Original Research Article

WORKERS EXPOSURE TO VOLATILE COMPOUNDS IN COOKING GAS AND PETROL STATIONS IN EFFURUN AND ENVIRONS

ABSTRACT

This project aimed to determine workers' exposure to volatile compounds in cooking gas and petrol stations in Effurun and its environs. A total of ten cooking gas and petrol stations were randomly sampled for the study. A gas analyzer (Eurotron 3000+ UniGas) was used to collect data, and the parameters analyzed were O_2, CO_2, CO, NO, NO_2, and SO. It was observed that the cooking gas and petrol stations were within OSHA standard rating, for O_2 = 206,000-ppm as OSHA = 195,000-ppm, for CO_2 = 23-ppm as OSHA = 5000-ppm, for CO = 14-ppm as OSHA = 50, for NO = 15-ppm as OSHA = 25-ppm and for SO_2 = 0-ppm as OSHA = 5-ppm, whereas NO_2 calculated was 18-ppm was higher than OSHA recommended value (5-ppm), hence could make the environment not conducive for workers if exposed over a long period. According to the calculated values, all ten (10) cooking gas and petrol stations covered in this project work complied with OSHA's recommended values for O_2, CO_2, CO, NO, and SO_2 except for NO_2 (18-ppm) as it was higher than the allowable limit of 5-ppm set by OSHA, this may be due to the presence of car exhaust fumes driving in and out of the gas and petrol stations and the release of cooking gas into the atmosphere from the gas stations. It was recommended that shift work be adopted to reduce the accumulation of volatile compounds in the workers' bodies; disposable masks should be used to reduce workers' inhalation of volatile compounds.

Keywords: Volatile Compounds; OSAH Recommended Values; Eurotron 3000+; UniGas; Environment; Gas Analyzer.

1. INTRODUCTION

Volatile organic compounds (VOCs) are everywhere in ambient air and originate from both natural processes (vegetation emissions, volcanic eruption and forest fire) and anthropogenic (originates from man) activities (fossil fuel combustion, industrial processes and solvent usage) [1, 2, 3].

As the key predecessor of 0_3 formations [4, 5, 6]. VOC categories exhibited different ozone formation potentials [7, 8, 9]. Some VOC species (benzene) exhibit detrimental effects on human health [10, 11]. Furthermore, they have negative impacts on air quality. VOCs are a large group of chemicals that are found in many products we use to build and maintain our homes, common examples of VOCs that may be present in our everyday lives are benzene, ethylene glycol, formaldehyde, methylene chloride, tetrachloroethylene, toluene, and xylene [12].
Horizontal drilling, hydraulic fracturing, and other drilling and well stimulation technologies are now widely used in the United States and in other countries. These processes enable increased oil and gas production but need to focus more on human health impacts. Air quality near oil and gas operations is an underexplored human health concern for five reasons; (1) prior focus on threats to water quality; (2) an evolving understanding of contributions of certain oil and gas production processes to air quality; (3) limited air state quality monitoring networks; (4) significant variability in air emissions and concentrations; and (5) air quality research that misses impacts important to residents. Preliminary research suggests that

volatile compounds, including hazardous air pollutants, are of potential concern [13].

The atmosphere of Earth is the layer of gases, commonly known as the air, that surrounds the planet Earth and is held by Earth's gravity. The atmosphere of Earth protects life on Earth by creating pressure allowing for liquid water to exist on the Earth's surface, absorbing ultraviolet solar radiation, warming the surface through heat retention, known as the greenhouse effect, and reducing the temperature extremes between day and night (the diurnal temperature variation) "By volume, dry air contains 78.09% nitrogen, 20.95% oxygen, 0.93% argon, 0.04% carbon dioxide, and small amounts of other gases. Air also contains a variable amount of water vapour, on average around 1% at sea level and 0.4% over the entire atmosphere. Air content and atmospheric pressure vary at different layers, and air suitable for use in photosynthesis by terrestrial plants and breathing of terrestrial animal is found only in Earth's troposphere and in artificial atmosphere" [14].

