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Identifying Production Sources and Quantifying H2S Gas from Underground Storage and Facilities of Masjid Suleiman Oil and Gas Exploitation Company

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Abstract. Hydrogen sulfide gas is one of the most dangerous gases in the workplaces of oil and gas industry and is considered as a contrary combination in gas reservoirs which not only reduces the economic contribution of hydrocarbon of gas reservoirs, but also is toxic and causes corrosion of equipment exploiting the reservoirs. In this study, due to high levels of hydrogen sulfide gases in Masjid Suleiman oil and gas Exploitation Company And risks associated with it, it was attempted to identify the sources of producing and detector hydrogen sulfide gas in the area. For this purpose, after identifying the sources of hydrogen sulfide gases emissions in the area of the study, finally 8 points (including 5 units of Masjid Suleiman oil and gas Exploitation Company such as unit 9 Bibayan, Talbezan, Anbar, Nargesi, and Zilaeai and 3 urban regions of Kuye Naftkhiz, Siberenj, and Pansium e Khayam) as the major points of leaks have been identified and evaluated in 4 months of May, July, September and November by the use of gas detector device. The results showed that the concentration of hydrogen sulfide gas in urban areas ranged from 15 to 17 ppm. While the amount of gas emissions in Masjid Suleiman oil and gas Exploitation Company was anticipated from 2 to 5 ppm respectively. It was also found that the differences of concentration of hydrogen sulfide gases are not significant in various months there. Comparison of the results with national and international standards confirmed that in urban areas, the concentration of hydrogen sulfide gases is beyond the scope of the standard but in the installations the amount of the gas is only beyond OEL-TWA standard values.

Keywords: Hydrogen sulfide gas, oil and sour gas reservoirs, air pollution, OEL standard, Masjid Suleiman oil and gas Exploitation Company

INTODUCTION

Today, environmental pollution is one of the biggest global crises. In the midst the pollutant gases produced by industries such as oil, gas and petrochemical industries play an important role. The most important pollutants released during the processes of the plants are hydrogen sulfide gas (H2S), sulfur oxides (SOx), nitrogen oxides (NOx) and hydrocarbons (CxHY) [1 and 2] The presence of hydrogen sulfide in the fluid reservoir is one of the major problems in the oil industry that leads to acidification, weak stream of fluid in the reservoir and corrosion of tanks and installations in the oil and gas industry. Such conditions lead to cracking oil and gas reservoirs, resulting in increased costs, reduced income and environmental concerns [3] The presence of hydrogen sulfide and carbon dioxide in the reservoir may cause fundamental problems on the materials used in the system, even a small leak of hydrogen sulfide can have harmful effects on human health and behavior and vary based on the concentration and duration of contact with gas [4]In addition to its toxicity to humans, the gas can cause significant damage to the materials especially the materials used in the construction of cultural works in museums [5 and 6] Hence, due to significant adverse effects of hydrogen sulfide gas on human health and its major environmental problems, it is necessary to identify the source and its concentration. Hence, in

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recent years several methods were used to identify the developed gas [3]This study aimed at identifying the emission sources of hydrogen sulfide gas and determining the amount of its emission in the area of Masjid Suleiman oil and gas Exploitation Company and proposing management strategies to reduce the negative effects of the gas.

Statement of the problem

With the beginning of oil exploration to access the underground oil and gas resources, the oil industry was born and the construction of infrastructure and superstructure for digging wells, construction of oil and gas pipelines, processing and refinery plants, refineries, pumping stations, gas compression units and gas and LPG factories were started. These facilities have a lot of advantages as well as disadvantages. Air pollution caused by the oil industry and its various segments, especially of the units exploiting the oil is one of the problems. In the units the produced oil and gas are first transferred by pipelines from wells to the units exploiting the oil. After the separation of associated gas produced and if the amount of salt dissolved is more than the allowed standards, 14ppm, the desalting operation starts, and then the produced oil is ready to be used in refineries and to send to terminals for export that this important part is done by oil and gas pipelines. On the other hand the produced gas is also used to inject into the underground storage facilities, gas compression factories, gas and liquid gas plants, refineries, gas and eventually as city gas for homes. At all stages mentioned, air pollution is caused and gas emissions from facility operations are an example and the most important ones is hydrogen sulfide gas. The study was done in the city of Masjid Suleiman where many problems occurred for the people there due to reservoir rock fracture; such as too much emission of gas in Kuy e Nagtkhiz, Siberenj, Pansiun e Khayam that led to the evacuation of mentioned residential areas from people and buying and evacuation and demolition of houses in the neighborhoods has brought about millions of dollars to companies to Masjid Suleiman oil and gas Exploitation Company. Today, environmental pollution is one of the biggest global crises. A large amount of natural gas produced in Iran is sour. The presence of hydrogen sulfide and carbon dioxide in the reservoir may cause fundamental problems on materials used the in the system, even a small leak of hydrogen sulfide can have harmful effects on human health and behavior and vary based on the concentration and duration of contact with gas (Rostami and Ashrafizadeh, 2006).

