delivering their cargoes, the vessels return in ballast to loading facilities to repeat the sequence.

Motor Vehicle and Railroad Transport of Petroleum Products

Crude oil and petroleum products were initially transported by horse-drawn tank wagons, then by railroad tank cars and finally by motor vehicles. Following receipt at terminals from marine vessels or pipelines, bulk liquid petroleum products are delivered by non-pressure tank trucks or rail tank cars directly to service stations and consumers or to smaller terminals, called bulk plants, for redistribution. LPG, gasoline anti-knock compounds, hydrofluoric acid and many other products, chemicals and additives used in the oil and gas industry are transported in pressure tank cars and tank trucks. Crude oil may also be transported by tank truck from small producing wells to gathering tanks, and by tank truck and railroad tank car from storage tanks to refineries or main pipelines. Packaged petroleum products in bulk bins or drums and pallets and cases of smaller containers are carried by package truck or railroad box car.

Railroad tank cars

Railroad tank cars are constructed of carbon steel or aluminium and may be pressurized or unpressurized. Modern tank cars can hold up to 171,000 l of compressed gas at pressures up to 600 psi (1.6 to 1.8 mPa). Non-pressure tank cars have evolved from small wooden tank cars of the late 1800s to jumbo tank cars which transport as much as 1.31 million litres of product at pressures up to 100 psi (0.6 mPa). Non-pressure tank cars may be individual units with one or multiple compartments or a string of interconnected tank cars, called a tank train. Tank cars are loaded individually, and entire tank trains can be loaded and unloaded from a single point. Both pressure and non-pressure tank cars may be heated, cooled, insulated and thermally protected against fire, depending on their service and the products transported.

Tank trucks

Petroleum products and crude oil tank trucks are typically constructed of carbon steel, aluminium or a plasticized fibreglass material, and vary in size from 1,900-l tank wagons to jumbo 53,200-l tankers. The capacity of tank trucks is governed by regulatory agencies, and usually is dependent upon highway and bridge capacity limitations and the allowable weight per axle or total amount of product allowed.

Rail tank car and tank truck loading and unloading

While railroad tank cars are almost always loaded and unloaded by workers assigned to these specific duties, tank trucks may be loaded and unloaded by either loaders or drivers. Tank cars and tank trucks are loaded at facilities called loading racks, and may be top loaded through open hatches or closed connections, bottom loaded through closed connections, or a combination of both.

Shipping products by rail box cars and package vans

Petroleum products are shipped by motor truck package vans and railroad box cars in metal, fibre and plastic containers of various sizes, from 55-gallon (209-l) drums to 5-gallon (19-l) pails and from 2-1/2-gallon (9.5-l) to 1-quart (.95-l) containers, in corrugated boxes, usually on pallets. Many industrial and commercial petroleum products are shipped in large metal, plastic or combination intermediate bulk containers ranging in size from 380 to over 2,660 l capacity. LPG is shipped in large and small pressure containers. In addition, samples of crude oil, finished products and used products are shipped by mail or express freight carrier to laboratories for assay and analysis.

Terminals and bulk plants

Terminals are storage facilities which generally receive crude oil and petroleum products by trunk pipeline or marine vessel. Terminals store and redistribute crude oil and petroleum products to refineries, other terminals, bulk plants, service stations and consumers by pipelines, marine vessels, railroad tank cars and tank trucks. Terminals may be owned and operated by oil companies, pipeline companies, independent terminal operators, large industrial or commercial consumers or petroleum product distributors.

Bulk plants are usually smaller than terminals and typically receive petroleum products by rail tank car or tank truck, normally from terminals but occasionally direct from refineries. Bulk plants store and redistribute products to service stations and consumers by tank truck or tank wagon (small tank trucks of approximately 9,500 to 1,900 l capacity). Bulk plants may be operated by oil companies, distributors or independent owners.

