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Harmful Impacts of Gas Flares in Niger Delta: Case Study, Oporoma

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ABSTRACT

The term "gas flaring" is referred as a combustion system that burns associated, or liquids and gases that are being released in excess during unplanned or normal operations that are over pressuring in numerous industrial procedures, including landfills, refineries, coal industry, chemical companies, and gas extraction. Gas flaring contributes greatly to greenhouse gas emissions. It generates heat, noise, and makes the environment uninhabitable. Oporoma Community is the administrative center of Southern Ijaw Local Government Area (SILGA), Bayelsa State, Niger Delta region. One of the Communities in the region of Niger Delta that produce oil is Oporoma, and its being used as a case study. The primary data was obtained through an interview with about one hundred and fifty (150) persons (both men and women) between the age of 18 - 90 years. 50 persons from the age groups of 18 – 30, 31 – 50, and 51 – 90 years which focused mainly on harmful impact of gas flaring on human health, and its environment. Every investigation and data that were gotten from Oporoma community has negative human health and environmental effect, because of burning of gas. This gas flaring practice has caused poverty to many people in the community with health, environmental, and economic challenges. The government and policy makers in the Niger Delta region of Nigeria are also contributing to the negative impacts of gas flaring on local communities and the environment. The challenges faced by people living in areas where gas is being flared, such as air pollution, water contamination, and soil degradation, are strong arguments for ending this practice. Companies that are failing to properly process the gases produced during oil extraction should be heavily fined. Instead of being wasted through flaring, these gases could be used to produce cooking and domestic gas, as well as electricity. It is time for gas flaring to be brought to an end, particularly in the Oporoma community of the Niger Delta.

INTRODUCTION

Gas flaring simply referred as a process in which an associated natural gas with burning of crude oil during production. It is also a method to burn natural gas in a controlled form, which cannot be processed for sale or use because of technical economic reasons (Canadian Association of Petroleum Producers, Flaring & venting, 2012). Gas flaring is also means of combustion devices designed to safely and efficiently destroy waste gases generated in a plant during normal operation. Globally, the practice has continued since oil production started more than 160 years ago (Oluwole, 2021). It comes from different sources e.g. gas plants, associated gas, well tests etc. The flared gas is collected in piping headers, which is delivered to the flare system that can be dispose safely. Gas flaring has become a significant issue in the environment where petroleum is being produced with inadequate infrastructure to put the generated natural gas to use. It also provides a way to get rid of the gas produced in certain regions. It looks simple as it sounds, but it causes a number of detrimental effects on both humans and the ecosystem as a whole (Orimoogunje *et al*., 2010). The adverse effect of gas flares on human health includes, skin diseases, asthma, respiratory attack, organs attack, sick building syndromes, chronic respiratory disease, cardiovascular, nervous system attack, and even cancer (Huang *et al*., 2017a; Shu *et al*., 2018; Cai *et al*., 2014; Lyu *et al*., 2017).

In the beginning of petroleum exploration, natural gas was not considered as a useful product, because of difficulties in transporting it to where it can be utilized or the problems associated with it storage. Because of that, the at the well, gas is simply burned off, or being vent into the atmosphere in order to create rooms for other operations, and also to save the system from being burnt down by gas explosion. Table 1 shows top ten countries that flare gas in the world between 2013 - 2018.

Therefore, burning of gas is a risky practice and a violation of human rights that advanced developed countries cannot tolerate, because, the gas pollutants contains over 250 toxins that harmful, poisonous, and un friendly to the national ecosystems and human habitats. Within the region of Niger Delta of Nigeria, gas flaring is being manifests with the help of gas leakages, which is released into the atmosphere, causing fires to occur and warming the air around us. Zabbet *et al*., 2004, reported that, pipelines carrying Nigerian Liquefied Natural Gas (NLNG) suffer leaks and fires in several communities,

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Table 1: Top Ten Gas Flaring Countries in the World in Billion Cubic Meters (bcm) from 2013 – 2018 (World Bank, 2020).