Research purposes

General purpose:

- Identifying production sources of Hydrogen sulfide gas and quantifying the gas from underground storage and facilities of Masjid Suleiman oil and gas Exploitation Company.

Partial purposes:

- Identifying production sources of H2S gas in the facilities of Masjid Suleiman oil and gas Exploitation Company;
- Quantifying the gas produced in the city and in the facilities of Masjid Suleiman oil and gas Exploitation Company;
- Comparison of the results with national and international standards;
- Proposing management solutions to reduce emissions of H2S in the environment.

Research questions

1. How much is the H_2S gas emissions in Masjid Suleiman oil and gas Exploitation Company in comparison with national and international standards?
2. How much is the H_2S gas emissions in residential area of the study in comparison with national and international standards?

3. Are there any significant differences between the amount of H_2S gas emissions in Masjid Suleiman oil and gas Exploitation Company and residential area of the study?
4. How much is hydrogen sulfide gas emissions based on the months of the study?

Review of literature

Fath Abadi [7] studied the management of corrosion resulted in hydrogen sulfide gas in oil and gas industry. In this study, with a corrosion management model for hydrogen sulfide gas, he proposed an example of the corrosion management systems for a variety of corrosive materials. The results of this study indicated that explaining the policies and strategies, organizing, planning and risk assessment, implementation and analysis, monitoring and performance measurement, review and audit procedures, are the main elements that make up the corrosion management system. Telmadarreie, et al [3] studied the source of hydrogen sulfide oil pollution in the Asmary oil tank in the oil area of Marun in the South West of Iran. Their research results indicated that migration (movement) of gas injection is the main source of emissions of hydrogen sulfide in Asmary oil reservoir Holubnyak et al [8] conducted a study named "the investigation of sour gas in Bakken oil reservoir. The findings of the study indicated that Mechanical, thermochemical and biogenic parameters were the main reasons of acidification of gases emissions from oil and gas sites. Riddle [9] studied the risks and hydrogen sulfide gas discovery in the exploration and exploitation of oil and gas. In his study, he described the risks of hydrogen sulfide gas and side sensors detecting the gas.

METHODOLOGY

In this study, after collecting basic information about the situation in the region and referring to the studied units, the map of the region was prepared. The study points where the possibility of hydrogen sulfide emissions was high were determined by experts. Then the major points of leaks were evaluated in 4 months of May, July, September and November by the use of gas detector device. Finally, by performing statistical analysis on data obtained from measurements and compared with existing standards, critical points of contamination were identified and to eliminate or reduce the amount of hydrogen sulfide gas emissions, management solutions have been proposed.

Field method

Visiting the study area and gather information about its environment, climate, land and water resources, biological environment, and demographic information of the study area and the staff of the company;

Interviews with experts of HSE unit of Masjid Suleiman oil and gas Exploitation Company and using their expertise;

Identifying exploitation and desalination operation to identify and understanding the different aspects of the work and to create a frame of mind the project and investigating conditions to start work.

Sampling and detector the samples

The samples were measured by the use of gas detector device of Gasman model which is portable and can detect flammable and poisonous gases. The device is small weighing 80 to 110 gram and its sensors are smart using the latest technology named number smart sensor and *Crowcon Portable Pc* software supervises them and informs operator unexpected problems. The device transmits the events and recorded data through RS232 port to *Crowcon Portable Pc* Software. To determine the sources of emissions, at many points from each unit, measurement was conducted.

After measuring by the device, it was put in charging device and the data were transmitted to a computer. The software of the device processed all transferred data and display and print the results. The sensitivity of the device is the 0 to 5000 ppm.

The statistical population and sample size

The statistical population involves all area of the study including 5 units of Masjid Suleiman oil and gas Exploitation Company and 3 urban regions identified as contaminated areas. Sampling was done on the mornings of the determined days and the areas of the study were sampled 3 times and their means were recorded. Overall, 32 samples (4 samples from each area of sampling) were obtained to study and analyze.

Investigating the results of analysis of variance hydrogen sulfide concentration in the stations of the study

Table (1) shows ANOVA results to study the presence or absence of significant difference in the concentration of hydrogen sulfide in the stations of the study. Duncan and LSD Tests have also been used to determine the differences and the results are presented in Table 2.

Table 1. Analysis of the results of analysis of variance hydrogen sulfide concentration in the stations of the study.

