

Determine Environment Impacts in Upstream Processes of Oil and Gas Industries

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Abstract. Indonesia's population increasing from 238.5 million to 305.6 million from 2010-2035 cause increase of energy supply to meet energy consumption needs and also correlate with global warming. One of them is from the oil and gas sector. The process of it production is divided into upstream process which starts from hydrocarbon extraction to become a ready-to-sell product and downstream process comprise of processing to consumer consumption. The research objective of this paper is to find out the upstream process of oil and gas industry as well as the impact that may be caused. The upstream process of the oil and gas industry begins with land clearing, hydrocarbon drilling / extraction from within the earth, feasibility testing, development and production, distribution, storage and distribution possible to the first consumer. From these activities, the impacts are caused by the decrease of air quality mainly due to the burning of flare gas and tool mobilization, the decrease of water quality, and the deterioration of soil quality.

Keywords: **global warming; hydrocarbon; oil and gas**

1 Introduction

Indonesia is faced with various environmental issues such as global warming which is driven by high carbon dioxide product (industry, transportation, mining), the increasing and use of energy, air pollution, water pollution, soil pollution, deforestation, erosion, endangered biodiversity that can cause ecosystem disruption and other issues are increasingly becoming a borderless problem. The growing of technology has resulted in giving information to all access on this earth. Not only local, but environmental issues have been perceived by locations outside our country. It makes the countries of the world competing for boundaries both through conferences that result in collective agreements, rules that aim to regulate and impede the deterioration of environmental functions.

There are several causes that are alleged interference of environmental function. One of them is increasing population. Indonesia's people increase in the number from year 2010 to 2035 is 238.5 million to 305.6 or 28.13% from the year 2010 [1]. These problem leads to increased consumption in various fields, especially in energy. Procurement of energy sources, especially fossil energy that is still be majoring energy is still continues. Oil production in the period from 2006 to 2015 tended to decrease from 287.30 million barrels (800,000 BPD) to 251.87 million barrels (690,000 BPD). While the dependence of fuel seen from the ratio of dependence of imports increased by 33% (2006) to 44% (2015)[2]. The following Table 1 is crude oil for production, export and import in Indonesia.

Table 1. Production, Export and Import of Crude Oil (Thousand bbl)

Year	Production	Export	Import
2012	314,666	106,485	95,968
2013	300,830	104,791	118,334
2014	287,902	93,080	121,993
2015	286,814	115,017	136,666
2016	268,877	125,516	148,361

Source: Ministry of Energy and Mineral Resources Republic of Indonesia, 2017

The decline in production is due to production wells are old. The search for new wells belonging to the upstream process category began to be done to boost production from petroleum. And these activities will indirectly cause some impacts on the environment especially on air, water, soil, and biodiversity.

The research objective of this paper is to find out the upstream process of oil and gas industry as well as the impact that may be caused. For obtaining the objective, reviewing of some paper is being used for this paper and literature to brief and explain the flow processing of oil and gas upstream industries and the impact of environment from those. And this paper be expected could give some perspective for the society to develop sustainable development with low carbon impact to obtain green product.

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2 Flow of processing

2.1 Exploration and exploitation

Before obtain the hydrocarbon (HC) from the earth, the seismic studies would undergo to figuring the reserve of hydrocarbon and mapping the border of the reservoir. Preparation starts for the exploration activity referring geological data from former studies. Construction to prepare the area involve mobilization the equipment, land clearing, build the temporary camp area should conduct in this phase. Heavy equipment and transportation such as dump truck, excavator, generator set and rig set should be installed before drilling begins. Exploration is activity to extraction the HC to probe and estimated the reservoir of HC mineral. After exploration, logging or drill steam test (DST) must be conducted to knowing the feasibility of the product with economic value. If the result “feasible” the process will be followed to exploitation. But if the result is “not feasible”, the well will be closed [3].

The exploitation is meaning the activity to obtain the economic product. The activity is similar with the exploration, but the extraction continues to produce the product and will be distributed through pipe or vacuum truck to processing facilities.

