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Method for Comparison of the Maximum Range of Chemical Pollutants[1]

S. Ketin[a], S. Sacirovic[b,c], S. Plojovic[d], R. Skrijelj[e], and R. Biocanin[f]

[a] *University of Novi Sad, Trg Dositeja Obradovica 5, Novi Sad, Vojvodina, 21000 Serbia*
e-mail: ketin.sonja@gmail.com

[b] *University of Nis, Faculty of Science and Mathematics, Nis, Serbia*

[c] *University of Belgrade, Faculty of Geography, Belgrade, Serbia*

[d] *International University of Novi Pazar,, Serbia*

[e] *State University of Novi Pazar, Novi Pazar, Serbia*

[f] *Serbian Royal Academy of Researchers and Scientists, Belgrade, Serbia*

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Abstract—This paper analyzes the oil and petrochemical complex with four scenarios (for different threshold limit values of pollutants concentrations) from whence the following conclusions have been made: Based on the results of modeling and analysis of aggregate data it can be concluded that the application of software ALOHA (model) it is possible to plan and manage the set limit values for concentrations of pollutants in industrial plants along with monitoring the dispersion of pollutants in the oil and petrochemical complex. The model was applied, which based on Gaussian distribution calculates maximum range of pollutants and pollutant concentrations. These researches are specific, highly complex and rare, and for the first time conducted by using the model of SO_2 and NO_2 dispersion, the dominant pollutants in the oil and petrochemical industry complex. The paper provides relevant information based on which emitters were detected with the highest level of environmental and working environment pollution. By the analysis of the used data conclusions were obtained about the effects of pollutants on pollution that provide safe and reliable conclusion on the emitters, causes of pollution of industrial plants of oil and petrochemical complex.

Keywords: pollutant, oil petrochemical complex, modelling

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EXPERIMENTAL

The experimental part consists of analytical consideration and graphical display of high emitters – sources of SO_2 and NO_2 in plants IPP1, IPP2 and IPP3. As IPP1 presented are the plants for the production of fertilizers, IPP2 are the plants for the production of petrochemicals and IPP3 are the plants of the oil refinery. To obtain accurate data the used model is licensed ALOHA®5.4.1. programme of the U.S. National Agency for Environmental Protection EPA. The analysis included a mathematical calculation of maximum range of pollutants for different boundary conditions (U.S. EPA and national standards). The ratio of the results was calculated and the analysis of each particular high emitter. Model testing is an integral part of the experimental work.

In Fig. 1a the percentage of the overall pollution for the high emitters of IPP1 is shown where it can be seen that the largest percentage share is of the emitter A6 (22%). In Fig. 1b it can be seen that the greatest share is of the emitter of P2 (35%) for IPP2. From Figs. 1a–1c high emitter with the greatest share R1 (18%) is recorded.

The limit values. In this paper specified are the limit values of SO_2 and NO_2 in Serbia and neighboring countries as well as in large industrial centers of the world. In the tables the data used in the calculations as input data are presented. The table shows the limit values for pollutants being used by the licensed model ALOHA®5.4.1 (for NO_2 limit values are 0.5, 12.5, 20 ppm; for SO_2 limits are 0.3, 3, 15 ppm) and atmospheric conditions.

The atmospheric conditions that were used as input data and did not change during the experiment are

[1] The text was submitted by the authors in English.

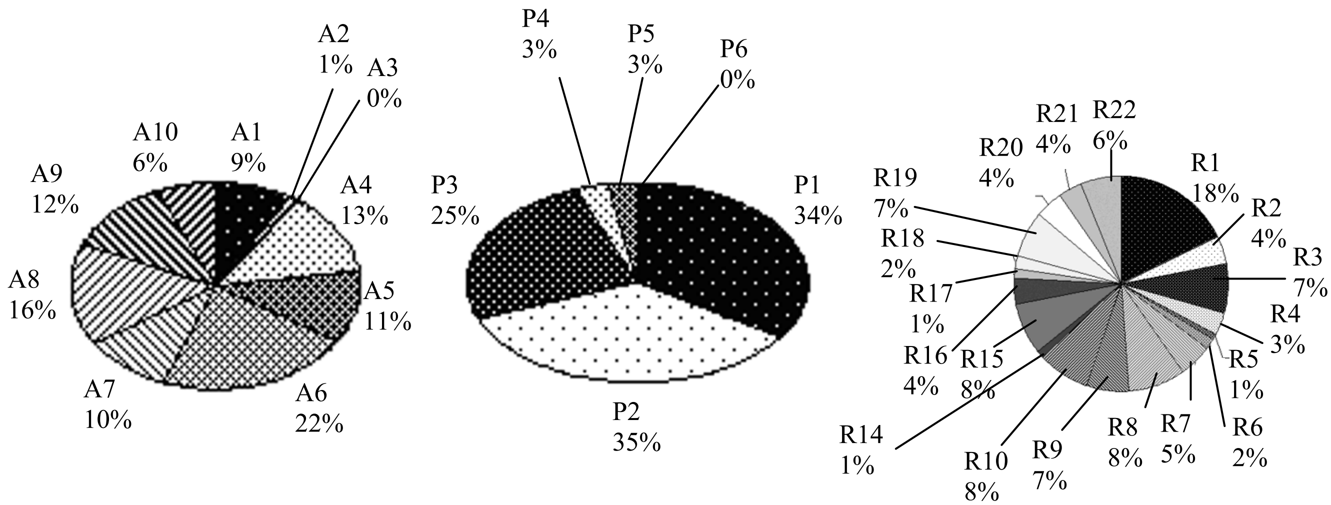

Fig. 1. Percentage share of high emitters for (a) IPP1, (b) IPP2, and (c) IPP3.

listed. Values were used for the worst case scenario ("worst case"): wind speed of 2 m/s, wind direction southeast, urban area, temperature 15°C, stability class F, relative humidity 50%.