Significance	F	Mean of square	Degree of freedom	The sum of squares	Stations
0	1167.613	207.4788	7	1452.352	**Intergroup**
		0.177695	24	4.264675	**Intragroup**
			31	1456.616	**Total**

Since sig. is less than 0.05, the hypothesis of equality of communities is not accepted. In other words, there are significant differences between the stations in terms of the production of hydrogen sulfide. Duncan, Toki and LSD Tests were used to identify the two stations with significant differences and the results of LSD Tests were presented in table 2.

Table 2. Investigating significant differences between the stations in terms of the production of hydrogen sulfide.

Pansiun e Khayam	Siberenj	Kuye Naftkhiz	Zilaei	Nargesi	Anbar	Talbzan	Bibayan	Stations
*0	*0	*0	0/290	0/593	*0/041	0/593	–	Bibayan
*0	*0	*0	0/593	0/290	0/118	–	0/593	Talbzan
*0	*0	*0	0/290	*0/012	–	0/118	*0/041	Anbar
*0	*0	*0	0/118	–	*0/012	0/290	0/593	Nargesi
*0	*0	*0	–	0/118	0/290	0/593	0/290	Zilaei
*0/01	*0/041	–	*0	*0	*0	*0	*0	Kuye Naftkhiz
0/118	–	*0/041	*0	*0	*0	*0	*0	Siberenj
–	0/118	*0/001	*0	*0	*0	*0	*0	Pansiun e Khayam

The presence of significant differences in the level of 05/0

According to the statistical tests, there are significant differences among the 3 urban regions, Kuye Naftkhiz, Siberenj, and Pansiun e Khayam.

Investigating the results of analysis of variance hydrogen sulfide concentration in the months of sampling

Table (3) shows ANOVA results to study the presence or absence of significant difference in the concentration of hydrogen sulfide in the months of the study.

Table 3. Variance analysis of hydrogen sulfide gas concentrations in different months.

Significance	F	Mean of square	Degree of freedom	The sum of squares	Months
1	0.019982	1.039736	3	3.119209	**Intergroup**
		52.03377	28	1456.946	**Intragroup**
			31	1460.065	**Total**

Since sig. is more than 0.05, the hypothesis of equality of communities is not accepted. In other words, there are no significant differences among the months in terms of the production of hydrogen sulfide.

Interpreting the results of statistical analysis and evaluation of the current situation with regard to the process of the concentration of hydrogen sulfide

For statistical analysis, analysis of variance was performed to evaluate the possible differences between the different stations and months in the level of confidence 0.95 and, to determine the difference, Duncan and LSD tests were used.

DISCUSSION

There are huge reserves of oil and gas resources in the country, especially with the neighboring countries which led to the interest in this sector and exporting gas and gas condensate make up the huge amount of the country's oil income. Hydrogen sulfide gas is one of the most dangerous gases in the workplaces of the oil and gas industry [10] Hydrogen sulfide is bad smelling and corrosive gas that causes corrosion and perforation of metals, steel wellhead facility and also its increase causes the precipitation of metal sulfides and produced fluids pollution [11] The processes in different installations of Masjid Suleiman oil and gas exploitation is actually a set of measures done to refine oil from waste (including gas, salt, water, etc.) to prepare oil with minimal impurities. However, biodegradation is one of the most important producers of H2S gas in natural reservoirs. Some live and anaerobic microorganisms that live in anaerobic environments can produce hydrogen sulfide gas under certain conditions and changes in organic compounds [12].

In this study, Identifying production sources and quantifying H2S gas from underground storage and facilities of Masjid Suleiman oil and gas Exploitation Company and environmental management solutions were analyzed. According to the measurements results of hydrogen sulfide it turned out that the amount of the gas emission from urban areas of the study is significantly more than its emission from exploitation units. The difference is due to the processes of desalination in units of the study and its blending with sweet reservoirs that leads to reduction of Hydrogen sulfide gas emissions in these areas than in urban areas where there is no process of purification and desalination.

The results of the comparison of hydrogen sulfide gas concentration with the studied standards also indicated that the amount of gas emissions standards in studied exploitation units was less than OEL-WTA standard. In the units the amount of hydrogen sulfide emissions was acceptably reduced due to sweetening operations. Accordingly, strict standards of the Ministry of Health and Medical Education on the limit of exposure to H2S (1 ppm) did not meet. Bagheri [13] also in his study on the amount of Hydrogen sulfide gas emissions at various facilities in Bibiyan exploitation unit and Telbzan desalination unit concluded that the amount of the gas is less than the limit in all units. However, Chang in his study on investigating the environmental management

system in exploitation unit in oil and gas field concluded that the concentration of hydrogen sulfide in the area of the study is more than environmental limits. However, studies performed in this study indicated that there is not a significant difference between the amounts of hydrogen sulfide gas in the areas of the study in terms of months of sampling. The amounts of hydrogen sulfide gas emission in November are high in compare to other months of the study. This is due to the heaviness of the gas and increase in its concentration in low temperatures. Therefore, it can be said that changes in temperatures does not have significant impact on the amounts of hydrogen sulfide gas emission in the area of the study. Bagheri [13] in his study confirmed that the most amounts of hydrogen sulfide gas emission are in September and the least amounts of hydrogen sulfide gas emission are in May. Royvaran and Jafarzadeh Haghighi [2] also indicated that in the sampling environment of sour oil, H2S gas concentrations increased 5 times from its limits in July and to 30 times from its limits in August which is very dangerous. These results are not in line with the results obtained in this study.

