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Aerodynamic Separation of Fly Ashes of Selective Sampling from Pulverized Combustion of Coals of Different Ranks

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This paper reports on the results of the investigation of fly ashes from pulverized combustion of coals of two ranks, i.e., the B2 (sub C) rank, which is taken from Fields 1–4 of the electrostatic precipitators at the BSDPS -1 (the Bfa series), and the T (sa) rank, which is taken from Fields 1 and 2 of the electrostatic precipitators at the MPP-22 (the Mfa series).
It has been shown that fly ashes of the Bfa series have a lower bulk density and a higher dispersity and a unimodal particle size distribution. The size of particles increases along the gas-and-dust flow, in particular from the Field 1 to the Field 2 of the electrostatic precipitators. Fly ashes of the Mfa series are characterized by a higher density, a substantially lower dispersity, a bimodal particle size distribution and have rather close size characteristics for ashes from the Fields 1 and 2 of the electrostatic precipitators. The use of the aerodynamic separation has made it possible to obtain three products from fly ashes of both series which differ significantly in the bulk density and size of particles. Combination of selective sampling and aerodynamic separation of fly ashes from pulverized combustion of coals are promising techniques for manufacturing ash products with a controlled density and dispersity.

Keywords: Fly ash; Aerodynamic separation; Dispersity.

Introduction

In pulverized combustion of coal, the fly ash amounts to 80–95% of the ash and slag wastes of coal-fired power plants and, consequently, represents the most significant (in volume) by-product of coal combustion [1–3]. The main directions in the utilization of fly ashes in the world are provided by industry of building materials, highway engineering, and reclamation of pits [1, 2, 4]. The improvement of the quality of fly ashes has been achieved, in particular, by means of the design and development of facilities for conditioning the fly ash with the use of air classification, sieving, drying, and grinding for the purpose of producing ash fractions with controlled sizes and properties [5, 6]. The size-classified ash

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has been employed to manufacture dry binding mixes, cements with improved properties, pigments, ceramic membrane filters, composite plastic materials, and industrial rubber goods [5–9].

Since coals of different ranks differ in reactivity, their combustion has been carried out using boilers with different degrees of grinding and at different temperatures [10,11], what is the important factor affecting the size of the ash particles. The fly ash is partially classified in an ash collection facility at a coal-fired power plants. For example, ash products of different compositions and dispersities are formed in different fields of mechanical and electrostatic precipitators [12–14]. For example, Lee et al. [15] studied aluminosilicate ashes taken from different fields of electrostatic precipitators and showed that, when changing over from the first field to the third field, the quartz content decreases, whereas the content of the glass phase increases and that, in the composition of the glass phase, the Al_2O_3 content increases, whereas the SiO_2 content decreases. Shanthakumar et al. [16] also observed an increase in the content of the glass phase (from 85.8 to 96.2%) in the fly ashes taken from six sampling points and revealed a tendency toward a decrease in the ferrospinel content, whereas the Fe_2O_3 content in the chemical composition of the fly ash taken from the third field increased with respect to the first and second fields of the electrostatic precipitators. In our recent study [17], we showed that, when changing over from the first field to the fourth field of the electrostatic precipitators, the contents of the glass phase and calcium sulfate in high-calcium fly ashes increase by a factor of 1.4 and ~2.0, respectively, whereas the contents of calcium aluminate, lime, quartz, and hematite decrease by a factor of 2.4, 2.8, 8.0, and 5.7, respectively.

The most substantial differences between the fly ashes taken from different sampling points are observed in the particle sizes. When there is a general tendency toward a decrease in the particle size along the gas-and-dust flow, the dispersities of fly ashes taken from different coal-fired power plants can differ significantly. This is associated with the grinding fineness of coal, the presence of unburned carbon–mineral particles, and other factors. For example, according to the data available in the literature for different coal-fired power plants [14], the content of the fraction <63 μm in the fly ash from the first field of the electrostatic precipitators amounts to 35–91%, whereas the corresponding content in the same ashes from the third field of the electrostatic precipitators reaches 60–98%. According to the data reported by Lee et al. [15], the average size of the ash particles decreases by a factor of 7 (from 28.1 to 3.8 μm) when changing over from the first field to the third field of the electrostatic precipitators.