The atmosphere has a mass of about 5.15x 1018 kg, three-quarters of which is about 11 km (6.8 mi; 36,000 ft) of the surface. The atmosphere becomes thinner and thinner with increasing altitude, with no definite boundary between the atmosphere and outer space. The Kármán line, at 100 km (62 mi), or 1.57% of Earth's radius, is often used as the border between the atmosphere and outer space. Atmospheric effects become noticeable during the atmospheric re-entry of spacecraft at an altitude of around 120 km (75 mi). Several layers can be distinguished in the atmosphere based on characteristics such as temperature and composition [14].

Oil and natural gas are important for the energy supply around the world. Exploring, drilling, transportation, and processing in oil and gas regions can release a lot of volatile organic compounds (VOCs), which could cause hazardous health effects that may build up in the body (eye, nose and throat irritations, headaches, loss of coordination and nausea, damage to liver, kidney and central nervous system).

Air concentration of volatile compounds has caused many illnesses that have not been noticed. In the long run, most people working near such areas suffer more and may accumulate such organic compounds in their systems for years. The study aim include;

- To determine the daily exposure limits of volatile compounds to workers in cooking gas plants and petrol filling stations.
- To measure the concentration of volatile compounds in the air at various gas plants and petrol filling stations.
- To compare the calculated air quality with standard recommended values

The project would cover some cooking gas and petrol filling stations in Effurun and be under study for at least 5 days for each station.

