Impact of Oil Exploration On Environment

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Abstract

Oil plays a vast and vital role in our society as it is organized today. Oil represents much more than just one of the main energy sources used by mankind. Besides being an important energy source, petroleum products serve as feedstock for several consumer goods, thus playing a growing and relevant role in people lives. On the other hand, the oil industry holds a major potential of hazards for the environment, and may impact it at different levels; air, water, soil and consequently all living beings on our planet. Within this context, the most widespread and dangerous consequence of oil and gas industry activities is pollution. Pollution is associated which virtually all activities throughout all stages of oil and gas production, from exploratory activities to refining. Wastewaters, gas emission, solid waste and aerosols generated during drilling, production, refining and transportation amount to over 800 different chemicals, among which of course, prevail oil and petroleum products. Other environmental impacts include intensification of the greenhouse effects, acid rain, poorer water quality, ground water contamination, among others. The oil and gas industry also contribute to biodiversity loss as well as to the destruction of ecosystem.

This paper aims to present the main environmental impacts of the oil and gas industry throughout the stages of exploration and discovery of new deposits, hydrocarbon production and oil refining. It also addresses the issue of environmental risks in the industry.

Introduction

Oil and gas exploration requires power generation and supply, infrastructure development, besides many other activities together with the consequent influx of people makes the exploration sites vulnerable to environmental degradation. The intensity of such activity can produce a variety of effects that vary with time and distance form the development site. The board environment issues faced by oil and gas exploration and production industry are manifested in both local and global levels. The effects may at times be far from the point source, for example contamination of water sources, changes in land-use, caused by access routes. They also include habitat protection and biodiversity, air emission, marine and freshwater discharges, incidents of oil spills and soil and ground water contamination. It is therefore important to consider immediate, short-term impacts as well as long-term, indirect and cumulative impacts from separate, but linked operations.

In the eighties, India was becoming increasingly self-reliant with respect of crude oil and petroleum products. Infact there was a gradual increase in the production of crude oil and natural gas production from 1975 onwards till about the 1998. This was owing to the increase in the exploration and exploitation of petroleum resources. This increasing trend in petroleum production resulted in considerable concern to the likely impact on the environmental conditions. The major by-products of oil field operation include oil field brine, oil-bearing water and oil drill mud. All these by- products require adequate treatment and safe disposal in order to prevent environment being contaminated with the offensive substances present

in these by- products. With the concern of environmental protection and the introduction of the new regulatory guidelines for the exploration resulted in taking adequate safely measures in disposing the wastes. There are mainly three types of emissions from upstream oil operation i.e., emissions to air, discharge to water, and waste disposal of cuttings.

Objectives

The main objectives of the study are to:

- Assess the effluents and other substance discharged in the neighborhood of the drilling site.
- Assess the linkage of drilling activity with the environmental degradation.
- Developing a data base to monitor various types of pollution from oil and gas production which includes social costs.
- Identify regulatory mechanism and guidelines for oil industries in India.
- Evolve a methodology, for environmental damage caused by blow out of gas wells.
- Suggest policy guidelines for the reduction in environment damages.

Source of Data

The study started with an overview of oil and gas exploration activity. This included collection of secondary data from various sources to assess the impact of effluents techniques.

Oil Industry And Air Emissions

The majority of air emissions are from production side due to controlled flaring and venting which are necessary for safe operations. Sometimes accidental discharge from well during blowout fire emits large amount of gases such as sulphur dioxide (So_2), carbon monoxide (CO), hydrogen sulphide (H_2S), and the other oxides of nitrogen as well as particulate containing partially burnt hydrocarbon and metals. All of these are potentially hazardous to human health and vegetation growth. The most important components of emissions to air are carbon dioxide (CO_2), nitrogen oxide (Nox), methane (CH_4) and Non-Methane Volatile Organic Compounds (NVOCs). Both onshore and offshore oil exploration activities constitute an important source of emissions. They include,

- Flaring, venting and purging gases, including black smoke emissions
- Dust from mud preparation and cementing operations and from movement of heavy equipment
- Smoke from pump engines and generators
- Carbon monoxide and hydro carbon released by incomplete combustion
- Nox and Sox produced from exhaust of internal combustion engines
- Fire protection systems
- Fugitive gas losses

There is considerable impact from oil exploration and production activities to the both regional and global environment.

