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Assessment of Air Pollution from the Oil Extraction Industry in Marinza Oilfield in Fieri, Albania

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Abstract

Patos Marinza *is oilfield was discovered in the year 1928 and it is the biggest oil producing field in Albania, with its 11,854 barrels (1,884.6 m³) per day –. Air quality assessment of Marinza oilfield was carried out for three years with reference to three criteria air pollutants which include particulate matter (PM_{10}), nitrogen dioxide (NO_2) and sulfur oxide (SO_2). The objective of the study was to determine the concentration of those air pollutants and to further assess the air quality level of Marinza Oilfield.*

The measurements were performed in four monitoring locations during the period from January 2015 to October 2017, by using mobile air quality monitoring devices. The sampling was carried out once a week in each of the four air monitoring locations, 3 times/day (morning, afternoon and evening) and 4 times a month and for each month the mean value was calculated. The obtained results of

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the study showed that the mean concentrations of the air pollutants in the investigated area during the years of the study ranged from 50.8 to 56.25 μg m^{-3} for SO_2,from 336.2 to 341.5-350 μg m^{-3} for NO_2, andfrom16.5 to 72.25 μg m^{-3} for PM_{10}. The obtained dates of each air pollutant showed not differences between four monitoring locations of the study areas. The obtained mean level of SO_2 exceeded the Albanian limits in all monitoring locations, also mean level of NO_2 exceeded the Albanian and European limit, while PM_{10} was higher than EU limits only in January 2015 in study areas. The findings of current study indicate that anthropogenic activities impact the air quality of the investigated area on causing high level of air pollutants. Strict monitoring of the atmospheric conditions of the study area is, therefore, recommended in view of the adverse health implications.

Keywords: Air pollution, pollutants, oil extraction, crudeoil, PM_{10}.

1. INTRODUCTION

Oil refineries can play an important role in the emission of pollutants (Karbassiet al 2008). Air emissions associated with oil and gas production can significantly impact air quality and impair visibility. Concerns regarding these impacts have expanded in recent years as oil and gas production in Marinza oilfield in Albania has grown substantially. Air emissions generated during oil and gas production, along with emissions from other sources, could be grouped into three categories: (i) air pollutants (ozone, CO, SO_2, PM, and their precursors, including NOx and VOCs); (ii) Hazardous air pollutants (HAPs, primarily fugitive VOC emissions from oil and gas production); and (iii) Haze precursors (which include ozone, NOx, SO_2, and particulates). In addition, (iv) greenhouse gases (GHGs, which include CO_2 and CH_4) are generated during oil and gas development (EPA 2008)

Marinza oilfield is located about 5 km Northeast of the Fieri district in Albania and has been traditionally used for oil extraction. Over 2,000 oil wells were drilled and operated during the past eight decades in the area. The drilling technology, exploitation and

management of wells, as well a soil extraction from wells and ancillary structures were much below international standards both in terms of work performance and environmental considerations, at least till the early 2000s. Endless oil-polluted puddles were found in the Marinza area around each well of crude oil, oil decantation centers, as well as along pipelines, all being a consequence of accidents and damage to pipelines. Pollution was evident in air quality, as well as surface water bodies and drainage channels that were spread throughout the area.

From 2005, apart from the state-run oil extraction company (Albpetrol) that has activity for decades in the area, a foreign company Bankers Petroleum Ltd (Bankers) started oil extraction operations in the Marinza oilfield.

Bankers Petroleum changed the exploitation management procedures, and many believe that this has reduced environmental pollution in the area. This was also revealed by environmental and health assessment study prepared in 2008 during the implementation of the project "Preparation of Environmental and Health Assessment and Action Plan for Patos Marinza zone, Fieri" funded by the EU. The project carried out numerous measurements and analysis of pollution levels including the quality of local air. These measurements and analyzes of environmental features have created a large baseline database that could be used as reference for comparison and projecting trends of pollution from 2008 and onwards. The figure 1 presents a view of the Marinza area.

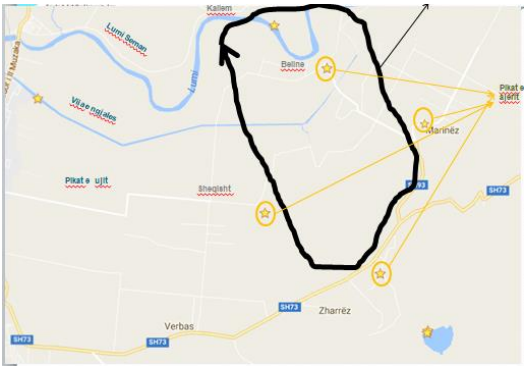

Figure1. The study area and air sampling stations in Marinza, Fieri

The primary air pollutants of interest in this article include nitrogen oxides (NOx), sulfur dioxide (SO_2), and particulate matter (PM) as precursors of regional haze, and NOx as precursors of ground level ozone. Nitrogen oxides, sulfur dioxide, volatile organic compounds (VOC), ozone, hazardous air pollutants (HAP), and methane as pollutants of concern related to O & NG activities (Field et al 2014). This study provided additional knowledge and insights regarding the environmental releases associated with oil and gas production.