Ranking	Countries	2013 (bcm)	2014 (bcm)	2015 (bcm)	2016 (bcm)	2017 (bcm)	2018 (bcm)
1	Russia	19.9	18.3	19.6	22.4	19.9	21.3
2	Iraq	13.3	14.0	16.2	17.7	17.8	17.8
3	Iran	11.1	12.2	12.1	16.4	17.7	17.3
4	USA	9.2	11.3	11.9	8.9	9.5	14.1
5	Algeria	8.2	8.7	9.1	9.1	8.8	9.0
6	Venezuela	9.3	10.0	9.3	9.3	7.0	8.2
7	Nigeria	9.3	8.4	7.7	7.3	7.6	7.4
8	Libya	4.1	2.9	2.6	2.4	3.9	4.7
9	Mexico	4.3	4.9	5.0	4.8	3.8	3.9
10	Angola	3.2	3.5	4.2	4.5	3.8	2.8

which burned uncontrollably for days destroying plants, and animals living in the affected areas and communities. According to Nigerian National Petroleum Corporation's monthly oil and gas report, in the last five years, Nigeria has flared 1,252 trillion cubic feet (Tcf) of natural gas to the atmosphere, posing health risks and lighting up global warming (Oluwole, 2021). Oil companies were ordered to halt flaring gas in the region of Niger Delta Nigerian courts in 2005. The Iwherekan community sued Shell Petroleum Development Company, Nigerian National Petroleum Corporation, and Nigeria's Attorney General, and the case was ultimately decided in their favor. The judge decided that it's unconstitutional to flare gas, and that it went against people's rights to dignity and life (Aderemi, 2021). At the recent concluded Unted Nations (UN) Climate Change Conference (COP26) in Glasgow, President Muhammadu Buhari said, Nigeria would cut its carbon emissions to zero by 2060. To achieve that, the nation must stop its widespread practice of gas flaring, there are now few indications that it possesses the necessary political will (Oluwole, 2021).

Research Objectives and Hypotheses

The main aim of this study was to determine the harmful impact of gas flaring on health and the environment of Oporoma Community in the Niger Delta Regions.

The specific objectives and research hypothesis are tabulated in Table 2.

Table 2: Summary of Objectives and Hypotheses

S/N	Objectives	Hypothesis
1.	Evaluate public health impact of environmental pollution due to gas flares.	Pollution due to gas flares has had a nega-tive impact on environment and community health.
2.	Assess disease prevention and treatment for diseases that are ex-pected to increase because of gas flaring.	Diseases that are more prevalent as a result of gas flaring were not easily prevented and treated.
3.	Evaluate the government's efforts in mitigating the adverse effects of gas flaring already being expe-rienced by host communities	Government's efforts in mitigating the ad-verse effects of gas flaring already being experienced by host communities were not sufficient.

METHODOLOGY

Data's were obtained through desk review of existing literatures online on oil and gas production in the Niger Delta region of Nigeria, gas flaring trend and regulations, and impact of gas flaring on the environment. And also, Participants were engaged in an interview, and were asked to provide free information on their health, families, and the environment on harmful impacts of gas flares in the community and its environment. This study was carried out in Oporoma Community, Bayelsa State. About 150 persons (both men and women) were interviewed from the community between the ages of 18 - 90 years. 50 persons from each of the age groups of 18 – 30, 31 – 50, and 51 – 90 years were interviewed, and their responses to harmful impact of gas flaring on human health, and its environment were evaluated. The justification for this study is to establish a trustworthiness of the findings on harmful impacts of gas flaring in Oporoma Community.

Flare Stack Configuration

A flare stack is a tool for gas combustion that is used in industrial plants, such as chemical plants, plant for processing natural gas and petroleum refineries, or a gas production sites that have oil and gas wells, offshore oil and rigs. In industrial facilities, flare stacks are typically employed to burn off combustible gases that are accidentally over pressurized and released into the atmosphere through pressure relief valves in gas plant equipment (Madueme *et al.*, 2010). Flare stacks are used in plant or incomplete activation and shutdown of plants

in order to planned for combustion of gases in a short period. When an equipment in the industrial plant is over pressured, the safety device needed to release the gases, and sometimes liquids is the pressure relief valve. These valves that relieve pressure are basically designed with industrial design guidelines and requirements for safety (Madueme *et al.*, 2010).

The expelled gases and liquids travel through substantial piping networks known as heads of flare to a high vertical flare, which is burned at flaring stacks. The flame's size and brilliance depends on the flammable materials flow rate. To reduce the amount of black smoke formations, steam is injected often into the flame. Also, too much steam should not be injected into the flame in order to avoid over steaming to occur, which will reduce the combustion efficiency and higher emissions. For the flare system to be functional, small quantity of the gas is burned continuously. Figure 1 shows a flow diagram and common elements of a complete industrial flare stack system. Major parts of a flare stack include (Barati *et al.*, 2019);

• Liquid knockout drum, which eliminates any liquid from the gases after being freed.

