

Environmental Control in Oil Industry

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Abstract: The Oil Industry is associated with the activities of exploration, production and refining of the petroleum products and by-products. The petroleum products are used for numerous activities in our day to day life. These products produces various chemical and biological wastes in concentration that are responsible for degrading the environment. The wastes includes a variety of chemicals, suspended and dissolved solids that are contaminated with hydrocarbons.

For the better protection of environment, a better system of training and education is required. This requires a proactive approach from the industry to minimize the adverse impact on the environment. This involves adoption of an environment responsible attitude that is protecting the environment along with carrying out the activities.

Index Terms - Environmental Impact; Hydrocarbon waste; Waste management; Drilling waste; Produced water

I. INTRODUCTION

Human beings require energy for various purposes which includes a propitious life and for technology improvement. There are various forms of energy which are being used and new forms are being developed to meet the society needs [12]. This quest for dependable, affordable and environmentally benign energy sources has occurred throughout human history; for the last century or so, crude oil has been the focus of world energy. In 2011, crude oil was estimated to provide 52.8% of the world's energy; with oil and natural gas accounting for 31.5% and 21.3% respectively [9]. Human reliance on oil and gas as an energy source is not without its attendant impact on the environment. During production, detrimental impacts on the environment (air, water and soil) include: oil spills and leakages; venting; sludge disposal; and flaring [14]. The post-production impact of oil and gas on the environment is also a major source of concern.

II. LITERATURE REVIEW

Petroleum exploration activities which also includes storage, refining and transport causes spillage which in turn pollutes the environment. [6][10]. A report of 6 lakhs metric tons with uncertainty range of 2 lakhs metric tons spillage of crude oil per year. [10]. Aromatic hydrocarbons namely Xylene, Benzene, Toluene, etc are released to the environment during petroleum activities [5].

These hydrocarbons are listed as pollutants that are of priority by the USEPA (United States Environment Protection Agency). They have carcinogenic, mutagenic, teratogenic and immunotoxic properties, so the availability of these on the environment is a matter of concern [21]. Human body gets exposed to the pollutants through ingestion and inhalation [20]. Due to the increase of environmental along with human health concern, various remediation techniques are adopted globally to overcome this problem [19].

2.1 Sources of Wastes

The major energy source for our daily life and industry in today's era is attained through petroleum products. A numerous number of activities that are associated with the production of petroleum produces wastes. The different categories in which these wastes fall into are drilling wastes, produced water as well as associated wastes. The Produced water contributes to 98% of the overall waste in the United States and drill cuttings to 2%. [1]

Produced water contains major impurities and if these impurities are present in high concentrations, it can harm the environment. The impurities consists suspended organic materials, dissolved solids and organic materials, formation solids, H₂S, CO₂, oxygen deficiency [15]. Naturally Occurring Radioactive Materials in low level may be also contained in produced water. [7] Drilling wastes contain formation fluid, drill cuttings. Drilling fluids may contain Barite, Haematite, Lignite, Biocides, corrosion inhibitors, lost circulation agents, lubricants. They also consists of heavy metals- mercury, chromium, cadmium, lead, barium. [2]

Associated wastes include pit wastes, solids in tank bottom, sludge, stimulation wastes from acidizing and fracturing, scrubber wastes, oil spills, transportation wastes, emissions from internal combustion engines.

Table-2.1 Concentration of heavy metals in produced solids. [3]

Metal	Total (ppm,)
Antimony	12
Arsenic	104
Beryllium	<1
Barium	316

Cadmium	<1
Chromium	83
Copper	54
Lead	23
Cobalt	10
Mercury	6
Molybdenum	15
Nickel	16
Silver	<1
Vanadium	16
Zinc	213
Fluoride	75

Table-2.2 Wastewater Composition. [16]

Constituent	Concentration (ppm)
Aluminium	0.5
Bicarbonate	22.182
Boron	20.7
Calcium	11.3
Copper	0.5
Carbonate	0
Fluoride	5.2
Magnesium	0.43
Iron	5.2
Nitrate	0.5
Phosphate	0.6
Potassium	0.7
Sodium	53.00
Sulfate	79.012
Sulfur Dioxide	410
Zinc	4.9
TDS	147.437

2.2 Impact on Environment

The toxicity from the waste to the exposed organisms is used to primarily measure the impact on the environment. The toxicity is the concentration in water which results in the death of half of the organisms within a given time. The concentration which is lethal to the half of test population is referred as LC50.

The impact on the environment from the hydrocarbons in the water varies in a considerable manner [13]. Hydrocarbon concentration less than one mg per litre in water have a sub lethal impact on some of the marine organisms. However after chronic exposures of the eco systems, the eco systems recover when the hydrocarbon source is removed. Evidence of irreversible harm to the marine environment on broader oceanic scale have not been observed.