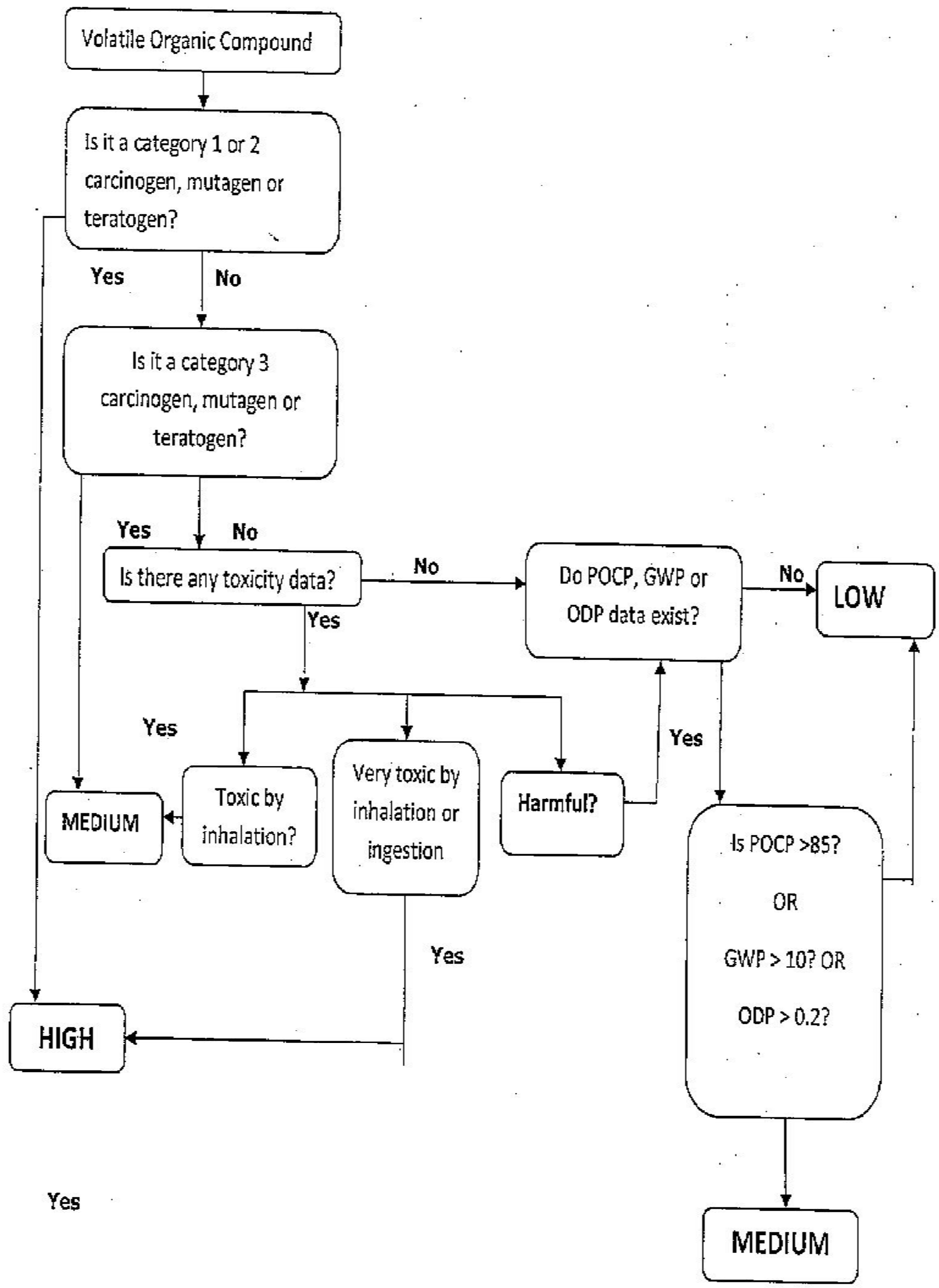

Fig 1: The Proposed Categorization Decision Tree for VOCs

Table 1: Information Concerning the Adverse Physiological Effects of Eight Example VOCs

Compound		**Organism**	**LD50 ppm**	**TLm ppm**	**Other**
					55 mg I-1 50% reduction of cell numbers after 1 day incubation , 20°C
Xylene	Algae Fish	Chiorella goldfish Fathead minnow Bluegill, guppies	13-18	20-35	92 mg I-1 inhibition of cell multiplication 525 mg I-1 50% reduction of cell numbers after 1 day incubation, 200C>1400 mg I-1 inhibition of cell multiplication mg kg-1 body weight
Benzene	bacteria algae fish rat	Pseudornonas chlorella microcystis goldfish fathead minnow, bluegill, guppies	46 5600-5700	20-40	1700 mg I-1 inhibition of cell multiplication 530 mg I-1 inhibition of cell multiplication
Methylene chloride		mouse	15000	10 13000	**Other**
Acetone	Bacteria Algae Arthropoda Fish Mosquito	Pseudomonas Microcystis Daphnia goldfish fish	5000	TLm ppm	6600 mg I-1 inhibition of cell multiplication 530 mg I-1 inhibition of cell multiplication
Compound		Organism	LD50 ppm	10000	
Methanol	Bacteria Algae Anthropoda Fish	Pseudomonas Microcystis brine shrimp trout mouse	61100	8000	1150 mg I-I. inhibition of cell multiplication
MEK	Bacteria Algae Fish	Pseudomonas Microcystis goldfish mosguitofish	5000	5600	110 mg I-1 inhibition of cell multiplication
Formaldehyde	Bacteria Algae Fish	Pseudomonas Microcystis guppy		50-200ww	14 mg I-1 inhibition of cell multiplication
Methyl mercaptan	Fish	Salmonides		0.6-0.9	0.4 mg I-1 inhibition of cell multiplication

(Sourced from the Categorization of Volatile Organic Compounds HMIP (1996).pdf)

Notes:

LD50 Median Lethal Dose: Dose of a substance estimated to be lethal to 50% of the test organisms.

TLm Median Tolerance Limit: It is the Concentration of a substance in water at which 50% of the test organisms survive after a specified time of exposure.

