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AIR POLLUTION AGAINST THE BACKGROUND OF GASIFICATION AND CLIMATIC FACTORS (EXEMPLIFIED BY THE SITUATION OF RABKA)

ZANIECZYSZCZENIE POWIETRZA NA TLE GAZYFIKACJI ORAZ CZYNNIKÓW KLIMATYCZNYCH (NA PRZYKŁADZIE RABKI)

In the paper the results of air pollution researches in Rabka (dust and sulphure dioxide concentration), conducted before and during the gasification of the town, are presented. The considerable decrease of the air pollution level has been appeared in the period 1993–1995. It is suggested that the introduction of gas as a main energy medium instead of coal and coke had an important influence on this decrease. The consequence of long winter 1995/96 with low temperatures was increase of pollutions levels.

INTRODUCTION

An extremely high level of air pollution as for a spa was observed in Rabka in the past years. Demonstrated in different types of research (Góra 1977; Miczyński 1981; Bartosik 1985) this situation became the concern of the public opinion. The danger was a subject of discussion and it was questioned whether the current situation allowed patients with diseases of the respiratory system to be sent to Rabka for treatment. The concentration of the sulphur dioxide, for instance, exceeded the permissible level on almost all days of December 1977. The concentration of the air pollution index in Rabka could cause the increase of the symptoms of the upper respiratory system diseases (Miczyński, Miczyńska 1981; Miczyński 1989). First, in order to prevent the general threat Rabka was provided with coal of higher quality. Then, at the end of the 1980s more radical steps were taken, i.e. it was decided that all the buildings in Rabka should be supplied with gas.

This created conditions for an objective research on the results of the expected improvement of the air cleanliness in the spa for the health sake of the present people.

The utilisation of gas as the main energy medium, instead of coal and coke, resulted in the gradual reduction of the levels of dust pollution as well as the concentration of the sulphur dioxide.

Rabka seems to be the right location for this type of research. The geographical situation of the place in a mountain valley, far from industrial centres, is the factor limiting the influx of the pollution from outside. There are no factories in Rabka and its vicinity which would be able to emit the specific substances polluting the air. The relatively small number of the permanent inhabitants of this town made it possible for the Institute of Tuberculosis and Pulmonary Diseases to carry out appropriate epidemiological tests on children.

Thus, a hypothesis was put forward that the use of gas as the main energy medium should result in a considerable reduction of the air pollution.

DATA AND METHODS

The area of research:

The town of Rabka is situated in Southern Poland, ca. 60 km south of Kraków.

The town was established on the border line between two mountain ranges – the Gorce and the Beskid Wyspowy mountains, differing in respect of the landscape, in a picturesque valley of shaped by the erosion of the Raba river and two right-bank tributaries – the Słonka and the Poniczanka streams. The town was built both along those valleys and on the mountainside slopes of Bania and Grzebień. The variation of the ground level ranges up to 100 metres, with the average elevation of the town of 550 metres above the sea level.

The stations for the measurement of the air pollution were situated in the following places:

a) in the lowest area of the Kotlina Rabczańska (the Raba Valley) – at the "entrance" to the valley,

b) in the spa area on the Słomka stream,

c) in the spa section of Rabka, on the ground uplift between the Poniczanka and the Słomka,

d) on the eminences – Maciejowa and Luboń.

The measurement was carried out by means of a stationary automatic station, aspirators of the AKZ-A1 type localised in the measurement

stations, and the passive method. The results presented below were recorded by the AKZ-A1 aspirators and constitute the longest measurements sequences.

The measurements of the suspended dust were carried out with the help of the reflectometric method, whereas the establishment of the sulphur dioxide concentration in the air was obtained by means of the West-Gaeke method.

THE RESULTS OF THE RESEARCH

The data for the winter months: December–February, in the winters of 1994/95, 1995/96 and 1996/97.

Table 1

The average concentration of the suspended particulate matter for the respective wind speeds

Średnie stężenie pyłu zawieszonego dla określonych prędkości wiatru

v(m/s)	DC ($\mu g/m^3$)
calm	65.97
$\leqslant 1.0$	57.26
1.1–2.0	34.06
2.1–3.0	19.33
3.1–4.0	16.52
>4.0	10.23

The analysis of the material revealed a typical relation between the weather factors and the measured concentrations of particulate matter. The highest average concentration of the suspended dust was demonstrated for the calm and slight winds.