The high concentration of dissolved salts in produced water have impact on the environment. The Typical range is 50,000 ppm to 150,000 ppm but the sea water concentration is around 35,000 ppm. This affects the plant's ability to absorb nutrients from soil. It alters the soil's structure, which intern disrupts the water transport and air transport to the root systems.

Radiation exposure of NORM disrupts the cell chemistry which alters the genetic structure of the cells. However radiation of NORM is less than man-made and natural radiation sources [17]. The toxicity of wastes vary in a considerable manner from highly toxic to low toxic [8].

2.3 Environment Protection Planning

Most of the activities in the oil industry have a potential impact on the environment in one way or the other. This happens due to the non-compliance of the regulations of the industry. As the resources of the nature are limited, optimum utilisation of these resources is necessary.

A very important step in developing an environmental programme is organizing an environment audit in order to identify waste stream of a particular area and to check whether the identified stream is being handled by the authority in compliance with the applicable regulations. After conducting the audit, a written plan of waste management is required to be developed. This helps in proper handling, storage, transport, treatment and disposal of wastes.

Some of the benefits are:

1. To ensure compliance to the environmental laws at reasonable cost.
2. To minimize damage to the environment from the operations.
3. To minimize short-term as well as long-term risks of operations.
4. To minimize the costs of operation by savings in costs of production.
5. To minimize waste treatment and waste disposal costs.
6. To minimize exposure of an employee to hazardous materials.

These plans are to be developed under guidance of knowledgeable people in fields of technical, operational, regulatory aspects. To be a success, it requires involvement from the top management as well as participation and implementation from field personnel. As technology is advancing and changing, periodic audits must be conducted and the plans of waste management must be updated whenever necessary.

2.4 Environmental Audit

The most important step for developing an effective plan for waste management is conducting an audit. Audits give comprehensive information of locations, categories, volumes, handling procedures of the substances that can cause an environmental impact. Audit also determines whether the operations are complying with the regulations.

Some of the benefits of an environmental audit:

1. To check compliance with the regulations.
2. To identify the actions in which improvement is necessary in order to minimize the risks and potential impact on the environment.
3. To provide early warning for problems.
4. To increase an awareness among operators and supervisors.
5. To reinforce the commitment of top management to environmental protection.
6. To identify training needs.
7. To develop measures for risk reduction.
8. Effective communication system between field personnel and environment staff.
9. To improve relationships with the regulatory agencies as well as the public.

If problems still exist then engineering analysis must be carried out. [4]. Audit follow up should also be carried out within 3 to 6 months to check the corrective actions being carried out or not.

2.5 Waste Management

Plans of management of wastes helps in identifying ways in which the stream of waste can be managed. It ensures that appropriate waste managing plans, proper record keeping, proper engineering controls as well as reporting systems in place. The details that are obtained from the audits helps to develop these plans.

The first and foremost plan in developing such plan is identifying the region as well as the scope that is to be covered. The data should include health, fire, chemical, toxicological, reactivity, first aid information. MSDS provides such information.

Factors like geology, soil conditions, topography and hydrology should be evaluated. Some other factors that are to be considered are sensitive areas like wetlands, historic areas, arctic icepack, arctic tundra, protected areas, archaeological sites etc.

The Resource Conservation Recovery Act categorises exempt waste and non-exempt waste. [18]

- Exempt Wastes are the wastes associated with oil and gas drilling.
- Non-exempt Wastes are non-hazardous wastes that are not associated directly with oil and gas drilling.

The most appropriate step in management of waste is reducing the volume of waste that is produced. The second action is to make it reusable. After that, treatment and disposal. Once the list of actions is identified, the actions are required to be prioritised followed by evaluation. This evaluation includes a study of risk assessment for optimization of funds use.

3 Conclusion

We want the benefits of energy as well as a place that is clean to live, water that is clean to drink, air that is clean to breathe, a toxic free and a pleasing environment to live. The key to produce oil in a responsible manner is developing awareness of potential hazards as well as planning ways that are effective for minimizing the hazards before the beginning of a project. Training and Education is very important. All project engineers, geologists etc must understand that all the companies exist with the society's will and can also be shut down by the society itself through legislation and litigation. The environment movement has brought many regulations that are to be strictly followed by the petroleum industry. The industry must operate in a responsible manner and must learn to adapt to the regulations for their survival. The attitude of pro active protection of the environment is to be followed as the past ways of carrying out business are no longer valid. This attitude of responsibility has been adopted formally by the API as *Guiding Principles For Environmentally Responsible Petroleum Operations*.

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