• Alternative gas recovery section, which can be used in partial plant startup/shutdowns. The salvaged gas is fed into the industrial plant's overall fuel gas system.

• Flashback seal drum, which prevents any flashback at the flare stack's peak.

• Steam injection system that provide external force for adequate air mixing with the gas after relief, which can promote smokeless burning.

• A spark ignition device, which can burn at all the time, so that it will be ready to ignite the gases when needed.

• The flashback protection section of the flare stack is at the upper part of the stack.

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Types of Gas Flaring

There are three types of gas flaring;

• Ground flares
• Elevated flares
• Pit flares

Ground Flares

Ground flare can be either open or close pit. It is used to burn the flame while reducing radiant energy and noise. Ground flare is made of a refractory material lined steel box or cylinder. The feature apertures around the base, and Its top is open to let combustion air in, and it might have several flare points to provide for turndown capabilities, and flame distribution over the flare area. One of the advantage of using this specific flare is that, it releases little radiation and produces less noise. Figure 2a shows a typical ground flare system (Argo Flare Services, 2021; Dey, 2021).

Elevated Flares

In elevated flare system, the gas is channeled through a vertical chimney and subsequently combusted at the stack top. An elevated flare system is made up of a flare header, knockout drum, and flare stack. The flare header collects the gas and condensate from the plant, the knockout drum separates the condensate, and the gas is burned in high elevation stack. Figure 2b shows a typical elevated flare system (Dey, 2021).

Pit Flares

The pit flares are also known as pilot burners, which are always parallel to the ground and a brick fire wall, and an earthen wall are both visible, or fence that surrounds the flare pit. A pit flare minimum should be 1,000 feet (305 m) long, and placed away from operating plants and common work areas, where the smoke and the heat will not threaten personal or damage equipment. Figure 2c shows a typical pit flare system (Naoinc, 2021).

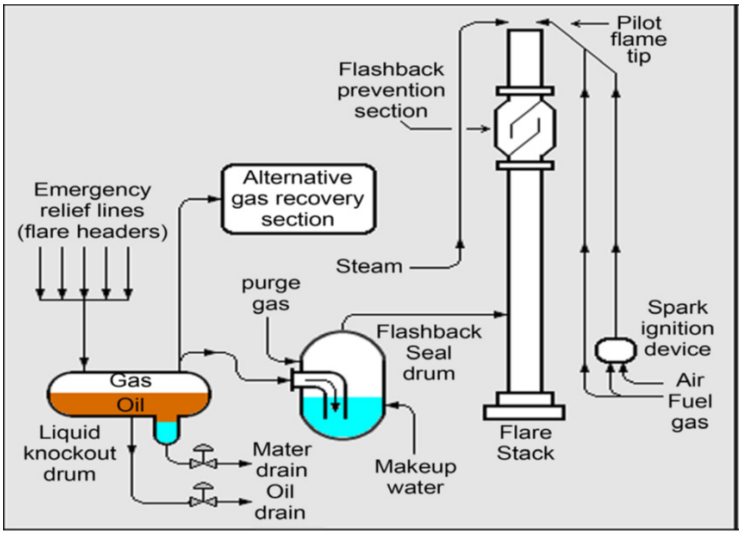

Figure 1: Diagrams depicting the general system flow for a vertical, elevated flare stack

