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Hydrocarbon Exploration

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Doctorate in Petroleum Engineering

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# INTRODUCTION

The quest for increased output in production, to run complicated power generation machines also called gas turbines and need to use super machines to achieve timely goals etc. has always been some of the reasons why the demand for oil and gas exploration is always on the high. Oil and gas products are used to propel vehicles engines, to drive turbine and super engines which produces electricity when transduced by electrical alternators, to drive boilers in industries and for other domestic and industries uses. For domestic use, insecticides, jellies, roofings, electric blankets, fishing boots, tennis rackets, plastic woods, ice cube trays, fishing rods, speakers, toilet seats etc. are all products from oil and gas. For industrial, Oil and gas are used to process product like fuel oil, pharmaceutical products (pills, capsule and syringe, fertilizer and pesticides, detergents and solvents, artificial scent and perfumes, asphalt and tars, lubricants, petroleum jellies etc. All the above are components or products gotten from oil and gas which necessitate the demand for Hydrocarbon Exploration

Hydrocarbon Exploration also known as Oil and Gas Exploration is the search by [petroleum geologists](https://en.wikipedia.org/wiki/Petroleum_geologist) and [geophysicists](https://en.wikipedia.org/wiki/Geophysicists) for deposits of [hydrocarbons](https://en.wikipedia.org/wiki/Hydrocarbon), particularly [petroleum](https://en.wikipedia.org/wiki/Petroleum) and [natural gas](https://en.wikipedia.org/wiki/Natural_gas), in the [Earth](https://en.wikipedia.org/wiki/Earth#Crust) using [petroleum geology](https://en.wikipedia.org/wiki/Petroleum_geology).

There are different phases to be covered in order to fully explain or cover Hydrocarbon Exploration which include Prospecting (which is the very first stage in the search for oil and gas fields. Activities tend to cover large areas in an attempt to see if petroleum accumulations might be present), Exploration (which is involves detailed data gathering and modelling including seabed sampling and seismic surveying over smaller, more specific areas. If analysis of data collected from these activities looks promising companies may decide to drill an exploration well) and Production (which commences once all infrastructure requirements are built and appropriately commissioned, the development project then moves into a production phase which involves 24 hours a day production, processing and transport of the petroleum products to market).

# DESCRIPTION OF COURSE COMPONENTS AND HOW IT RELATE TO MODERN WORLD

Hydrocarbon Explosion also known as Oil and Gas Exploration is a compound process which encompasses the processes and methods involved in locating potential sites for oil and gas drilling and extraction. In the early days, Hydrocarbon also known as Oil and Gas were discovered via physical surface signs like natural oil seeps, but developments in science and technology have made oil and gas exploration more efficient. Nowadays, Technology has made it possible for explorers to utilize efficient methods like seismic surveys, electric/ electromagnetic methods etc. to make the process of finding hydrocarbon deposit easy which also make exploration economically viable.

The different topics to be covered to better explain Hydrocarbon Exploration are:

* 1. Understanding Hydrocarbon and the segment in Oil and Gas industry: Hydrocarbon is an organic raw material created by the compression of the remains of plants and animals in sedimentary rocks such as sandstone, limestone, and shale which are naturally occurring substances found in rock in the earth's crust called Oil and Gas. The Hydrocarbon or oil and gas industry is broken down into three main segments which are **Upstream** (refers to points in production that originate early on in the processes. Also called exploration and production (E&P), upstream is farthest from the end-user consumer in the oil & gas supply chain), **Midstream** (refers to points in the oil production process that falls between upstream and downstream. In particular, midstream activities include the storage, processing, and transportation of petroleum products) and **Downstream** (.are the processes involved in converting oil and gas into the finished product. These include refining crude oil into gasoline, natural gas liquids, diesel, and a variety of other energy sources) (McClay, 2021).
  2. The petroleum permit lifecycle and Block Offer: Since these deposits are located in a specific geographical area and residing in an own territory, there must be an agreement to operate. Different territory operate different laws which determines the requirements needed to permits to be given before exploration is allowed. International permits, national permits, state permits and local government permits requirements are all different and are subject to the laws of the land (Mineral, 2021).
     1. Assessment: Has to do with Prospecting permits
     2. Exploration: Has to do with Exploration permit
     3. Production: Has to do with mining permit
     4. Decomposition and restoration: has to do with requirements regarding plugging and abandoning of petroleum wells
  3. Phases of Petroleum Exploration and Production: This covers Prospecting and exploration activities aim to identify the location and size of petroleum fields and whether extracting the resource is likely to be profitable (Minerals, 2021):
     1. Prospecting: first stage in the search for oil and gas fields. Prospecting activities tend to cover large areas in an attempt to see if petroleum accumulations might be present.
     2. Exploration: to identify areas with the right geologic conditions for a profitable accumulation of petroleum and to mine them.
     3. Production: To make the extracted oil and gas useful commercially via adding and removing other components.