2. NAME AND LOCATIONS OF STUDY AREA:

It is expected that the Project study after the conclusion will be of a benefit to Delta State and other states as a whole.

This study's significance would help to know the air contamination level around areas where oil and gas processes are being carried out and also measure the air quality in Warri and its environment. The project would help the community know the measures to be taken and would help them prevent it.

Table 2: Location of Stations

Name of Stations	Acronyms	Location
Adios Grindo LPG Gas Plant	A	Mr. & Mrs. Alegimenlen Street Osubi
AS Rano Nigeria Limited	B	Warri Sapele Road, Effurun
Benelta Gas Plant	C	Off PTI Road Effurun Warri
Esteek Oil and Gas	D	UTI Street, off PTI Road Effurun Delta State
Kinmason Petroleum and Gas Limited	E	Airport Road
Masio Synergy Gas Plant	F	KM1, Effurun/Sapele Express Way, Delta State
Nelmic Limited	G	Airport Road
Tango Gas Plant	H	Osubi Express Way Osubi, Delta State
Tonimas Gas Station	I	Warri Sapele Road
Victory Joe Gas Plant	J	Osubi Express way Osubi, Delta State

3. MATERIALS AND METHODS

The major way used in the collection of data in this project work is; The use of the Eurotron 3000+ UniGas device.

Unigas 3000+ is an advanced flue gas analyzer for up to 4 gases: O_2, CO, NO & NO_2 or SO_2 with electrochemical sensors, plus CO_2 and NOx calculated.

This gas analyzer provides data for up to 10 fuels to calculate combustion values. It is equipped with audible alarms on gas measurements. Flue gas sampling probes with different lengths and shapes are available to meet all the application requirements. The sampling probe is connected to the instrument with a single or dual hose, a water trap and a suspended particle filter.

The instrument is delivered with a built-in rugged impact printer. The same internal battery powers the analyzer and its internal printer. The charger is supplied as standard.

A remote Pt100 probe is available for remote combustion air temperature measurement. This probe is strongly recommended to obtain a highly accurate measurement in forced air boilers. Smoke index measurement is performed using the optional external hand pump. The results can be stored in the internal memory and printed on the report. A procedure can be selected to monitor the CO in ambient air using the internal sensors. An internal program allows CO max measurement in atmospheric boiler room tests with 15 logged values.

Table 3: Measuring Parameters for EUROTRON device

Measured parameter	Range	Resolution	UniGas 3000
O_2	From 0 to 25% vol.	0.1%	Ec
CO	From 0 to 8000 ppm	1 ppm	Ec
CO	From 0 to 20000 ppm	1 ppm	Ec
CO_2	From 0 to 99.9°k	0.1%	Calc
NO	From 0 to 4000 ppm	1 ppm	Ec
NO LOW	From 0 to 500 ppm	0.1ppm	Ec
NOx	From 0 to 4000 ppm	1 ppm	Calc
$N0_2$	From 0 to 1000 ppm	1 ppm	Ec
SO_2	From 0 to 4000 ppm	0.1%	Ec
Efficiency	From 1to99.9%	0.01%	Eclc
Excess air	From 1 to infinite	0.01hPa	Calc
Delta p	±100 hPa	0.1°C	✓
Tair/Tgas	-10... 100°C/0...1000°C		Pt100/tc K Calc

Table 4: Further features

Zero calibration	Automatic calibration procedure at instrument power-on. Fresh air inlet with electrovalve and separate pneumatic circuit
Self-diagnosis	Sensor efficiency test with diagnostic page
Ambiant CO monitoring	With an external probe
Gas level alarms	Programmable from PC with GasConfig software
Sampling pump	1.4 l/min - 100 mbar
Smoke measurement	Using the external manual pump
Printer	24 columns with 58 mm paper roll Autonomy; 40 reports with full battery

