

COURSE CODE:	EMT 512
COURSE TITLE:	Petroleum & Environment
NUMBER OF UNITS:	3 Units
COURSE DURATION:	3 hours per week

COURSE DETAILS:

Course Coordinator:	Dr. Mrs. O.O. Olayinka
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Office Location:	EMT Dept COLERM
Other Lecturers:	

COURSE CONTENT:

Origin and composition of crude oil, composition of refined oils, extents, source fate and effect of oil in the environment. Characteristic of biogenic and petrogenic hydrocarbons control of oil pollution. Oil pollution monitoring, sampling, sample containers, extraction, clean-oil, identification and quantitation, oil tagging. Use of bio-indicators in oil pollution monitoring. Biomarkers.

COURSE REQUIREMENTS:

This is a compulsory course for all 500 level students in the Department. It is compulsory that students should participate in all the course activities and have minimum of 75% attendance in order to be qualify to write the final examination.

READING LIST:

1. Fulkerson, W. Judkins, R.R and Sanghri, M.K. 1990. "Energy from fossil fuels" Scientific American 263 (3): 128-135. A good overview of fossil fuels in terms of sources, consumption and environmental consideration.

LECTURE NOTES

INTRODUCTION

Petroleum or crude oil is the oily liquid which occurs naturally and consists principally of hydrocarbon; it is found occasionally in springs or pools but usually obtained from beneath the earth surface via drilling wells. The physical and chemical composition of petroleum varies and the difference is brought about by the source of oil. The color of crude oil maybe black, red, amber, or brown. Hydrocarbons constitutes 50-90% of petroleum the remaining fraction constitutes oxygen, nitrogen, sulfur and trace amount of organometallic compounds.

Crude oil being drawn from the earth also contains impurities like water, mud and salt. The typical nature of crude oil from different sources is different. The individual oil even from the same well at different time of extraction differs in characteristics in terms of chemical composition, but the basic trend is almost the same for each type of crude oil.

Oil was first discovered in Nigeria in commercial quantity in January 1956 by shell B.P in Ilu'bin river state. After 40 years activities in the sector with regards to exploration, transportation has widened, following tremendously with both local and foreign. Now the sector account for only 90% of foreign exchange and about 80% of the Federal government total revenue.

Nevertheless, the discovery of oil in Nigeria resulted in a wide range of environmental problems: oil spillage, being the accidental oil discharge on land, offshore, or coastal water release. Petroleum hydrocarbons which pollute aquatic environment including the marine, freshwater and likewise ecosystem.

There is need to combat spills of liquid hydrocarbon (oil pollution) in general by the already developed advanced technology for the contaminant and treatment of oil spills.

Rehabilitation of degraded oil spill sites should also be embarked upon. Oil pollution and or environmental pollutant have proved to be insidious, ending the quality of life particularly the ecosystem in general. Portable factors such as difficult terrain, poor enforcement of environmental regulations, operating practice that falls below international requirement, community, animosity (hostility), limited finding and lack of commitment make a nuisance of possible effort to protect the environment from incessant spills. It must be emphasized that to protect and sustain the ecosystem from degradation, the existing regulatory framework must be implemented when occasions demands to serve as a measure of checks and balances. Oil companies should rise up to the challenge of cursing incessant spillages, speedy evacuation and control measures in addition, to adequate compensation of victims.

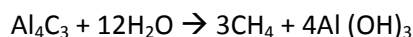
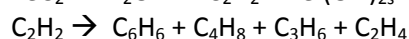
EVOLUTION OF CRUDE OIL

There are two basic theories governing the evolution of crude oil namely: organic and the inorganic theory.

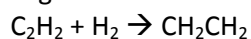
INORGANIC ORIGIN OF CRUDE OIL

1. Reaction of metal carbides with H₂O

Metal carbide exists naturally in the earth crust. This theory states that when such metal carbides come in contact with H₂O under increased temperature, hydrocarbons are formed which can later polymerize and form oxide condensed hydrocarbon compounds



2. Hydrogenation of unsaturated hydrocarbons.



All these reactions are more theoretical than practical, feasible only in the laboratory.

ORGANIC ORIGIN

Geological and geochemical evidences support the organic formation of crude and the theory goes thus: Crude oil is found trap in some of the sediment dry rocks of the earth crust. It is believed that millions of years ago, large number of microscopic animals and plants (planktons) died and fell to the bottom of the sea and their remains were then covered by mud. More deposits of sediments resulted burial of layers of sediment. With increase in temperature and pressure, the plant and animals remains were transformed and slowly changed to crude oil.

