UNIVERSITY OF NOVI SAD
Technical faculty "Mihajlo Pupin"
Zrenjanin, Republic of Serbia

In cooperation with partners

Industrial Engineering and Environmental Protection
IIZS conference

PROCEEDINGS

IX International Conference – Industrial Engineering And Environmental Protection (IIZS 2019)

Zrenjanin, 3rd-4th October 2019.

University of Novi Sad
Technical faculty "Mihajlo Pupin"
Zrenjanin, Republic of Serbia

IX International Conference Industrial Engineering and Environmental Protection (IIZS 2019)

Proceedings

Zrenjanin, 3rd - 4th October 2019.

IN COOPERATION WITH PARTNERS:

UNIVERSITY POLITEHNICA TIMISOARA, FACULTY OF ENGINEERING, HUNEDOARA, ROMANIA

UNIVERSITY «St. KLIMENT OHRIDSKI«, TECHNICAL FACULTY, BITOLA, MACEDONIA

“AUREL VLAICU” UNIVERSITY OF ARAD, FACULTY OF ENGINEERING, ARAD, ROMANIA

UNIVERSITY OF EAST SARAJEVO, FACULTY OF MECHANICAL ENGINEERING EAST SARAJEVO, REPUBLIC OF SRPSKA, B&H

UNIVERSITY OF GIRESUN, FACULTY OF ENGINEERING, GIRESUN, TURKEY

IX International Conference - Industrial Engineering and Environmental Protection (IIZS 2019)

Organizer of the Conference:
Technical faculty “Mihajlo Pupin”, Zrenjanin, University of Novi Sad, Republic of Serbia

Reviewers:
Ph.D Snežana Filip, Technical faculty “Mihajlo Pupin”, Zrenjanin, Republic of Serbia
Ph.D James G. Speight, CD&W Inc., Laramie, Wyoming, USA
Ph. D Francisc Popescu, University Politehnica Timisoara, Timisoara, Romania
Ph.D Bogdana Vujić, Technical faculty “Mihajlo Pupin”, Zrenjanin, Republic of Serbia
Ph.D Eleonora Desnica, Technical faculty “Mihajlo Pupin”, Zrenjanin, Republic of Serbia
Ph.D Ljiljana Radovanović, Technical faculty “Mihajlo Pupin”, Zrenjanin, Republic of Serbia
Ph.D Jasmina Pekez, Technical faculty “Mihajlo Pupin”, Zrenjanin, Republic of Serbia
Ph. D Vladimi Šinik, Technical faculty “Mihajlo Pupin”, Zrenjanin, Republic of Serbia
Ph.D Višnja Mihajlović, Technical faculty “Mihajlo Pupin”, Zrenjanin, Republic of Serbia
Ph. D Slavica Prvulovic, Technical faculty “Mihajlo Pupin”, Zrenjanin, Republic of Serbia

Publisher:
Technical faculty “Mihajlo Pupin”, Zrenjanin, University of Novi Sad

For publisher:
Ph.D Dragica Radosav, Dean of Technical faculty “Mihajlo Pupin”, Zrenjanin

Technical treatment:
MSc Mića Đurđev, Technical faculty “Mihajlo Pupin”, Zrenjanin, Republic of Serbia
Ph.D Zoltan Kazi, Technical faculty “Mihajlo Pupin”, Zrenjanin, Republic of Serbia
MSc Ivan Palinkaš, Technical faculty “Mihajlo Pupin”, Zrenjanin, Republic of Serbia
M.Sc Una Marčeta, Technical faculty "Mihajlo Pupin", Zrenjanin, Serbia
M.Sc Jelena Mićić, Technical faculty "Mihajlo Pupin", Zrenjanin, Serbia

The Conference is supported by the Ministry of Education, Science and Technological Development and Autonomous Province of Vojvodina, Provincial Secretariat for Higher Education and Scientific Research, Republica Srbija

ISBN: 978-86-7672-324-9

CIP - Каталогизација у публикацији
Библиотеке Матице српске, Нови Сад

62:005.3(082)(0.034.4)
502/504(082)(0.034.4)

INTERNATIONAL Conference Industrial Engineering and Environmental Protection (9 ; 2019 ; Zrenjanin)
Proceedings [Elektronski izvor] / IX International Conference Industrial Engineering and Environmental Protection (IIZS 2019), Zrenjanin, 3rd-4th October 2019 ; [organizer Technical Faculty "Mihajlo Pupin", Zrenjanin]. - Zrenjanin : Technical Faculty "Mihajlo Pupin", 2019. - 1 elektronski optički disk (CD-ROM) : tekst ; 12 cm

Nasl. sa naslovnog ekrana. - Bibliografija uz svaki rad.