CONCLUSION

In this study, the following results are obtained:

The range of changes in hydrogen sulfide concentrations in the units of the study in Masjid Suleiman oil and gas Exploitation Company varies between 2 to 5pmm. Among the units of the study, Nargesi unit with the mean hydrogen sulfide concentrations of 2.15pmm had less pollution and danger. The range of changes in this pollutant in the urban regions of Masjid Suleiman is between 15 to 17pmm which indicates high concentrations of this pollutant in the points and increasing beyond all allowed limits and standards on hydrogen sulfide. Shallowness of reservoir of Asmari oil field in Masjid Suleiman, lack of residence and breaks in stone cover, penetrating water and also low temperature in the reservoir can be the effective factors in biodegradation and hydrogen sulfide gas emission in the areas. According the previous studies, it was found that there is no significant difference between the measured amounts of hydrogen sulfide concentrations in different months, although a little increase in hydrogen sulfide concentrations was evident by lowering the temperature. In this study, OWL-STEL and OEL-TWA standards on hydrogen sulfide concentrations in the area of the study were evaluated. In all sampling points of Masjid Suleiman oil and gas Exploitation Company, hydrogen sulfide concentrations was less than all standards except OEL-TWA which is the job limit of Ministry of Health and Medical Education. Tis standard determines the mean concentrations of chemical materials for 8 hours working on a day and 40 hours working in a week. On the other hand, hydrogen sulfide concentrations in urban regions is more than all international standards and urgent measures are needed to remove or lessen the pollutant in the points.

Suggestions for management solutions

Environmental management program implemented as development plans in many countries now is a powerful tool to mitigate the negative effects of policies and strategies to maintain policies compatibility of industry with the environment. One of the most important goals of an environmental management program is consistent communication between natural ecosystems and features system of the study. To reduce the harmful effects of hydrogen sulfide gas the following guidelines and suggestions are proposed:

- In areas where there may be gas, there should be leak warning devices and masks with air cylinders;
- patrol officers should not inspect these units alone and be equipped with a wireless device;
- employees should be trained and pay attention to the early signs of poisoning such as headaches, eye irritation and blurred vision;
- Using the equipment of hydrogen sulfide gas detector, the use of corrosion-resistant alloys are also other proposed solutions;

- Environmental Management in exploitation unit is going to reduce complications and injuries of gas on the environment by moving residential units to places away from urban areas and gas accumulation and disposal and disinfecting, or using them in industrial uses. For example, moving unit 9 to Tambi region (an uninhabited place) or collecting polluted urban environments and move them to more secure environments;
- Lack of oil burning in the well due to releasing gases burned incompletely;
- considering correction in oil and gas facilities designs;
- Designing and constructing the refineries based on biological cleaning to clean wastewater from oil (In fact, the main purpose of the biological process in a refinery is to remove organic matter from wastewater).

Practical suggestions

- The development of new industrial processes and the use of new technologies in petroleum industry;
- Determination of monitoring stations in the environment of sample facilities with a higher concentration of emissions to the environment;
- Precise measurement and identification of sources of H_2S emissions of and causes of its release and proposing management solutions to reduce and control emissions;
- Creating H_2S gas sweetening stations and sulfur recovery plants and absorbing sulfur oil in the region;
- Creating Portable gas trap;
- In high contaminated areas and where there are serious leaks, gas burning to produce thermal energy and using this energy in areas such as mobile kitchens, swimming pools or public baths and the use of sulfur with the observance of safety rules;
- Using NH4 ammonia gas to neutralize H_2S gas in an emergency;
- Educating and informing the public and making regular, active and functional classes and workshops in the areas contaminated by gas leaks and;
- Making Plastic tube traps with different sizes in order to trap and direct the released gases resulted in cracks in the ground in some areas and directing them to the proper places and efficient use of them;
- Deviation drilling techniques to reduce the reservoir pressure near the infected area and transporting additional gas into suitable and safe underground reservoirs to use in the coming years, such as reservoirs in Sarajeh Qom or Shurijeh in Fars Province;
- Use of pilot scrubber dynamic device (made by Amir Kabir Industrial University) which eliminates pollutants in the air such as NO2, NO, CO, H2S and dust at the same time and its efficiency is 80%.

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