The Effect of Gas Flaring on the Environment and Public Health in Libya

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Abstract:

This paper discusses the issue of gas flaring in oil & gas industry in the world generally, and special in Libya. The gas flaring has enormous negative effects on the climate, human health and environment of workplace. Libya is one of the top countries in Africa for gas flaring. According to data from the World Bank's Global Gas Flaring Reduction Partnership (GGFR), Libya flares billions of cubic meters of natural gas annually. This not only represents a waste of valuable energy resources but also contributes to environmental pollution. Gas flaring releases large amounts of carbon dioxide (CO2) and methane (CH4), both of which are potent greenhouse gases. This contributes to climate change and has local environmental impacts, including air pollution and health issues for nearby communities. This paper also discuss the ways of reducing gas flaring emissions in oil & gas industry and taking advantages of commercial products. Moreover, consider this problem during design any future project. The second highlights discussion will be about the recent significant increasing in oil & gas production and exploration activities by National Oil Corporation (NOC). Also the negative impacts of these activities on the environment and public health. Finally, we will discuss the effects of training performance related to the technology developments.

Key words: Libya, gas flaring, environment, public health, oil & gas industry

1. Introduction

Oil and Gas industry is one of most economical fields that Libya depends on it to grow and develop all country sectors which are related to construction, financial affairs, economic affairs, education system, communication foundation, etc. the recent

improvements in Oil and Gas industry cause an appearance many techniques used to produce oil, gas water, petrochemicals, chemicals, petroleum products, plastic products, and other materials.

The enormous developments and improvements in Oil and Gas industry assess to grow the education system in many countries. These improvements also help to increase the capability and reliability in oil and gas exploration, drilling and production methods (Nazari and Musilek, 2023).

Oil and gas industry has huge developments in technology that use in oil and gas processes, which include separation methods, treatment systems, dehydration processes, distillation process, power generation plants. In addition to the improving in oil and gas processes control communication systems (Iulianelli and Drioli, 2020).

Eventually, technology affects to reach high quality and considerably pure final products to use or export. Even though, technology has advantages and disadvantages of using it. The oil and gas industry operations have effective aspects in environment and safety. So that all oil and gas processes are designed to meet all safety regulations and instructions. Also, the oil and gas industry influence in environment and climate change all around the world (Blundell and Kokoza, 2022).

In this paper we will highlight the importance of taking all responsibilities towards environment and all aspects that affect the climate change and public health in Libya. On the top the environment pollutes due to hydrocarbons flaring during processes operations or different cases.

2. Background

Petroleum is a complex mixture of hydrocarbons. It is naturally occurring in underground earth. It is also called crude oil. It exists in liquid, gaseous or solid forms. The liquid form of it is crude oil. The gaseous form is natural gas, whilst bitumen, shale or tar sands and coal is the solid form. The crude oil has many types (light oil, medium oil, heavy oil, extra heavy oil and bitumen) it depends on specific gravity and API gravity (Canadian Centre for Energy Information 2012).

Crude oil and natural gas are the most subjected in oil and gas industry operations. The exploration and drilling activities are based on oil and gas reservoirs. Oil reservoir is the subsurface space which contain or storage oil in it (trap). To achieve the production operation the drilled oil well accomplished completely. Then the crude oil is flowing through well head and X-mass tree assembly, flow lines, manifolds, separation stages, storage and metering system (Schlumberger, 2006).
During separation processes the associated raw natural gas is separated from crude oil. Associated raw gas is then goes to next gas treatment facilities to produce condensate liquid (LPG) products, gas injection or otherwise via to flare system.

3. Natural & Associated Gas

Natural gas is occurring naturally from gas reservoirs or can be associated with crude oil during production operation. Natural gas consists mainly Methane (CH4) and small amount of Ethane (C2H6). These components are produced as dry gas to facilitate the power generation network and other quantity goes to export pipeline. The hydrocarbons of (propane, butane) used for civilians' usage. Other hydrocarbons are used to produce Gasoline, Kerosene, diesel fuels and lubricant oils, etc.
There are many types of natural gas depends on the composition of the gas and percentage of impurities such as Raw Gas, Dry Gas, Wet Gas, Condensate Gas, Sour Gas, and Sweet Gas. Natural gas also consists of amount of impurities which are carbon dioxide, nitrogen, hydrogen sulfide and water vapor. These impurities must be removed by different processes techniques to protect processes equipment (dehydration process, chilling train system, instrument air network, compression station, delivery and metering system, etc.) plants networks and delivery pipelines (Mokhatab et al., 2015).
Removing of these impurities leads to improve the quality of final product to use in many purposes to ensure processes performance, capability and reliability. Also, the purity of the final product helps to optimize processes operation, select the appropriate operating techniques, planning overhauling maintenance, shutdown cases, etc.

