

Air pollution in Ostrava

Method of predominant source of air pollution identification
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Main aims of the study

Evaluation of ambient air quality in Bartovice in the period 2003 - 2006 with identification of pollutants exceeding limits
Supporting or refusing of assertion that air pollution in this locality is significantly affected by emissions from industrial complex Mittal Steel

On the periphery of city district Ostrava-Bartovice, Nad Obcí, Three houses equipped by gas heating are located in southwest direction towards Mittal Steel. Green belt with trees and shrubs, 1.5 km wide, follows; this belt is crossed by four lanes communication Rudna in the distance of 700 meters from monitoring station (number of cars in 16 hours by 2005 is 17 235, including 2880 lorries). Communication Teinska (number of cars in 16 hours by 2005 is 6399, including 666 lorries) is located in northeast direction from station in the distance of 50 meters.

Location of station

Main sources of pollution

Mittal Steel, Traffic - Teinska, Local heating (gasification in a part of the locality) - impact of local heating is not relevant for non-heating season

Monitored parameters

PM10, NOx - 24 hours concentrations, O3 - max 8 hours concentrations; continual measurement
Metals, PAU, VOC - 24 hours concentrations; interval each 6th day
Meteorological parameters (wind speed and direction, temperature, humidity, pressure)

For evaluation of air pollution quality: 1.1.2003 - 31.12.2006

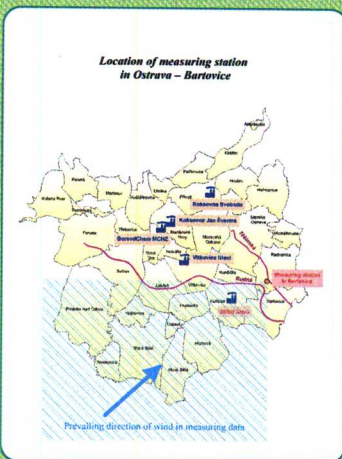
For evaluation of impact of Mittal Steel 1.1. - 31.12.2005 (1.5.-31.10. non-heating season, 1.1. - 30.4. 1.11. - 31.12. heating season)

Annual average results of basic pollutants, metals, PAU and VOC's in period 2003-2006

Tab. No. 1

Pollutant	Arithmetic average/number of short term concentrations exceeding limits					
	2003	2004	2005	2006	2003 at 2006	2003 at 2006
PM10						
NOx	64/161	64/171	63/190	65/187	64/177	
NO2	22/0	24/30	29/0	27/10	25/6/0	
O3 -8hod	75,2/40	63,8/19	61/14	69,2/38	67,3/29	
As	NM	14,7	12,4	13,4	13,5	
Cr	NM	2,0	2,0	4,4	3,4	
Mn	NM	8,9	10,5	12,2	10,5	
Pb	NM	86,1	100,0	114,0	100,0	
Fe	NM	157,9	114,0	118,0	130,0	
Zn	NM	7239,0	8844,7	10300,0	8794,6	
Fenanthrene	NM	630,0	262,2	368,4	430,2	
Anthracene	NM	92,6	90,9	91,7		
Fluoranthene	NM	13,7	17,5	15,6		
Pyrene	NM	39,2	47,1	43,2		
Benzo(a)anthracene	NM	27,0	33,0	30,0		
Chrysene	NM	10,8	10,9	14,1	19,4	13,1
Benzo(b)fluoranthene	NM	4,4	10,3	11,2	12,5	9,9
Benzo(k)fluoranthene	NM	8,8	9,5	9,1	10,1	9,4
Benzo(a)pyrene	NM	4,2	5,0	5,2	5,5	5,0
Dibenz(a,h)anthracene	NM	7,4	10,0	10,3	11,8	9,3
Benzo(g,h)perylene	NM	1,7	1,9	1,2	1,0	1,5
Indeno(1,2,3-c,d)pyrene	NM	3,3	8,4	6,6	7,4	6,4
Benzeno	NM	6,2	7,6	6,4	6,2	6,6
Toluene	NM	1,5	4,0	3,9	3,1	
1,3 - xylene	NM	6,5	24,2	11,7	14,1	
Styrene	NM	1,6	3,8	2,2	2,6	
	NM	0,6	0,6	-0,34	0,5	

In red - values exceeding limits according to Government Regulation No. 350/2002 Coll. and reference concentrations by National Institute of Public Health
NM - not measured



PM10 fraction of dust

Average annual concentrations of PM10 ranged in narrow range from 63 to 65 µg/m³; hereby annual limit 40 µg/m³ was exceeded in each year of measurement by minimally about 58 %.
The lowest number (161x) of exceeding of daily limit 50 µg/m³ was detected in 2003; maximum number (190x) of exceeding was related to the year 2005, whereas in legislation it is allowed to exceed daily limit only 35 times in a year. Daily pollution by dust exceeding limits was recorded approximately in a half of each year.

