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Study on Air Pollution and its Impacts in the Petroleum Industry

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Abstract **- The petroleum industry has placed greater emphasis on minimizing environmental impact of its operations. Improved environmental protection requires better education and training of industry personnel. There is a tremendous amount of valuable information available on the environmental impact of petroleum operations and on ways to minimize that impact. In this paper, the various aspects of drilling and production and impacts related to them. It also emphasis the toxic materials transport, plan and manage activities that minimize potential environmental impacts. The treatment of drilling and production wastes to reduce their toxicity and/or volume before disposal.**

Keywords: Environmental impact, drilling, production, waste, toxicity

INTRODUCTION

Drilling is the process in which a hole is made on the earth to allow subsurface HCs to flow to the surface. The process of drilling oil and gas wells generates a variety of different types of wastes. Some of these wastes are natural by-products of drilling through the earth, e.g., drill cuttings, and materials used to drill the well, e.g., drilling fluid and its associated additives. The major way in which drilling activities can impact the environment is through the drill cuttings and the drilling fluid used to lift the cuttings from the well. Secondary impacts can occur due to air emissions from the internal combustion engines used to power the drilling rig. Increasing concerns on the air quality regulation have urged the petroleum refining industry to produce cleaner products by removing heteroatom containing molecules from their major products, diesel and gasoline.

Oil or petroleum refinery is an industrial process plant where crude oil is processed and refined into more useful petroleum products, such as gasoline, diesel fuel, asphalt base, heating oil, kerosene and liquefied petroleum gas. Oil refineries are typically large sprawling industrial complexes with extensive pumping running throughout, carrying streams of fluids between large chemical processing units. The crude refining process in the oil refinery (WRPC) releases numerous chemicals into the atmosphere daily. Consequently, there are substantial air pollution emissions and a notable odor which normally accompanies its operations. Aside from air pollution impacts there are also wastewater concerns, risks of industrial accidents such as explosion and industrial noise.

Gas flaring is a major source of pollution at the WRPC which has tremendous effect on the ecosystem.. Gaseous wastes are emitted everyday through the flaring gas point into the atmosphere. This is as a result of regular refining and processing operations in the fuel plants. The flare only goes off when it is intentionally switched off for maintenance. At the entrance of the refinery, a thick black smoke is usually seen protruding into the atmosphere. This escalates when combustion is at its peak in the fuel plants creating a depressed environment engulfed by pollution. Processing operations in the plant also generate noise which is another source of pollution as machines and equipments are constantly running. Some of these machines aid the refining and processing of crude product and cooling of hot pipes to prevent them from overheating. The environment we live in is exposed to different forms of pollutant. Pollutants are substances that have the capacity to cause harm to living organisms. They comprise of organic pollutants (compounds containing carbon and hydrogen and elements of oxygen, sulphur and phosphorus) and inorganic pollutants (carbon monoxide and carbon dioxide) (Notoma, 2010). They contaminate the environment when they are introduced in an amount that can cause instability, disorder, harm or discomfort to the ecosystem. Their common effects are the incalculable damage to aquatic life, agriculture and human health. Agreed that environmental pollution also results from natural causes such as volcanic eruptions, majority are caused by human activities. Pollution can take the form of chemical substances, or energy, such as noise, heat, or light (Azubike, 2010). Engelking (2009) considers pollution as contamination of the earth's environment with materials that interfere with human health, the quality of life, or the natural functioning of the ecosystems (living organisms and their Physical surroundings). Notoma (2010) regards pollution as the introduction of any substance or stressor, in such quantity and characteristics for such duration that a deleterious effect is produced on the biota in terms of their viability, relative abundance, health, mortality, etc. Many of the gases emitted by refineries are harmful to humans, and can cause permanent damage and even death. They can cause respiratory problems such as asthma, cough, chest pain, skin irritation, headaches, and cancers. The young children and the elderly are usually the worst hit.