Table 5: General specifications

size	115x90x330mm
Weight	1.1 kg with battery and printer
Power supply	110/230VAC (50/60 Hz)
Battery	Type: Rechargeable 7.2 Ah Battery life: 10 hours continuous use Charging time: 3 h at 90%
Communication ports	USB
Internal test memory	Up to 250 complete analysis data points structured by boiler

Table 6: Environmental specifications

Operating From reference range	5°C to +45°C (up to 5O°C for short time)
Storage From temperature limits	20 to +60°C (3 months max. at temperatures exceeding the operational limits)

4. RESULTS AND DISCUSSIONS

In this project, part of the objective is to compare with standards. Furthermore, these results have been compared to OSHA standards for O_2, CO_2, CO, NO, NO_2, and SO_2, respectively.

Although OSHA does not have any standards for Volatile Compound in general, there are standards for each of these components a worker is to be exposed to per 8 hours of working days as specified below;

1. O_2: While a normal atmosphere contains between 20.8 to 21% oxygen, OSHA defines oxygen deficient as any atmosphere (an atmosphere lacking O_2) that contains less than 19.5% oxygen and an oxygen-enriched atmosphere with more than 22%.
2. CO_2: OSHA has established a Permissible Exposure Limit (PEL) for CO_2 of 5000ppm (O.5% CO_2 in air) average over 8 hours work day (Time Weighted Average or TWA). Therefore, a TLV-STEL of 30,000ppm is considered appropriate.
3. CO: The OSHA standard for CO is 5Oppm (O.005%). OSHA prohibits workers' exposure to more than 50ppm (0.005°h) during 8 hours.
4. NO: OSHA standard for NO is 25ppm, including employees who may be pregnant.
5. NO_2: The current TLV-STEL for NO_2 is 5 ppm and is based on human studies that indicate that normal respiratory function may be compromised at exposures below the current OSHA ceiling limit of 5 ppm.
6. SO_2: The OSHA Permissible Exposure Limit (PEL) for SO_2 is 5ppm (O.005%) for 8 hour working period.

Contribution of pollution from different sources in Jamshedpur, the steel city of India. The first approach aims mainly at preparing a comprehensive emission inventory and estimating the spatial distribution of pollution loads in terms of SO_2 and NO_2 from different types of industrial, domestic, and vehicular sources in the region. The results indicate that industrial sources account for 77% (770,000 ppm) and 68% (680,000 ppm) of the total emissions of SO_2 and NO_2, respectively, in the region. In contrast, vehicular emissions contributed to about 28% (280,000 ppm) of the total NO_2 emissions. In the second approach, the contribution of these sources to the ambient air quality levels to which people are exposed was assessed through air pollution dispersion modelling. The analysis indicates that emissions from industrial sources are responsible for more than 50% (500,000 ppm) of the total SO_2 and NO_2 concentration levels. Vehicular activities contributed to about 40% (400,000 ppm) of NO_2 pollution, and domestic fuel combustion contributed to about 38% of SO2 pollution (Atmospheric Environment, 2005). This work shows that NO_2 (18 ppm) was seen to be above the OSHA-recommended values due to vehicular emissions or activities. There were no calculated values for SO_2 (0 ppm) as these domestic fuels are among those present but not yet heated, as being heated from domestic fuels and cooking gas at gas stations strongly does not allow any heat source.