Limit values of pollutants in other countries of our region are given in this paper of the dissertation and show how great are the values variations depending on the country prescribing them. The limit values of Serbia (for NO_2 limit values are 0.15, 700, 2 mg/m^3; for SO_2 limit values are 0.35, 5, 500 mg/m^3) and Russia (for NO_2 limit values are 0.25; 0:04; 0.002 mg/m^3; for SO_2 limit values are 0.500; 0.200; 0.050 mg/m^3).

Fig. 2. Cumulative effect of dispersion of NO_2 in the oil and petrochemical complex for the emission values.

RESULTS AND DISCUSSION

The table shows the comparison of the obtained maximum ranges of pollutants for the modeled values (EPA, national and Russian concentration limit values) and the design of values of pollutants' range. Modeled value is the column originated as the result of research of Scenario 1 and Scenario 4, the design value of pollutants range is the result of research of Scenario 3. Whereas the column "worst case" emerged as the highest score of all four Scenarios. "Worst Case" is necessary in research and modeling as the highest values are obtained.

From the table it can be concluded that the "worst case" is formed from the modeled values of Russian emissions except for the emitters R15 and R19. The worst case scenario for emitters R15 and R19 was formed in the modeling of the pollutants for the national limit values.

Graphically presented are the cumulative effects of the dispersion for pollutants SO_2 and NO_2 in the oil and petrochemical complex. Shown are all emitters in the oil and petrochemical complex of the pollutants SO_2 and NO_2 with emission limit values and maximum allowable concentration (MAC). The largest contribution is to the emerging of the pollutant SO_2 for IPP3, then for IPP2 and lowest for IPP1. The largest

Comparison of the obtained maximum range of pollutants for calculated, modeled and design values[a]

Emiters	Pollutant	"Worst case," km	Model, km			Design, km
			international		national	
			EPA	Russia		
A1	NO_2	10.00	0.67 0	10.000	3.700	–
A2	NO_2	1.900	0.075	1.900	0.394	–
A3	NO_2	0.338	0.013	0.338	0.067	–
A4	NO_2	10.00	1.000	10.000	5.700	10.000
A5	NO_2	10.00	0.896	10.000	4.900	10.000
A6	NO_2	10.00	1.700	10.000	9.300	10.000
A7	NO_2	10.00	0.764	10.000	4.200	–
A8	NO_2	10.00	1.200	10.000	6.800	–
A9	NO_2	10.00	0.968	10.000	5.300	–
A10	NO_2	10.00	0.506	10.000	2.700	–
P1	NO_2	10.00	0.460	10.000	5.600	0.892
P2	NO_2	10.00	0.460	10.000	5.700	0.892
P3	NO_2	10.00	0.336	10.000	4.100	0.892
P4	SO_2	0.711	–	0.711	0.513	1.400
P5	NO_2	2.200	–	2.200	0.450	2.000
P6	SO_2	0.028	–	0.028	–	–
R1	SO_2	10.00	10.000	10.000	10.000	0.625
R2	NO_2	10.00	2.300	10.000	2.400	0.625
R3	NO_2	10.00	2.300	10.000	4.100	1.400
R4	SO_2	5.600	1.300	5.600	1.900	1.400
R5	NO_2	2.600	0.344	2.600	0.512	1.400
R6	NO_2	2.400	0.095	2.400	0.880	0.306
R7	SO_2	2.900	0.280	1.200	2.900	0.178
R8	NO_2	10.00	0.545	10.000	4.700	2.900
R9	SO_2	6.300	1.500	6.300	3.700	1.800
R10	NO_2	10.00	0.703	10.000	4.300	1.500
R11	SO_2	5.800	1.400	5.800	–	1.300
R12	NO_2	1.200	–	1.200	–	–
R13	SO_2	0.062	–	0.062	–	0.133
R14	NO_2	1.700	0.086	1.700	0.589	0.297
R15	SO_2	4.500	0.193	0.818	4.500	0.297
R16	SO_2	6.000	1.400	6.000	2.100	–
R17	SO_2	2.900	0.687	2.900	0.789	0.891

Table. (Contd.)

Emiters	Pollutant	"Worst case," km	Model, km			Design, km
			international		national	
			EPA	Russia		
R18	SO_2	1.100	0.262	1.100	1.100	0.891
R19	SO_2	3.900	0.358	1.500	3.900	0.891
R20	SO_2	5.300	0.545	5.300	2.300	1.400
R21	NO_2	10.00	0.184	10.000	2.000	1.400
R22	NO_2	9.400	0.383	9.400	3.500	1.200
R23	SO_2	4.700	–	4.700	1.000	4.700

[a] (A1–A10) high emitters in plants IPP1, (P1–P6) high emitters in plants IPP2, (R1–R22) high emitters in plants IPP3.

contribution to the emerging of the pollutant NO_2 is in IPP1, then in IPP3 and lowest in IPP2.

In Fig. 2 the cumulative dispersion of pollutant NO_2 is presented, which takes into consideration all of the high emitters and the maximum ranges of the pollutant for IPP1, IPP2, and IPP3. The figure shows that the maximum range is up to City of Pancevo. Wind direction is south-east because the least favorable option is considered.

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