Tank farms

Tank farms are groupings of storage tanks at producing fields, refineries, marine, pipeline and distribution terminals and bulk plants which store crude oil and petroleum products. Within tank farms, individual tanks or groups of two or more tanks are usually surrounded by enclosures called berms, dykes or fire walls. These tank farm enclosures may vary in construction and height, from 45-cm earth berms around piping and pumps inside dykes to concrete walls that are taller than the tanks they surround. Dykes may be built of earth, clay or other materials; they are covered with gravel, limestone or sea shells to control erosion; they vary in height and are wide enough for vehicles to drive along the top. The primary functions of these enclosures are to contain, direct and divert rain water, physically separate tanks to prevent the spread of fire in one area to another, and to contain a spill, release, leak or overflow from a tank, pump or pipe within the area.

Dyke enclosures may be required by regulation or company policy to be sized and maintained to hold a specific amount of product. For example, a dyke enclosure may need to contain at least 110% of the capacity of the largest tank therein, allowing for the volume displaced by the other tanks and the amount of product remaining in the largest tank after hydrostatic equilibrium is reached. Dyke enclosures may also be required to be constructed with impervious clay or plastic liners to prevent spilled or released product from contaminating soil or groundwater.

Storage tanks

There are a number of different types of vertical and horizontal aboveground atmospheric and pressure storage tanks in tank farms, which contain crude oil, petroleum feedstocks, intermediate stocks or finished petroleum products. Their size, shape, design, configuration, and operation depend on the amount and type of products stored and company or regulatory requirements. Aboveground vertical tanks may be provided with double bottoms to prevent leakage onto the ground and cathodic protection to minimize corrosion. Horizontal tanks may be constructed with double walls or placed in vaults to contain any leakage.

Pipeline and marine receipts

An important safety, product quality and environmental concern in tank storage facilities is to prevent intermixing of products and overfilling tanks by developing and implementing safe operating procedures and work practices. Safe operation of storage tanks depends on receiving product into tanks within their defined capacity by designating receiving tanks prior to delivery, gauging tanks to determine the available capacity and ensuring that valves are properly aligned and that only the receiving tank inlet is opened, so the correct amount of product is delivered into the assigned tank. Drains in dyke areas surrounding tanks receiving product should normally be kept closed during receipt in case an overfill or spill occurs. Overfill protection and prevention can be accomplished by a variety of safe operating practices, including manual controls and automatic detection, signalling and shut-down systems and a means of communication, all of which should be mutually understood and acceptable to product transfer personnel at the pipeline, marine vessel and terminal or refinery.

Storage tank fire protection

Storage tank fire protection and prevention is a specialized science which depends on the interrelationship of tank type, condition and size; product and amount stored in the tank; tank spacing, dyking and drainage; facility fire protection and response capabilities; outside assistance; and company philosophy, industry standards and government regulations. Storage tank fires may be easy or very difficult to control and extinguish, depending primarily on whether the fire is detected and attacked during its initial inception. Storage tank operators should refer to the numerous recommended practices and standards developed by organizations such as the American Petroleum Institute (API) and the US National Fire Protection Association (NFPA), which cover storage tank fire prevention and protection in great detail.

Storage and Handling

Bulk storage tanks

LHGs are stored in large bulk storage tanks at the point of process (gas and oil fields, gas plants and refineries) and at the point of distribution to the consumer (terminals and bulk plants). The two most commonly used methods of bulk storage of LHGs are:

- *Under high pressure at ambient temperature.* LHG is stored in steel pressure tanks (at 1.6 to 1.8 mPa) or in underground impermeable rock or salt formations.
- *Under pressure close to atmospheric at low temperature.* LHG is stored in thin-walled, heat-insulated steel storage tanks; in reinforced concrete tanks above and below ground; and in underground cryogenic storage tanks. Pressure is maintained close to atmospheric (0.005 to 0.007 mPa) at a temperature of -160°C for LNG stored in cryogenic underground storage tanks.

LPG bulk storage vessels are either cylindrically (bullet) shaped horizontal tanks (40 to 200 m^3) or spheres (up to 8,000 m^3). Refrigerated storage is typical for storage in excess of 2,400 m^3. Both horizontal tanks, which are fabricated in shops and transported to the storage site, and spheres, which are built onsite, are designed and constructed in accordance with rigid specifications, codes and standards.