2. MATERIAL AND METHODS

The air monitoring samples were taken in vicinity of residential areas in the surrounding Mariza oilfield during year 2015-2017.

Marinza oil field is located in a flat area few miles Northeast of Fieri, a major city about 60 miles South of Tirana in Albania. This oilfield is surrounded by several villages including Zharrza, Marinza, Sheqishta and Beline. Outer rages of inhabited main settlement incorporate several cities such as Fieri few miles Southwest, Patosi in the South, and Roskoveci in the East, as well as the villages Joagodina, Kallmi and Mbrostari in the Northwest of the area. Nowadays, some informal houses are found even inside the oilfield. Three potential impact from air pollution (SO_2, NO_2 and PM_{10}) were investigated due to the oil extraction industry in the Marinza Oilfield, Fieri, Albania, . The measurements were taken during the years 2015 – 2017 and reveal potential tracks of air pollutants in the inhabited areas next to the Marinza oilfield.

Four locations were studied, and seasonal analysis were taken each year in January, April, July and October from 2015 to 2017. The air samplings were carried out in accordance with the Standard Methods of Air Sampling and Analysis (Lodge et al. 1988). The air analyses have been performed at the "A Consultant" Laboratory .

The air pollution measurements / analysis were observed through mobile air quality monitoring devices, such as HOUND FR which works on principle of UV light absorption by different gases for monitoring air parameters. The Cerex Hound analyzers operated by sending a beam of UV light through the sample gas within the instrument. The UV beam is directed by a series of optics to a high-

resolution miniature spectrometer where the absorption due to target gases is measured and recorded. A classical least squares regression analysis compared the measured absorption spectrum to calibrated reference absorption spectra files. Beer's law is then used to determine gas concentrations per USEPA TO-16 Methodology. Hound analyzer detected many gases simultaneously at ppb or $\mu g/m^3$ concentrations within complex mixtures.

The sampling were carried out once a week in each of the four air monitoring locations, 3 times/day (morning, afternoon and evening) for each month; and based in the data obtained, the mean value and standard deviation were calculated.

Sampling for the total dust particles and PM10 was carried out using EGO PLUS TT PF 11221, 732 standard UNI EN 1232: 1999 and UNI EN 12919: 2001 for the measurement and analysis of air quality parameters in the workplace. The device had a precision ± 2 %. For the weighing of total dust samples and PM10 the micro analytical scales were used, the sensitivity and the numbers after the press showed the same. This device had sensitivity: 0.01 mg=10μg and linearity: ±0,03mg = ±30μg. Method / Standard of measurement: Gravimeters / EN 12341: 1998.

3. RESULTS AND DISCUSSION

The obtained results of SO_2, NO_2 and PM_{10} concentrations in the location of Zharrza, Marinza, Beline, Sheqishta for the years 2015, 2016 and 2017 are presented in the tables from 1 to 4.

The mean concentrations values of SO_2, were 52.25±2.21μg m^{-3} in 2017 in Zharrza, 52.3±1.6 μg m^{-3} (2017) in Marinza, 56.25±3 μg m^{-3} (2017) in Beline and 56.25±3μg m^{-3} (2017) in Sheqishta. The Albanian and European air quality regulations determine that the average SO_2 concentrations should not exceed 40 and 60 μg m^{-3} respectively (Council directive 1999/30/EC; Albanian Legislation for Environment). The mean level of SO_2 in all investigated locations fell within the European limits but exceeded the Albanian limits. The high concentrations of SO_2 could be explained due to higher sulphur contents of heavy oil as had been observed and reported in previous findings (Karbassiet al 2008).

The obtained concentrations of the NO_2 in the ambient air at the Zharrza, Marinza, Beline and Sheqishta stations revealed that the higher concentrations were recorded in 2015 for Zharrza and Marinza with 340.7±6.8 µg m^{-3} and 341.5±6.8 µg m^{-3} respectively, and in 2017 for Beline and Sheqishta with 341.5±6.55 µg m^{-3} and 341.5±6.55 µg m^{-3}, respectively.

The mean values of NO_2 during 2015-2017 in all locations were about 10 times higher than both the Albanian and the EU limits (Council directive 1999/30/EC; Albanian Legislation for Environment). These high values were likely due to the impacts of gas emissions associated with crude oil extraction. Since more than 6 years the Bankers petroleum has burned the associated gas in flaring tower and thus it is likely to have converted those gases to NO_2, and SO_2. Previous surveys have reported that NO_2 emissions are primarily from production operations and equipment such as engines (both stationary and mobile), turbines, and process heaters (EPA 2008).

The PM10 concentrations in April and July 2015 in Zharrza were 55 and 58 µg m^{-3}, respectively, and these values resulted to be higher than the values for 2016 and 2017 and also higher than EU limit.

Similarly, the PM10 concentrations in Marinza were higher in April and July 2015, with mean values 71 and 90 µg m-3, being higher than both Albanian and EU limits (Council directive 1999/30/EC; Albanian Legislation for Environment) and also higher than Zharrza area.

