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EMISSIONS OF CO_2 AND CH_4 IN ASMARI GAS COMPRESSOR STATION IN NATIONAL IRANIAN SOUTH OIL COMPANY USING EMISSION FACTOR

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ABSTRACT

Introduction: Iran is located in the seventh rank in terms of CO_2 emissions resulting from the combustion of fuel in the world. Asmari gas compressor station due to the several sources of contaminants are causing the release of large amounts of CO_2 and CH_4, which will cause damage to the environment and a change in the weather conditions. This study was aimed to assess the extent of the greenhouse emissions (CO_2 and CH_4) in a selected Asmari gas compressor station at National Iranian South Oil Company.
Materials and methods: In this study, the emission factor method, provided by various organizations, was used for determining emissions of CO_2 and CH_4 from sources.
Results: According to the results, the total amount of CO_2 emissions in selected units is equal to 1825.533 tons/day and the total emissions of CH_4, is equal to 2.473 tons/day. Among the sources of pollutants in the fixed combustion sources, turbines have the highest amount of CO_2 emissions, and among the exit gas source (repair and maintenance activities), the highest emissions of CH_4 belongs to the compressors.
Conclusions: The amount of CO_2 emissions from indirect sources (electrical equipment) from natural gas are more than fuel oils for burning, and CH_4 gas from volatile sources in the gas compressors have the highest emissions compared to other sources.

INTRODUCTION

Due to the growth and expansion of industrialization, the energy demand across the globe is increasing rapidly. This growth in energy has been led to environmental degradation, water and air and greenhouse gas emissions and other pollutants [1]. Greenhouse gases include CO_2, CH_4, N_2O, HFC_S, PFC_S, and SF_6, which the most important of them are respectively the CO_2 that is a product of natural fuel combustion, and CH_4, which the most important reason for its release to the atmosphere, is the anaerobic decomposition of wastes, intestinal fermentation in the livestock, rice cultivation, production and distribution of oil and natural gas, coal production, and incomplete combustion of fossil fuel [2, 3]. researchers have studied the increased adverse effects of greenhouse gas emissions; furthermore, sea level rise, liven up diseases that human was trying to eliminate them for many years, and many other issues, such as the drought and go away vegetation have been amongst the obvious cases studied [4]. According to the evaluations of the Research Center for energy and environmental studies, share

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of greenhouse gas emissions in the country's oil industry that the most important part of it are associated gases burned and gases burned in the oil units, is about 35% of the country's total greenhouse gas releases [5].

Overview of the gas compressor station shows that the major sources of greenhouse gas emissions (CO_2 and CH_4) are from various sources such as flares, turbines, tanks, electrical equipment, gas valves and compressors, and such resources are of the major share of contribution in the similar units in terms of greenhouse gas emissions; in addition, and because these gases are parts of the most important greenhouse gases, and are a great impact on the global warming, this research becomes more important. Different methods for estimating emissions include sampling or direct measurement, mass balance, fuel analysis or other engineering calculations and emission factors. Generally, the most accurate method for calculating of clear emissions is the direct measurement, but it is the costly and it is difficult to conduct it for some resources. The calculation programs and engineering often can provide the exact estimation much more than emission factors; although in some cases they may require a lot more effort. Since the entries of program require specific data of the process, the results are specific estimations of the process [6].The emission factor is an index value that is in an attempt to link the quantity of a pollutant released in the atmosphere with an activity related to the release of related pollutants. These coefficients that are usually expressed as the weight of pollutant are classified into a unit of weight, volume, distance or duration of an activity of the spread of contamination [7].

Ahmadi et al., estimate greenhouse gases by emission factor in sugarcane development company and gas pressure booster station in the Bangestan field of the National Iranian Oil Company [8, 9]. Park et al.; using energy - environment models, conducted a study on the assessment of CO_2 emissions and its potential reductions in the oil refining industry of Korea, and found that new technologies and alternative scenarios can decrease carbon dioxide emissions in the national and industrial sectors respectively to 0.048% and 0.065% [1].