The design pressure of storage tanks should not be less than the vapour pressure of the LHG to be stored at the maximum service temperature. Tanks for propane-butane mixtures should be designed for 100% propane pressure. Consideration should be given to additional pressure requirements resulting from the hydrostatic head of the product at maximum fill and the partial pressure of non-condensible gases in the vapour space. Ideally, liquefied hydrocarbon gas storage vessels should be designed for full vacuum. If not, vacuum relief valves must be provided. Design features should also include pressure relief devices, liquid level gauges, pressure and temperature gauges, internal shut-off valves, back flow preventers and excess flow check valves. Emergency fail-safe shut-down valves and high level signals may also be provided.

Horizontal tanks are either, installed aboveground, placed on mounds or buried underground, typically downwind from any existing or potential sources of ignition. If the end of a horizontal tank ruptures from over-pressurization, the shell will be propelled in the direction of the other end. Therefore, it is prudent to place an aboveground tank so that its length is parallel to any important structure (and so that neither end points toward any important structure or equipment). Other factors include tank spacing, location, and fire prevention and protection. Codes and regulations specify minimum horizontal distances between pressurized liquefied hydrocarbon gas storage vessels and adjoining properties, tanks and important structures as well as potential sources of ignition, including processes, flares, heaters, power transmission lines and transformers, loading and unloading facilities, internal combustion engines and gas turbines.

Drainage and spill containment are important considerations in designing and maintaining liquid hydrocarbon gas tank storage areas in order to direct spills to a location where they will minimize risk to the facility and surrounding areas. Dyking and impounding may be used where spills present a potential hazard to other facilities or to the public. Storage tanks are not usually dyked, but the ground is graded so that vapours and liquids do not collect underneath or around the storage tanks, in order to keep burning spills from impinging upon storage tanks.

Cylinders

LHGs for use by consumers, either LNG or LPG, are stored in cylinders at temperatures above their boiling points at normal temperature and pressure. All LNG and LPG cylinders are provided with protective collars, safety valves and valve caps. The basic types of consumer cylinders in use are:

- Vapour withdrawal (1/2 to 50 kg) cylinders used by consumers, with larger ones usually refillable on an exchange basis with the supplier
- Liquid withdrawal cylinders for dispensing into small consumer-owned refillable cylinders
- Motor vehicle fuel cylinders, including vehicle cylinders (40 kg) permanently installed as fuel tanks on motor vehicles and filled and used in the horizontal position, and industrial truck cylinders designed to be stored, filled and handled in the upright position, but used in the horizontal position.

Properties of hydrocarbon gases

Flammable (combustible) gases are those which burn in the normal concentrations of oxygen in air. The burning of flammable gases is similar to flammable hydrocarbon liquid vapours, as a specific ignition temperature is needed to initiate the burning reaction, and each will burn only within a certain defined range of gas-air mixtures. Flammable liquids have a flashpoint, which is the temperature (always below the boiling point) at which they emit sufficient vapours for combustion. There is no apparent flashpoint for flammable gases, since they are normally at temperatures above their boiling points, even when liquefied, and are therefore always at temperatures well in excess of their flashpoints.

ENVIRONMENTAL RISKS

***Water contamination**:* Many terminals have oil/water separators to handle contaminated water from tank containment areas, run-off from loading racks and parking areas and water drained from tanks and open-top tank roofs. Terminals may be required to meet established water quality standards and obtain permits before discharging water.

***Air pollution**:* Air pollution prevention includes minimizing releases of vapours from valves and vents. Vapour recovery units collect vapours from loading racks and marine docks, even when tanks are vented prior to entry. These vapours are either processed and returned to storage as liquids or burned.

***Spills on land and water**:* Government agencies and companies may require that oil storage facilities have spill prevention control and counter-measure plans, and that personnel be trained and aware of the potential hazards, notifications to be made and the actions to take in case of a spill or release. In addition to handling spills within the terminal facility, personnel are often trained and equipped to respond to offsite emergencies, such as a tank truck rollover.