Oil being less dense than water will rise under pressure from below and capillarity effect may escape from the rock depending on the nature of the rock. If the rocks are porous and permeable, the oil often escapes but the oil cannot rise through the rocks if they are not permeable. Hence, the oil gets trap underneath the rock such impermeable rocks are known as cap rocks. The rocks which then contain the oil are called Reservoir rocks.

Reservoir rocks are characterized by high porosity and permeability and can often be identified by critical, geological examination.

Oil companies can then drill down through the impermeable rocks to obtain the oil, crude oil takes millions of years to form, these implies that the rate of usage is faster than the rate of formation.

CLASSIFICATION OF CRUDE OIL

1. Classification by location of its origin, example West Texas Intermediate (WTI).
2. Classification by its relative weight or viscosity e.g. light, intermediate and heavy crude.
3. Classification by sulphur content: IT GIVES "sweet" or 'sour'. Sweet- for crude oil characteristics that has little sulphur content, sour- for those characterized by substance containing sulphur.

This grade (sour) requires more refining to meet correct products standard and specifications. Most of Nigerian petroleum is classified as light or sweet meaning that the oil largely free of sulfur and is predominantly cyclic hydrocarbon and aromatics. The sulphur content in the range 0.1-0.3%.

EVOLUTION OF CRUDE OIL FROM ORGANIC MATTER

The physical and chemical transformation of organic matter during the geological history of sediment is controlled by factors such as:

1. Biological activities.
2. Temperature.
3. pressure
4. organic-inorganic matter
5. Time
6. Nature and abundance of organic matter
7. Composition of minerals and structure of the rock
8. distribution of organic fluid phases

The major stages involves in the evolution are Diagenesis, catagenesis, metagenesis and metamorphosis.

DIAGENESIS: When animals or plant matter is buried during sedimentation, the constituent of organic molecules or compound (Lipids, carbohydrate, amino acids, lignin compounds), breakdown due to increase in temperature and pressure, this transformation occurs within the first 100m of burial and the result in the creation of a basic product called Kerogen.

Sediment deposited into sub aquatic environment consists of H₂O which is 60% by weight of the total sediment, minerals, dead organic materials and living microorganisms. Such mixtures result from various sedimentary processes and primary component of different origin. The mixture is not homogeneous because its rather out of equilibrium and unstable. Diagenesis is a process through which the system

tends to approach equilibrium under condition of shallow burial. In this process, the sediments become consolidated (stabilized). In early diagenesis, the main agent of transformation is microbial activities which could be aerobic or anaerobic organic material within the sediment proceeds towards equilibrium previous biogenic polymers (carbohydrate, lipids etc) are destroyed by microbial activities, there constituents becomes progressively engaged in new poly condensed structure (Geopolymers).

Kerogen found in various oil shales worldwide, it is waxy in nature. The most important hydrocarbon formed during diagenesis is methane.

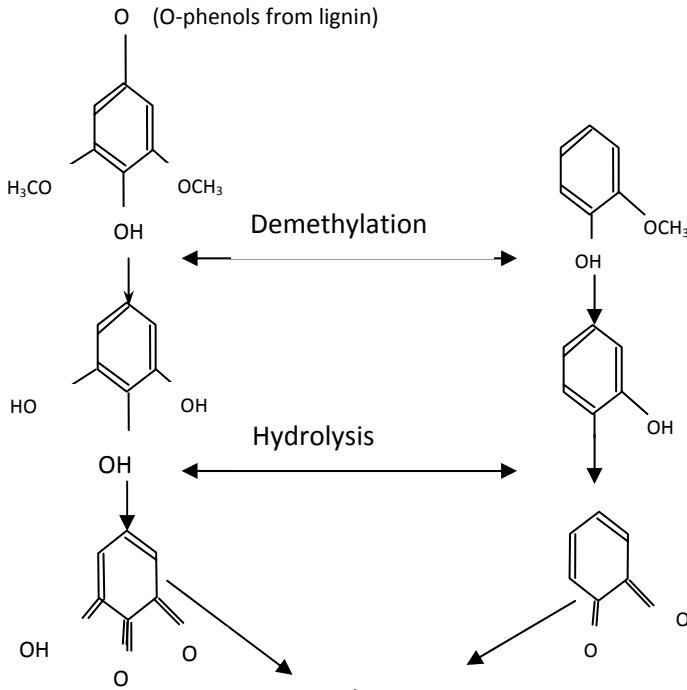


Fig 3: Hypothetical process of transformation of biogenic polymers, biogeopolymer to kerogen.

The end of diagenesis marked at the level where extractable humic acid have vised to a small (minor) amount where most of the carboxyl groups have being removed practically, this correspond to a vitrinite reflect CH₃ about 0.5%.