Arsenic

Average annual concentrations of arsenic were measured in the range starting from 12.4 up to 14.7 ng/m³; annual limit 6 ng/m³ (with date of fulfillment on 31.12.2012) was exceeded annually minimally about 107%.

PAU

Average annual concentrations of benzo(a)pyrene ranged from 7.4 to 11.5 ng/m³, with exception in 2005. Annual concentrations always exceeded annual limit 1 ng/m³ approximately about ten times. The date of fulfillment has been set up for this annual limit on 31.12.2012. Results of the last 4 years performed slightly increasing trend.
Average annual concentrations of benzo(a)anthracene showed increasing trend ranging from 10.8 to 16.4 ng/m³; thereby reference concentrations 10 ng/m³, given by National Institute of Public Health (NIPH), were exceeded annually with maximum in 2005 approximately about 64%.

Other pollutants

Concentrations of other pollutants, evaluated according our valid legislation, met criteria for air quality.

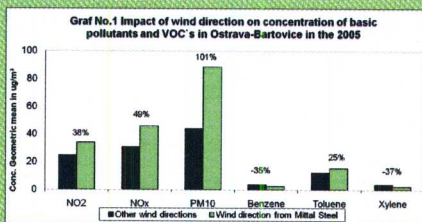
Impact of emissions from Mittal Steel on air quality in Ostrava-Bartovice in 2005

Assumptions - graphs No. 1, 2 and 3:

- Difference between measuring and comparative data (relatively in percentage) was selected for expression of impact of pollutants during prevailing direction of wind from Mittal Steel.
- Measuring data - perform a set of 24 hours concentrations in those days, when more than 26 half hour values of meteorological parameters i.e. wind speed in direction from Mittal Steel to station was higher than 0.5 m/s.
- Comparative data - perform a set of 24 hours concentrations in those days, when more than 22 half hour values of meteorological parameters i.e. wind speed and direction was different from that blowing from Mittal Steel to station or it was calm.
- Emissions from industrial complex Mittal Steel plus background emissions were a source of pollution in measuring data (we assume, that impact of communication Rudna was reduced by 700 meters wide belt of trees).
- Emissions from traffic from communication Teinska plus emissions from local heating plus background emissions were a source of pollution in comparative data.
- Background concentrations from direction from Mittal Steel might be affected only by pollution originated from city districts Ostrava-Hebřovice, Vyskeřovice, Dubina, Stara Bels, Horna Bels.
- Background concentrations from direction different than from Mittal Steel might be affected by other sources in Ostrava (Vázkovice steel, coke ovens) and was likely higher or equal to background from direction from Mittal Steel.
- Method of analysis of variance was used for statistical comparison of measuring and comparative data, which resulted in finding, whether for individual pollutants difference was or was not statistically significant. As far as the level of significance was higher than 0.05, the difference was not statistically significant and vice versa.

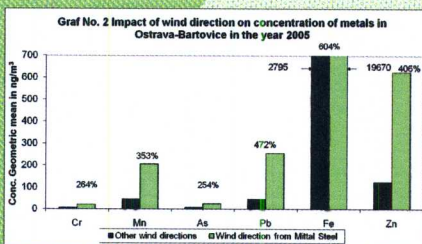
Analysis of variance

	No. of measurements	Geometric mean ug/m³	Level of significance	Excess in % In measuring data
PM10 fraction of dust	M 88	69	<0,001	181
Nitrogen dioxide	M 85	34	<0,001	38
Nitrogen oxides	M 249	25	<0,001	49
Arsenic	M 14	0,0242	<0,001	254
Chromium	M 43	0,0048		
Manganese	M 13	0,0209	<0,001	264
Lead	M 43	0,0455	<0,001	353
Iron	M 14	19,67	<0,001	472
Zinc	M 43	2,79	<0,001	604
Anthracene	M 14	0,024	<0,001	406
Fluoranthene	M 14	0,0122	0,058	150
Pyrene	M 14	0,0099	0,091	81
Benzo(a)anthracene	M 14	0,0162	0,132	64
Benzo(b)fluoranthene	M 14	0,0134	0,109	75
Benzo(k)fluoranthene	M 14	0,0107		
Benzo(a)pyrene	M 14	0,0113	0,093	71
Dibenz(a,h)anthracene	M 14	0,0096		
Benzo(g,h)perylene	M 14	0,0053	0,085	66
Indeno(1,2,3-c,d)pyrene	M 14	0,0032		
Benzeno	M 14	0,0099	0,131	69
Toluene	M 14	2,45	0,063	35
1,3 - xylene	M 14	12,3	0,558	25
	M 41	3,55	0,036	37