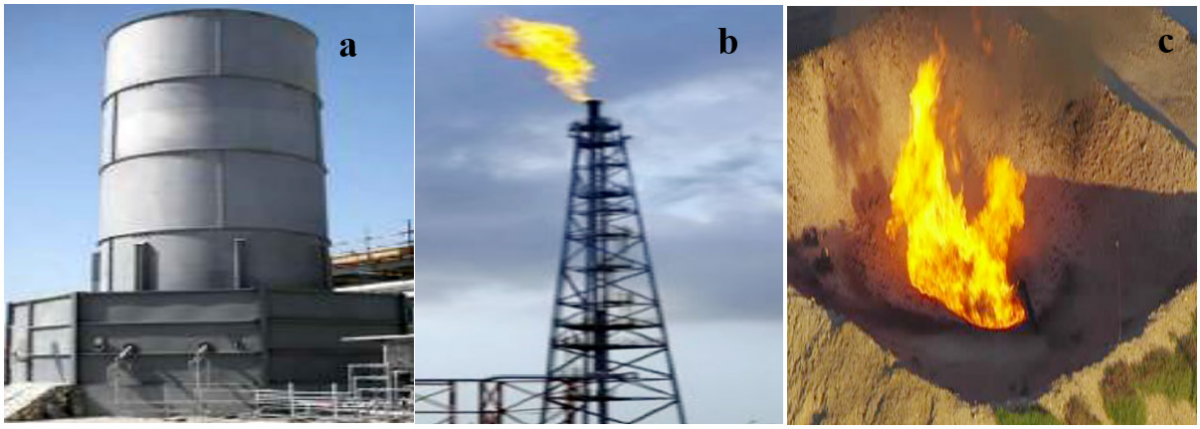

Figure 2: Schematic diagrams of the three types of gas flaring; (a) Closed ground flare (b) Elevated flare and (c) Pit Flare (Keynes *et al.*, 2020 and Getty Images, 2021).

The Study Area

The Nature of Environmental and Health Challenges in the Niger Delta:

In conjunction with the Niger Delta crude oil drilling, Nigeria flares 17.2 billion m3 of natural gas annually. Nine states constitute the Niger Delta (Figure 3), with more than 37 million residents, or 22% of Nigeria's total (National Population Commission, 2006). There are more than 1500 towns there that serve as hosts for the oil industry (Forest and Sousa, 2006). The area is primarily made up of rural villages, but includes some important Nigerian towns such as Port Harcourt, Warri, Yenagoa, Calabar, and Akwa-Ibom. The majority of locals depend on fishing and agriculture to exist, and they typically live below the poverty level (United Nations Development Programme, 2006). The oil wealth that has made Nigeria the greatest producer of petroleum in Africa, and the sixth greatest producer of oil producer in the world is found in the region of Niger Delta. (Watts *et al.*, 2004).

Oil spills are frequent in the Niger delta and have been associated with infrastructure decay, refinery processing spills, pipeline corrosion, and inadequate maintenance, human error, and vandalism committed on purpose or oil theft (Amnesty International, 2009). According to the United Nations Development Programme (2006), there were roughly 6800 oil spills totaling 3,000,000 barrels between 1976 and 2001. Likewise, according to reports, at the beginning of 2008, there were 419 cases, 2007 had 588 oil spills, and 253 in (Yakubu *et al.*, 2008). The Shell Petroleum Development Company (SPDC) (2014) reported that between 2007 and 2013, its facilities leaked roughly 324,000 barrels of crude oil in about 1500 incidents. According to SPDC, of the overall amount of oil that spilled from SPDC installations in 2013, about 75% is due to sabotage/theft, and 15% due to operational spills resulting from corrosion, equipment failure, or human error.