The average concentration of the sulphur dioxide for the calm totalled 30 $\mu g/m^3$. The pollution examined in relation to the wind direction demonstrated that the high concentrations for winds from the E to S direction attest to the influx of pollution from valleys of the Słomka and Poniczanka streams.

Likewise, the temperature was in the inversely proportional relation to the level of pollution.

The evaluation of the interdependencies between the measured pollution and rainfall also colaborates the general tendency. The highest dust concentrations

in Rabka were demonstrated for days without rainfall, and they were lowest for the days with the rainfall of more than 5 mm. The following tables present the findings.

Table 2

Air pollution in relation to daily precipitation

Zależność zanieczyszczenia powietrza od opadów atmosferycznych

Rainfall (mm)	DC ($\mu g/m^3$)	SC ($\mu g/m^3$)
< 0.0	51.18	25.04
0.0–5.0	36.39	23.86
> 5.0	24.60	21.61

Table 3

Air pollution in relation to winter total precipitation

Zależność zanieczyszczenia powietrza od sumy opadów atmosferycznych okresu zimowego

Winter	$\sum$ of rainfall (mm)	DC ($\mu g/m^3$)	SC ($\mu g/m^3$)
1994/95	159.1	28.69	22.04
1995/96	85.7	56.96	26.42
1996/97	72.6	41.79	24.21

The analysis of the variation of pollution measured in relation to the synoptic situation was also conducted.

The synoptic situation was divided into 21 types (Niedźwiedź 1988). The highest average concentrations of the suspended dust as well as of the SO_2 were demonstrated in anticyclonic situations, i.e. for K_a (that is the anticyclonic wedge, occasionally a number of indistinct centres or a fuzzy area of a higher pressure, the axis of the ridge of high pressure).

The intensification of the air pollution in the last years before 1995 revealed that in the coldest months – January and February – a considerable decrease of the pollution measured in Rabka was observed, which is illustrated in the table below:

Thus, the further analysis was based on the winter periods. They were regarded as the most characteristic periods of relatively high levels of pollution, and at the same time as periods which generated the longest sequences of data. The analysis was conducted by means of comparison of the measurement data of the air pollution demonstrated for years preceding

Table 4

The comparison of air pollution in the coldest months for two selected periods

Porównanie zanieczyszczeń powietrza w dwóch najzimniejszych miesiącach roku dla wybranych okresów

The type of pollution	Month	Average	
		1974–1979	1991–1995
Suspended dust	Jan.	73	36
	Feb.	94	34
Sulphur dioxide	Jan.	93	37
	Feb.	89	50

the gasification, i.e. 1984, 1991, 1992 and the years of the advanced gasification in Rabka, i.e. 1993, 1994, and 1995. Thus, the months of January and February were selected for the analysis of the winter period and June and July of the summer period. The collected data were equated by means of the consecutive mean and the trends were described. In the course of time a distinct decrease and a declining tendency of the level of the air pollution were observed. The continuation of this trend in 1994 and the initial months of 1995 suggested that the supply of gas to Rabka essentially contributed to the decrease of the concentration of the suspended dust and the sulphur dioxide in the atmospheric air in the above-mentioned period.

It can be generally stated that the concentrations of the pollution index declined more than twice till 1995 in relation to the 1970s. However, it is difficult to establish on the basis of the above-mentioned results what role the economic recession, the pro-ecological activities (mainly the use of gas) and warm winters played in the decrease of the air pollution in the analysed years. It was probably the result of the combination of all the factors.

The decrease of the concentrations of the air pollution in Rabka was also accompanied by the respective tendencies of decline of sickness rate of the respiratory system diseases in the case of children. This positive change was statistically significant only in the case of the bronchitis which is most frequent among small children. It has to be emphasised here that the positive changes in the health condition of children were more visible in the case of Rabka than in the case of Cracow. This would correspond the more distinct decline trend of the air pollution in Rabka. However, because the diseases of the respiratory system are a chronic process in the case of children and they are sensitive to a number of conditions apart from the quality of the inhaled air the collected data does not allow us to draw ultimate conclusions (Hałuszka, Miczyński, Pisiewicz 1995).

It was thus rightly concluded that the decrease of the air pollution in Rabka resulted from the introduction of gas as a main energy medium instead of coal and coke. In 1995 gasification was introduced in as much as 80% of the town of Rabka, and at the end of 1996 the gasification process covered 95% of the town.