2.2 Processing

Processing crude oil or HC compound is taking place in processing facilities. There are a few stages to produce

the sales product. The first stage commonly generates to separator. Some well should through the sludge catcher to precipitate the sand contain before lead up to the separator. In this equipment (separator), HC will separate to three phase (oil, gas, and water) using compress system and steam system. The separated product will be leaded to storage tank and then distribute to FSO (Floating Storage and Offloading), LPG Plant or the other consumer. In the storage tank, there is a facilities called gas boot. It use for separate gas which is still contain in crude oil, wherein that gas will be circulate to some uses (gas lift, turbine fuel) or will be distributed to LNG plant. To generate power for all facilities, turbine generator has been used.

In gas processing, there is some treatment to remove CO₂ (acid gas) and H₂S (sour gas) for getting purest (sweet gas) and the other unused compound. Result of these processes will be lean gas which is ready to sales. If there is some unused gasses and hazardous, it will send to the thermal oxidizer to burn in flare stack [4].

2.3 Distribution

Distribution of sales product to first consumer is usually using pipeline. The welding was conducted when installed the piping instrument.

The major flow processes in upstream processes oil and gas industries are following **Error! Reference source not found.**

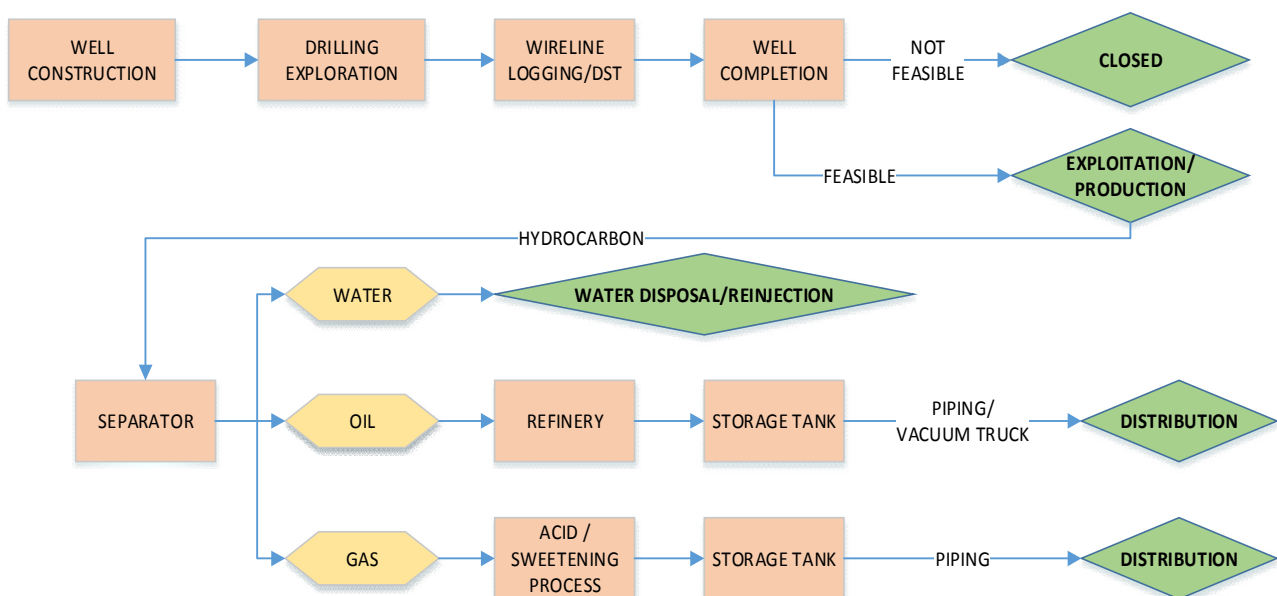


Fig. 1. Flow Process of Upstream Processes in Oil and Gas Industries

3 Environment impact

The activities of oil and gas upstream processes have several impacts which could influence the environment condition such as human health and climate change indirectly. The following impact comprises below.

3.1 Impact for the air

In construction and exploration phase, the ambient air quality would be affected from the mobilization equipment, land preparation, drilling process, well completion. The mobilization will be emitted from vehicle that using for mobilization. CO_x, CO and NO_x from incomplete combustion will cause acid rain, global warming and decreasing of human health. As we know that methane, carbon dioxide is the component of

Greenhouse Gasses that cause global warming and climate change.