EMISSIONS IN TERMS OF EFFECT AND QUANTATIY

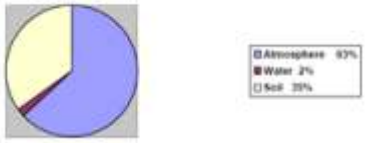
1.	Emission to air (m tons)		
	VOCs		19,528
	Methance		16,942
	Sulphur oxide (SOx)		1,588
	Nitrogen Oxide (NOx)		25,821
	Carbon monoxide (CO)		13,658
	Particulate		398
	Total Emission to air (m tons)		**77,933**
2	Discharge to water (m tons)		
3.	Oil in produced water		1293
	Oil on mud and cuttings		1295
	Total oil discharged to water (m tons)		**2578**
3	Total on site disposal		0
	Total offsite disposal		**43,036**
	TOTAL EMISSION AND DISCHARGED (m tons)		**1,23,547**
	total production (million tons)		**1,20,253,000**
	EMISSION AS A PERCENTAGE OF PRODUCTION		**0.1%**

Source : BP's (British Petroleum) New Horizon annual HSE report.

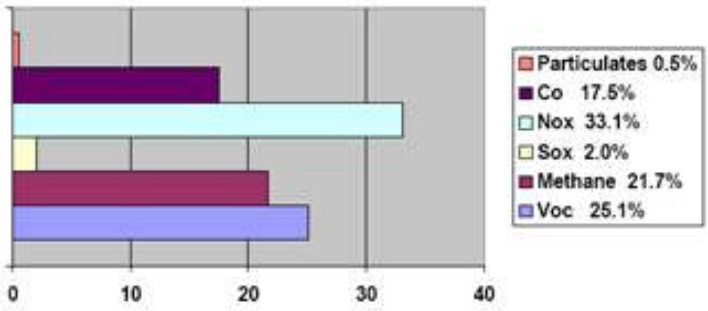
As it can be seen from table emission from exploration and production activities is 0.1% of the actual production and represents a very small percentage. Most of these emissions (60%) are atmospheric and one third are solid and only 1-2% are discharges to water. Almost half of the emissions are hydrocarbon consists predominantly of methane. The remaining emissions, principally NOx, SOx and Co are produced during fuel combustion. CO_2 is not included in this data set because its impact is much lower on a per ton basis. Even though the units appear to be different the data is totally converted into million tons equivalent and reported here.

The above data is illustrated in the following two figures. Atmospheric emissions are the highest of the order of 63%, followed by soil with 35% Similarly, shows components of air pollution at the exploration and production stage.

Emissions Profile – exploration & production



Exploration and Production air emission component



Effect of Emissions

Volatile organic Compounds (VOCs) – The principle effect of VOCs is their local ambient ozone forming potential in combination with nitrogen oxides and sunlight. Ozone can affect the respiratory system in humans and affect plant growth. Methane can be considered separately from other VOCs as its main impact is its global warning potential, which is second only to that of carbon dioxide.

- Sulphur oxides (Sox) – Sulpur oxides lead to acid rains. This may corrode buildings, increases the acidity of poorly buffered soil, reduction of forest life and marine life.
- Nitrogen oxide (Nox) – Along with VOCs and sunlight, Nox can combine to increase ambient ozone that causes photochemical smog, particularly where there is no air dispersion. Inhalation of NO and NO_2can affect the respiratory system directly.
- Carbon oxides (CO2 / CO) – Carbon dioxide is the predominant green house gas which could bring about global climate change. Carbon monoxide increase the lifetime of VOCs by atmospheric chemistry and also produces ozone in its own, although slowly.
- Hydrocarbons in water – There are different effects from lowering the oxygen level in water due to bio-degradation, to the gross contamination caused by oil spills. Contaminants in the soil can leach into ground water and thereby pollute potable sources. Some aromatic hydrocarbon components are toxic to aquatic life.

Oil Industry and Noise

Noise is an unwanted sound. Noise pollution can result from various activities related to drilling operations, exploration activities, vehicular movements and production operations. Noise affects not only humans but also wildlife. Loud sounds used in seismic surveys during the exploration can have a range of effects on living creatures, depending on how close to the source they are.

During seismic surveying underwater explosions of around 250 decibels (the human pain threshold is at 140db) are created with air guns. This has a particularly disturbing effect on cetaceans, who use sound for communication and navigation, and may even be responsible for whale grounding. Fish are also displaced,

which in turn affects the cetaceans and birds, which feed on them. The blasts can damage tissues, including lungs, guts and ears in mammals, and swim bladders in fish.

With in a few meters of the sound source, aquatic organism can be killed or injured. Thus the impact of oil and gas exploration is of varying magnitude both on socioeconomic and environmental parameters. However, the threshold, also varies from place to place.