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Crude oil contains relatively high quantities of sulphur. When crude oil is heated at the refinery to produce fuel, the sulphur is converted into a gas called Sulphur dioxide (SO2). This is a colorless gas with an offensive smell, like rotten eggs. Exposure to very high concentrations of SO2 (particularly during accidental leakage at a refinery) can result in painful irritation of the eyes, nose, mouth and throat, difficulty in breathing, nausea, vomiting, headaches and even death. Some of the health effects from daily exposure to the gas are tight chests, worsening of asthma and lung disease, and narrowing of air passages in the throat and chest – a situation that provokes asthma attacks.

2. SOURCES OF WASTES

All drilling muds generally have a number of unwanted components that can potentially harm the environment. The most common of these are heavy metals, salt, and HCs. The concentration of these materials varies significantly. The primary concern arises when the drilling fluid must be disposed off.

2.1 Heavy metals

Heavy metals can enter into drilling fluids in two ways: many metals occur naturally in most formations and will be incorporated into the fluid during drilling. These includes arsenic, barium, cadmium, chromium, lead, mercury etc. also metals are added to the drilling fluid as part of the additives used to alter the fluid properties. This includes barium from barite weighing agents and chromium from chrome-lignosulfonatedeflocculants. Heavy metals may incorporate into the Drilling fluid from the thread compound (pipe dope) used on the pipe threads when making up a drill string or from the formation containing crude oil.

The heavy metals encountered during drilling activities are related to a variety of environmental concerns, depending on the metal and its concentration. At very low concentrations, some metals are essential to healthy cellular activity. Because most concentrations encountered during drilling are relatively low, the environmental impact is generally observed only after chronic exposure. The environmental impact of heavy metals is manifested primarily through their interaction with enzymes in animal cells. Enzymes are complex proteins that catalyze specific biochemical reactions. Heavy metals affect the action of enzymes. Excess concentrations of metals inhibit normal biochemical processes in cells. This inhibition can result in damage to the liver, kidney, or reproductive, blood forming, or nervous systems. These effects may also include mutations or tumors.

2.2 Salts

Another unwanted component of drilling fluid at disposal time is salts, like sodium or potassium chloride, are often added to drilling fluid to protect sensitive formations from reacting with the drilling fluid. Salt (sodium chloride) in low concentrations is essential to the health of plants and animals. At concentrations different from the naturally occurring levels found in a given ecosystem, however, salt can cause an adverse impact.

2.3 Hydrocarbons

Except for oil-based mud, HCs are normally an undesirable material in drilling mud because they contaminate the cuttings. HCs enter into mud while drilling through a HC bearing formation or when oil is used for spotting fluid when a pipe becomes stuck.

3. TOXICITY OF HYDROCARBONS

A number of bioassay tests have been conducted to determine the toxicity of various HCs on marine animals. The toxicity of HCs has been found to vary considerably and generalizations cannot be easily made. Factors that affect toxicity include molecular weight, HC family, the organism exposed to the HC, and life-cycle stage of the organism exposed (egg, larva, juvenile, or adult). For mixtures of HCs, such as crude oil, toxicity also depends on the history of the exposure. For HCs of a similar type (the same family), the toxicity tends to increase with decreasing molecular weight. Smaller molecules tend to be more toxic than large molecules. Light crude oils and refined products tend to be more toxic than those of heavy crude oil, because heavy crude oil has a higher average molecular weight. For similar molecular weight HCs, the toxicity varies with family. The toxicity of HC families generally increases in the following order: alkanes, alkenes, cycloparaffins, aromatics, and polyaromatic HCs. Some of the least toxic HCs include dodecane and higher paraffins. In fact, these high molecular weight paraffins are used in cooking, food preparation, and candles. The most toxic HCs are the low-boiling-point aromatics, particularly benzene, toluene, ethylbenzene, and xylene. Because of their similar properties, these four aromatic molecules are commonly referred to as BTEX. The most toxic HCs also tend to have a high solubility in water.