Other results from project work done in Kosovo in assessing the level of CO_2, CO, NO, NO_2, and SO_2 in indoor air using a dragger sensor revealed the 45-minute concentration of CO_2 at 20°C to be in the range of 1500–7000 ppm with an average of 5296.54 ppm. This shows a significantly high level of CO_2 in most indoor air samples that exceed the allowable WHO limit value due to the influence of indoor pollution sources from burned soil gas, coal, and biomass fuels. This, concerning this project work, shows that the reason for CO_2 exceeding WHO and OSHA standards is due to the presence of these burned soil gas, coal, and biomass fuels, which would influence the presence of CO_2 in the atmosphere and cause the ailment to workers. My results have gotten CO_2 = 23.00 ppm, which is well below OSHA standards due to the absence of these burned soil gas, coal, and biomass fuels. Furthermore, CO was found to be in the range of 0.6–17 ppm, which is not above the WHO and OSHA standards. In relation to this work, CO = 14 ppm, which is within the OSHA allowable limit. And also, for SO_2, no recorded values were registered (0 ppm), which is the same result gotten in my work study due to the absence of any cause or generator of SO_2, while NO_2 and NO were recorded to be 0.8 ppm and 0.7 ppm, respectively, which do not exceed WHO and OSHA recommended values, which, in relation to this project work, are 15 and 25 ppm, respectively, with NO_2 not meeting the OSHA standard in my project work due to the presence of vehicular fumes and cooking gas expulsion (Fatbard et al., 2017).

Table 7: Gases Measured at the Ten Cooking Gas Filling Stations with OSHA recommended values.

	All measurements in PPM					
Stations	**O_2**	**CO_2**	**CO**	**NO**	**NO_2**	**SO_2**
A	206,000.00	10.00	10.00	20.00	20.00	0.00
8	207,000.00	20.00	20.00	20.00	20.00	0.00
C	203,000.00	10.00	10.00	10.00	10.00	0.00
D	201,000.00	30.00	20.00	10.00	20.00	0.00
E	203,000.00	30.00	10.00	20.00	20.00	0.00
F	212,000,00	20.00	10.00	20.00	10.00	0.00
G	198,000.00	50.00	30.00	10.00	30.00	0.00
H	200,000.00	30.00	10.00	10.00	20.00	0.00
I	218,000.00	20.00	10.00	20.00	10.00	0.00
J	212,000.00	10.00	10.00	10.00	20.00	0.00
OSHA rated values	195,000.00	5,000.00	50.00	25.00	5.00	5.00

5. CONCLUSION

This project work covers the measurement of some of the necessary VCs present in the atmosphere. It cuts across ten cooking gas fueling stations in Warn, Effurun Delta State. Ultimately, the aim is to determine the daily exposure limits of VOCs to workers and objectives measuring the concentration of VOCs in air and comparing them with OSHA standards that were met.

In the results gotten from the project work, we can see that workers are under no serious threat in this cooking gas station on an average rating for O2 = 206,000-ppm (20.6%), CO2 = 23-ppm (0.0023%), CO =14-ppm (0.0014%), NO = 15-ppm (0.0015%), NO2 = 18-ppm (0.0018%), and SO2 = 0-ppm (0%) and only NO2 that does not meet up with OSHA standard and can lead to workers ill health due to vehicular emissions.

From the project work, the following is recommended:

- Shift work should be adopted to reduce the accumulation of these VCs.
- Workers should be let know (awareness creations) of what they are being exposed to daily.
- Managers should adopt disposable masks for workers to further reduce VCs' impact.
- Training should be conducted on workers to know what to do if any symptoms of VC exposure arise.
- Training should also be conducted for employers and employees to know what these symptoms look like and how to handle them.

COMPETING INTERESTS DISCLAIMER:

Authors have declared that they have no known competing financial interests OR non-financial interests OR personal relationships that could have appeared to influence the work reported in this paper.