# 3.0 General Analysis Additional relevant details about the topic and examples on how the applies in reality

Before going into the detail of Hydrocarbon Exploration, let’s first define the terms involved which is Hydrocarbon and Exploration. Hydrocarbon refers to the most basic type of [organic molecules](https://energyeducation.ca/encyclopedia/Organic_molecule) ([molecules](https://energyeducation.ca/encyclopedia/Molecule) that are made of [carbon](https://energyeducation.ca/encyclopedia/Carbon) and [hydrogen](https://energyeducation.ca/encyclopedia/Hydrogen) and can include other elements (like [oxygen](https://energyeducation.ca/encyclopedia/Oxygen) and can also contain [nitrogen](https://energyeducation.ca/encyclopedia/Nitrogen), [sulfur](https://energyeducation.ca/encyclopedia/Sulfur), [phosphorous](javascript:%20void(0)), and others) and they are comprised of only 2 elements which are [hydrogen](https://energyeducation.ca/encyclopedia/Hydrogen) and [carbon](https://energyeducation.ca/encyclopedia/Carbon). They have one or more atom of carbon at the center and hydrogen atoms in a chainlike manner surrounding it or them. There are four main categories of hydrocarbons: [Alkanes](https://energyeducation.ca/encyclopedia/Alkane) CnH2n+2, [Alkenes](https://energyeducation.ca/encyclopedia/Alkene) CnH2n, [Alkynes](https://energyeducation.ca/encyclopedia/Alkyne) CnH2n-2, and [Aromatic hydrocarbons](https://energyeducation.ca/encyclopedia/Aromatic_hydrocarbon). Alkanes are described as saturated hydrocarbons, while alkenes, alkynes, and aromatic hydrocarbons are said to be [unsaturated](https://www.britannica.com/science/unsaturated-compound). Figure 1 below shows the structure of representative Hydrocarbons (Chary, 2020):

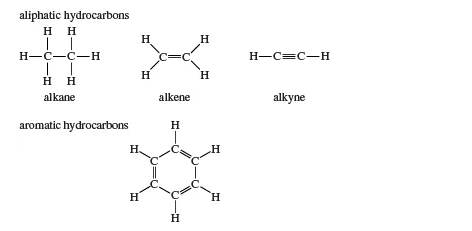


Figure 1: Structure of Representative Hydrocarbons

Alkanes are hydrocarbon with single bonds between the carbon atoms and some examples of Alkanes are Methane (CH4), Ethane (C2H6), Propane (C3H8), Butane (C4H10), Pentane (C5H12), Hexane (C6H14), Heptane (C7H16), Octane (C8H18) etc. and figure 2 below show some of the structures of Alkanes:

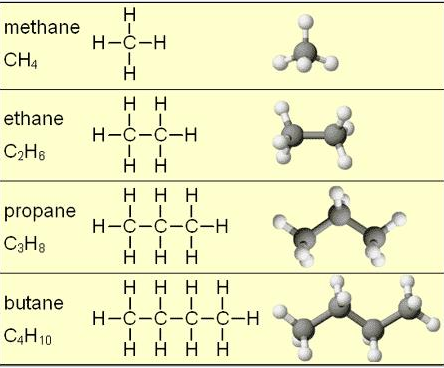


Figure 2: Some Alkanes structures

Alkenes are hydrocarbons unsaturated compounds with at least one carbon-to-carbon double bond surrounded by hydrogen and some of it examples are Ethene (C2H4), Propene (C3H6), Butene (C4H8), Pentene (C5H10), Hexene (C6H12), Heptene (C7H14), Octene (C8H16), Nonene (C9H18) etc. and figure 3 below show some of the structures of Alkenes:

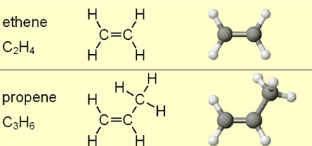


Figure 3: Some Alkenes structures

Alkynes are hydrocarbons with carbon-carbon triple bonds surrounded by hydrogen and some of it examples are Ethyne C2H2, Propyne C3H4, 1-Butyne C4H6, 1-Pentyne C5H8, 1-Hexyne C6H10, 1-Heptyne C7H12, 1-Octyne C8H14, 1-Nonyne C9H16, 1-Decyne C10H18 etc. and figure 4 below show some of the structures of Alkynes:

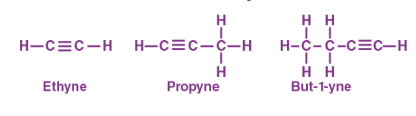


Figure 4: Some Alkynes structures

Aromatics (arenes) are true hydrocarbons ([molecules](https://energyeducation.ca/encyclopedia/Molecule) are made up of only [hydrogen](https://energyeducation.ca/encyclopedia/Hydrogen) and [carbon](https://energyeducation.ca/encyclopedia/Carbon)) with strong fragrance and [unsaturated](https://energyeducation.ca/encyclopedia/Unsaturated_hydrocarbons) rings (they have at least one double bond between the carbon atoms). They contain benzene ring and some of their examples are Benzene (Phenyl hydride), Toluene (Methylbenzene), O-Xylene (1, 2-dimethylbezene) etc.

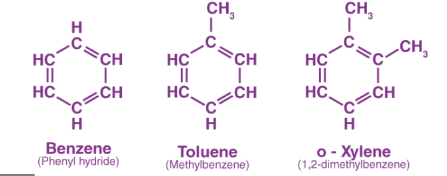


Figure 5: Some Aromatic Hydrocarbon structures

Exploration on the other hand is an investigation or a travel experience or the act of searching for the purpose of discovery of information or resources, especially in the context of geography or space, rather than research and development that is usually not centred on earth sciences or astronomy. Also, is an act of extracting or mining that which is deposited in the subsurface of the earth or water.

Combining both, hydrocarbon exploration is the process of extracting or mining the oil and gas deposits in the subsurface of the earth or water.

3.1 Understanding Hydrocarbon and the segment in Oil and Gas industry: The submission above the clearly explained what Hydrocarbon is and the further expanciate the different segments of the Oil and Gas industry (Upstream, Midstream and Downstream), we will have to do it one after another:

3.1.1 Upstream: this is one and the most important segment of the oil and gas industry which deals with the exploration and production of hydrocarbon. The Upstream sector which is also known as the Exploration and Production (E&P) involves the search for [hydrocarbons](https://www.investopedia.com/terms/h/hydrocarbon.asp), which are the primary components of petroleum and natural gas. Land surveys are performed to help identify the areas that are the most promising. The goal is to locate specific minerals underground in order to estimate the amount of oil and gas reserves before drilling. The Explorers also known as Geologists study rock formations and layers of sediment within the soil to identify if oil or natural gas is present in commercial quantity before extraction takes place. Magnetic, gravimetric, or seismic (including refraction/reflection) techniques might be used to locate the deposit of hydrocarbon depending on the method which better suits the environment and purpose for exploration in the geographical area. If an area shows potential to host a resource, exploratory wells are drilled to test the resource. In the oil and gas sector, test drilling is an important component of the exploration phase. In the event that the exploratory well is successful, the next step is to construct wells and extract the resource. Upstream companies also operate the wells that bring the crude oil or natural gas to the surface. Many of those employed in the upstream part of the industry include geologists, geophysicists, service rig operators, engineering firms, scientists, and seismic and drilling contractors. So, the Upstream terminates after water is separated from the oil and gas, impurities are removed, oil and gas is treated and stored in tanks.