CATAGENESIS: Humus that hydrocarbons are formed, in this way under certain temperature and pressure crude oil and gas are formed. These hydrocarbons are formed during the diagenesis of organic matter. The process is characterized by consecutive and continuous burial of sediment for several kilometers. This implies a considerable increase in temperature and pressure. The geostatic pressure may increase to 5000 to 10000 psi. The main concern is the change in the composition and texture of the mineral matter. The main concern is the change in the composition and texture of the mineral matter. The main concern is the change in the composition and texture of the mineral matter. The main concern is the change in the composition and texture of the mineral matter.

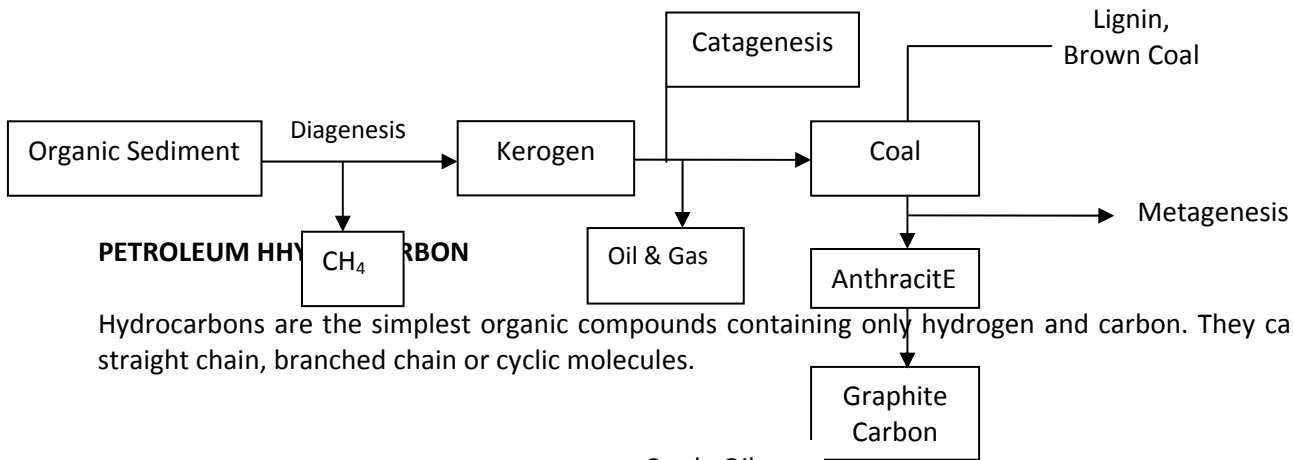
Humus continues to increase in temperature and pressure, the humus compound will transform into kerogen (waxy substance) and produces first liquid petroleum. In a latter stage and oil condensate are accompanied/associated with significant amount of methane gas, the end of catagenesis is marked by the disappearance of aliphatic carbon chain in the kerogen molecules fragment and then followed by the development or the ordering of the basic kerogen units. Practically, this corresponds to vitrinite reflectant of about 2.0%.

METAGENESIS:

With further evolution, there is no more generation of petroleum only limited amount of petroleum is produced. It is a point that anthracite formation begins. Minerals are severely transformed. For instance, clay minerals loosed their inter layers water and gain in higher crystallinity. Severe pressure may result in disappearance of the original rock structure. At this stage, organic matter gives only methane gas and carbon residue and the formation of coal commences.

METAMORPHOSIS:

This is apparently the last stage of evolution of sediment, in this case, temperature and pressure reach very high values, rocks are exposed to the influence of magma and hydrothermal effects. In the methmorphism, coal transform into meth-anthracite which has a vitrinite reflectant of 40%. The constituents of kerogen are converted to graphite carbon.



Hydrocarbons are the simplest organic compounds containing only hydrogen and carbon. They can be straight chain, branched chain or cyclic molecules.