4. Flare and Burning Pit System

The flare and burning pit system is a safety device or system. It is equipped with the plant processes to blow down the gas feed streams and discharge all plant processes liquids during normal operation, maintenance activities, shutdown activities or emergency cases, In addition to all safety valves, relief valves, and blow down valves are connected directly to flare and burning pit system (API, 2014).
The flare and burning pit systems consist of flare and burning pit feed lines, knockout drums, flare tip, pilots and burner assembly, flare stack, fuel and air lines and ignition control panel.
The flare and burning pit systems are designed to accommodate all production designed quantity. Moreover, it is essential part of ensuring safety and environmental responsibility in many industrial setting. Also operation variables and fluid composition are important for design the flare and burning pit stack pipes.

5. Gas Flaring Classifications

Gas flaring can be classified into two types

- Routine gas flaring (planned gas flaring):
  This gas flaring occurring during planned overhauling maintenance, routine preventive maintenance, purging activities, depressurized equipment that includes (vessels, individual process, gas compressors, pumps, knockout drums) etc. these activities planned in advance to aware of gas flaring sources (Alsuwailem, 2021).
- Non routine gas flaring (unplanned gas flaring):
  This type occurs when unplanned or unexpected shutdown of processes operation. It includes when unexpected depressurization of plant processes, and emergency depressurization (EDP) or emergency shutdown (ESD). Moreover, it includes gas flaring during power failure situation and during a sudden shutdown of receiving stations (Emekwuru, 2024).

6. Effects of Gas Flaring on Climate & Environment

Gas flares at oil production sites worldwide burns around 140billion cubic meters of gas in 2023. This gas flaring is typically associated gas composition. Assuming a typical associated gas composition, a flare combustion efficiency of 98% and global warning potential for methane of 28. Each cubic meter of associated gas results about 2.6 kilograms of

CO2 equivalent emissions (CO2) resulting about 350 million tons of CO2 equivalent emissions annually. The methane emissions from inefficiency of flare combustion contribute significantly to global warning. According to intergovernmental panel on climate change, methane is over 80 times more powerful than carbon dioxide.

Gases that trap heat in the atmosphere are called greenhouse gases. The most significant greenhouse gases are water vapor, carbon dioxide, methane, nitrous oxide and fluorinated gases. These gases allow sunlight to pass through the atmosphere and warm the Earth's surface. The Earth then radiates heat back outwards, but greenhouse gases absorb some of this heat preventing it from escaping into space. This trapped heat warms the atmosphere and Earth's surface (Sekyi, 2017).

Consequently, the increase in greenhouse gases is causing a variety of environmental problems. It includes rising sea levels, more frequent and intense heat-waves, changing in precipitation patterns and ocean acidification. Additionally, the significant improvement in oil and gas industry leads to increase the greenhouse gases in emissions, especially during gas flaring. This led to a rapid increase in global temperature, resulting in climate change.

Greenhouse gases effects on climate depends on the act of each greenhouse gas's effect, and this depends on three main factors which are:

- How abundant are greenhouse gases in the atmosphere?
- How long do greenhouse gases stay in the atmosphere?
- How strongly do greenhouse gases impact the atmosphere?

7. Gas Flaring Reduction Methods

In order to reduce the gas flaring and flaring emissions of greenhouse gases is to take in consideration the design processes to take all benefits of gas production especially the associated raw gas. The gas can liquefied in NGL recovery plant and produce a pure final products such as C3+ as condensate exports in liquid state, C5+ gasoline pumped with oil and C3 pure propane used as cooling media, in addition to produce C3 and C4 to using them in heating and cooking.