ISBN 978-86-7672-324-9

а) Индустријско инжењерство -- Зборници б) Животна средина -- Заштита – Зборници

COBISS.SR-ID 330863111

SPECIAL TECHNIQUES FOR PREDICTION POLLUTANTS IN THE ENVIRONMENTAL SAFETY

Sonja Ketin[1], Vladimir Šinik[2], Drazen Serjanovic[3], Rade Biocanin[3]
[1]Faculty of Maritime Academic Studies Belgrade, Serbia
[2]University of Novi Sad, Technical Faculty "Mihajlo Pupin", Zrenjanin, Serbia
[3]International University of Travnik, Travnik, Bosna and Herzegovina
e-mail: ketin.sonja@gmail.com

Abstract: The paper presents a new method of prediction pollutants (organic and inorganic) in an integrated system of environmental safety. In the following thesis, results of innovative research which included pollutants` NO_2 and SO_2 in complex process systems have been presented. Licensed EPA (Environment Protection Agency) model was used for the dispersion of pollutants into the air ALOHA (Areal Locations of Hazardous Atmospheres). ALOHA is a modeling program that estimates with hazardous chemical releases, including toxic gas clouds, fires and explosions. A threat zone is an area where a hazard has exceeded a user specified Level of Concern (LOC). Input data of the model are: pollutants` flow at the source, diameter of emitter`s opening and meteorological data. Achieved results represent maximum distance that SO_2 and NO_2 pollutants reach. All high emitters of industry have been modelled and the dispersions of pollutants have been presented for the highest emitters.
Key words: monitoring, predictions, environmental security

INTRODUCTION

The paper presents modeling of pollutants SO_2 and NO_2 for industry (example 1(*fertilizer industry*), 2(*petrochemical industry*) and 3(*oil industry*)) to represent maximum reach of pollutants in the atmosphere. Sulfur and nitrogen oxides have been selected because of the acid rain which is extremely harmful to the environment. There are other programs for modeling pollutants, but we used ALOHA, because of its quick and easy results. In the following paper, results of pollutants modelling in the oil and petrochemical industry are presented. These industries represent the highest emitters of two important pollutants: SO2 and NO2, and we evaluated their influence on the environment. No study that deals with the pollution in this manner has ever been made.

METHODS

An US EPA (Unated States Environment Protection Agency) model was used for the dispersion of pollutants into the air, called ALOHA (Areal Locations of Hazardous Atmospheres) [1]. ALOHA is a modeling program that estimates the hazardous chemical releases, incuding toxic gas clouds, fires and explosions. ALOHA is a good programme because it includes both physical and chemical charasteristics of pollutants (density of the gas, molar mass, boiling point) in its calculations. A threat zone is an area where a hazard has exceeded a user spefiied Level of Concern (LOC). Data used for the analyses has been taken from the project documentation and measurements of emissions performed by the certified institutions. Certified institutions are accredited organizations that perform the tests; they fulfill all of the set conditions and they have permission from the ministry, which is in charge of environmental problems, to perform air monitoring and/or the measuring of emissions.

Input data of the model are: pollutant flow at the source, diameter of emitter`s opening, meteorological data, chemical properties, ground roughness, and source location. The Achieved results represent maximum distance that SO_2 and NO_2 pollutants reach. All high emmiters of oil and petrochemical industry have been modelled and dispersion of pollutants are presented for the highest emitters. Input data represent emissions of inorganic pollutants, meteorological data in the worst case scenario. As the foundation we used a geographical map with the positions of emitters (all emitters are over 2m). All the Necessary information for the modeling which represents dimension of emitters are provided by the certified institutions that performed the measurements.
The Oil and petrochemical industry releases pollutants that are supposed to be measured and controlled. The Law on Integrated Prevention and Pollution and Control IPPC defines and requires

the reduction of pollutants to clearly determined levels. The Emitters that release pollutants are presented on Figure 1. ALOHA will plot user-defined levels of concern (LOC).

