Research Article

Waste Management System in Petroleum Refinery

1Fatemeh Hasani and 2Nader Nabhani
1M.Sc. student of Petroleum University of Technology, Abadan, Iran.
2Ass. Professor of Petroleum University of Technology, Abadan, Iran.
*Corresponding author: Email: F.Hasani@ait.put.ac.ir, Tel: +989185910846

ABSTRACT
The purpose of oil refineries is to produce marketable products from crude oil or other hydrocarbon feedstocks. The refining processes have environmental impact on their neighbors and on the air, water, and land, and it is important that refiners at least meet the standards set and implement continuous improvements to minimize their impact if they are to retain community acceptance. The best way to reduce pollution is to prevent it in the first place. Some companies have creatively implemented pollution prevention techniques that improve efficiency and increase profits while at the same time minimizing environmental impacts. This can be done in many ways such as reducing material inputs, re-engineering processes to reuse by-products, improving management practices, and employing substitution of toxic chemicals.

This paper looks at the types of pollution created by petroleum refineries, the environmental impacts of that pollution and the technologies and techniques available to enable refineries to meet environmental standards through pollution prevention.

Key Words: oil refineries, reduce pollution, pollution prevention, waste management.

[I] INTRODUCTION
The environmental impacts of petroleum refining and the use of its products have resulted in a number of environmental laws and regulations. Some of the statutes that have the most impact are those that focus on altering the formulation of products to reduce air emissions generated by their use. These often require substantial changes in refinery processes along with large capital investments. In addition, a number of federal and state regulations focus on reducing refinery emissions to air, land, and water. In other words, petroleum refineries not only have to deal with the environmental impacts of their operations, but also have to face complex regulatory issues regarding their products. Notwithstanding the lengthy and complex list of regulations governing the petroleum refining industry, critics of this industry accuse it of taking advantage of loopholes in the existing laws and producing a significant amount of pollution. The EPA has reported significant levels of refinery noncompliance with air regulations, water standards, and solid waste regulations. Refineries are the second largest industrial source of sulfur dioxide, the third-largest industrial source of nitrogen oxides, and the largest stationary source of volatile organic compounds (VOC) emissions—the precursor to urban smog. The accumulation of refinery air emissions such as hydrocarbons, sulfur dioxide, and particulate matter also contributes to acid rain. Petroleum refineries also use large quantities of chemicals during the processing of crude oil, many of which are toxic. Toxic chemicals are monitored through the Toxic Release Inventory (TRI), instituted under the Emergency Planning and Community Right-
to-Know Act (EPCRA). Under the TRI, companies are asked to report on how they manage toxic chemicals, including transfers, treatment, disposal, recycling, energy recovery, and releases to land, air, or water [6].

The majority of gas streams exiting each refinery process contain varying amounts of refinery fuel gas, hydrogen sulfide and ammonia. These streams are collected and sent to the gas treatment and sulfur recovery units to recover the refinery fuel gas and sulfur emissions from the sulfur recovery unit typically contain some H₂S, SOₓ and NOₓ. Other emissions sources from refinery processes arise from periodic regeneration of Catalysts. (Environmental performance for SOₓ & NOₓ & CO₂ emissions was consistent with historical levels in 2010 and 2012. Figure 2 & 3 & 4 shows this subject [8].

**Fig: 1.** Past and future approach to waste management

**[II] AIR EMISSION**

Air emissions from refineries include fugitive emissions of the volatile constituents in crude oil and its fractions, emissions from the burning of fuels in process heaters, and emissions from the various refinery processes themselves. Fugitive emissions occur throughout refineries and arise from the thousands of potential fugitive emission sources such as valves, pumps, tanks, pressure relief valves, flanges, etc.

While individual leaks are typically small, the sum of all fugitive leaks at a refinery can be one of its largest emission sources. Fugitive emissions can be reduced through a number of techniques, including improved leak resistant equipment, reducing the number of tanks and other potential sources and, perhaps the most effective method, an ongoing Leak Detection and Repair (LDAR) program. The numerous process heaters used in refineries to heat process streams or to generate steam (boilers) for heating or steam stripping, can be potential sources of SOₓ, NOₓ, CO₂ particulates and hydrocarbons emissions. When operating properly and when burning cleaner fuels such as refinery fuel gas, fuel oil or natural gas, these emissions are relatively low. If, however, combustion is not complete, or heaters are fired with refinery fuel pitch or residuals, emissions can be significant.

