POLSKIE TOWARZYSTWO MINERALOGICZNE – PRACE SPECJALNE
MINERALOGICAL SOCIETY OF POLAND – SPECIAL PAPERS
Zeszyt 22, 2003; Volume 22, 2003

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ALUMINOSILICATE PARTICLES IN FLY ASH AND ATMOSPHERIC DUST

INTRODUCTION

Coal is the most popular fuel in the Upper Silesia region. Coal combustion takes place in large industrial boilers of various types and in stoves of domestic households. Atmospheric pollution in Upper Silesia is higher than permissible standards and dominant in the winter season, specially relative to total suspended particles (TSP) and particular matter 10 (PM10) (Szymanska-Kubicka L., et al. 2001). The concentrations of respirable particles in Upper Silesia were relatively high in comparison with industrial areas in Western Europe and the United States (Pastuszka J., 2001).

Numerous papers describe components of air pollution. Information on the phase composition of these pollutants is seldom met (Manecki ed., 1984; Manecki and Marszałek, 1993; Rietmeijer and Janeczek, 1997). This paper presents data on the most popular particles, which form during coal combustion. These aluminosilicate particles are one of the main components of atmospheric dust.

EXPERIMENTAL

Samples of fly ash were collected from the six section**s** of electrofilters installed on exhaust gases of stoker fired boilers. The fly ashes originated from the coal combustion of particles less than 500 μm at temperatures in the range 850 – 1000^{o}C. Atmospheric dust samples have been collected monthly in glass jars (1 dm^3 volume) from 1999 to 2002 in a few cities in the Upper Silesia region.

All samples were examined by X-ray powder diffraction on Philips PW 3710 instrument (with Co K_α radiation). Samples were observed on Philips XL30 TMP scanning electron microscope (SEM method) working in the environmental mode and equipped with EDAX system, EDS type Sapphire. Microprobe JEOL 8600 equipped with four WDS spectrometers (PET, LIF and TAP) and EDS have been applied also**.** Samples of fly ashes were studied by JARRELL ASH type ENVIRO and PERKIN ELMER 6000 spectrophotometers.

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RESULTS AND DISCUSSION

Major components in atmospheric dust and fly ashes from coal combustion are aluminosilicate particles containing different concentrations of K, Fe, Ca, Mg, Na, Ti, Cu, and Zn. Those particulates usually have spherical and oval or polygonal shapes (Fig.1 and Fig.2). Some of them are smooth and other has porous surface. Aluminosilicate particles have different diameters, in fly ash the range is 5 - 200 □m and in atmospheric dust 1 - 80 □m. Particles less than 30 □m are often smooth and glassy, larger particles are usually porous and rugged. Porous and rugged particulates have also dendritic or fan-like forms.

Aluminosilicate particles have variable concentrations of K, Ca, Fe, Mg, Na, Ti, Cu and Zn both in fly ash and atmospheric dust (Table 1 and Table 2). Particles of fly ash and atmospheric dust contain similar proportion of SiO_2 and MgO. Atmospheric dust particles contain higher concentrations of Al_2O_3, Fe_2O_3, TiO_2, CaO, Na_2O, K_2O, ZnO and CuO than the fly ashes.

Table 1 Chemical composition of aluminosilicate particles of fly ash from six sections of electrofilters (%wt).

Components	Section of electrofilter					
	1	2	3	4	5	6
SiO_2	69.09	47.29	49.45	46.00	41.40	47.85
Al_2O_3	11.65	17.34	21.74	21.87	19.98	21.36
Fe_2O_3	4.14	18.67	8.54	9.29	14.43	10.17
TiO_2	0.36	0.66	0.83	0.98	0.86	0.77
CaO	5.03	5.26	4.56	6.12	5.22	5.00
MgO	2.72	3.08	3.47	3.91	3.47	3.39
Na_2O	0.38	0.48	1.12	1.06	1.04	1.01
K_2O	0.86	1.28	1.49	1.30	1.76	2.13
ZnO	0.015	0.030	0.075	0.075	0.067	0.033
CuO	0.007	0.015	0.020	0.025	0.027	0.016
other	5.63	5.68	8.55	9.19	11.61	8.11
TOTAL	99.88	99.79	99.84	99.82	99.87	99.84

other – calcination and other oxides

Table 2. Chemical composition of aluminosilicate particles of atmospheric dust from selected cities of Upper Silesia (%wt)