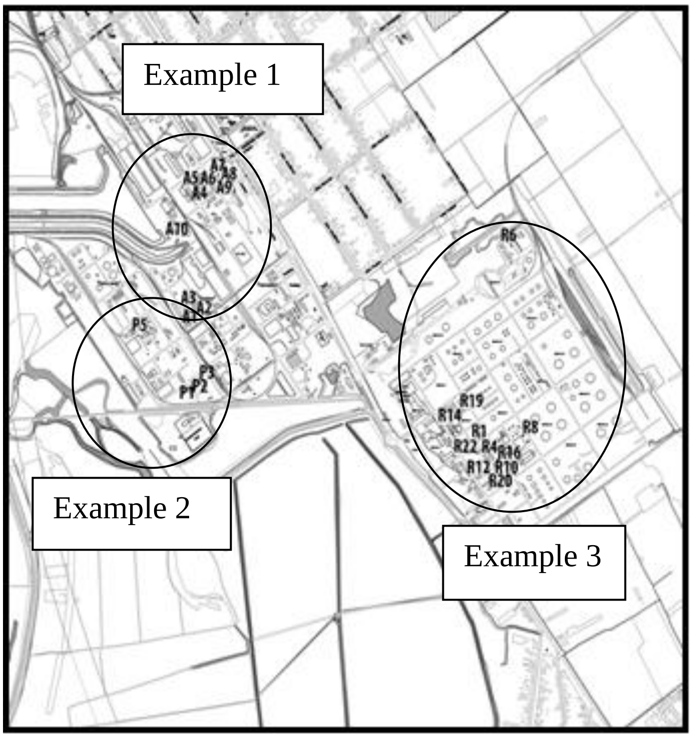

Figure 1. Position of emitters` measuring points in industry (example 1, 2 and 3)[2].
A, P, R are symbols for high emitters in the plants of chemical industry

A model of integral control and the prevention of pollution in oil and petrochemical industry has been developed using ALOHA to determine what emission rates are allowable under the law as compared to what is actually happening. In this case do you consider superposition of all the emitters. You have a map of the locations, you can use ALOHA with MARPLOT to plot the plumes on the map and see where the problem areas are. This model indicated the most critical points where we could reduce pollution using the technical and technological measures[3,4,5]. A developed model of integral control and the prevention of pollution utilizes diffusion equations of emissions during the continual work of the plant as well as equations for the performance of plant when it is not functioning properly.

EXPERIMENTAL

Modelling of inorganic pollutants has been done as an experiment in the oil and petrochemical industry.

Example 1. Modelling of pollutants NO_2 and SO_2 in the oil and petrochemical industry

The model for integral control and the prevention of pollution for the industry (example 1) has been applied on defined emitters A1-A10 (Figure 2). Table 1. represent result of modelling for pollutant NO_2.

Table 1. The Result of modelling for pollutant NO_2 (Example 1)

Measuring spot*	Pollutant ***	Mass flow rate (kg/h)	Height of emission source (m)	Maximum distance** (km)
A4	NO_2	83.4	82	5.7
A6	NO_2	213.21	82	9.3
A8	NO_2	116.8	18	6.8

** A are symbols for high emitters for the industry (example 1) (facility emission source location).*
*** Distance from high emitter to max range*

**** Pollutant SO_2 is not considered because example 1 use gas in the production process*

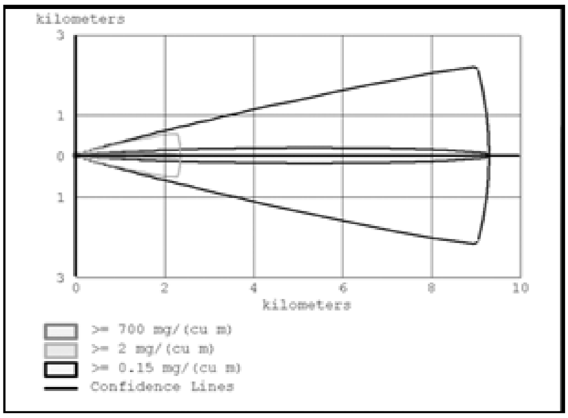

Figure 2. Graphical presentation of NO_2 dispersion at A6 measuring point

Example 2. Modelling of pollutants NO_2 and SO_2 in industry

The model for integral control and the prevention of pollution for the industry (example 2) [3,4,5] has been applied on defined emitters P1-P6 (Figure 3). Table 2. represent result of modelling of pollutants SO_2 and NO_2.