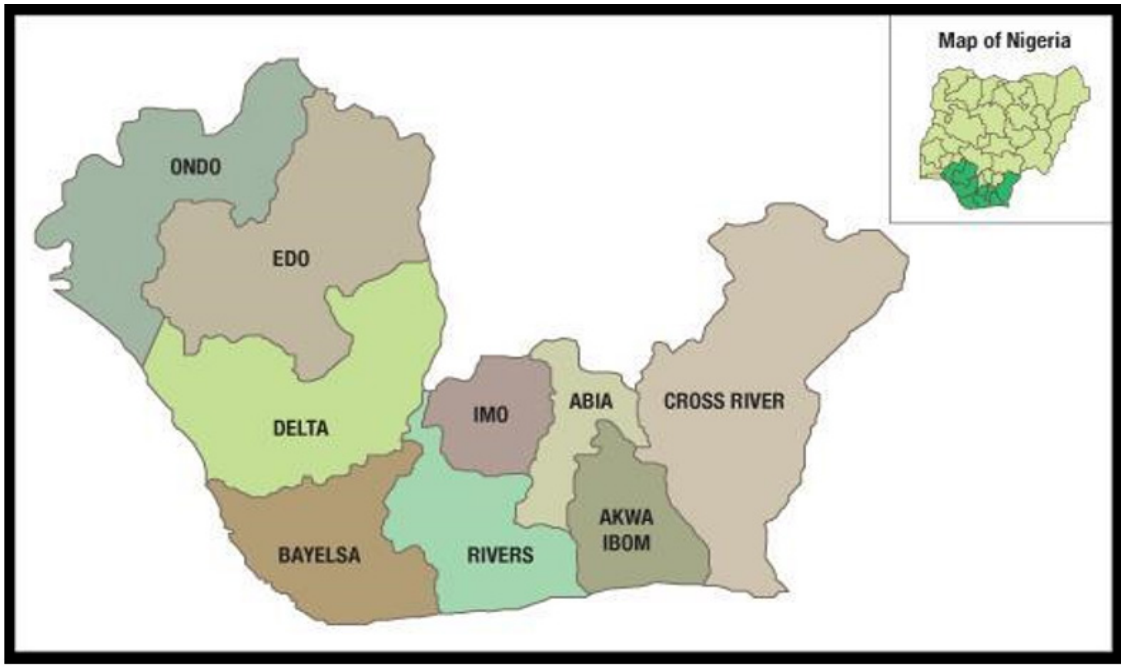

Figure 3: Niger Delta Region Map Showing Nine State (Udotong *et al.*, 2017).

Oporoma Community

The SILGA administrative center is located in Oporoma Community, Bayelsa State, which is dominated by Ijaw ethnic group, and it's a populous area in Bayelsa State. It is situated at a 215-meter elevation above sea level. It's located at coordinates 4°48'17" N, and 6°4'44" E in DMS (Degree Minutes Seconds), or 4.80472 and 6.07889 (in decimal degrees). Oporoma is a significant oil producing community in the region of Niger Delta, in which SPDC is carrying out its oil exploration activities.

Figure 4: Map of Bayelsa State Showing all the Local Government Headquaters.

Since 1965, production of oil, and gas flaring has been taken place in SPDC facility, known as Nun River Flow Station

Figure 5: Gas Flare Stack System in Oporoma.

Figure 6: Corroded Building Roofs with Acid Rain in Oporoma

Figure 7: Polluted fishing Lake in Oporoma community

DISCUSSION

About 150 persons (both men and women) were interviewed from the Oporoma community between the age of 18 - 90 years. 50 persons each from the age groups of 18 – 30, 31 – 50, and 51 – 90 years were interviewed, and their responses to harmful impact of gas flaring which has affected many lives and its environment is that, some people get strange sicknesses and diseases (cancer, birth defects, diabetes, hypertension, respiratory problems, kidney diseases, and cardiovascular diseases), especially children and pregnant women. The water, air, and land is constantly mixed with oil spills, and carbons from gas flares and power plants. This is not healthy for humans, fishes and other sea/river creatures. Therefore, their fishing business is being rendered useless, and their farm land has also been badly polluted, that it is no longer suitable for agriculture. But, little attention is being given to the people within the environment. Some of the interviewed persons said, the community representatives have made numerous efforts to inform SPDC to operate in an environmental friendly way and to integrate the community in their affairs, but instead they were kept away. The people believe that SPDC does not follow the standard of environmental policies of ISO-14001 and OSHAS 18009.

The people complained of the water, air, and land that is constantly mixed with oil spills, and carbons from gas flares and power plants, which are not healthy for humans, fishes and other sea/river creatures. Therefore, their fishing business is being rendered useless, and their farm land has also been badly polluted, that it is no longer suitable for agriculture. The indigence also complained that gas flare-ups have contributed to acid rain, and that the rain corroding their buildings roofs, and they do drinks from that same rain water during rainy session. The carbon particles from the flare will form a layer that covers the cloud. The people that have farm land around the SPDC flow station complained that they do not have any protection material, or equipment that they can use while working in their farm land with the roaring noise and intense heat that comes from the flare point. They believed that most cases of respiratory problems they are facing, like asthma, bronchitis, lung disease, heart attack, miscarriage, and skin disease are on account of dinking contaminated water, and exposure to heat from oil exploration related activities. Gas flaring, exploration and production of petroleum has cause serious effect on the region more than fifty years, in energy, sustainable development, human wellbeing and the environment, and socio-economic (Ite *et al.*, 2013). Long time gas flaring has caused serious hardship and damage to human, plant and animal life.