3.1.2 Midstream: This is the second segment in the oil and gas industry which activities include the processing, storing, transporting, and marketing of oil, natural gas, and [natural gas liquids](https://www.investopedia.com/terms/n/natural-gas-liquids.asp). They serve as an intermediary between the Upstream and the Downstream storing, transporting and storing explored/ produced hydrocarbon from its origin to where it will be refined into components that will best suit man’s needs. In most cases, oil and gas reserves are not located in the same geographic location as refining assets and major consumption regions. Transportation is a big part of midstream activities and can include using pipelines, trucking fleets, tanker ships, and rail cars.

3.1.3 Downstream: This is the third and last segment in the oil and gas industry which activities include the converting or processing of oil and gas into the finished product which is used to satisfy man’s needs on a daily basis. Some of these products include liquefied natural gas, gasoline, heating oil, synthetic rubber, plastics, lubricants, antifreeze, fertilizers, and pesticides. The downstream are either refineries or manufacturing companies thus, the end production as an out of the oil and gas input injected or inputted into their process machines.

Hydrocarbon, also known as liquid petroleum, also called crude oil, also known as oil and gas is found [accumulated](https://www.britannica.com/dictionary/accumulated) in various porous rock formations in [Earth’s](https://www.britannica.com/place/Earth) crust and is extracted for burning as fuel or for processing into chemical products. As mentioned above, Paraffins, also called alkanes are the most common hydrocarbons in crude oil (certain liquid paraffins are the major [constituents](https://www.merriam-webster.com/dictionary/constituents) of [gasoline](https://www.britannica.com/technology/gasoline-fuel) (petrol) and are therefore highly valued). Naphthenes also called cycloalkanes are an important part of all liquid refinery products, but they also form some of the heavy [asphalt](https://www.britannica.com/science/asphalt-material)like residues of refinery processes. Aromatics generally [constitute](https://www.merriam-webster.com/dictionary/constitute) only a small percentage of most crudes. The most common aromatic in crude oil is [benzene](https://www.britannica.com/science/benzene), a popular building block in the [petrochemical](https://www.britannica.com/science/petrochemical) industry. Crude oil physical properties ranges from colourless to black and its [specific gravity](https://www.britannica.com/science/specific-gravity) (i.e., the ratio of the weight of equal volumes of a crude oil and pure [water](https://www.britannica.com/science/water) at standard conditions). It specific gravity also ranges from heavy: 10–20° API gravity, Medium: 20–25° API gravity to Light: above 25° API gravity. API gravity (from American Petroleum Institute) is a measure of the [specific gravity](https://www.sciencedirect.com/topics/earth-and-planetary-sciences/density-mass-volume) of the oil at 60°F or 16°C. It is somewhat arbitrarily defined by the equation

API°=141.5/specific gravity−131.5 (Clayton, 2005)

This system is used as it gives an integer value that is easier to dis They are also categorized as sweet or sour depending on [sulfur](https://www.britannica.com/science/sulfur) level content in it, which occurs either as elemental sulfur or in [compounds](https://www.merriam-webster.com/dictionary/compounds) such as [hydrogen sulfide](https://www.britannica.com/science/hydrogen-sulfide). The term for crude that has zero or less sulfur content is known as Sweet crudes (usually 0.5 percent or less by weight) and sour crudes have sulfur contents of 1 percent or more by weight. More heavier the crude oil is as a result of its sulfur content and this sulfur is removed from crude oil during refining, because sulfur oxides released into the atmosphere during combustion of oil are a major [pollutant](https://www.britannica.com/science/air-pollution).

Some companies in the Oil and Gas industries are either a single segment company which operate either of the three segment, dual segment or triple segment. For example IOC like ExxonMobil is a triple segment oil company because they have the Upstream, Midstream and the Downstream segment in their operations.