The highest values of PM10 with concentrations were recorded in Beline and Sheqishta reaching at 84 and 120 µg m-3 for April and July 2015. The Albanian and European air quality regulations foresee that the average solid particles and PM10 concentrations should not exceed 60 and 40 µgm^3 respectively (Council directive 2008/50/EC; DCM no 352/2015). Since air monitoring had been recorded continuously for a number of years at various seasons and locations in the project area we noticed that the pollutants concentrations were different depending on locations, seasons and years, as well as on the amount of emitted gases and their composition, but also depending on weather conditions, such as wind direction and speed, temperature and humidity.

However, the average PM10 concentrations for all the locations in the project area fall within EU and Albanian norms (Table 1 to Table 4).

Table 1: The SO2, NO2 and PM10 concentrations in Zharrza location from January 2015 to October 2017

Years	Months	SO_2	NO_2	PM_{10}
		µg m^{-3}		
2015	January	51	345	18
	April	51	348	55
	July	53	334	58
	October	50	336	37
	Mean concentration	51.25±1.25	340.7±6.8	42±18.5
2016	January	51	337	33
	April	51.2	339	29
	July	52	334	36
	October	50	335	17
	Mean concentration	51.05±0.8	336.2±2.2	28.75±8.3
2017	January	53	335	10
	April	55	344	22
	July	50	334	23
	October	51	338	11
	Mean concentration	52.25±2.21	337.7±4.5	16.5±6.9
Albanian limit		40	40	60
EU limit		60	32	40

Table 2: The SO2, NO2 and PM10 concentrations in Marinza location from January 2015 to October 2017

Years	Months	SO_2	NO_2	PM_{10}
		µg m^{-3}		
2015	January	55	350	22
	April	49.3	344	71
	July	53	336	90
	October	50	336	58
	Mean concentration	51.6±2.6	341.5±6.8	60.2±28.7
2016	January	55	337	45
	April	51.2	339	42
	July	50	338	48
	October	52	334	14
	Mean concentration	52.05±1.8	337.2±2.1	37.25±15.7
2017	January	56	335	11
	April	51	347	25
	July	53	336	28
	October	49.3	338	12
	Mean concentration	52.3±1.6	339±4.8	19±7
Albanian limit		40	40	60
EU limit		60	32	40

Table 3: The SO2, NO2 and PM10 concentrations in Beline location from January 2015 to October 2017

Years	Months	SO_2	NO_2	PM_{10}
		µg m^{-3}		
2015	January	63	342	25
	April	58	335	84
	July	53	342	120
	October	50	335	60
	Mean concentration	56±5.7	338.5±4	72.25±40
2016	January	51	337	45
	April	51.2	339	42
	July	49.3	338	48
	October	49.3	334	14
	Mean concentration	52.05±1.8	337.2±2.1	37.25±15.7
2017	January	56	340	12
	April	58	351	34
	July	52	339	37
	October	59	336	18
	Mean concentration	56.25±3	341.5±6.55	25.25±12
Albanian limit		40	40	60
EU limit		60	32	40

Table 4: The SO2, NO2 and PM10 concentrations in Sheqishta location from January 2015 to October 2017

Years	Months	SO_2	NO_2	PM_{10}
		µg m^{-3}		
2015	January	52	342	25
	April	50	335	84
	July	49.3	342	120
	October	52	335	60
	Mean concentration	50.8±1.2	338.5±4	72.2±34
2016	January	52	341	45
	April	51	338	42
	July	50	335	48
	October	52	336	14
	Mean concentration	51.25±0.9	337.5±2.64	37.25±15.7
2017	January	56	340	24
	April	58	351	16
	July	52	339	14
	October	59	336	11
	Mean concentration	56.25±3	341.5±6.55	16.25±5.5
Albanian limit		40	40	60
EU limit		60	32	40

Based on some other tests, no detection of associated gases (benzene and hydrogen sulphide) concentration was recorded from oil extraction industry in the study area. This could be due to the

introduction of a collection system and burning in flaring towers installed in the area.

The air quality, in particular concentrations of SO_2, NO_2 and PM10 measured in the air, have severe impacts on the local population leading to significantly reduced health in local population and statistically leading to more cases of asthma, more cancer cases and ultimately leading to fatalities.

4. CONCLUSIONS

Based on the obtained data, the local air quality in Fieri region was classified as critical. The burning of associated gases has increased the concentrations of burning gases like SO_2 and NO_2. The air quality data indicated that there were higher level of pollutants present in the area, compared to EU and Albanian standards for some of the monitored parameters. The mean level of SO_2 in all the air quality monitoring locations exceeded the Albanian limits, but it was lower that EU limit. The mean values of NO_2 during 2015-2017 recorded in all the locations were about 10 times higher than both the Albanian and the EU limits. These high values could be explained due to the emissions gasses as associated with crude oil extraction.

The PM10 concentrations recorded in all sampling stations demonstrated substantial seasonal variability but was likely influenced by other factors as well such as intensity of oil extraction activities, locations, climate etc. Often those concentrations were higher than both the Albanian and the European standards, albeit the average values remained well within the domestic and European limits.

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