Environmental Implications of Gas Flaring

There is a significant problem with gas flaring, which is a global issue today. The consequences that comes with gas flaring have an impact on the people of the environment, which results into several health problems. Gas flaring something of visible, and emits heat and noise (Adewale *et al.*, 2015). Gas flaring has some effects;

Climate Change

Gas flaring normally raises the dangers of climate change that causes problem to developing countries, such as Nigeria, and the world at large (Oruonye *et al.*, 2022). The burning of greenhouse gases, fossil fuel, and gas has lets to global warming, and it's getting worse in the 21st century, according to the Intergovernmental Panel on Climate Change (IPCC). The UN and World Meteorological Organization (WMO) set up this scientific body in 1988 in order to tackle climate change. The developing countries has serious challenge in climate change, which is viewed as extremely susceptible with little capacity to adapt. The main greenhouse gas, which is emission of carbon dioxide, is mainly cause by gas flaring to climate change. Venting of gas without burning is a practice in which, it seems the flaring is being treated as a synonymy, releases methane, the second main greenhouse gas. Together and crudely, these gases make up about 80% of global warming to date (Anslem *et al.*, 2013).

Acid Rain

Acid rain is correlated with the activities of gas flaring (Friends of the Earth (FOE), 2004; Medilinkz, Nigeria, 2010). Gas flaring has cause the roofs of buildings in the region of Niger Delta to get corroded fast on account of the mixture of the emitted gases with the rain that falls on them. Emission of Sulphur dioxide (SO_2), and nitrogen oxides (NO) are the main causes of acid rain, which combine with atmospheric moisture to form sulfuric acid and nitric acid respectively. Acid rain acidifies lakes and streams and damages vegetation. Additionally, acid rain speeds up the rate of building materials to get decay and paints. When gases like NO_2 and SO_2 fall to the ground, they produce particulate matter derivatives called sulfates and nitrates that reduce visibility and are harmful to human health.

Figure 8: Air Pollution from Gas Flaring.

Effects on Agriculture

Gas flaring contribute greatly to atmospheric contaminations, which includes; hydrocarbons and ash, particulate matter, petrochemical oxidants, nitrogen oxide (NO_2), carbon dioxide (CO_2), Sulphur dioxide (SO_2), and

hydrogen sulfide (H_2S) (Obioh *et al*., 1999; Kindzierski *et al*., 2000). These contaminates acidify the soil, therefore destroying the soil nutrient. Sometimes, due to the extreme heat that is being generated, and the acid nature of the soil pH, there will be no vegetation within the area surrounding the flare (Ubani *et al*., 2013). The changes in temperature affects the crops with stunted growth, and causes young crops to withered (Orimoogunje *et al*., 2010).

Pollution

When gas is flared, it emits pollutants, which are harmful to humans and the environment. Not finished combustion can always lead to the production of carbon monoxide which one of the principal pollutants with adverse effects on both human health and society at large. The environmental and economic implications of this very excessive gas level of flaring in the region is a total waste from potential fuel is contaminating the Niger Delta's soil, water, and air (Chukwu *et al*., 2021).

Effects of Gas Flaring on Health

Adverse Effects

Exposure to the dangerous chemicals released during incomplete gas combustion has an impact on human health (Anslem *et al*., 2013). These pollutants have so many health effects, such as reproductive, cancer, neurological, deformities in children, skin problems, and lung damage (Ovuakporaye *et al*., 2012).

Haematological Effects

In hematological environment, hydrocarbon compounds can cause some changes. These changes can affect the blood, and the blood forming cells becomes negative, and this may result in anemia (aplastic), pancytopenia and leukemia (Kindzierski *et al*., 2000).

Economic Loss

Gas flaring also causes economic loses of billions of dollars, which is being burnt off daily into the atmosphere. Most of these flared gases can serve as domestic gas, and electricity generation, which can burst domestic gas and electricity supply to meet national demand. Effiong and Etowa, 2012, reported that Nigeria has loss huge amount of revenue due to flared gases, and crude oil spillage. In Nigeria, more than 65% of the governmental revenue comes from oil, and annual government income losses from gas flaring are roughly $2.5 billion (Arowolo and Adaja, 2011).

Possible solutions to Gas Flaring

Gas flaring doesn't solve any problem, it rather causes more issues. It pollutes the environment, and affects the lives of people. Many options are available to deal with this issue, such as; reinjection in secondary oil recovery, energy source and petrochemical feedstock, Liquefied Natural Gas (LNG), and Compressed Natural Gas (CNG).