3.2 The petroleum permit lifecycle and Block Offer: Before exploration is allowed to be carried out, the laws of the land has to be taken into consideration. These laws are put in place to curtail the degradation of the environment, to protect the citizens and dwellers in the environment, to protect workers, to ensure that standards are followed, explorers have the technology and finance to operate etc. when requirements are met, permits are issued. The agencies involved and the roles they play differ depending on the phases of the petroleum permit and whether it is onshore or offshore and the include:

3.2.1 Assessment: one of the major role of the agencies responsible for issuing permits is assessment. Assessment is done to issue of give:

3.2.1.1 Prospecting Permits: these are of two types which are exclusive and non-exclusive types. Non-exclusive are for speculative prospectors to acquire and on-sell data on a multi-client basis to explorers. However, if a capable operator wants to search for petroleum on a proprietary basis over an area with no other interest, an exclusive prospecting permit may be granted.

3.2.1.2 Land Access: Permit holders must provide 10 days. 30 days etc. (depending of the law of the land) notice of planned minimum impact activities to landowners and occupiers on private land. Permission is required from the responsible department or agency for minimum impact activities on public conservation land.

3.2.1.3 Environmental Protection: Different surveying techniques including seismic carried out onshore or within 12 nautical miles (nm) of the coast may be a permitted activity (subject to compliance with specific criteria) and require resource consent depending on the rules in the relevant agencies in the local, state or federal level.

3.2.2 Exploration: This also requires permit from the responsible agencies in the local, state or federal level.

3.2.2.1 Exploration Permit: This is the first step of gaining permission to explore for petroleum, getting a Petroleum Exploration Permit (PEP). This is gotten when the requirement from the relevant authorities are met. Finance, competency of personnel, technology, documented experience etc. are considered before the permit is given.

3.2.2.2 Land Access: Having the exploration permits alone do not give the permit holder automatic rights to access an onshore permit area. They must notify landowners and those occupying the land of planned minimum impact activities, or enter into a contract with the land owner/occupier known as an access arrangement for more invasive activity such as drilling. When it comes to government-owned land, an access arrangement would be required from the relevant government department.

3.2.2.3 Environment Protection: In the early phase of exploration, surveying may be a permitted activity or require a resource consent from the relevant agency if onshore or within 12 nm of the coast but before the actual drilling commences, a resource consent is likely to be required, depending on the rules in the relevant agencies in the local, state or federal level.

3.2.2.4 Oil Spill Response: Knowing that hydrocarbon is banned to spill during exploration or production, operators need to apply to the relevant agency for approval of their Oil Spill Contingency Plan.

3.2.2.5 Health and Safety: Considering the exploration operation which is always hazardous, different safety and health requirement (ambulance, clinic, rescue equipment, personnel safety training records etc.) has to be assess by relevant departments/ agencies before permit is giving for a closure before exploration can commence.

3.2.3 Production: Apart from the exploration permit, the production phase also requires permit before production can be carried out. This include:

3.2.3.1 Mining Permit: If the operator decides not to sell off the commercial quantity of the hydrocarbon gotten during exploration stage, they will need a different permit from that of the exploration to be able to produce what which was explored. Granting the permit includes agreeing on a development programme that ensures maximum responsible recovery of the resource over the life of the field.

3.2.3.2 Land Access: This also requires a permit in the production stage. Operations can’t be done in isolation from the documented agreement, it has to be done according to the permitted agreement.

3.2.3.3 Environment Protection: Both the geographical location, the owner and the occupiers has to be protected considering that the hydrocarbon exploration and production process is hazardous. Before drilling or mining can begin onshore or within 12 nautical miles (NM) of the coast, resource consent is likely to be required in accordance with the relevant agencies or departments plan.

3.2.3.4 Oil Spill Response: Operators need to apply to to relevant agency/ department in the local state or federal level for approval of their Oil Spill Contingency Plan.

3.2.3.5 Health and Safety: Operators must have a [Safety Case approved by relevant unit](https://worksafe.govt.nz/topic-and-industry/petroleum/major-accident-prevention-policy-and-safety-case-requirements/) and comply with the relevant health and safety regulations.

3.2.4 Decommissioning and Restoration: WorkSafe (an international health and safety regulatory body)and other state based safety and health bodies have requirements regarding plugging and abandoning of petroleum wells – including the [submission of a revised Safety Case](https://worksafe.govt.nz/topic-and-industry/petroleum/major-accident-prevention-policy-and-safety-case-requirements/) before a production facility can be retired. So, before hydrocarbon operation is decommissioned or restored, it has to go through a checklist to ensure that the process will be safe and a permit will be issue if all requirements are met.