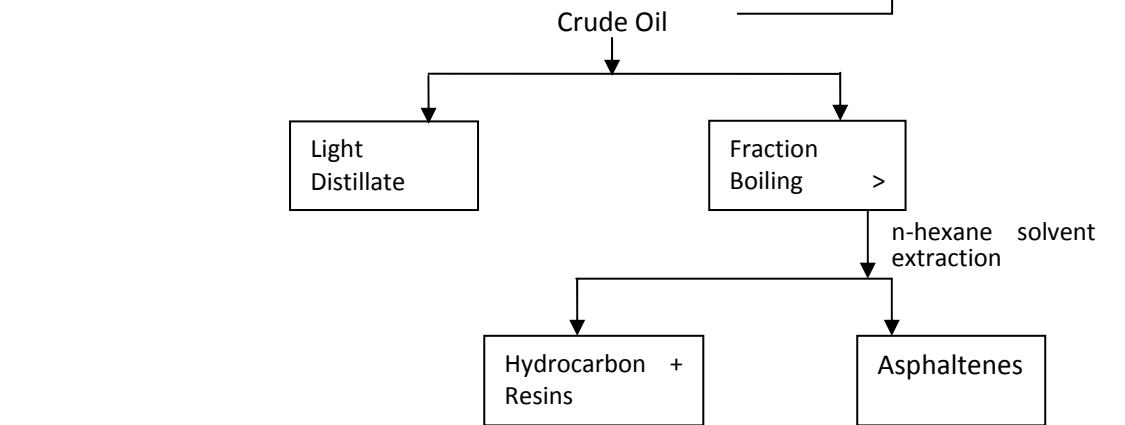
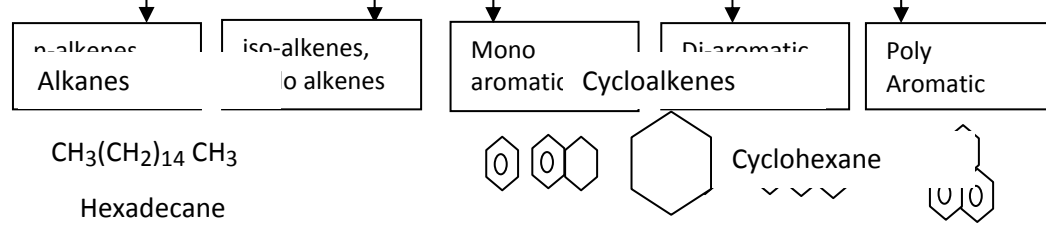
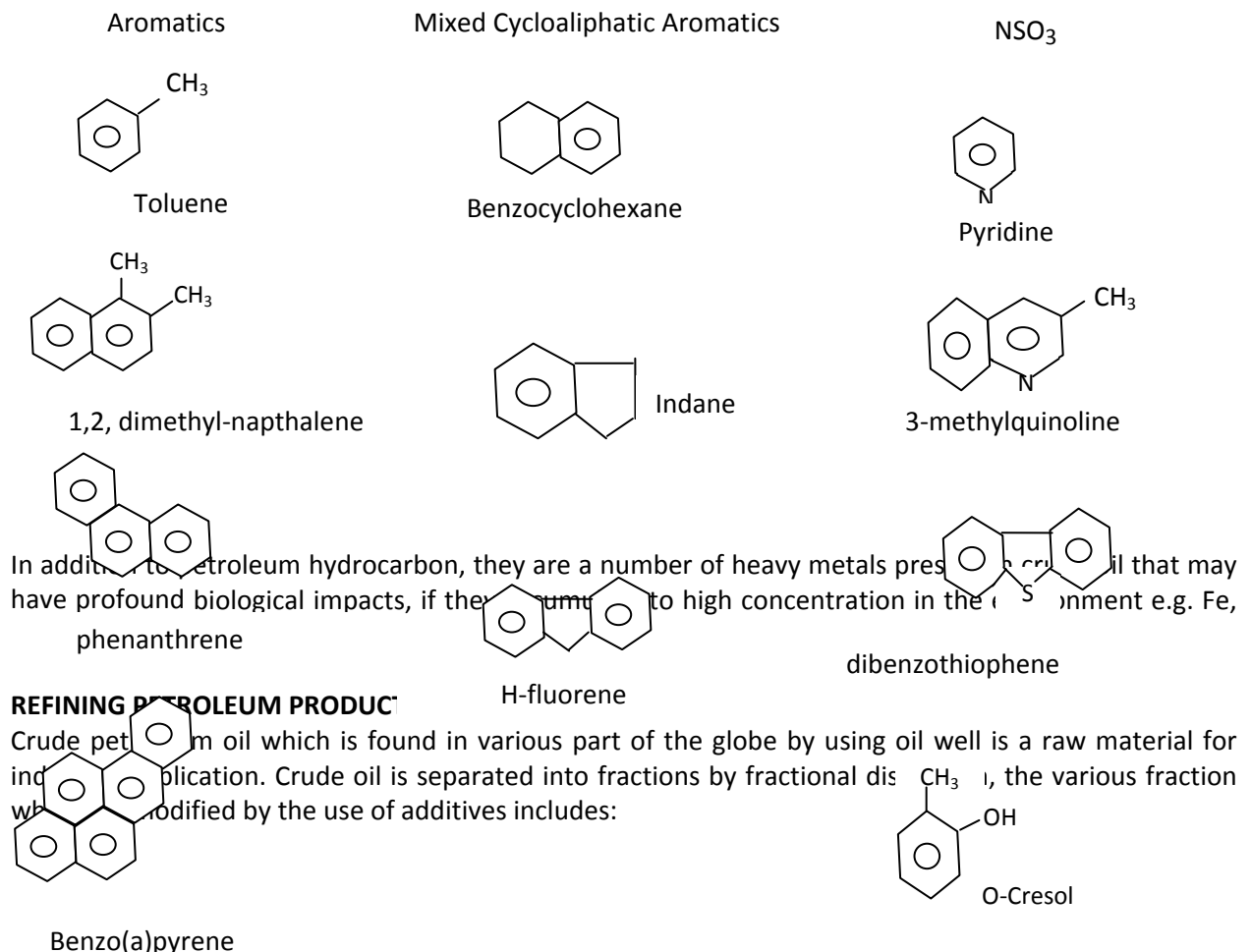