Table 2. Result of modelling for pollutant NO_2 (Example 2)

Measuring Spot**	Pollutant	Mass flow rate (kg/h)	Emission height (m)	Maximum distance (km)
P1	NO_2	82	40	5.6
P2	NO_2	84	40	5.7

*** P is symbols for high emitters for industry (example 2) (facility emission source location).*

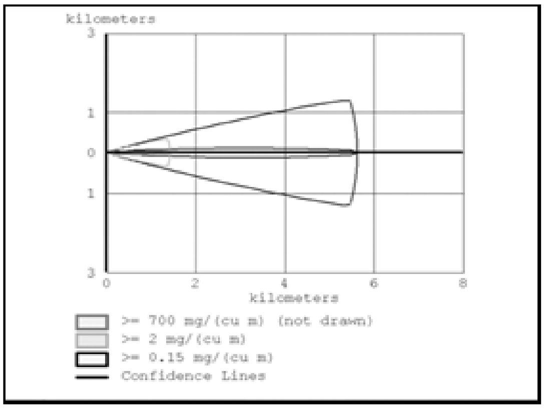

Figure 3. Graphical presentation of NO_2 dispersion at P1 measuring point

Example 3. Modelling of inorganic pollutants NO_2 and SO_2 in industry

The model for integral control and the prevention of pollution for the industry (example 3) has been applied on defined emitters R1-R22 (Figure 4). Table 3 represent result of modelling of pollutants SO_2.

Table 3. Result of modelling for pollutant SO_2 (example 3)

Measuring spot***	Pollutant	Mass flow rate, (kg/h)	Emission height, (m)	Maximum distance, (km)
R1	SO_2	$204.0 \cdot 10^3$	40	10
R19	SO_2	96.67	150	3.9
R22	SO_2	77.5	50	3.5

**** R is symbols for high emitters for industry (example 3) (facility emission source location.*

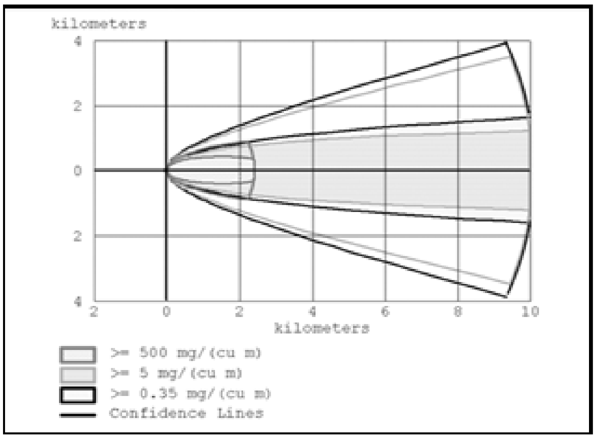

Figure 4. Graphical presentation of SO_2 dispersion at R1 measuring point

RESULTS AND DISCUSSIONS

Modelling results for the industry (example 1) present the maximum reach for boundary values of inorganic pollutants` emissions at:

- A6 measuring point (max reach of NO_2 is 9.3 km),
- A8 measuring point (max reach of NO_2 is 6.8 km),
- A4 measuring point (max reach of NO_2 is 5.7 km) and
- A9 measuring point (max reach of NO_2 is 5.3 km).

The Results are shown in Table 1. The highest percentage has A6 emitter and it is 22%, which can be seen in Figure 5.
Modelling results for industry (example 2) present maximum reach of inorganic pollutant nitrogen dioxide boundary values of inorganic pollutants` emissions at:

- P2 measuring point (max reach 5.7 km),
- P1 measuring point (max reach 5.6 km) and
- P3 measuring point (max reach 4.1 km).

The Results shown in Table 2. The highest percentage has P2 emitter and it is 34%, which can be seen in Figure 6.
Modelling results for industry (example 3) present maximum reach of inorganic pollutants for boundary values of inorganic pollutants` emissions at:

- R1 measuring point (maximum reach is 10 km),
- R8 measuring point (maximum reach is 4.7 km),
- R10 measuring point (maximum reach is 4.3km),
- R15 measuring point (maximum reach is 4.5 km),
- R19 measuring point (maximum reach is 3.9 km),
- R9 measuring point (maximum reach is 3.7 km) and
- R22 measuring point (maximum reach is 3.5 km).

The Results shown in Table 3. The highest percentage has R1 emitter and it is 18%, which can be seen in Figure 7. According to the results, maximum reach values (over 5 km) can be expected at A1 point. Measuring point R1 has the maximum pollutants` reach of over 10 km, and A6 point is in the vicinity. Maximum reach for industry (example 1) with inorganic pollutants` modelling can be expected at the following measuring points: A1, A6, A8, A9. Maximum reach for industry (example 2) with inorganic pollutants` modelling can be expected at the following measuring points: P1 and P2. Maximum reach for industry (example 3) with inorganic pollutants` modelling can be expected at the following measuring points: R1.