3.3 Phases of petroleum exploration and production: This section will cover the different stages also known as phases which is involved in the exploration and production of oil and gas. It’s actually the phases from an individual or company decides to venture into the business to where they sales or use the hydrocarbon or components of the hydrocarbon. These phases are:

3.3.1 Prospecting: This is the very first and critical stage in the search for oil and gas fields. The activities covered during this phase include desktop studies, land or seafloor sampling and geophysical surveys. These are all minimal impact activities which the environment, owners of the land or occupiers are not really impacted. Drilling of well is not part of this stage because the actual aim of this stage is to know if there is hydrocarbon where it is suspected to be and if it is in commercial quantity.

3.3.1.1 Desktop Studies: As prospecting is the first stage of exploration activities, so is desktop studies to prospecting. It is the literature and data review stage of prospecting. Here, data from rock and soil samples are collected analyzed, reviewed and models will be created using specialized computer software to visualize how the area has changed over both time and space to know if there is hydrocarbon and the quantity present in the area. Here, interpretation and comparison of data from both present data are done to ascertain the presence of hydrocarbon.

3.3.1.2 Geological Mapping: Here, geologist physically going out into the field and recording geological information from the rocks that outcrop at the surface. A geological map of an area of prospective hydrocarbon sites can be put together from existing geological information maps and/or new field work. The maps are of geological features on the surface and subsurface of the earth.

3.3.1.3 Geochemical surveys ('General sampling'): Here, the surveys involve sampling of rocks, soils, and stream sediments, which are then analyzed. The results of the chemical survey can reveal many things, such as where the hydrocarbon originally came from, the hottest temperature it got to and whether it has been broken down by bacteria along the way. Chemical that makes up these samples are analyzed and data gotten gives direction how exploration should be done to avoid breaking or contaminating the required hydrocarbon.

3.3.1.4 Geophysical surveys: Here, geophysical data are collected for spatial studies. These data are gotten via Seismic test, Siesmoelctrical test, Geodesy and gravity test, Magnetic geophysical test etc. These surveys are used to generate images of underground structures/ layers and are used to explore for spots that may contain oil and/or gas without physically drilling into the surface of the earth. The main two surveys used for hydrocarbon exploration are Swath bathymetry (which an acoustic mapping tool used to create a map of the seafloor. It is effectively sonar, similar to a powerful fish finder used in many vessels. Typically the sound waves can only travel meters into the seafloor) and Seismic surveys (which may be done on land (for example from a truck), or offshore by boat. These surveys create sound waves which can travel kilometers into the earth and are reflected from layers of rock and recorded. The information collected tells geologists about the layering and nature of the rocks under the surface of the earth).

3.3.2 Exploration: This stage can only be done if there is a detailed data gathering and modelling including seabed sampling and seismic surveying over smaller, more specific areas. If analysis of data collected from these activities looks promising companies may decide to drill an exploration well. The different stages of exploration include:

3.3.2.1 Pre-drilling: Drilling an exploration well is the only conclusive way to test for the presence of an oil and gas field. Before this is done, some operations called the pre-drilling operations has to be carried out. These operations include moving focus from evaluating the geologic risks to evaluating the operational risks (It is the point at which environmental, geological and financial risk all converge). Both hired experts from consulting firms and exploration in-house team combines their knowledge to create a plan for operational drilling activities. The highlights the requirements needed prior to drilling of the exploration well taking into account both the geologic and environmental challenges and which engineering solutions best meet the challenges.

3.3.2.2 Environmental Considerations: This is also considered during exploration. The environmental challenges of most concern to offshore drilling operations are the ocean conditions such as the wind, ocean currents, and swell (known as a metocean study). Historical data of the environment are analyzed which will help guide the predictions to be made to curtail incidents during exploration. Impact assessment is carried out and report which should include some mitigation step of curtailing that which might impact the marine environment is given. The impact assessment is done in collaboration of the locals of the environment.