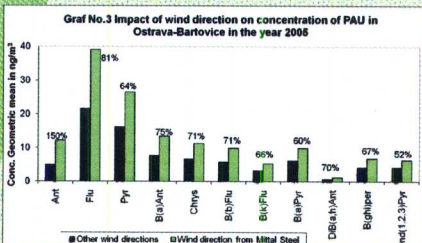
Graph No. 1

Statistically significant differences in NO2, NOx and PM10
Excess by 38% for NO2, 49% for NOx and 101% for PM10 was recorded during the circulation from Mittal Steel to location Bartovice
Average concentration of measuring and comparative data PM10 was higher than annual limit
PM10 fraction of dust was higher, on average, about 45 µg/m³ during prevailing wind direction from Mittal Steel
Results were not univocal for a group of VOC's; statistically significant difference was found only for the sum of xylenes with higher values as far as the wind direction was different from Mittal Steel
Differences in other VOC's were not statistically significant



Graph No. 2

Statistically significant differences were found for Cr, Mn, As, Pb, Fe a Zn
Excess ranged from about 254% (As) to 604% (Fe) during the circulation from Mittal Steel to locality Bartovice
Average concentration of measuring and comparative data of arsenic was higher than was the target annual limit with the date of fulfillment on 31.12.2012
Concentration of arsenic was higher, on average, about 17 ng/m³ during prevailing direction of wind from Mittal Steel
For manganese, only for measuring data, the average concentration was found higher than annual recommended value given by NIPH
Average difference between measuring and comparative data of manganese was 160.4 ng/m³



Graph No. 3

Differences for PAU were not statistically significant
Deficient excess ranged from 52 % [In(1,2,3)Pyr] to 150% (Ant) during the circulation from Mittal Steel to locality Ostrava-Bartovice
Concentration of benzo(a)pyrene was higher, on average, about 3.8 ng/m³ during prevailing direction of wind from Mittal Steel
It would be necessary to collect more data for confirmation of statistically significant differences

Conclusion

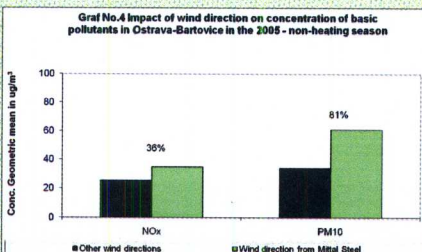
1) Evaluation of air quality in the period 2003 - 2006 :

In Ostrava-Bartovice, in the period 2003-2006, criteria were not met for the following pollutants:
> PM10 fraction of dust
> benzo(a)anthracene
> arsenic
> benzo(a)pyrene

2) Impact of emissions of Mittal Steel on air quality in 2005:

Statistically significant excess of concentrations has been detected for the following pollutants during prevailing direction of wind from Mittal Steel:
> Dust by 101 % (by 81% in non-heating season)
> Nitrogen oxides by 49% (by 36 % in non-heating season)
> Nitrogen dioxide by 38%
> Metals by 254% - 604%

Statistically not significant excess of concentrations has been detected for:
> PAU by 52% - 150%
Emissions from industrial complex Mittal Steel significantly increased air pollution by dust, nitrogen oxides and metals in the locality Ostrava-Bartovice in the year 2005



Assumptions - Graph No. 4:

1) Comparing data for non-heating season has arisen from the same assumptions as for data for the whole year 2005 only with that difference that measuring and comparative data were selected only from the non-heating season of the year 2005 (May to October).
2) This period guaranteed us for 100%, that the air quality really was not affected by local heating.

Graph No. 4

Results for non-heating season corresponded with results for the whole year
Statistically significant difference was confirmed for PM10 fraction of dust and for NOx
For non-heating season only the excess of 36% for NOx and 81% for PM10 was recorded during the circulation from Mittal Steel to locality Ostrava-Bartovice