

MOVEMENT TREND OF AIR QUALITY IN THE ZENICA CITY AREA (1987 – 2008)

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ABSTRACT

Introduction: The main source of air pollution in the Zenica are plants of black metallurgy, and geographic characteristics of Zenica valley contribute to development of high air pollution.

Objective: The basic goal of this work was, to determine the trend of air quality in the city of Zenica, in the period from 1.1.1987. to 31.12.2008. **Methods:** Analyzed the movement of average annual concentrations of sulfur dioxide and complete hovering particulates in three measuring positions, the maximal values of concentrations of these pollutants, and the number exceeding the high values of the concentrations of these pollutants. **The results:** The average annual concentrations of sulfur dioxide recorded in the city of Zenica, were, in the period of 1987. - 1989. year: 166, 206, 214 $\mu\text{g}/\text{m}^3$ of air; 1998. - 1999.: 62, 52 $\mu\text{g}/\text{m}^3$ of air; 2006. - 2008.: 73, 99, 98 $\mu\text{g}/\text{m}^3$ of air. The average annual concentrations of complete hovering particulates recorded in the city of Zenica, were, in the period: 1987. - 1989. Year: 151.198, 190 $\mu\text{g}/\text{m}^3$ of air; 1998. - 1999.: 84, 77 $\mu\text{g}/\text{m}^3$ of air; 2006. - 2008.: 77, 74, 89 $\mu\text{g}/\text{m}^3$ of air. Maximal concentrations of sulfur dioxide in the city of Zenica, were recorded in the period: 1987. - 1989.: 1269, 1700, 1717 $\mu\text{g}/\text{m}^3$ of air; 1998. - 1999.: 495, 367 $\mu\text{g}/\text{m}^3$ of air; 2006. - 2008.: 503, 903, 843 $\mu\text{g}/\text{m}^3$ of air. Maximal concentrations of complete hovering particulates in the city of Zenica, was recorded in the period: 1987. - 1989.: 1008, 369, 1104 $\mu\text{g}/\text{m}^3$ of air; 1998. - 1999.: 449, 236 $\mu\text{g}/\text{m}^3$ of air; 2006. - 2008.: 493, 560, 810 $\mu\text{g}/\text{m}^3$ of air. During the calendar year, average daily concentrations of SO_2 was greater than 240 $\mu\text{g}/\text{m}^3$ of air in the city of Zenica, several times: in the period of 1987. - 1989. year: 76, 109, 91; 1998.-1999.: 12, 7; 2006. - 2008. 16, 34, 35 times. During the calendar year, average daily concentrations of complete hovering particulates was greater than 350 $\mu\text{g}/\text{m}^3$ of air in the city of Zenica, several times: in the period of 1987. - 1989.: 53, 56, 63; in 1998. 3 times a year, in 1999. not exceeding recorded; 2006. - 2008. 4, 6, and 5 times. **Conclusion:** The main cause of air pollution in the Zenica are the plants of black metallurgy industry and specific climate conditions of valley of Zenica. After activation of integral production in the the plants of black metallurgy, there is a clear trend of increasing concentrations of air pollutants in city Zenica.

Key words: Air quality; the trend of movement; the city of Zenica.

1. INTRODUCTION

Iron and steel industry has always been strongly associated with the environment, not only because of the technological process, but also because of general use products of black metallurgy.[1,2,3,4,5] Milestone in the development of Zenica, and its transformation in the industrial city, there was at the end of the XIX century, when Europe splashed wave of industrialization. The production was constantly growing, in order to achieve its maximum in 1988. year, with production of 1.374 million tons of coke, 1.669 million tons of iron, 1.879 million tons of steel, etc. [6,7,8] Zenica valley is about 12 km long. The valley is 2 km wide. Elevation the valley is about 350 m. The valley is bounded surrounding hills heights around 1000 m, while the chimneys height of 100 m, maximally 150 m, which means that in Zenica dominated by weak air currents, weak terms of dispersion of harmful substances, or are many elements contributing to high air pollution.[9,10] In Zenica, was the regular occurrence of episodes of high air pollution, due to unfavorable weather conditions in late autumn and winter. One of these episodes occurred in late December 1987. and early January 1988. year. In the village of Tetovo, was then continuously 7 days the status of the third-highest level of alarm. [7,10] Especially difficult was the situation in January 1989. year. Then it established a very large number of days of the highest level of alarm.[7] Zenica are polluted waste matter from industrial chimneys 130, 25 city boiler houses and home fireplaces and traffic.[10] Control over the quality of the air and the concentration of pollutants in the air of communal environment of city of Zenica is done on the basis of positive laws [11] and by-laws.[12,13]. In the city of Zenica, regular monitoring of air conducts Institute "Kemal Kapetanovic" Zenica [14], and earlier, and the tasks performed and Cantonal Institute for Public Health Zenica. [15]

2. OBJECTIVE

The basic goal of this work was to determine the trend of air quality in the city of Zenica, in the period from 1.1.1987. to 31.12.2008.