3.3.2.3 Surface/near surface site survey: To understand the surface/ near surface site, a survey has to be carried out to ensure that the site is safe. This survey scans the sea floor to image its bathymetry (sea floor terrain) and collect very high resolution 2D seismic data in order to understand the near surface geology and detect the presence of shallow gas or any other hazards. For onshore, a site survey is not required but surface considerations are taken into account in the well-pad location and well planning stage.

3.3.2.4 Subsurface activities: Using the Seismic analyzed data, the subsurface formulations has to be understood before drilling activities is carried out in order to plan a well trajectory aiming to intersect the target zone at the best angle and avoid any fracture zones or zones of high pressure. Geophysical data from seismic survey and prior drilling results are also used to help forecast the pressure as the well is drilled which is used to decide on casing points, cement strengths and appropriate mud weights, which are essential safety measures to prevent the flow of hydrocarbons and retain ‘well control.

3.3.2.5 Drilling a well: Post metocean, site survey and well plan for the offshore site, the exploration proper which is to test their theory that the prospect contains a commercial accumulation of hydrocarbons. The first step is to safely secure the rig on site according to the site survey results. The drill rig used for the exploration well is dependent on both the water depth and water conditions. Where wells are in relatively shallow water (up to 120 m), Jack-up rigs are commonly used. In deeper waters, Semi-submersible rigs or drill ships are used. These rigs can either use dynamic position systems in very deep water or anchors and cables/chains to maintain their position in shallower water. Well-pad is constructed before a drill rig is built on it for onshore drilling. The first section of the well is drilled after completing the positioning of the rig. It is cased with steel pipe that is cemented in place and a blowout preventer (BOP) is installed. These two serves as safety measures. The casing isolates the low pressure upper sections from the higher pressure lower section of the well and the BOP helps control the flow of petroleum when the well reaches the target zone. Test are carried out to ensure that the drilling and installed casing are safe with the introduction of high pressure to ensure the piping does not rupture. Once it passes this test, the next phase is carried out. The hole is then drilled in sections to the target zone. During the drilling, the well diameter decreases at set depths, known as casing points. At each casing point the drill bit is pulled out of the well and a steel casing (pipe) is inserted and cemented in place. The well is then pressure tested to ensure that the cement and casing are secure. Pressure control is very significant, throughout drilling the pressure in the rock and the well need to be balanced. Balancing these pressures prevent petroleum entering the wellbore in uncontrolled way and protects the integrity of the surrounding rock. Drilling fluid (mud) is used to control these pressures. The drilling mud also cools and lubricates the drill bit and as it returns to the surface, carries with it the small rock fragments or chips produced by the drilling. These are separated from the drilling mud and analyzed by a geologist to determine the actual rock being drilled and ensuring that the trajectory plan predicted the rocks correctly. Getting to the desired location where fluid and gas are located, samples are collected to evaluate the commercial potential of the zone. The well is also wire-line logged; this is a process where geophysical tools are lowered down the well to help determine the geology and the presence of hydrocarbons. If the well encounters hydrocarbons, it enters the discovery appraisal phase.

3.3.2.6 Discovery appraisal: Unlike the pre-drilling activities which are the initial or beginning stages of exploration, the discovery appraisal is the ending stage of exploration which gives account data of fluid and gas encountered in the subsurface. This appraisal operations will usually involve considerable amounts of technical analysis of the discovery well. In some cases, further seismic (often 3D) will be deemed necessary to further map the target structure, or to identify additional targets in the area. Reservoir size and the rate at which petroleum flows from the well are determine and documented in this phase of exploration activity.

3.3.3 Production: This is a stage which follows the exploration stage. If the hydrocarbon discovered during exploration is considered commercially viable, petroleum operators will begin the process to commercially extract oil and gas. Petroleum mining permit is required before production can commence which normally cover just the area of the extractible hydrocarbons and are much smaller than either exploration or prospecting permits. Only a small percentage of exploration permits are progressed to active producing operations. The phase for production include:

3.3.3.1 Production life estimation: This is also known as a discovery appraisal and it covers how big the resource is, the component of hydrocarbon to be produced (i.e. crude oil/condensate and/or natural gas), the specific chemical composition of such hydrocarbon and how much of the resource can be extracted (i.e. reserves). The above and other technical information, will allow the expected production life of the field to be known and documented.