The dry gas mainly Methane CH4 and some amount of Ethane C2H6 exported to green stream pipeline. Also, it uses to utilize the power

generation plant. It uses as a fuel gas for industrial or heavy-duty gas turbines to generate the heat energy and then convert to mechanical movement and therefore generate the electricity. The produced raw gas can be used as a drive mechanism by injected it into injection wells to prevent gas flaring and avoid the black carbon pollutes the environment and workplace area

8. Influence of Technology on Oil & Gas Industry

The development and improvement in technology effect on oil and gas industry. It improves the processes performance by increasing in processes capability and reliability. Now days the challenge in technology improvements makes some companies concentrate and take advantages of any investment related to oil and gas engineering. These companies have improved and grow their experience in technology to give more accuracy and intelligent in processes performance. Technology improvements appearance in chemical processes technology (dehydration system, distillation processes, rectification system, etc.), gas turbines applications, gas compression techniques, plant processes control system, well control system, well testing equipment, water treatment applications. As well as firefighting systems, safety equipment (smoke detectors, fire detector, heat detectors, call points, etc.), and fire and gas control panels. In addition to the comprehensive improvements in software's and processes communication control system which include programmable logic control system (PLC) and distribution control system (DCS).

9. Gas Production & Gas Flaring Performance

Actually, oil and gas sector exploration and production operation managed by Libyan National Oil corporation LNOC since 1970.and it takes all responsibilities to administrate energy technical resources. Also becomes the first institution that get confidence overcome all circumstances and different situations all the time It has enormous oil and gas companies which some of them is national companies and other divided companies. The LNOC aimed to increase the oil and gas production to about 2 to 3 Mbbl/D by 2027 also to achieve and succeed some biggest projects in oil, gas and renewable energy. These companies

have their own strategy and working policy. Each company also has its fields. The most major companies are:

- **Melittah Oil and Gas. BV. Libya brunch:**

Associated gas production amounts in MSCM						
year	R82	Abu-Attifel field	Alburi field	Alwafa field	Alfeel field	Total associated gas MSCM
2018	171	1.807	1.098	1.617	9	4.702
2019	92	1.984	1.110	1.435	13	4.634
2020	49	398	1.172	930	3	2.551
2021	196	1.699	1.197	1.081	12	4.186
2022	161	1.342	1.204	1.147	8	3.862
2023	248	1.831	1.266	1.041	31	4.418
total	917	10.021	11.646	13.675	97	36.355

Produced gas from gas wells (MSCM)			
year	Alwafa field	Baher alsalam NC41	Total produced gas non associated gas
2018	3.764	9.181	12.945
2019	4.547	11.298	15.844
2020	4.439	10.235	14.674
2021	3.424	10.130	13.554
2022	2.895	9.879	12.774
2023	2.545	10.089	12.634
total	37.465	99.977	137.441

Produced and exported treated gas (MSCM)					
year	Alwafa field	Baher alsalam NC41	Total treated gas	Total export gas	Total fuel gas
2018	4.140	7.036	11.176	8.795	2.381
2019	4.513	8.386	12.899	10.631	2.268
2020	3.969	7.439	11.407	8.990	2.418
2021	3.326	7.284	10.610	8.290	2.320
2022	2.898	7.168	10.066	7.763	2.303
2023	2.477	7.108	9.586	7.244	2.342
total					

- **Sirt Oil |Company:**

Field Name	Production and flaring quantity				
	Oil BPD	Gas (SCF)			Gas flaring MSCF
		30"	36"	36" associate gas	
zolton	50515	35.1 MSCF / M associated gas for 36"			Average daily flow rate = 1.7 MSCF/D for flares system
Aljabal	14289	345.0 MSCF /D 348.2 MSCF / M			100.2 MSCF /D daily due to

		non associated gas for 36"	operation reasons
Alralh	400	100.0 MSCF / D 71 MSCF /M for 30"	7.2 MSCF /D acidic gases
Alwadi	2750		
Alwadi mem	3978		
Alaheeb	12800		
Almaqeel	3209		
Alrashad	357		
Alraqoubah	16011		
Alkher	1106		
Kamelea	3126		
Almahereqah	145		
matkandosh	4615		

- **Waha oil Company:**

Field Name Faregh field	Production and flaring quantity
Net Oil shipping	14089 bbls / D at 130F at gialo 106F
Total gas delivered to 24' pipeline	69.260 MMSCF/D
Gas delivered to Sarir	49.744 MMSCF/D at 625 psig at Zuetina 523 psig
Gas sales to Sarir	51.079MMSCF/D
Gas sales to Sahel	124.454 MMSCF/D

- **Alsarer Oil Company:**

Production performance and flaring flow rates
Oil production from A-91 & A-107 = accyual field 55093 and export 41354 bbl/D
Oil production from A-91 = actual 39889 bbl/d and export about 25808 bbl/d
Oil production from A-107= actual 15204bbl/d and export about 15556 bbl/d
Gas export = 36.057 MMSCFD. The gas via Sahel . condensate production =2860 bbld
Flaring flow rate =1.999 MMSCFD at A-91. A-107 = 0