3. METHODS

On the basis of primary data on the movement of concentrations of sulfur dioxide and of complete hovering particulates in the air of communal environment city of Zenica, obtained from the Laboratory Institute "Kemal Kapetanovic" in Zenica, and the Cantonal Institute for Public Health Zenica, in the period from 1.1.1987. year to 31.12.2008., analyzed the movement of average annual concentrations of sulfur dioxide and of complete hovering particulates, the maximal values of concentrations of these pollutants, and the number exceeding the high values of the concentrations of these pollutants.

4. RESULTS

Analyzing primary data on the movement of concentrations of sulfur dioxide and complete hovering particulates in the air of communal environment of city of Zenica, we found that the average annual concentrations of sulfur dioxide recorded in the town of Zenica: 166 $\mu\text{g}/\text{m}^3$ of air in 1987., 206 $\mu\text{g}/\text{m}^3$ of air in 1988., 214 $\mu\text{g}/\text{m}^3$ of air in 1989., 53 $\mu\text{g}/\text{m}^3$ of air in 1997., 62 $\mu\text{g}/\text{m}^3$ of air in 1998., 52 $\mu\text{g}/\text{m}^3$ of air in 1999., 73 $\mu\text{g}/\text{m}^3$ of air in 2006., 99 $\mu\text{g}/\text{m}^3$ of air in 2007., and 98 $\mu\text{g}/\text{m}^3$ of air in 2008. (Table 1.) We found that the average annual concentrations of complete hovering particulates in the air of communal environment of city of Zenica: 151 $\mu\text{g}/\text{m}^3$ of air in 1987., 198 $\mu\text{g}/\text{m}^3$ of air in 1988., 190 $\mu\text{g}/\text{m}^3$ of air in 1989., 84 $\mu\text{g}/\text{m}^3$ of air in 1998., 77 $\mu\text{g}/\text{m}^3$ of air in 1999., 77 $\mu\text{g}/\text{m}^3$ of air in 2006., 74 $\mu\text{g}/\text{m}^3$ of air in 2007., and 89 $\mu\text{g}/\text{m}^3$ of air in 2008. (Table 1.) We found that the maximal concentrations of sulfur dioxide in the air of communal environment of city of Zenica: 1269 $\mu\text{g}/\text{m}^3$ of air in 1987., 1700 $\mu\text{g}/\text{m}^3$ of air in 1988., 1717 $\mu\text{g}/\text{m}^3$ of air in 1989., 495 $\mu\text{g}/\text{m}^3$ of air in 1998., 367 $\mu\text{g}/\text{m}^3$ of air in 1999., 503 $\mu\text{g}/\text{m}^3$ of air in 2006., 903 $\mu\text{g}/\text{m}^3$ of air in 2007. and 843 $\mu\text{g}/\text{m}^3$ of air in 2008. (Table 1.) We found that the maximal concentrations of complete hovering particulates in the air of communal environment of city of Zenica: 1008 $\mu\text{g}/\text{m}^3$ of air in 1987., 369 $\mu\text{g}/\text{m}^3$ of air in 1988., 1104 $\mu\text{g}/\text{m}^3$ of air in 1989., 449 $\mu\text{g}/\text{m}^3$ of air in 1998., 236 $\mu\text{g}/\text{m}^3$ of air in 1999., 493 $\mu\text{g}/\text{m}^3$ of air in 2006., 560 $\mu\text{g}/\text{m}^3$ of air in 2007., and 810 $\mu\text{g}/\text{m}^3$ of air in 2008. (Table 1.) During the calendar year, average daily concentrations of SO₂ was greater than 240 $\mu\text{g}/\text{m}^3$ of the air of communal environment of city of Zenica, several times: in 1987. 76 times, in 1988. 109 times, in 1989. 91 times, in 1998. 12 times, in 1999. 7 times, in 2006. 16 times, in 2007. 34 times, and in 2008. 35 times. (Table 1.) During

the calendar year, average daily concentrations of complete hovering particulates was greater than $350 \mu\text{g}/\text{m}^3$ of the air of communal environment of city of Zenica, several times: in 1987. 53 times, in 1988. 56 times, in 1989. 63 times, in 1998. 3 times, in 1999. overdrafts are not recorded, in 2006. 4 times, in 2007. 6 times, and in 2008. 5 times. (Table 1.)

4.1. Trend of annual average concentrations, recorded the maximal concentrations and the number of days exceeding the high values of SO_2 , and of complete hovering particulates, in the period 1987. to 2008.