The analysis of the average daily course of concentrations of the suspended dust in the selected winter months, i.e. January, February and March of the 1993–1996 period in relation to the total use of gas in Rabka showed that in the years 1994/95 a considerable decrease of the pollution level was observable. In January 1996, during the severe winter of 1995/96, the average dustiness of the air increased in comparison to the previous years. The increase of the dust level took place despite the continuous gas use at that period and in spite of the extension of the gas pipe network and the growing amount of gas service to individual households. The gasification was assumed to decrease the air pollution in Rabka – it was one of the main motivations for the project! This situation can be associated with a number of reasons. The low temperature was one of the indirect reasons of the high air dustiness in January 1996. It forced the inhabitants of the individual households to a higher (in comparison to the previous years) use of the sources of energy necessary for heating the houses. The other indirect factor which decided about the level of the air pollution was the price of gas. As a result of their economic calculations the individual users of gas began to doubt whether it was the right decision to attach their households to the gas network. Many of them still had another stove for traditional fuel in their houses. After all, coal, coke, briquettes, timber, garbage and even rubber and leather refuse are much cheaper sources of energy.

The evaluation of the sources of energy used in the individual households and the rate of their utilisation was conducted by means of questionnaires and interviews carried out in approximately 150 households. The respondents described the use of different fuels before the gasification of Rabka and afterwards and evaluated them.

Before the year 1994 approximately 90% of houses were heated by means of coal and coke. In the winter 1994/95 as many as 39% of individual households utilised gas, and in the winter 1995/96 the number of houses using gas increased by mere 3%, as only 42% of the respondents heated their houses by means of gas. It has to be stressed that it happened during the intensive process of gasification in Rabka. A number of houses had already been linked up to the network, while at the same time some of the inhabitants ceased to use the gas heating and returned to the solid energy mediums. There were also individual households which intended to cut themselves off the gas main and remove the gas meter.

This is a very disturbing fact which questions the principal issue – the justification of the gas use!

This fact is also reflected in the general opinion of the respondents about the use of gas. More than 50% of the respondents believed that gas was definitely too expensive, but at the same time they maintained that gas was an efficient ecological fuel (65%).

CONCLUSIONS

1. The research on the air pollution conducted in Rabka demonstrated that in the first stage of gasification of the town a considerable decrease of the air pollution index was observed.

2. An increase of the levels of concentration of the suspended dust was recorded in Rabka during the severe winter of 1995/96 in relation to the preceding winters despite the considerable advancement of the gas use in the town.

3. The questionnaire showed that during the winter of 1995/96 a certain set-back of the actual use of gas to heat up the individual households was observed and the return to burning coal, coke and all types of refuse, even garbage were attested.

PRACTICAL CONCLUSIONS

1. To maintain the cleanliness of the air in the Polish spas and leisure centres like Rabka the provisional preferential rates concerning the payments for the gas used for heating should be applied. The respondents suggested the subsidy should be about 30%.

2. The problem should be analysed on different levels, with the consideration of the low interest credits for the realisation of two objectives:

– the first one should involve the concept of the general reconstruction of the old-fashioned uneconomical central heating systems in the individual households and the introduction of the modern saving-energy systems,

– the second should concern the widespread process of the additional protection of the existing houses against cold.

In this situation the use of gas as an energy medium will be not only ecologically, but also economically justified, and what is more, it will be put into practice. Then the level of concentration of the air pollution will relatively decrease.

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STRESZCZENIE

W pracy przedstawiono wyniki badań zanieczyszczenia powietrza pyłem i dwutlenkiem siarki w Rabce, przeprowadzone przed, jak też w trakcie gazyfikacji miasta i rozpatrywane na tle czynników pogody.

Ocena dotychczasowego materiału wykazała, iż od 1993 r. zaznaczył się wyraźny spadek poziomu zanieczyszczeń powietrza w odniesieniu do lat wcześniejszych i sugerowała, iż wprowadzenie gazu jako nośnika energii w miejsce węgla i koksu miało istotny wpływ na zmniejszenie zanieczyszczenia powietrza do roku 1995. Długa i charakteryzująca się niskimi temperaturami zima 1995/96 istotnie zaburzyła występującą prawidłowość i w konsekwencji wystąpił wzrost poziomów zanieczyszczeń i pogorszenie oczekiwanych efektów aerosanitarnych, a w efekcie korzyści zdrowotnych uzdrowiska Rabka.