Environment Impacts

Oil and gas transportation generates serious problems of land and marine pollution in forms of accidents, oil spills, and operational discharge. Monitoring and evaluating such environmental impacts have received great attention from policy and operation sides. The *Exxon Valdez* disaster of 1989 raised the awareness of environmental risks of maritime transport activities. It caused more than 11 million gallons of oil to leak from the vessel which took 3 years to clean and cost $2.5 billion. Although oil spills are a definite source of marine and coastal pollution, industrial waste remains the major cause of ocean oil pollution. Tanker accidents contribute 5% and tanker operations account for 7%, and other shipping accounts for14%. However, better operations and improved ship design have reduced the number of large spills. It is noted that the frequency of large spills has declined during the 1990s. Figure 20.12 shows accidental oil spills from tankers.

The improvements in tanker operations and strict regulations have reduced the frequency and amount of oil spills. Tankers used to discharge dirty bal- last water (oil mixed with sea water) into the ocean. Now with improved designs of the tankers and legal obligations, many tankers have segregated ballast tanks that separate oil from water. The environmental impacts are not restricted to marine settings but also occur on land when it comes to pipeline transportation of oil and gas. Petroleum industry damages to the environment occur at different stages from production to distribution including processing and refining. The effects of the damage are social and economic in terms of cleanup, prevention, and financial compensation in case of social harms.

The oil industry has developed information and techniques for precautions to avoid and manage the consequences of oil spills. As a precaution measure in transporting oil and gas by tankers, the oil industry performs a necessary ship vetting process. Such vetting arrangements will ensure that the tanker is meeting the necessary requirements of safe berthing and loading operation. However, in the event of an oil spill, a series of planned actions will be implemented. These actions start from spill collection and monitoring to cleanup of the sea and shoreline.

Moving oil from the wellhead, through the refining process, to the ultimate user of oil products involves a complex blend of oceangoing tankers, river barges, pipelines, and rail and road tank cars. Which form the mix takes in any particular case is a function of both geography and economics, with occasional political and strategic factors thrown in. Economics of scale are often important in determining which set of transport modes will be used. And all require a complex system of infrastructure: terminals, storage tanks, good roads, and railroad tracks and rolling stock. They also need to be flexible to accommodate both market growth and shifting relative product demand. Above all, basic economics are the primary shaper of the way transport systems develop. This is applicable to natural gas transportation from the gathering pipelines system to distribution through pipelines or LNG tankers.

Factors affecting the storage of Crude oil

Formation and deposition of crude oil sludge during oil production and refining operations (extracting, transporting, storage, and refinery processing) has received much attention in recent years.

According to an investigation conducted by U.S. EPA, each refinery in the USA produces an annual average of 30,000 tonnes of oily sludge. It is estimated that, in 2001, large oil refineries (processing (2–5) × 105 barrels per day) in the USA, produced 10,000 m3 of sludge and in India about 50,000 tonnes. Total production of sludge goes up because of the increasing demand for refined petroleum products worldwide.

The sludge formation has adverse impacts for the oil companies due to some problems associated with it. These wastes lead to reducing the capacity of storage tanks, reducing the processing rate by disrupting the operations, blocking of tank discharge lines, having toxic effects for workers and accelerating corrosion. Additionally, improper disposal of sludge causes serious threats to the environment. However, the sludge should be considered as a valuable compound, since it can be recycled to the refineries to reuse recovered oil from the sludge, for processing and reformulating (See et al. 2015; Reynold and Heuer 1993; Nahmad Gandi 2009; Rocha et al. 2009).

The sludge found in crude oil storage tanks typically is made up of water, petroleum hydrocarbons, and solids. It forms when crude oil properties are changed due to several factors. Storage conditions, storage period, the composition of the crude oil, the amount of water and sediments, the temperature of the crude oil, and the mechanical conditions of the storage tanks represent the most common causes of sludge formation. Depending on the source of petroleum sludge, its composition can be quite varied, but typically, it is composed of 5%–90% hydrocarbon oil phase, 1%–52% water, and 0.8%–86% solid particles. Sludges are produced by gradual settlement of heavy oil fractions such as asphaltene, paraffin, and solid particles; thus, they can be classified into asphaltene-based crude oil sludge, and paraffin-based crude oil sludge. Woodrising Resources Ltd.

Asphaltenes are heavy hydrocarbons that are in colloidal dispersion in the oil and are stabilized by resins adsorbed on their surface, thus the interaction between asphaltenes and resins results in the precipitation of asphaltenes. Although the sludge formation is mainly attributed to the presence of asphaltene in crude oil, paraffin can also form paraffin-based crude oil sludge. This type of the sludge forms when the heavier straight- chain hydrocarbons (heavier than C20) flocculate. They accumulate on the bottom of the tank as a viscous gel, the concentration of which will increase by vaporizing the volatile components, and resulting in increased density and viscosity and decreased mobility.

Eventually, the sludge must be removed from storage tanks. Known methods of sludge removal involve oil recovery methods and disposal methods. Thermo-chemical methods, solvent extraction, froth flotation, pyrolysis, surfactant, ultrasonic irradiation, electro-kinetic methods, microwave irradiation, freeze/thaw, and centrifugation are known as oil recovery methods. Cleaning methods such as manual cleaning, robotic methods, biodegradation, oxidation, stabilization/solidification and incineration are known disposal methods. Some studies use of surfactants for cleaning of wastes is a relatively fast process, which has the potential to treat large volumes. After mixing the sludge with solvents and surface- active agents, and then applying thermal and mechanical actions, sludge is converted to an emulsion, which causes viscosity reduction by reduction of interfacial tension. So sludge removing from storage tanks or other refinery apparatus becomes possible.