The aim of this study was to assess the level of CO_2 and CH_4 emissions at a selected gas compressor booster station in Oil South fields by the use of the emission factor. Thus, it is expected that the results would be a great achievement for executives and lovers of the environment to be more diligent in controlling greenhouse gases (CO_2 and CH_4).

MATERIALS AND METHODS

In this study, one of the Asmari gas compressor stations of NIOC in South west Iran was investigated. The gas compressor booster stations, which have been constructed in the adjacent of operating plants, receive rich gases, which are separated from oil during the second, third and fourth stages of breakdown in the operating unit of oil separators, and after compressing and separating liquids from them, send their final products in the form of gas and gas liquids to do further refining and processing on them to the gas and liquid gas plants [10].To calculate emissions, first, the overall process of gas compressor booster station in relation to the sources of production of the pollution was detected. After identifying the sources, including fixed combustion sources, exit gas sources (repair and maintenance activities), indirect sources and escape sources, type and rate of fuel consumed in the designated unit, and according to the emission factors provided by various organizations, which have been presented in Table 1, emissions for each sources was estimated using the equation [1]:

$$E = A \times EF \times [1-(ER/100)] \qquad (1)$$

In this equation, E is the rate of emission of pollutants (the amount of pollutant mass); A is the amount of activity; EF is an emission factor (the amount of pollutant mass emitted per the amount of product produced or The rate of activity); ER is the overall percentage reduction of emission that this value is considered to be zero, due to the lack of using pollutant reduction systems in the Asmari Gas compressor booster station [7]. Finally, by comparing a variety of sources of pollutants in a unit studied, the data were examined and analyzed using Excel software.

Table 1. Emission factors for the emission sources by various references

Source		Unit	Emission factors				Reference
			CH_4		CO_2		
Gas flares		lb/MMBTU	0.61		-		[11]
Gas flares		g/m^3 gas	13.6		1853		[12]
Gas flares		lb/MMBTU	0.12		-		[13]
Gas flares		lb/MMBTU	-		120.72		[14]
Gas flares		lb/MMBTU	-		141.01		[15]
Gas flares		lb/MMBTU	0.389		105.01		[16]
Gas flares		lb/MMBTU	0.012		148.98		[17]
Gas flares		lb/MMBTU	0.61		144.76		[18]
Gas turbines		tons/10^6 BTU (HHV)	Uncontrolled	$3.9*10^{-6}$	-		[2]
Gas turbines		tons/10^6 BTU (LHV)	Uncontrolled	$4.3*10^{-6}$	-		[2]
Gas turbines		lb/MMBTU	0.012		-		[11]
Gas turbines		g/m^3 gas	0.138		1769		[12]
Gas turbines		lb/MMBTU	$8.6*10^{-3}$		110		[19]
Repair and maintenance activities tank		tones/vessel-year)	0.0015		according to CH_4 emission factor is calculated		[2]
Compressor		tones/compressor-year	$2.42*10^{-2}$		according to CH_4 emission factor is calculated		[2]
Repair and maintenance activities of Compressor	Start	tones/compressor-year	0.162		according to CH_4 emission factor is calculated		[2]
Repair and maintenance activities of Compressor	Blowdown	tones/compressor-year	0.07239		according to CH_4 emission factor is calculated		[2]
Valve	Valve-Gas	tones/valves-day	$4.5*10^{-6}$		-		[2]
Valve	Valve-Heavy Oil	tones/valves-day	$8.4*10^{-9}$		-		[2]
Valve	Valve-Light Oil	tones/valves-day	$2.5*10^{-6}$		-		[2]
Valve	Valve-Water	tones/valves-day	$9.8*10^{-8}$		-		[2]
Electrical equipment		**Type of fuel**	**Natural Gas**	**Fuel oil**	**Natural Gas**	**Fuel oil**	
Electrical equipment		tons/MMBTU		-	0.0542	-	[20]
Electrical equipment		tons/MMBTU	-	-	0.0531	0.0743	[20]
Electrical equipment		tons/MMBTU	$1.06*10^{-6}$	$3.17*10^{-6}$	$1.06*10^{-6}$	$3.17*10^{-6}$	[2]
Electrical equipment		tons/MMBTU	-	-	0.052	-	[20]
Electrical equipment		tons/MMBTU	-	-	0.0556	0.0703	[20]
Electrical equipment		lb/10^{6}SCF	2.3	-	120000	-	[21]
Electrical equipment		tons/MMBTU	-	-	0.0532	0.0743	[20]
Electrical equipment		tons/MMBTU	-	-	0.0531	-	[20]

To estimate the amount of emissions of pollutants (CO_2 and CH_4), fuel type and the amount of fuel consumed in each resource should be determined separately. Since fuel consumed for the sources of pollutants in the study unit is fuel gas, so, the data contained in the Asmari Gas Compressor Station presented in Table 2 have been used.