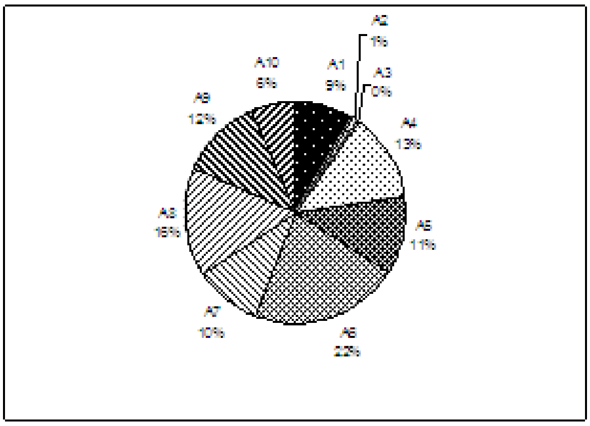

Figure 5. Percentage of inorganic emitters in pollution in industry (example 1)

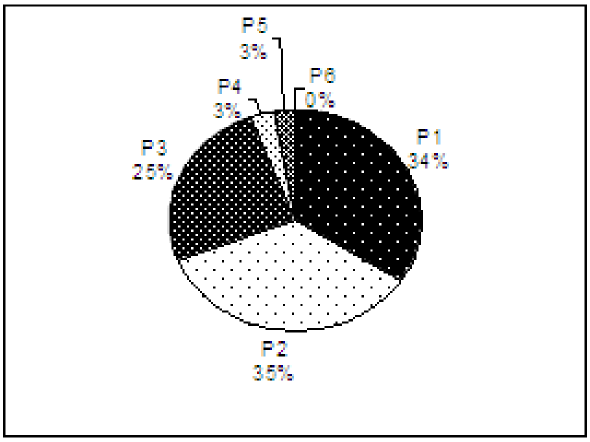

Figure 6. Percentage of inorganic emitters in pollution in industry (example 2)

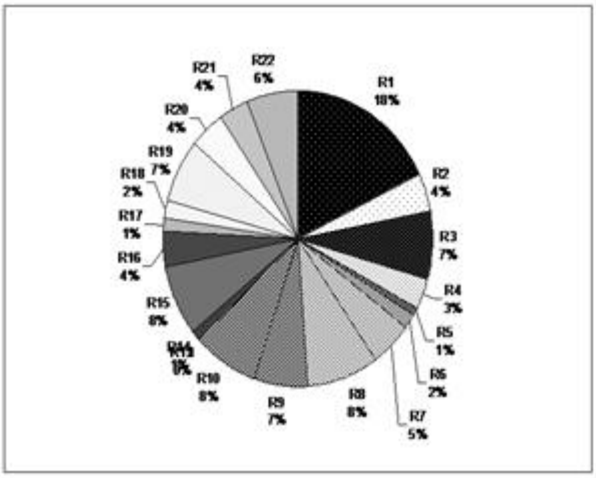

Figure 7. Percentage of inorganic emitters in pollution in industry (example 3)

Figure 8 represents the relation between measuring points and the maximum reach of pollutant. In graph 4. we can see that emitters with the highest reach during the modelling of inorganic pollutants SO_2 and NO_2 are: A1, A6, A8, A9, P1, P2 and R1. The Emitters with the lowest reach during the modelling of inorganic pollutants SO_2 and NO_2 are: A2 ,A3, P4, P5, P6, R5, R6, R14, R17. These results enable the formation of groups on the map (the zones with very bad conditions) and they can help you mark where the greatest problems in the area are[12,13].