Hydrocarbon compound and most pollutant from combustion source related are benzene, CO, H₂S, NO, PM, SO_x and other VOC's can cause respiratory irritation, blood disorder, and carcinogen. The release of NO_x and react with the sunlight will make chain reaction and cause the ozone depletion. Furthermore, if the depletion of ozone occurs, UV light will directly penetrate the earth. As we know, UV light (UVB) can cause skin deterioration function [5], [6].

These are several air pollutant will be emitted from some source such as mobilization (CO_x, CO and NO_x), drilling operation (CO₂, CH₄, SO₂, and NO₂), engines and compressor (PM_x, CO, NO), venting and flaring (VOC, CO, NO, CH₄, SO₂), and storage tank (CH₄) [5], [7], [8].

3.2 Impact for the water

Water quality also have tendency contaminated from these processes.

3.2.1 Mud / Sludge

Mud as the residue from drill activity also could contaminate the body water around the site. It should concern to manage the mud in order to not waste. Impermeable layer could be used to prevent seep of the mud to body water [6].

3.2.2 Produce Water

Produce water is water which originated from well (formation water, injection water, chemical additives for drill used or separate water and oil) and still mingled with crude oil and gas. In some literature, 2% of chemical additives are contained in fracturing fluid. It should be concern about flow back water from the formation has organic compound that cause human toxicological [5], [6].

3.2.3 Oil Spill

Oil spilled could be happened from leakage of flange or pipe or within transportation system, and leakage from the storage. The leakage will be flow by rainwater till the body water. If the body water source is a river or water with domestic purpose, it will be contaminate the human and could decreasing human health.

There is study taking place in Pennsylvania which is some problem occur in milk production of cow. Although this study is not specifically address for drilling activities, but it is examine of the change milk production related drilling activity. They found that the change of milk production was associated with increasing drilling activity [5].

3.3 Impact for the soil

3.3.1 Oil Spill

Other pollutants such as benzene, hydrocarbon, and other metal from drilling fluids also could contaminate the soil. There is no evidence state soil contaminate caused by drilling activities. But the metal, sludge and residue of drilling activities can be absorbed / adsorbed

to soil help by rainwater. The spill will flow and stay in the soil and can be ingested purposefully.

3.3.2 Oil Sludge

Oil sludge is waste which is formed from collecting, oil contaminated precipitation. The main component of it is As, Hg, Cu, Zn, Cr and other metal. Oil sludge originated from tank cleaning and flushing [6].

3.4 Impact for the social

Social is one of environment element. The impact of these activities can affected of social perception and increasing job vacancy for local community. The industries which have good CSR (corporate social responsibility) will have good perception in community, commonly. The other side, the existence of this, will change the local culture to be modern culture (especially in rural area).

3.5 Impact for the flora fauna diversity

Decreasing quality and quantity and also change of live pattern from flora fauna around the site will be happening since construction phase until post operation phase. Land clearing will reduce of amount the land for habitat. If the site will be taking place in the forest, it will be increasing deforestation amount. Noisy from heavy equipment and the light could make disorientation for the biology hour and metabolism time. The light will attract the animal to close to "sleep" and they will have assumption that the light is a sun. So that, they will think that the night never be occur.

Furthermore, the heat of flaring activity could be cause the death of animal and make the deterioration of soil quality so that they can be planted or the crop will have decreasing production [9].

The companies should give concern for these problems. They should make rehabilitation or forest reclamation after the operation is ended and the site will be abandoned. The contaminated soil must be remediated so as can be planted again.

4 Conclusions

Increasing population cause increasing energy consumes especially from fossil energy. To supply of this the government boosted oil and gas production, such as exploration activities to obtain new production well. This activity has the advantage for energy supply for this country but have more disadvantages for the environment. Pollutant will be emitted from land clearing, drilling, production and distribution would be influence for the air, water, and soil pollution. The other side would be influence for the social aspect and flora fauna diversity.

Upstream processes of oil and gas industries have many stages to produce sales oil and gas. The air impact would be influences for air pollution, global warming, ozone depletion, and human health deterioration cause flaring and drilling and production operation. The water impact will be followed to water quality deterioration because oil spilled, produced water, and mud/sludge. The soil impacts are similar with the water impact because of the residue from oil spilled and mud/sludge.

Social impact will be influenced by social perception, job vacancy and the changing of local culture. The last is flora fauna impact. Decreasing quantity and quality from vegetation because land clearing and heat from flaring. The changing of animal metabolism influenced by light, land clearing and heat of flaring.

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