RESULTS AND DISCUSSION

CO_2 and CH_4 emissions from gas f ares

Table 3 shows the calculated emissions for a gas flares on Asmari Gas Compressor Station with an average rate of 0.1 million ft^3/day

CO_2 and CH_4 emissions from the gas turbine Emissions calculated from gas turbines of Asmari Gas Compressor Station with an average 1.6 mil-lion ft^3/day can be seen in Table 4.

CO_2 and CH_4 emissions from repair and maintenance activities of compressor and tanks

As in Tables 5, 6 and 7 can be seen, the amount of CO_2 and CH_4 emissions resulting from compressors, activities related to the maintenance of compressor and tank for each maintenance activity have been calculated.

Table 2. Composition and properties of the fuel gas used in combustion sources and other sources of emission in Asmari Gas Compressor Station [10].

Characteristics		Stages			
		First	Second	Third	Fourth
Breakdown pressure (PSIG)		480	80	18	1
Temperature (° F)		138	130	126	122
Gas-oil ratio (SFF/BBL)		680	134	36	23
Components Mole (%)	Methane	82.21	64.95	34.42	11.44
	Ethan	9.31	16.96	25.29	24.54
	Propane	3.79	9.2	20.72	30.96
	Butane	0.52	1.34	3.51	6.14
	Pantan	1.05	2.72	7.31	13.28
	Normal Pantan	0.3	0.75	2.09	4.02
	Hexane and	0.27	0.66	1.86	3.6
	Heptane to top	0.2	0.43	1.21	2.38
	Carbon Dioxide	0.23	0.43	1.82	1.57
	Hydrogen sulfide	1.67	2	1.76	0.99

Table 3. CO_2 and CH_4 emissions from gas flares

Emission* (tons/day)		Reference
CH_4	CO_2	
0.027	–	[11]
0.038	5.247	[12]
0.005	–	[13]
-	5.475	[14]
-	6.396	[15]
0.017	4.767	[16]
0.005	6.757	[17]
0.027	6.563	[18]

*Returns for the flares are assumed to be 98%.

Table 4. CO_2 and CH_4 emissions from gas turbines

Emission* (tons/day)		Reference
CH_4	CO_2	
7.38×10^{-3}	-	[2]
9.797×10^{-3}	-	[11]
7.02×10^{-3}	140.25	[12]
7.02×10^{-3}	139.706	[13]

*The emission factor provided by the API and EPA for gas turbines with no means of control (with yield ≤ 80%)

Table 5. CO_2 and CH_4 emissions from compressors

Emission (tons/day)		Reference
CH_4	CO_2	
3.642	0.42	[2]

Table 6. CO_2 and CH_4 emissions from repair and maintenance activities of the compressor

Emission (tons/day)		Reference
CH_4	CO_2	
0.455*	0.05*	[2]
0.203**	0.023**	

*Start **Blow down

Table 7. CO_2 and CH_4 emissions from repair and maintenance activities of tanks

Emission (tons/day)		Reference
CH_4	CO_2	
0.01	$9.927*10^{-4}$	[2]

CO_2 and CH_4 emissions from electrical equipment

The CO_2 and CH_4 gas emissions, based on the emission factors according to the use of 560MW/h in Asmari Gas Compressor Station and according to the conversion of fuel to electricity are presented in Table 8.

Table 8. CO_2 and CH_4 emissions from electrical equipment [20].