Fig 2: Analytical procedure of Assay cat. the GC column, characterization of crude oil. In MS, Aromatic compounds, G.C. between 5-35 carbon atoms. Sometimes a greater than 35 carbon atoms may be found. Relative MS active aliphatic and cyclic hydrocarbons present in petroleum and petroleum products.



Alkenes are relatively rare (unsaturated or olefin are rare in crude oil) but may be present in significant quantity in petroleum products. Branched alkanes are common, cyclic aliphatic are also common and they may be monocyclic, diacyclic, substituted or unsubstituted. A wide range of aromatics are available in crude oil and compounds containing both cyclo aliphatics and aromatic ring are also found.

Representative aromatic compounds found in oil or petroleum includes the following:



1. Gases: Products found here are methane, propane and butane, the first two are use for fuel gases C₁- C₂, while propane and butane are sold as bottled gas (cooking).
2. Petrol: Hydrocarbons rise in the range of C₇- C₈, they are basically alkenes and after additive have been added to them, they are used as fuel for internal combustion engines.
3. Kerosene: It is sometimes called paraffin and its used as fuel for jet engines, lamps and stoves.
4. Diesel oil: Used for diesel engines.
5. Lubricating oil: Which are further refined and treated before used as lubricants in machine.
6. Paraffin wax: It is of very high molecular weight made up of alkenes. Used for candle production.
7. Bitumen: Usually referred to as residue, it is used for road making and related activities. Some refined products of crude oil provides chemical for industries, for the manufacture of medicinal drugs, plastics, detergent, synthetic rubbers as well as many solvents e.g. Benzene. Hexene.

CRACKING OF PETROLEUM

Cracking is a process employed to convert the fractions of high boiling point into those of low boiling point, it is the conversion of large molecules to smaller ones, in this way the amount of petrol is increased. There are two basic types of cracking:

1) Thermal cracking 2) Catalytic cracking.

- 1) Thermal cracking: This can be achieved in various ways such as very strong breaking. This upgrades atmosphere vacuum residues by thermal conversion to middle distillate and heavy fuel oil by reducing viscosity.
- 2) Delayed coking: This is capable of cracking heavy oils that are not easily cracked. The resultant cracked gas oil can be suitably used as feed stock.
- 3) Fluid coking: This is the thermal cracking of the heaviest residue, utilizing fluid bed technology. Any pumpable hydrocarbon can be processed using this technology.
- 4) Flexi-coking: In this process, fluid coking and coke gasification are combined, how caloric gas derived from coke can be used in steam boilers, processed furnace or steam reforming furnace.

CATALYTIC CRACKING: This process is carried out in the presence of catalyst, the heavy fraction (diesel oil or lubricating oil) is heated so that the components vaporized and are fed into a reactor together with a very finely powdered catalyst. The oils are then converted to alkanes of lower molecular weight which are suitable for automobile fuel.

There are seven basic types of catalytic cracking:

1. Residue fluid catalytic cracking (RFCC)
2. Reduced crude cracking (RCC)
3. Heavy oil cracking (HOC)
4. Deep catalytic cracking (DCC)
5. Residue flexi-cracking (RFC)
6. Asphalt residue treating (ART)
7. Combined fluid and heavy oil cracking (CF/HOC)

1. RESIDUE FLUID CATALYTIC CRACKING:

The figure below is a fluidized bed process, consisting of a reactor and a regenerator section. Hot regenerated catalyst is mixed with raw oil feed in a short contact time of about 1-3sec in a riser reactor system. At the end of the reactor, the spent catalyst is separated from the cracked products and directed downward via a streaming zone into the regenerator where the coke of the catalyst is burnt off. This process restored the catalyst activity and selectivity.