Locality	Zabrze	Zabrze	Katowice	Sosnowiec	Sosnowiec	Chorzów
Components						
SiO_2	44.84	44.60	32.54	35.76	60.29	37.61
Al_2O_3	31.76	28.22	41.13	29.91	14.95	17.28
Fe_2O_3	4.97	28.22	16.17	12.62	8.48	35.48
TiO_2	7.81	2.93	3.06	1.86	not detected	1.73
CaO	2.46	7.83	2.77	7.61	2.63	not detect.
MgO	1.69	3.82	2.70	4.72	6.16	1.58
Na_2O	3.17	3.18	0.93	0.91	not detected	not detect.
K_2O	2.98	2.02	0.69	3.88	not detected	3.29
ZnO	not detected	1.88	not detected	1.03	7.25	2.80
CuO	not detected	1.62	not detected	1.43	not detected	not detect.
TOTAL	99.68	99.66	99.99	99.73	99.76	99.77

Calcium in fly ash occurs in concentration in the range, 4.5 - 6 % wt., in atmospheric dust Ca range is 2.5 - 7.8 % wt.

Higher concentration of described elements in atmospheric dust is connected with diameter of particles. Particles less than 5 □m are not adsorbed on electrofilters and penetrate into the atmosphere.

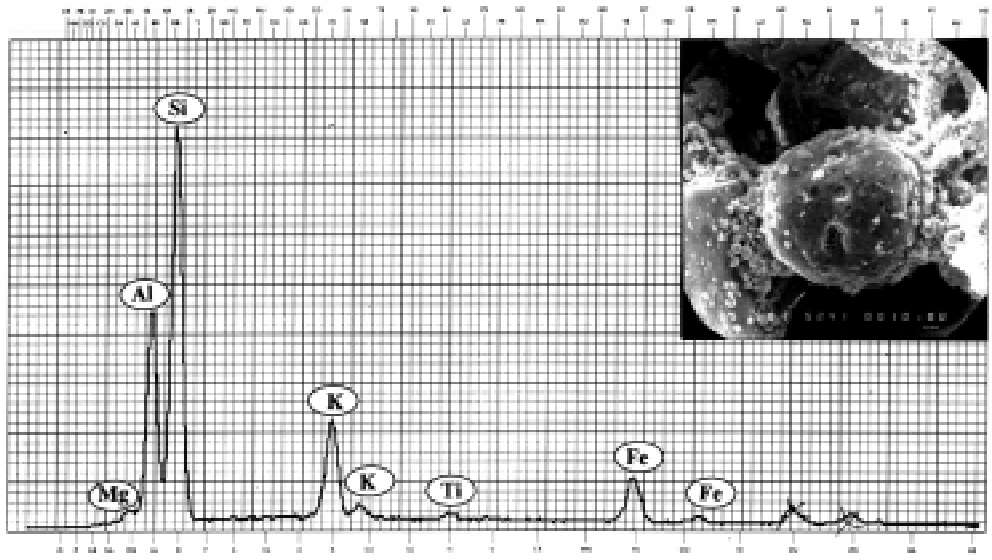

Fig.1. Porous and spherical particle of fly ash from electrofilter.

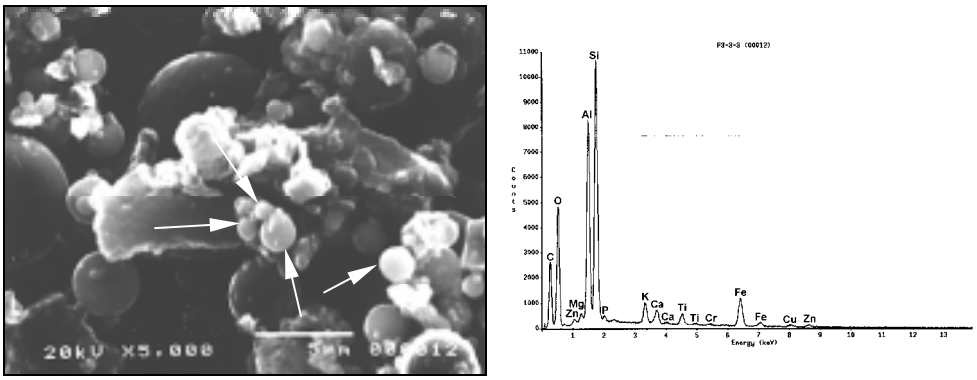

Fig.2. Spherical particles in atmospheric dust from Sosnowiec.

CONCLUSIONS

Aluminosilicate particles penetrate into the air and polluted atmosphere as a result of coal combustion. Aluminosilicate particles in fly ash and atmospheric dust have the same elements but in different proportions. Similar are only concentrations of Al_2O_3 and MgO. The quantity of Na, K, Fe, Ca, Ti, Zn and Cu increases in particles of atmospheric dust. Aluminosilicate particles observed in the atmosphere often have a diameter less than 10 □m and therefore can be a potential health hazard.

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