Oil Industry and Hydrological Impacts

Aquatic ecosystems are a major concern from the pollution arising out of oil and natural gas production, as it involves varies activities that affect the normal functioning of water ecosystems. The potential affect of water resources, both ground and surface waters needs to be evaluated for any major impacts by the operations, particularly where local people, fisheries and wildlife populations use water.

Excavation and infill can use significant alternatives to the existing water sources and drainage patterns, which can lead to marked changes in the floral and faunal diversity in the vicinity. Further operational activities can also introduce contaminants into the aquatic environment. Sensitive wetland communities are also susceptible to pollution arising from the various activities related to petrol exploration. The principal aqueous waste streams from oil and gas operations are:

- Produced water
- Drilling and well treatment fluids
- Process, wash and drainage water

Specific impacts may include,

- Alteration of drainage patterns due to topographical changes
- Creation of water, pond-dominated landscapes by topographical changes
- Creation of higher, drier landscapes by introduction of fill material into surface water overlying permafrost
- Direct and indirect impacts to water supplies by clearing of vegetation
- Disruptions to surface water movements and changed in quality by vehicle traffic, removal of vegetation and impounding.
- Contamination of ground and surface water by drilling fluids and oil during the drilling of wells
- Contamination of ground and surface water from operational discharges, leakage, site drainage and accidental releases.

Water bearing formations in the surrounding areas may also be spoiled by seepage of water containing dissolved salts and mud chemicals from drilling. Mud stored in pits around drill sites, oil spills on land and on water may damage the ecology of the surrounding area and the waste products produced during these operations may pose problems in there disposal.

Impacts on Soil Ecosystem

The extent of nay disturbance on soil will depend on the soil type and the geology of the area. Since soils have a low resistance to degradation and are vulnerable to changes in temperature, and chemicals introduced by the various human activities it can dramatically reshape the land. The most significant potential effects of oil and gas development activities on soil include:

- Compaction
- Contamination from various operational discharges, leakage, site drainage and accidental releases.
- Changes in the drainage patterns
- Erosion resulting change in the landscape and pooling of water

Impacts on Biodiversity

Flora

Loss of fauna is of great concern in any oil exploration site. The disturbances of the ecosystem lead to a slow recovery owing to long gestation periods. Further loss of vegetation also affects nutrient cycles, removes the organic litter, accelerates soil erosion, reduces the availability of habitat for wildlife. Vegetation can also be lost or altered due to construction activities for access roads, drilling and production sites, support infrastructure, borrow sites, as well as habitat structure, prolonged changes in vegetation cover can disturb the ecosystem stability considerably possibly beyond redemption.

Fauna

Animal populations are largely affected by the changes in vegetation, soil, water and noise levels arising from these activities due to changes in – habitat, food supplies, migration routes, breeding areas, vulnerability to predators or changes in herbivore grazing patterns etc. Some of the major effects of exploration and production activities on wildlife include:

- Displacement in the immediate vicinity
- Habitat disturbance
- Direct habitat loss and modification
- Blockage of access to habitats

Habitat losses or modification could result from loss of certain key stone or endemic species resulting in irreversible loss in diversity. Also habitat disturbance could include vegetation or soil removal, erosion-changes in soil structure, changes in topology, sedimentation, and hydrology. Access to habitats can be blocked by the construction of roads and pipelines. It is important to note that changes in the abundance and distribution of certain wildlife species can have significant impacts on the livelihood of indigenous people as well. Thereforeits important to consider, to the extent possible on the basis of existing knowledge when evaluating the likely effects of development on biodiversity that include:

- Rate of extinction occurring and likely to occur
- Minimum sustainable gene pools and population size
- Dynamics of ecosystems that support threatened or endangered species
- Status, distribution and vulnerability of individual species
- Regional differences in extinction rates

Recommendations

- In the oil-fields, environmental awareness must be given top priority and all sections of people should be made aware of the necessity of environmental protection.
- It is essential that ETPs are constructed in all the oil-fields for the treatment of entire effluent.

- Discharge of effluent to suitable underground strata or into dry-wells may be practiced but it must be seen that such effluent does not mix with the aquifers of shallow or deep-tube wells.
- Ways and means must be found out to use the natural gas, so that the practice of flaring may be discontinued except for emergency.
- Dissolved air floatation system wherever possible and is found to have practical application may be attempted.
- Operations must not continue where new environmental risk. The operator of a petroleum activity is not allowed to carry out any activity after the occurrence of any significant new environmental effect or risk, or significant increase in an existing environmental effect or risk, arising from the activity unless the new effect or risk, or increase in the effect or risk, is provided for in the environment plan in force for the activity.

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