OCTANE RATING

A straight run gasoline consists primarily of straight chain hydrocarbons and is of limited value as an automobile fuel. A high content of straight chain hydrocarbon causes a fuel to begin burning before the

spark plug ignites it, this premature ignition produces a knocking sound and leads to a loss of engine power and eventual damage to the engine. The tendency of gasoline to cause knocking is rated according to arbitrary scale known as Octane rating which was established in 1927 when a large number of branched and straight chain hydrocarbons in the gasoline range were tested separately for performance in a standard engine. The branched hydrocarbon (2, 2, 4-trimethyl pentane).

Iso-octane was found to be a superior fuel that burned without causing knocking; it was then assigned an octane rating of 100. The straight chain hydrocarbon (n-heptane) in contrast causes a serious knocking and was giving a rating of zero.

In other words, octane rating is a octane rating measure of resistance of gasoline and other fuel to engine knocking.

OCTANE NUMBER: The octane number of gasoline is measured in a test engine and defined by comparison with the mixture of iso-octane and n-heptane which would have the same anti-knocking capacity as the fuel under it. The % by value of iso-octane in that mixture is the octane number of the fuel e.g. an 87-octane gasoline possesses the same anti-knock rating of a mixture that consist of 87% (by value) iso-octane and 13% (by value) n-heptane. A gasoline with the same knocking characteristics has a mixture of 90% iso-octane and 10% n-heptane would have an octane number of 90.

note that this does not mean that the gasoline 60 actually contain these hydrocarbon in this proportion, it simply means that it has the same anti-knocking capacity as the reference mixture. Oil spill, containment, and remediation

Oil spillage is accidental or intentionally discharges oil. It is categorized into three main groups namely:

1. Minor oil spills: This takes place when the oil discharge is less than 25barrels in inland waters or less than 250barrels on land or coastal waters.
2. Medium oil spills: This takes place when about 250barrels are discharged in inland water or 250-2,500 barrels are discharged on land or coastal water.
3. Major oil spills: This takes place when the discharge is in excess of 2,500 barrels in inland water or over 2,500 barrels on land or coastal waters.

SOURCES OF OIL SPILLS

Quite a no of factors cause oil spillage, they include:

1. Well blow-out
 2. Pipeline rupture
 3. Storage failure
 4. Overflow of drilling mud
 5. Hose failure on tanker loading system
 6. Offshore/onshore production activities/accidents
 7. Washing of tankers
 8. Shipping and terrestrial traffic accidents
 9. Sabotage of well ends and pipe flow lines
 10. Leakage at the depot and gas station
- Disposal of petroleum waste etc.

Oil spillage from most of these sources could be prevented by proper engineering practices, equipment and procedures. Sporadic incidences of oil spills have been reported worldwide from time to time. In Nigeria, over the last two decades till date, the country has recorded several oil spill cases with net volume of up to 3million barrels.

MOVEMENT OF OIL FROM A POINT SOURCE ON A SOIL SAMPLE

The hydrophilic component of the oil tends to migrate into the aqueous phase and have the potential to contaminate ground water. Only the lighter more mobile hydrocarbons contaminate the ground water, while crude oil and heavier refined oil are relatively low in hydrophilic components.

Lateral of oil facilitates the evaporative removal of low molecules weight components, but increases contaminated area. Vertical flow minimizes these process but result in deep seated pollution of ground waters.

Movement of oil in soil is influenced by the following factors:

1. Spill volume
2. Hydrocarbon viscosity
3. Temperature
4. Wind speed
5. Land contour topography
6. Vegetation
7. Soil composition or soil chemistry

When oil spills in water, it spreads across its surface wind and wave action may spread or blow the slick to one side. Persistent hydrocarbons finally settle on the sediments. Generally oil is found in water body has films, solution, emulsion or tar balls depending on the solubility.

OIL SPILL CONTAINMENT: Containment is a process in which attempts are made to restrict the movement of oil to prevent it from further spread. The dangerous nature of oil spills has led to the development of containment devices. The following devices are employed in oil containment.

1. Chemical dispersal
2. Booms
3. Skimmers
4. Erection of earthen moat around storage tanks
5. Collection of oil by vacuum trucks or suction by foam.

USE OF CHEMICAL DISPERSAL

Some dispersant enhance hydrocarbon oxidation by microorganisms while others inhibits de oxidation process. This implies that some dispersant are harmful and toxic to the microbiota (micro-organism). Furthermore, addition of chemicals to spilled oil to sink it into the bottom of the sea may put a threat to aquatic organisms and even subsequent biodegradation is retarded both by the lack of O₂ and because of limited surface area.