**Fig: 2.** Annual SOₓ emissions from BP Refinery (Kwinana)

**Fig: 3.** Annual NOₓ emissions from BP Refinery (Kwinana)

These processes generate streams that may contain relatively high levels of carbon monoxide, particulates and VOCs. Before being discharged to the atmosphere, such off-gas streams may be
treated first through a carbon monoxide boiler to burn carbon monoxide and any VOCs, and then through an electrostatic precipitator or cyclone separator to remove particulates [2].

**Fig: 4.** Annual CO2 emissions from BP Refinery (Kwinana)

### [III] WASTEWATER
Wastewaters consist of cooling water, process water, sanitary sewage water, and storm water. Wastewaters are treated in onsite wastewater treatment facilities and then discharged to POTWs or discharged to surfaces waters under NPDES permits. In addition, some facilities use underground injection of some wastewater streams. Many refineries unintentionally release, or have unintentionally released in the past, liquid hydrocarbons to groundwater and surface waters. At some refineries contaminated groundwater has migrate off-site and resulted in continuous “seeps” to surface waters. While the actual volume of hydrocarbons released in such a manner are relatively small, there is the potential to contaminate large volumes of ground water and surface water possibly posing a substantial risk to human health and the environment [2].

### [IV] OTHER WASTES
Other wastes are generated from many of the refining processes, petroleum handling operations, as well as wastewater treatment. Both hazardous and non-hazardous wastes are generated, treated and disposed. Residual refinery wastes are typically in the form of sludge’s, spent process catalysts, filter clay, and incinerator ash. Treatment of these wastes includes incineration, land treating off-site, land filling onsite, land filling off-site, chemical fixation, neutralization, and other treatment methods [2]. A significant portion of the non-petroleum product outputs of refineries is transported off-site and sold as byproducts. These outputs include sulfur, acetic acid, phosphoric acid, and recovered metals. Metals from catalysts and from the crude oil that have deposited on the catalyst during the production often are recovered by third party recovery facilities.

### [V] ENVIRONMENTAL AND HEALTH IMPACTS OF PETROLEUM REFINING
Petroleum refinery emissions seriously impact human health and the environment. Some of the health impacts associated with exposure to hazardous air pollutants include severe burns, skin and eye irritation from high levels of benzene and hydrogen sulfide fumes, and increased cancer risks from exposures to benzene, xylene, and arsenic. Apart from this, workers in refineries are at risk of chronic lung disease from long-term exposure to coke-dust, silica, and hydrogen sulfide; headaches have leaks, whereas the average leak rate from valves at refineries is 5.0 percent—four times higher than the average reported leak rate. This failure to detect emissions from leaking valves has a detrimental impact on air quality. The EPA has estimated that the unreported fugitive emissions from refineries add millions of pounds of harmful pollutants to the atmosphere each year, including more than 80 million pounds of VOCs and more than 15 million pounds of toxic pollutants and mental disturbances from carbon-monoxide exposures; and psychosis and peripheral neuropathies from exposures to lead alkyls used as gasoline additives [6]. Fugitive emissions from refineries pose an important threat to the environment and often tend to go undetected, thereby magnifying the problem of air pollution. It has been found that the majority of refinery emissions actually occur through leaks rather than through regulated smokestacks or effluent pipes. In 1999, Congressman Henry A. Waxman...
commissioned an investigation into fugitive emissions from refineries by the minority staff of the House of Representatives Government Reform Committee. The average refinery reports to state and federal regulators that 1.3 percent of the valves at its facilities [6].

[VI] ENVIRONMENTAL ASPECTS
An environmental aspect is an element of an organization’s activities, products or services that can interact with the environment. An environmental aspect has the potential to have an environmental impact, which is any change to the environment, whether adverse or beneficial, that results from an organization’s operation [8].

The process of refining crude oil characteristically has many environmental aspects and potential environmental impacts. Raw material input to petroleum refineries is primarily crude oil; however, petroleum refineries use and generate an enormous number of chemicals, many of which leave the facilities as discharges of air emissions, wastewater, or solid waste. Pollutants generated typically include VOCs, carbon monoxide (CO), sulfur oxides (SOx), nitrogen oxides (NOx), particulates, ammonia (NH3), hydrogen sulfide (H2S), metals, spent acids, and numerous toxic organic compounds [2].