Reinjection for Secondary Oil Recovery

Instead of flaring the gas, it is employable for gas lifting, or gas injection to put more pressure on in the reservoir, which will increase the crude oil production from the reservoir. Heavy crude is present in the majority of oil wells worldwide, therefore, natural gas could be used to burst the production of this heavy crude. The natural gas injection increases the pressure in the oil well, which causes more gas molecules to dissolve in the oil in order to lower its viscosity and thereby increasing the well's output (Robinson, 2013).

Energy Source and Petrochemical Feedstock

Natural gas is also referred as clean burning, because it produces less harmful by-products, compared to oil and coal. The carbon dioxide content released by fossil fuels per kilowatt hour of power produced is around half that of coal. Furthermore, it uses less energy (Gervet *et al*., 2007). Among the main sources of electricity generation is natural gas, such as gas and steam turbines. It is also used in association with renewable energy sources such as wind or solar. In combined cycle mode, high efficiency can be achieved when combining gas turbine with steam turbine. In 2012, the Energy Information Administration of US gives report of 6,799 metric tons of natural gas, 11,695 metric tons of petroleum, and 13,787 metric tons of Coal carbon dioxide that was emitted.

Liquefied Natural Gas (LNG)

Another possible solution is to liquefy the gas into bottles and vessels as liquid natural gas. This is more environmentally friendly, economical and safer instead of flaring the gas (McFarlan, 2020). Several procedures can be used to liquefy gas from wells or natural gas from crude oil production. Additionally, the majority of the time, it begins by eliminating impurities like water and other gases created by the gas, as well as other substances. Solid particles may also be present in the produced gas and must be removed before processing to maximize the mechanical efficiency in the LNG equipment. For liquefaction to occur, methane is the major composition of natural gas. For liquefaction of methane gas, the temperature must be reduced to -160 °C.

Compressed Natural Gas (CNG)

CNG referred to methane stored at high pressure. To succeed in achieving standard atmospheric pressure, fewer than 1% of the natural gas's volume is to be compressed. It is safer to store and distribute in hard containers at pressures ranging from 20 - 25 MPa, usually in cylindrical or spherical shapes. Natural gas can serve as CNG, or LNG in transportation (Hassan *et al*., 2013). Natural gas has low energy density than that of liquid petroleum fuels. It is safer to store more energy in a compressed or liquefied form. In order to use natural gas, vehicles must have a CNG or LNG specific fuel storage and delivery system installed. The United State Environmental

Protection Agency (USEPA), controls emissions for all automobiles in the United States. Because all vehicles are required to meet greater requirements, the pollution benefits of natural gas fueling have decreased in recent years (Davies *et al.*, 2001). Some restricted emissions, such as carbon monoxide, nitrogen oxides, and hydrocarbons, are reduced by using CNG. These reductions vary according on the type of vehicle and its duty cycle (Azeez *et al.*, 2017).

RECOMMENDATIONS

The challenges Oporoma community faced because of gas flaring is sufficient enough to justify putting an end to gas flaring. SPDC should try and find a means of cleaning up the environment, and to meet up the demands of the operating community. Government needs to act immediately, put more effort to strengthen their laws, and to penalize the defaulting companies. The gas could be treated and turned into residential or cooking gas, and also for generation of electricity.

CONCLUSION

One of the main energy sources for accelerating developmental needs is gas, especially in the developing countries, like Nigeria. Gas is being wasted through flaring, producing dangerous air pollutants in Nigeria. The flared-up natural gas in Nigeria can be used for the purpose of cooking to about 320 million people. Petroleum production and exploitation in the region of Niger Delta over the years have caused so many environmental, socio-economic and political problems in the region. Spills of crude oil and gas flare-ups in Oporoma community has caused several environmental problems to the environment such as; loss of plants, human health, and animals lives. The oil producing companies, and government are also losing revenue. Therefore, gas flaring should be avoided, instead let it be utilized as domestic and electricity generation to even burst the economy of the company and the government. In most nations, it is forbidden to flare gas, but it can only occur in some circumstances, such as unplanned maintenance, disruption to the process system, and emergency shutdowns. In 31st December, 2012, the proposed Petroleum Industry Bill (PIB) in Nigeria stipulates that "natural gas should neither be vented nor flared in the generation of gas and oil operations, either onshore or offshore, block or field, other than a gas facility under exceptional and temporary circumstances", this draft is yet to be passed into law. Legislative backing and governmental bureaucracy still remains a stumbling block.

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