FLOATING BOOMS

These are floating devices used to prevent oil from spread in aquatic environment. There are various sizes available for use in calm protected open water. The system is manufactured in such a way that they come in different length of up to a maximum of 200metres graded into sections. Each sections buoyancy tube has internal bulk ends every 3m to form independent chamber these are completely sealed, and in the event of damage to anyone chamber. The booms integrity and ability to contain oil is still retained. About 500metres length of a good boom can be deployed in less than 20minutes. The speed is due to the innovative feature of point inflation, a continuous air feeder sleeve and in one way valve to every 3m valve. Booms are usually durable. The seams are vulcanized to ensure good retention of excellent mechanical properties even after a prolong storage, it also gives resistant to degradation from exposure to hydrocarbon and ultraviolet light.

Good booms are easy to clean. After deployment, the booms are easily clean with normal detergent and hot or cold pressure washers. The booms continuous cylindrical shape, coupled with low air inflation pressure increases flexibility and produces a very responsive containment system.

The smooth continuous boom profile inhibits formation of coagulates (coagulated oil) on the surface, thereby discouraging oil loss. In summary, an excellent boom device used for oil containment must possess the following qualities:

1. Integrity
2. Rapid and easy deployment
3. Durability
4. Easy to clean
5. Flexibility

6. Wave resistant
7. Oil retention with no loss especially under the boom.

Finally, with the event of damage occurring in the fabric of the boom, a portable electrical device is taken to the site to carry out repairs on the damage.

ENVIRONMENTAL FATE OF CRUDE OIL OR PETROLEUM

Fuels are typically released to the environment when storage and delivery system leak or when sudden accidental spill occurs. Storage tank either above ground or underground are made of steel which is known to corrode and leak if not properly outfitted with anticorrosion devices. Fuel storage and delivering systems are in physical contact with air, soil and/or ground H₂O. The environmental fate of sub-surface crude oil release is determined by a number of inter related factors which include:

1. The type of crude oil released
2. Rate of release
3. Characteristics of the ground water surface
4. Vertical distance to ground water surface
5. Proximity to surface H₂O body

An oil spill into the marine environment has the following fate:

1. Physical transport
2. Dissolution
3. Sedimentation/Biosedimentation
4. Emulsification
5. Aggregation
6. Microbial degradation
7. Oxidation and destruction

1. Physical transport: The distribution of oil spill on the sea surface occurs under the influence of gravitational force, viscosity of oil and surface tension of H₂O. During the first day after an oil spill, a considerable part of oil will be transformed into the gaseous phase. The oil slick will also lose H₂O soluble hydrocarbon rapidly. Further changes take place under the combined impact of meteorological and breakdown of oil into less harmful compounds, adsorption of hydrocarbon into or by organic matter in the environment will also occur. In the unsaturated soil, being above the ground water zone, fuel migrates downward under the force of gravity and is spread horizontally under other mechanical forces. Once the fuel reaches the ground H₂O, it will dissolve to a minor degree and they accumulate at the ground H₂O surface where it will continue to volatilize into the dry soil above and dissolve in the ground H₂O below.

FATE AND BEHAVIOUR OF OIL IN THE MARINE ENVIRONMENT

Complex processes of oil transformation in the marine environment start developing from the first second of oil contact with sea water. The progression, duration and result of this transformation depend on; Sedimentation of oil can be an extremely slow process simultaneously with the process of biosedimentation occur: plants, filtrations and other organisms absorb the emulsified oil and they sediment to the bottom with their metabolites.

2. Dissolution: Most oil components are water soluble to a certain degree especially low molecules with aliphatic and aromatic hydrocarbons. Polar compounds formed as a result of oxidation of some oil fraction in the marine environment also dissolve in sea water.

Hydrodynamic and physico-chemical conditions in surface H₂O also strongly affect the rate of the process (dissolution).

3. Sedimentation and biosedimentation: This involves the adsorption of some oil component on suspended materials in the H₂O and deposition at the bottom. This may happen in the narrow coastal zone and shallow water where particulates are abundant and water is subjected to intense mixing.

4. Aggregation: Oil can aggregate in form of petroleum lump and tar balls, or pelagic tar and this can be found in both open coastal water as well as the beaches. Hydrological factors are mainly on the power and direction of wind waves and current. An oil slick usually drifts in the same direction as the wind storms and active turbulence speed up the dispersion of the slick and its fragment.

5. Microbial degradation: The fate of most petroleum substance in the environment is ultimately defined by their transformation and degradation due to microbial activity. There are several known species of bacteria and fungi that are able to use oil component to sustain their growth and metabolism. Biochemical processes of oil degradation with microorganism participation include several types of enzyme oxidation based on oxygenases, dehydrogenases, hydrolysis, reductases as well as amidases. These cause aliphatic and aromatic oxidation and hydroxylation, oxidative deamination, hydrolysis and other biochemical transformation of the original oil substances and the intermediate products of their degradation.