- The general categories of environmental aspects are: [8]
  - Air emissions
  - Water emissions
  - Soil and groundwater contamination
  - Solid waste
  - Public nuisance (noise and odour)

[VII] THE PREVIOUS RESEARCH
- Sabet, Zarei & Emrani in Identification, classification and waste management of Shiraz Oil Refinery on the basis RCRA (2013), the aim of this study was to identify and classify the waste until the last stage of waste management in the oil refinery in Shiraz.

This study forms in the field of oil refinery Shiraz. Found in this study after study of the production process, the production of waste, and discharge of waste type and amount of waste produced, was discovered by RCRA the hazardous waste identification code allocated special hazardous use and non-hazardous waste to be separated. After identifying the waste, it was determined by the laws of RCRA, 43% of industrial wastes are considered hazardous waste produced in oil refineries Shiraz. 91% of the total hazardous waste identified in the list of F (List of hazardous waste with non-specified sources) and 9% in the list of K (hazardous waste at source identified) were used. So that 54% of waste has toxic properties, 22% of the flammability characteristics, 23%, reactive, corrosive and 1% respectively.

Finally, how to properly manage the waste produced by the oil refinery in Shiraz based on a hierarchy which is America’s Environmental Protection Agency, also show new ways to reduce production of oil sludge and offer a place to keep industrial waste with convenient features. A new method to keep industrial waste special has been proposed [12].

- Jamali & alizade in Check the status and management of oil and industrial waste Tehran Oil Refining Company (2011), this paper evaluated the current situation of waste it Refining Company and also set appropriate management improvements in the process of disposal and recycling of industrial waste and oil-based and field-theoretical methods studied. The most important results of the study is to determine and utilization of inimprove environmental quality in Tehran oil Refining Company, through the adoption of an action plan with the aim to maximize the amount of recycling, reuse and appropriate from an environmental standpoint as well as the prevention of environmental disasters and reduce the risks associated with waste, particularly special waste [9].

- Miraeèe & colleagues in Waste Management in Sarkhon and Qeshm Gas Refinery (2011). In this article, we review the types of waste produced at the refinery, to their
management practices is provided. To achieve this goal, first of all wastes were identified by questionnaires or site visits. Then each of them was determined hazardous waste coded and levels. Finally, the management of any waste presented.[10]

- Azam Namdari and colleagues study as comprehensive wastewater management and operation of the desalination plant in Ahvaz oil, based on their RCRA [11]. Hoagland study entitled Assessing and analyzing industrial waste management system did in this study in Sweden examined the waste management system [3]. Masri and colleagues study entitled norms waste management in the oil and gas industry (Experience Syria) did [4]. Salihoglu study under the management of industrial hazardous waste in Turkey [7].

[VIII] ENVIRONMENTAL MANAGEMENT SYSTEM

Refinery’s EMS aims to achieve: [8]
- Compliance with legislation and regulations,
- Continual improvement,
- Management of significant environmental issues and
- Prevention of pollution.

The purpose of the EMS is to provide a structured transparent and auditable framework to manage environmental issues. Therefore, Refinery’s EMS is a continual improvement process of planning, implementing, checking and reviewing. [8]

![Plan, Do, Check, Feedback Cycle](image1)

![Plan, Do, Check, Feedback Cycle](image2)

Fig: 5. Plan, Do, Check, Feedback Cycle [5]

Fig: 6. The continual improvement process of the Refinery’s EMS [8]
[IX] ENVIRONMENTAL AUDITING
Auditing is often used to ensure that management of environmental procedures and control are assessed and opportunities for improvements and also weaknesses are identified and corrected.

Figure 7 shows the basic steps of an environmental audit program. This process should be carried out at regular intervals and may involve both internal and external auditors. [1]

Fig: 7. Basic steps of an environmental audit. [1]

[X] CONCLUSIONS
The impact of the petroleum refining industry is significant and widespread. This paper has attempted to take a first pass at examining the environmental and health impacts of the refining industry. Significant research is required to better understand, measure, and evaluate impacts of the petroleum refining industry on the environment and on communities living in proximity of such facilities. While oil is at the center of current economic activities, it is also at the heart of some of the most troubling environmental and health problems. Hence it is critical to understand the distribution of impacts of oil and the effectiveness of current regulations systems in reducing the impacts and their disparity. Additional research needs to examine issues of compliance and enforcement records for polluting industries, including factors affecting the compliance of companies with environmental regulations and those affecting the enforcement actions of regulatory agencies.

REFERENCES