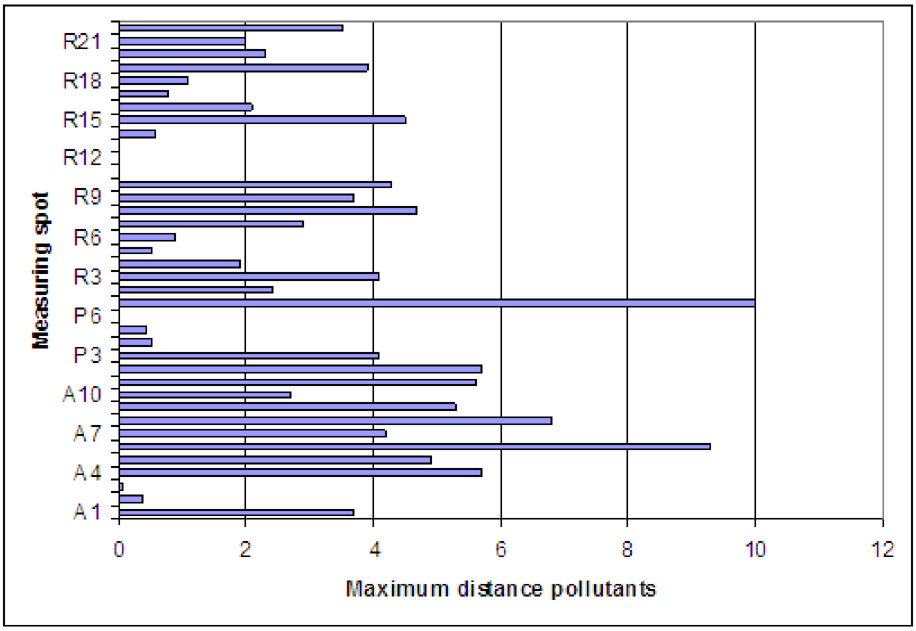

Figure 8. Relation between measuring points and maximum reach of pollutant

CONCLUSION

The Paper presents emitters with the highest reach during the modelling of pollutants SO_2 and NO_2 : A1, A6, A8, A9, P1, P2 and R1. Emitters with the lowest reach during the modelling of inorganic pollutants SO_2 and NO_2 are: A2 ,A3, P4, P5, P6, R5, R6, R14, R17. The least influence on the reduction of pollution is in the industry (example 2), which has the smallest number of emitters and takes a small part in the pollution. The graph shows the highest emission concentration, at what distance from the emission source SO_2 and NO_2 is 10 km. It has been calculated for the emitters in industry (example 3), which leads to a conclusion that the highest reach for inorganic pollutants is in the industry (example 3) as well as the greatest number of emitters that release pollutants.

As Presented here, the new modeling of pollutants in industry (example 2 and 3) could be applied on organic pollutants (benzene, toluene, xylene). The Results of pollutants` modeling in industry (example 2 and 3) show points (emitters) that could significantly influence the air quality as well as points of pollution reduction. The reduction of pollution as well as the control of pollutants` emission is regulated by the law that was defined by the Law on integral prevention and the control of pollution[8,9,10,11].

REFERENCES

[1] http://www.epa.gov/emergencies/
[2] http://ekologija.pancevo.rs/
[3] Stefanov, S., Comparative analysis of the monitoring for the assessment of risk in the complex process system. Master's Thesis. Novi Sad (Serbia): University of Novi Sad, Faculty of Technical Science, 2004.
[4] Stefanov, S.: The estimate of chemical accident hazard in the process of high density polyethylene production. Expert's Study. Novi Sad (Serbia): University of Novi Sad, Faculty of Technical Science, 2003.
[5] Stefanov,S., Vojinovic Miloradov,M., Sokolovic,S., Bogdanovic,V., Integrated pollution prevention and control in oil-petrochemical industry in Pancevo, XII Symposium on Analytical and Environmental Problems, Szeged, Hungary, 2005.
[6] Gastor, Strategic environmental impact assessment (Oil and Petrochemical plant), 2005.
[7] Stefanov S., Vojinovic Miloradov M., Basic Đ., Comparative Analysis Of The Monitoring And RA of the Chemical Accidents in Serbia, PSU-UNS International Conference, on Engineering and Environment – ICEE-2005, Novi Sad, 2005.

[8] Law on integrated environmental pollution prevention and control,"Official Gazette of the Republic of Serbia", No. 135/2004.
[9] Limits values, methods of measuring emissions, establishing criteria for measuring and places of data recors, "Official Gazette of the Republic of Serbia", No 54/92, 30/99, 19/2006.
[10] Law on air protection,"Official Gazette of the Republic of Serbia", No. 36/2009.
[11] Law on environmental protection, , "Official Gazette of the Republic of Serbia", No. 135/2004.
[12] Biocanin, R., Stefanov, S., Urosevic, S., Mekic, S. (2012) Modeling of Pollutants in the Air in Terms of Fire on Dumps, Ecological chemistry and engineering S – Chemia i inzynieria ekologiczna S 19, 609-616.
[13] Takic, Lj., Ketin, S., Marjanovic, R, Preljevic, A., Sacirovic, S. (2018) Comparison of maximum range of pollutants. Frenesius Environmnetal Bulletin,Vol.27, No.2,pp.1157-1163