***Sewage and hazardous waste**:* Terminals may be required to meet regulatory requirements and obtain permits for discharge of sewage and oily waste to public or privately owned treatment works. Various government requirements and company procedures may apply to the onsite storage and handling of hazardous waste such as asbestos insulation, tank cleaning residue and contaminated product. Workers should be trained in this activity and be made aware of the potential hazards from exposures which could occur.

http://www.ilo.org/safework_bookshelf/english?content&nd=857171254

DISPOSAL METHODS

Disposal of oily solid waste, mixed with domestic rubbish, to designated landfill sites is a commonly used disposal method, however in some countries (eg EU States) waste pre-treatment may be required. Modern sites are usually enclosed by an impermeable membrane to prevent substances from leaching from the site but, provided the waste is properly mixed with the domestic refuse, there is little risk of oil leaching from the site. Nevertheless, in parts of the world where such linings are not regularly used, care is needed to make sure that contamination of nearby ground and surface water does not occur.

When shorelines are only lightly contaminated with oily debris or tarballs, small quantities of the collected material may be buried at the back of the beach. However, this should only be done when there is no risk of damage to vegetation or of the oil being uncovered by winds or other activities.

Landfill sites are often licensed under specific conditions; therefore acceptance of waste into landfills may be limited to permissible types, volumes, or contaminant levels of waste.

Incineration

When oil is first spilt it is a flammable material. However, within a few hours at sea it loses any volatile components and picks up a high proportion of water. Consequently burning the oil itself without first removing the water is very difficult. Burning oily debris directly in the open is not a recommended method of disposal, except in very remote areas, due to the resultant smoke levels. When oil is burnt by this method it also tends to spread and to penetrate into the ground. Additionally, a tar-like residue may remain since it is rarely possible to achieve complete combustion.

These problems can be overcome by using an incinerator which contains the waste to be burnt and which, by burning an auxiliary fuel, generates the high temperatures necessary for total combustion. Although many types of incinerators are available, rotary kiln and open hearth furnaces are the most appropriate for oils containing large amounts of solid debris. Industrial and domestic waste incinerators may not have sufficient capacity to deal quickly with the large quantities of oily waste and so substantial storage facilities may be required. Large pieces of debris must be removed prior to burning.

A number of helicopter transportable incinerators have been developed for use on site in remote locations. Similarly, a kiln can be assembled from low cost materials such as 45 gallon drums which can handle small quantities of oil contaminated beach material.

The applicability of both direct burning and incineration depends largely on local legislation and environmental conditions. In addition, the costs of incineration are often considerably higher than other techniques and this should be taken into account if this method of disposal is selected.

Oiled Beach Materials

Although oiled beach materials may be disposed of in landfill or buried at the back of the beach other methods are available for their disposal.

Stabilisation

Stabilisation is a method that can sometimes be used with oiled sand. This entails mixing the oiled sand with an inorganic substance such as quicklime (calcium oxide) powder to form an inert product. The oil binds with fine particles which prevent leaching. However, this method is not appropriate for cobbles or if the sand is mixed with large amounts of wood, seaweed or other debris. Stabilised material can usually be disposed of with fewer restrictions than untreated oily sand and can be used in land reclamation or similar applications.

Although quicklime appears to be the best binding agent, other materials might also be used such as cement and pulverised fuel ash from coal fired power stations. The cost effective use of this technique does, however, depend upon a plentiful supply of stabilising material close to the spill location and suitable arrangements to deal with the quantities of inert stabilised material produced.

Biodegradation

Oil and oily wastes are broken down by biological processes. The term "bioremediation" is used for methods which attempt to accelerate this natural process. One such technique is Landfarming whereby the oil and debris is spread over an area of land. Biodegradation of oil by micro-organisms only takes place at the oil-water interface so that the oil must be first mixed with a moist substrate. It may take as long as three years before the bulk of the oil is broken down although this can often be shortened by aeration and the application of fertilisers.

Landfarming is only likely to be applicable to relatively small spills because of the large amount of land required. Ideally the land selected should be of low value, located well away from drinking water supplies and should not be permeable. Once the oil has degraded, the soil may be capable of supporting a wide variety of plants including trees and grasses.

There are a number of bioremediation products on the market which contain oil-degrading micro-organisms. Attempts to use these products in actual spill situations have met with very little success, mainly due to the oil concentrations being too high and the difficulty in maintaining required nutrient levels.

http://www.itopf.com/spill-response/clean-up-and-response/disposal/