The biodegradation of petroleum is essential to the elimination of oil spill, oil degraded by both marine bacteria, filamentous fungi. In some cases the rate of degradation is limited by available nitrate and phosphate. The physical form of crude oil makes a large difference on its degradability. Degradation in water occurs at the water-oil interface. Therefore, thick layers of crude oil prevent contact with bacteria enzymes and oxygen. Apparently, bacteria synthesize emulsifiers that keep the oil dispersed in water as a fine colloid and accessible to the bacterial cell.

6. Oxidation and destruction: chemical transformation of oil in water surface and in the H₂O column starts to reveal them not earlier than a day after oil enters the marine water. The chemical often involves photochemical reactions under the influence of UV waves. These processes are catalyzed by some trace elements. E.g. vanadium and inhibited by compounds of sulphur, the final products are usually hydroperoxide, phenol, carboxylic acid, ketone and aldehyde. All of them usually have increased H₂O solubility.

TOXICITY OF PETROLEUM HYDROCARBON

Hydrocarbons are the most commonly used substances in industries and developing societies, hydrocarbon products are not pure substances but mixtures of saturated, unsaturated ring and straight chain molecules. The liquid form comprises molecules containing 5-15 carbon atoms that are arranged in aliphatic, alicyclic, and aromatic structures with varying amounts of sulfur, nitrogen, oxygen impurities. Confusion has existed for many years as to the toxicity of petroleum hydrocarbons, partly because hydrocarbon products are not a single class of compounds but may contain other more toxic compounds. For instance fuel such as gasoline, petroleum naphtha is among the most commonly ingested petroleum distillates, although they carry a low systemic toxicity, they are dangerous when their fumes are inhaled. Solvent thinners on the other hand are more dangerous systemically because of their high content of benzene, toluene, xylene, halogenated hydrocarbons.

MICROBIAL HYDROXYLATION

This often accompanies oxidation and it involves the attachment of OH groups to the hydrocarbon chain or ring. It consists of more than one OH group. An example of epoxidation and hydroxylation is the metabolite production of 7,8-diol-9,10-epoxide of benzo pyrene.

The metabolism of benzo pyrene according to the reaction above is of environmental and toxicological composition, because one of the isomers of the product binds strongly to cellular DNA and this can cause cancer in an organism. Viscosity is the most important property because it relates directly to the risk of pulmonary aspiration. It determines the likelihood of a hydrocarbon entering the lungs structure. For example, a substance with low viscosity has less resistance to flow, consequently. Even a small volume can be spread along the mucus membrane of the oral cavity into the airway. Low viscosity and surface tension therefore increase the aspiration hazard.

CLINICAL SYMPTOMS OF HYDROCARBON INTOXICATION

1. Respiratory symptoms: This includes burning sensation in the mouth, choking, gagging, cough, cyanosis and fever.
2. CNS symptoms of hydrocarbon ingestion: These include light headedness, lethargy, dizziness, headache, visual disturbance, seizure and coma.

This shows that toxicity of petroleum, varies according to composition and as a chemical group, aromatic hydrocarbons are generally more toxic than other types of hydrocarbons.

ROUTE OF ABSORPTION

Orally (ingestion), inhalation (respiratory), dermal or cutaneous.

Ingestion is the most common and may lead to chemical pneumonitis, CNS depression and gastro intestinal irritation.

Direct skin contact may result in dermatitis or contact burn, and the inhalation of hydrocarbon may result in CNS dysfunction, cardiac, renal and liver toxicity as well as lead poisoning.

Benzene: It is usually regarded as the most dangerous hydrocarbon in industries today, it is rapidly absorbed upon ingestion, inhalation or skin.

Skin contamination has a particular affinity for nerve tissue. The symptom of acute inhalation includes marked excitatory effect with subsequent depression and respiratory failure. Chronic poisoning is much more common and may result in hematological abnormalities such as leukemia, a plastic anemia and acute myelo plastic leukemia. Because of its toxicity, benzene has been bound as ingredient in product intended for home use.

SYMPTOMS OF TOLUENE INTOXICATION

These include: hallucination, blurred vision, slurred speech, stupor, abdominal pain, depression, brain atrophy and ataxia (shaky movement)

Gastrointestinal effects: effects such as nausea, vomiting, abdominal pain and diarrhea are usually mild and due to direct mucosal irritation.

SYSTEMIC TOXICITY

This has been associated with some hydrocarbons, additives and some hydrocarbon products. Aromatic hydrocarbons e.g. Benzene, toluene, xylene, halogenated hydrocarbons, carbon tetra chloride. Additive e.g. lead, camphor etc.

The symptoms are related to the chemical composition and volatility of the injected substances.