3.1 Impact of Crude Oil on Marine Animals

The actual impact of HC exposure on marine animals is more complex than simple bioassay tests reveal. Oil at sublethal concentrations can significantly alter the behavior and development of marine organisms. These effects, however, are difficult to quantify. The problem of determining sublethal toxicity is further compounded because different species have different reactions and there is mixed effect when multiple toxins are present. Behavior changes from exposure to HCs are primarily those involving motility, while in higher organisms, changes affect avoidance, burrowing, feeding, and reproductive activities. Exposure to HCs can adversely affect the development of organisms in some species at concentrations below 1 mg/L. Some species show no long-lasting damage, while other species can suffer long-term damage at an oiled site. The impact of HC exposure also depends on whether the HC is dissolved or dispersed as suspended droplets. The effect of oil on marine mammals is highly variable. Fur-insulated mammals lose their ability to thermally regulate their temperature as their oil-contaminated fur loses its insulating capacity. The loss of thermal insulation creates a higher metabolic activity to regulate body temperature, which results in fat and

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muscular energy reserves being rapidly exhausted. This can result in the animal's death by hypothermia or drowning. Many species show no avoidance response to oiled areas. Chronic contact of marine mammals with oil may also result in skin and eye lesions.

3.2 Impact of Crude Oil on Ecosystem

Only a few studies have been conducted on the chronic effects of HC releases on ecosystem. No apparent long-term impacts on the productivity of ecosystem have been observed. In all cases, the affected areas recovered after the HC source had been removed, although full recovery could take a number of years. One difficulty with ecosystem studies, however, is that little is known about ecosystems that have not been exposed to HCs. This makes it difficult to determine what lasting effects HCs do have on ecosystems; one important way to gain information about the effects of chronic exposure of ecosystems to crude oil is to study areas having natural oil seeps. Studies at natural seeps at Coal Oil Point in the Santa Barbara Channel, California, have shown that the level of macro fauna is reduced when the HC content in the sediments is high. The reason for the lower faunal level is the reduced amount of oxygen, high sulfide content, and high level of dissolved HCs (mostly aromatics) in the surrounding water.

4. IMPACT ON HUMAN HEALTH

The impact of HCs on human health depends somewhat on whether exposure was from ingestion, inhalation, or dermal (skin) contact and on whether the exposure was acute (short-term) or chronic (long-term). The acute effects of ingestion may include irritation to the mouth, throat, and stomach, and digestive disorder and/or damage. Small amounts of HCs can be drawn into the lungs, either from swallowing or vomiting, and may cause respiratory impact. The chronic effects of ingestion may include kidney, liver, or gastrointestinal tract damage, or abnormal heart rhythms. Prolonged and/or repeated exposure to aromatics like benzene may cause damage to the blood-producing system and serious blood disorders, including leukemia,

A number of PAHs have been linked to cancer of the skin, lung, and other sites on the body. Most human exposure to PAHs comes from nonpetroleum sources, including cigarette smoke, fossil fuel combustion products, and food. The acute symptoms of HC exposure by inhalation may include irritation of the nose, throat, and lungs, headaches and dizziness, anesthetic effects, and other central nervous system depression effects. Chronic effects of inhalation exposure to HCs containing high concentrations of aromatic compounds, including gasoline, can be weight loss from loss of appetite, muscular weakness and cramps, and possible liver and renal damage.

CONCLUSION

Flaring and venting of natural gas is a significant source of green house gas emissions. The release of CO_2 and other poisonous gases into the atmosphere causes unnatural heating effect on the earth's surface leading to global warming. The Clean Air Act and stringent state regulations have also caused the industry to incur extremely high costs for environmental compliance. These costs are accrued because refineries must produce reformulated, cleaner-burning gasoline, which require companies to replace or modify existing equipment with devices for controlling emissions. These costs of compliance are having a detrimental effect on refineries trying to expand and to keep pace with the country's increasing demand.

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