Table 1. Trend of annual average concentrations, recorded the maximal concentrations and the number of days exceeding the high values of SO_2 , and of complete hovering particulates, in the period 1987. to 2008.

| Years of observation | Average annual values (in $\mu\text{g}/\text{m}^3$ of air) | | Maximal annual values (in $\mu\text{g}/\text{m}^3$ of air) | | Number of days exceeding the high values | |
|----------------------|---------------------------------------------------------------|--------------------------------|---------------------------------------------------------------|--------------------------------|------------------------------------------|--------------------------------|
| | SO_2 | complete hovering particulates | SO_2 | complete hovering particulates | $240 \mu\text{g}/\text{m}^3$ | $350 \mu\text{g}/\text{m}^3$ |
| | | | | | SO_2 | complete hovering particulates |
| 1987 | 166 | 151 | 1269 | 1008 | 76 | 53 |
| 1988 | 206 | 198 | 1700 | 369 | 109 | 56 |
| 1989 | 214 | 190 | 1717 | 1104 | 91 | 63 |
| 1998 | 62 | 84 | 495 | 449 | 12 | 3 |
| 1999 | 52 | 77 | 367 | 236 | 7 | 0 |
| 2006 | 73 | 77 | 503 | 493 | 16 | 4 |
| 2007 | 99 | 74 | 903 | 560 | 34 | 6 |
| 2008 | 98 | 89 | 843 | 810 | 35 | 5 |

5. DISCUSSION

Average annual concentration of SO_2 in the air of communal environment city of Zenica, in the period 1987. - 1999. ($166; 206; 214 \mu\text{g}/\text{m}^3$ of air) was significantly above the boundary values ($90 \mu\text{g}/\text{m}^3$ of air), and especially above the target values ($60 \mu\text{g}/\text{m}^3$ of air). In the period from 1998. - 1999., the values of SO_2 ($62; 52 \mu\text{g}/\text{m}^3$ of air) were, more or less, within the limits of the target values. In the period 2006. - 2008., see the gradual growth of these values, which were in 2006. within the limits ($73 \mu\text{g}/\text{m}^3$ of air), and in 2007. and in 2008. the concentrations exceeding limit values ($99; 98 \mu\text{g}/\text{m}^3$ zraka). [12,13]. Measured the average annual concentrations of complete hovering particles, in the period of 1987. - 1989. ($151; 198; 190 \mu\text{g}/\text{m}^3$ of air), were above the limit values ($150 \mu\text{g}/\text{m}^3$ of air), and, in particular, above the target values ($75 \mu\text{g}/\text{m}^3$ of air). These values of annual average concentrations of complete hovering particles, in the period of 1998. - 2006. were below the limit values, and in 2007. below the target values. In 2008. the value of this ($89 \mu\text{g}/\text{m}^3$ air) was below the limit values and above the target values of the average annual values of concentrations of complete hovering particles. [12,13]. Maximum concentration of SO_2 , in the period of 1987. - 1989. year, was reaching the high values, recognized with the largest value of $1717 \mu\text{g}/\text{m}^3$ of air in January 1989. Particularly high values of SO_2 were again recorded in December 2007. year, with a value of $903 \mu\text{g}/\text{m}^3$ of air. Recorded the maximal total concentrations of complete hovering particles in the air of communal environment city of Zenica is $1104 \mu\text{g}/\text{m}^3$ of air in January 1989. Since 2006, again recorded an increase of maximal concentrations of complete hovering particles in this city, with the largest value of recognized $810 \mu\text{g}/\text{m}^3$ of air in March 2008. [14,15] Although positive legislations [12,13] to permit the values of SO_2 of $240 \mu\text{g}/\text{m}^3$ of air and complete hovering particles of $350 \mu\text{g}/\text{m}^3$ of air, may be exceeding up to 7 times in a year, the values of SO_2 were exceeding 76 times in 1987., 109 times in 1988. and 91 times in 1989., and complete hovering particles were 53 times in 1987., 56 times in 1988. and 63 times in 1989. Trend increase in the number of exceeding these values for SO_2 is reported again in 2006. from 16 times exceeding values, especially in 2007., with 34 exceeding in 2008., with 35 exceeding the values of

SO₂ from 240 µg/m³ of air. Exceeding the values of complete hoverly particles of 350µg/m³ more than 7 times a year, there was no in period of 2006. - 2008. [14.15]

6. CONCLUSION

The main cause of air pollution in Zenica are ferrous metallurgy plants and specific climate conditions in the valley of town Zenica. Activating the integrated production plants in ferrous metallurgy, we are a clear trend of increasing concentrations pollutants in the air of the town Zenica, their average annual concentrations, the high maximal values of pollutants, as well as the increase in the number exceeding the values of 240 µg/m³ of SO₂, as well as a smaller exceeding values of 350µg/m³ of complete hoverly particles in the air of communal environment city of Zenica.

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