Emission (tons/day)			
CH_4		CO_2	
Natural Gas	Fuel oil	Natural Gas	Fuel oil
-	-	1749.293	-
-	-	1713.79	2.645
0.033	$1.128*10^{-4}$	1713.79	2.645
-	-	1678.288	-
-	-	1794.477	2.612
0.033	-	1756.852	-
-	-	1717.018	2.502
-	-	1704	–

CH_4 emissions from valves

Table 9 shows emissions from Gas valves of Asmari Gas Compressor Station.

Table 9. CO_2 and CH_4 emissions from valves

Emission (tons/day)	Reference
0.099	[2]

According to calculations obtained from Asmari Gas Compressor Station a total of 1825.533 tons of CO_2 gas per day is released, which indirect emissions sources (electrical equipment) with 94% have the largest share of CO_2 emissions. The second share of emissions is awarded to gas turbines with 4%, and the third source of emissions is awarded to gas flares with a share close to 1%. Finally, gas compressors and the repair and maintenance activities of compressors and tanks are those resources that due to the lack of combustion, have a negligible contribution into the emissions. In a study carried out by Ahmadi et al. estimated GHG_s in pressure booster station in the Bangestan field of the National Iranian Oil Company, they report the total CO_2 emissions is equal to 7739.027 tons/day and the total amount of CH_4 emissions is 4 tons/day (8). Also Ahmadi et al showed lime kilns, diesel generators, steam boilers and electrical equipment were the main source of greenhouse gases in sugarcane development company, and the total emissions of carbon dioxide and methane were, 279695.528 and 3134.07 tons/year, respectively [9]. The difference in being more amount of emissions produced by these studies can be attributed to the indirect emissions sources (electrical equipment), exit gas resources (repair and maintenance activities) and fugitive resources as well as constant combustion sources considered in the present study.

A total of 2.473 tons/day of CH_4 gas is released from Asmari Gas Compressor Booster Station CH_4, the gas compressors with a 91% have a very considerable share in the CH_4 emissions. Then, fugitive emissions from valves with 6% and electrical equipment with 2% respectively are the second and third largest sources of emissions in the selected station. Next, burners with 1%, and finally the turbines and repair and maintenance activities related to the compressors and tanks have the lowest share in the methane emissions from the station. A study conducted to measure fugitive emissions from natural gas plants in Alberta, Canada, found that gas compressors are the main source of CH_4 emissions. Operation Torch, then in another pilot plant is an important source of emissions; then the operation of the burner in the pilot mode is another important source of emissions at the plant. According to the results obtained, CH_4 emissions from compressors is 1272 kg / day and from burners are 650.4 kg/day, which are consistent with the results of this study; so that the compressors of the selected unit are 1647 kg/day tonnes per day greater than the amount emissions from flares with 19 kg/day [22].

According to previous studies, the total amount of CO_2 emissions in the world is 28999.4 million tons/year, which the Iranian part of this sector is 1.83% and the share of emissions from the world oil sector is 10630.8 million tonnes, which is 2.48% of it is the shares of Iran [23]. Asmari Gas Compressor Station emits 666319.545 tons CO_2 gas per year (or 2%) compared with Iran's oil sector. Due to the potential global warming of CO_2 gas is greater than CH_4 gas, the main focus in this section has often been on carbon dioxide.

CONCLUSIONS

The results of the study suggest that the largest emissions of CO_2, are indirect emissions (the electric equipment) with 94%; as well as for CH_4 gas, gas compressors have a very substantial contribution compared to other resources that due to the importance of the issue of global warming and changes in weather conditions should be corrected immediately. Some of the strategies that can be used for decreasing emissions of gases studied in Asmari Gas Compressor Station include the use of new lighting control systems, the Lamps used, new systems of loading and unloading of electric motors, collecting and controlling emissions from sealing using the system of exit closed gas or by improving the performance of sealing systems by use of dual mechanical seals for compressors [24]. Optimization of combustion burners and gas turbines, replacing electric turbines with gas turbines, replacing alternative hydrogen fuels with gas fuel, improving operations of repair and maintenance and a timely overhaul for equipment emitting pollutants [8].

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COMPETING INTERESTS

There is not any competing interests between authors.

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ETHICAL CONSIDERATIONS

Ethical issues (including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, redundancy, etc) have been completely ob-served by the authors.

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