3.3.3.2 Production facility design: The engineering design is dependent of what will be produced, the location which the production operation will be carried out (looking at water depth and distance to other fields) and designs appropriate infrastructure to ensure the safe, effective and efficient extraction of the resource. Although this phase is capital intensive, but the above is worth considering in order for the facility to operate safely and efficiently for the extent of the field’s production life. This facility can either be offshore facility or onshore facility.

3.3.3.2.1 Offshore facility: This facility consist of the subsurface infrastructures like the underwater well, the subsurface reservoir horizon, steel piping, casing and structures which supports all piping from the subsurface to the Xmas tree on the rigs or platforms where the oil is produced.

3.3.3.2.1.1 Infrastructure arrangement: the professional arrangement of piping to able fluid flow from the subsurface to the surface where the fluid are processed.

3.3.3.2.1.2 An offshore platform arrangement: It’s a central hub where offshore operations are coordinated. Work live there, fluid from the subsurface are collected there and process are processes and are either stored or transferred for storage or sales. This platform have helidecks where choppers or helicopters land to drop or carry workers, have boat landing where boat anchor to drop or carry workers and materials for work, have living accommodation where workers rest or sleep, have production area where hydrocarbon is processed and have the flare stack where excess gas are flared.

3.3.3.2.1.3 Means of transport: this is mostly piping which convey fluid or hydrocarbon to centralized processing onshore location. Some companies used transfer boat but the piping is more economical because it is a 24 hours operation.

3.3.3.2.2 Onshore facility: a facility which is based onshore which products from offshores is piped to for further processing or storage. This facility house big tanks for receiving of product offshore, this tanks also stores processed hydrocarbon before they are sold.

Once the required infrastructures are in place, the development project then moves into a production phase which involves 24 hours a day production, processing and transport of the petroleum products to market to meet man’s need when refined.

# 4.0 General Recommendations Your suggestions and comments

Hydrocarbon Exploration, though its lucrative business which can yield a lot of funds in return of investment ROI, is also a capital intensive business. With this is mind, the following recommendations and suggestions will help curtail loss while venturing into it:

4.1 Know and understand the business: knowledge about the business is very key to the business being a success. Since a lot of funds (either owned or borrowed) will be invested, it is worth getting experts to plan through all the activities and phases to avoid failure and loss of capital which might lead to court litigations and loss of assets which is avoidable.

4.2 Getting necessary permits: Oil and gas deposits are situated in geographical locations. These locations are owned by a country, state, local government etc. which means that the hydrocarbon deposit is own either by an individual or a government. It is worth seeking the consent of the owners of the land or occupiers before the deposits in their land is tampered with. This is where permits comes in to place. The permit means that consent by the owners have been sort and given. This will curtail litigation and breakdown of law which could impact negatively the business.

4.3 Exploration and Production companies should be environmentally friendly: Both exploration and production companies should considering sighting basic projects to help their operating communities, consider them first for employment especially for non-expert positions in other to promote a peaceful operating environment. Royalties to leaders of the operating environment should also be considered because this will go along to foster good operating relations with the host communities.

4.4 A good staff recruiting system should be employed: Either outsourced or made in-house, a good human resource system should be put in place to help with staffing. Right and competent personnel for each position required will go a long way of reducing project operation incident which is very key to continuous operation of the venture.

4.5 Making the host community or nation feel the impact of the Exploration/ production: the operating company should segment a percentage of oil and gas explored/ produced to the benefit of the host community or nation. This should be done either by refining or cash give back.

# 5.0 Conclusion:

In conclusion, Hydrocarbon exploration is a very profitable business but it needs to be done in accordance to the law of the land. Understanding the business will help curtail a lot of losses which are brought into the process via cost cutting and exploration/ production phases bypassing. Permits, royalties and give back to host communities help enhance good and cordial operating relations between operating companies and host communities/ nations. In order to reduce medical cost, operation downtime, machinery/ equipment downtime etc. a good human resource management should be put in place to help with competent staffing. Good return of investment ROI and profit is the mindset of every investor, so, what is worth doing, is worth doing well.

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