10. Future Achievements in Oil & Gas in Libya

Oil and gas sector is an important sector that Libyan Country depend on it to grow and develop all country department. The LNOC is directing all decisions to the companies in active way. Also, it works with very important and main international partners Eni, Total, Repsol, Wintershale to exchange knowledge, training. and community growth.
The future plan of LNOC to increase the oil and gas production to grow Libyan economy and to take the benefit of this source to build up our country. Actually, there are an ambiguity and abnormality that influence towards Libyan community related to environment, country facilities and citizen income. Libyan citizens do not find and take benefits of oil and gas products as interrupting in electricity, fuel supplies, road construction, water supplies, education system, etc.

The LNOC achievements should improve the capability of petroleum locations to utilize final products to citizens or export them. The oil and gas sector developments and exploration very important to lead Libyan country internationally by increasing the production and compete between the countries which export oil and gas. Thus, it will provide brilliant environment, more improvements lead to increase production of processes, increase in economics affairs.

11. Importance of Training in Oil & Gas Sector in Libya

LNOC provides many courses to qualify and training employees. This training should be scheduled clearly and accurate to give an employee to take advantage of it. The improvements in technology make the training aspects very essential to aware of all possibilities, processes optimization, design consideration, heat and materials balances, future plans, system upgrades, etc.

12. Conclusion & Recommendations

- I personally suggest that to treat the flared associated gas especially at locations which have high quantity of flare flow rate.
- To reach zero flare flow rate, it should be increase the capacity of some oil and gas processes.
- I recommend to take full analytical results of flared gas to be awarded of all gas properties, then can be asses to design an appropriate process or to connect it another location.
- I personally suggest that to increase the capacity of Libyan refineries especially Alzawia oil refinery, Albreiqa oil refinery to provide final products such fuel, Naphta, oils, kerosene, etc.
- To continuous of doing planned maintenance to increase the capability and reliability of processes.
- NOC should give more support of experienced employees by training programs.
- It essential to make upgrade of any old systems as the improvement in technology and take all advantages of using it.
- To increase the oil and gas production it should take in consideration of associated gas processes operation optimization. Also improve produced gas pipeline network.

References

Alsuwailem, M. (2021). The Road to Zero Routine Gas Flaring: A Case Study from Saudi Arabia. Conference: International Petroleum Technology Conference.
10.2523/IPTC-21182-MS.

API STD 521, Pressure-relieving and Depressuring Systems, Sixth Edition, January 2014.

Blundell, W. & Kokoza, A. (2022). Natural gas flaring, respiratory health, and distributional effects. Journal of Public Economics 208(4):104601.
https://doi.org/10.1016/j.jpubeco.2022.104601.

Canadian Centre for Energy Information. "What is crude oil?" Archived 2014-07-10 at the Wayback Machine. Retrieved on: 2012-09-10.

Emekwuru, N. (2024). Characterization of the Dominant Stages at Which Gas Flaring Is Introduced: Impacts and Policy Options to Ameliorate Them. Environments, 11(7), 158.
https://doi.org/10.3390/environments11070158

Iulianelli, A. & Drioli, E. (2020). Membrane engineering: Latest advancements in gas separation and pre-treatment processes, petrochemical industry and refinery, and future perspectives in emerging applications. Fuel Processing Technology, 206, 106464.
https://doi.org/10.1016/j.fuproc.2020.106464.

Mokhatab, S., Poe, W. & Mak, J. (2015). Handbook of Natural Gas Transmission and Processing (Third Edition), Chapter 3 - Basic Concepts of Natural Gas Processing, Gulf Professional Publishing, Pages 123-135,
https://doi.org/10.1016/B978-0-12-801499-8.00003-1.

Nazari, Z., & Musilek, P. (2023). Impact of Digital Transformation on the Energy Sector: A Review. Algorithms, 16(4), 211.
https://doi.org/10.3390/a16040211

Schlumberger Excellence in Educational Development. (2006). What is a Reservoir? Archived from the original on April 27, 2006. Retrieved January 30, 2006.

Sekyi, A. (2017). The Impact of Gas Flaring On Man and His Environment and the Way Out. International Journal of Engineering and Management Sciences. 2. 82-90. 10.21791/IJEMS.2017.3.8