REFERENCES

1. Cal, C., Geng, F., Tie, X., Yu, Q., and An, J. (2010): Characteristics and source apportionment of VOCs measured in Shanghai, China, Atmos. Environ., https://doi .org/10. 10 16/j.atmosenv.
2. Leuchner, M. and Rappenglück, B. (2010): VOC sourcereceptor relationshipsinHoustonduringTexA QS47 II, AtmosEnvirOfl.,44,4U5 https://do.orgIIO.1016/j.atmosenv.2009.0 2.029,
3. Baudic, A., Gros, V., Sauvage, S., Locoge, N., Sanchez, O., Sarda Estève, R., Kalogridis,C.,Petit,) E.,Bonnaire,N.,Baisnée,D., Favez, O., Albinet, A., Sciare, 3., and Bonsang, B. (2016): Seasonal variability and source apportionment of volatile organic compounds (VOCs) in the Paris megacity (France), Atmos., https ://doi .org/10. 5194/acp- 16-11

4. Fujita, E. M. (2001): Hydrocarbon source apportionment for the 1996 Paso del Norte Ozone Study, Sd. Total Environ., HYPERLINK "https://doLorgL10.1016/S0048-9697(01)00778-1HYPERLINK https://doLorq/10.1016/S0048-9697(01)00778-1" HYPERLINK .bttps ://doi .org/10.10 16/S0048-9697(0 1)00778-.ttps:IIdoi .org/10.10 16/S0048-9697(0 1)00778-1.
5. Geng, F., Tie, X., Xu, J., Zhou, G., Peng, L., Gao, W., Tang, X., and Zhao, C. (2008): Characterizations of o7one, NOx, and VOCs measured in Shanghai, China, Atmos. Environ., https ://doi.org/10. 10 16/j.atmosenv.
6. Ran, L., Zhao, C., Geng, F., Tie, X., Tang, X., Peng, L., Zhou, G., YU, Q., Xu, 3., and Guenther, A. (2009): Ozone hotochemical production in urban Shanghai, China: Analysis based on ground level observations, J. G'eophys. Res., iipS://dQg1i0 1029/2008JD0 10752.
7. Carter w. p. L. (1994): Development of Ozone Reactivity Scales for Volatile Organic Compounds, Air Waste, https://doj.org/lo.1080/lO73l6lX.l994. 10467290,1994. 44, 881—899.
8. Atkinson, R. and Arey, 3. (2003): Atmospheric Degradation of Volatile Organic Compounds, Chem. Rev., https://doi.org/10.1021/cr0206420,2003. 103, 4605—4638
9. Zou, V., Deng, X. J., Zhu, D., Gong, D. C., Wang, H., Li, F., Tan, H.B., Deng, T., Mai, B.R., Liu, X.T., and Wang, B.G. (2015): Characteristics of 1 year of observational data of VOCs, NOx and 03 at a suburban site in Guangzhou, China, Atmos. Chem. Phys., https://doi.org/10.5194/acp-15-6625-2015, 15, 6625—6636.
10. Colman Lerner,. E., Sanchez, E. Y., Sambeth, 3. E., and Porta, A. A. (1995): Characterization and health risk assessment of VOCs in occupational environments in Buenos Aires, Argentina, Atmos. Environ., https://doi. org/i 0.101 6/j.atmosen v.2012.03.041,2012. 55, 440-447
11. He, Z., Li, G., Chen, J., Huang, Y., An, T., and Zhang, C. (2015): Pollution characteristics and health risk assessment of volatile organic compounds emitted from different plastic solid waste recycling workshops, Environ. mt., httys://doi. or/1 0.101 6/j.envint. pp 77, 85—94
12. Vega, E., Sánchez-Reyna, G.., Mora-Perdomo, V., Iglesias, G. S., Arriaga, 3. L., Limón-Sánchez, T., Escalona-Segura, S., and Gonzalez-Avalos, E. (2011): Air quality assessment in a highly industrialized area of Mexico: Concentrations and sources of volatile organic compounds, Fuel, https://doi.org/10.1016/j.fuel. 90, 3509—3520.
13. Macey, G.P. (2014): Air concentrations of volatile compounds near oil and gas production: a community based exploratory study. Environmental health.
14. Zimmer, Carl. (3 October 2013): "Earth's Oxygen: A Mystery Easy to Take for Granted". The New York Times. Retrieved 18 January 2019.