In the case where the fly ashes are used as additives to cements and concretes, they should satisfy the requirements for dispersity. In particular, the fly ashes should have a fineness retained 80 μm sieve ≤15–20% according to State Standard [18]; and a fineness retained 45 μm sieve ≤34%, ≤40%, ≤12%, and ≤10% according to the foreign standards ASTM 618-2005, BS EN450-1995, BS3892-1996, and JIS A 6201-1999, respectively [19–22]. In order to satisfy these requirements, it is common practice to use the mechanical activation of ashes [23], sieving [24], conditioning facilities [5], and aerodynamic classification [25–27]. At the same time, the selective sampling of the fly ash at different points of the ash collection facility, in many cases, makes it possible to satisfy these requirements for dispersity.

Fly ashes of finer fractions < 10 or 20 μm (Microsit M10 and M20, respectively) have been used for manufacturing high-strength concretes, plastic materials, and paints [5]. A fraction < 5 μm has served as a filler in polymer products or as a component of road pavements with a high strength and a high water resistance [28] or high-strength multifunctional cements [29]. It should be noted that, in practical applications of fly ashes, the positive effect (improvement of plasticity, regularity of the structure, etc.) has been achieved due to a microspherical shape of ash particles. Therefore, the grinding of fly ash is undesirable. A combination of selective sampling with aerodynamic separation is a promising technique for producing ash products with a controlled dispersity without grinding of the ash.

The purpose of this work was to study of the fly ashes sampled from different fields of electrostatic precipitators (EPs) at two coal-fired power plants, which have burnt coals of different ranks, and the products of aerodynamic separation of these ashes.

Objects of investigation and experimental techniques

The objects of our investigation are fly ashes from the pulverized combustion of brown coal from the Berezovsky surface mine in the Kansk–Achinsk Basin at the Power Plant BSDPS-1 and those of black coal from the Kuznetsk Basin at the Moscow Electric Power Plant No. 22 (MPP-22). The fly ashes series are designated as the *Bfa* and *Mfa*, accordingly. The coal characteristics, boiler types, coal combustion conditions, and sampling points of the fly ashes are presented in Table 1 [10, 30,31]. As follows from this table, the BSDPS-1 uses a low-rank coal, i.e., coal of the B2 (sub C) rank with high moisture, high volatile matter content, low ash content, and low heat of combustion. This coal is combusted in a P-67 boiler with the dry-ash removal at a temperature of 1350–1450°C. In contrast to the BSDPS-1, the MPP-22 uses a high-rank coal, i.e., coal of the T (*sa*) rank with low moisture, low volatile matter content, high ash content, and high heat of combustion. This coal is combusted in a TPP-210A boiler with the slag-tap removal at a temperature of ≥1600°C. The difference in the

Table 1. Coal characteristics, boiler types, fly ash yields, and sampling points for the fly ashes of Bfa and Mfa series [4,30,31]. (W_t^r - the total moisture content of the fuel under operating conditions, Q_i^{daf} – the heat of combustion and V^{daf} – the volatile substances in dry ash-free basis, A^d – ash content of fuel in the dry basis)

No.	Characteristic	Fly ash series	
		Bfa	**Mfa**
1.	Power Plant	BSDPS-1	MPP-22
2.	Coal (deposit)	Berezovsky coal mine (Kansk-Achinsk Basin)	Kuznetsk Basin
3.	Coal rank according to: GOST 25543-88 [32] ASTM D388-98a [33]	 B2 sub C	 T sa
4.	W_t^r (%)	33.0	7.0
5.	Q_i^{daf} (MJ/kg)	25.92	34.0
6.	V^{daf} (%)	48.0	12.5
7.	A^d (%)	7	20
8.	Slag removal type	Dry-ash removal	Slag-tap removal
9.	Boiler type	P-67	TPP-210A
10.	Furnace temperature (°C)	1350-1450	>1600
11.	Fly ash yields (%)	≥95	80-90
12.	Sampling points (fields of electrostatic precipitators)	1, 2, 3 and 4	1 and 2

Table 2. Yields and characteristics of size distribution for initial fly ashes of the Bfa and MS series and the products of their aerodynamic separation

Fly ashes and products of separation	Yield (%)	ρ bulk, (g/cm³)	Average diameter (μm)	d90 (μm)	Maximum (μm)
Bfa, Field 1	-	0.93	9.3	41.8	21.3
- heavy	29 - 33	1.13	26.2	62.2	37.9
- medium	52 - 56	0.79	7.5	26.5	13.6
- light	10 - 12	0.58	2.8	10.2	4.3
Bfa, Field 2	-	0.69	3.1	11.8	5.3
Bfa, Field 3		0.67	2.8	9.1	4.0
Bfa, Field 4	-	0.63	2.4	7.9	3.4
- heavy	53 - 62	0.72	4.8	13.4	8.9
- medium	23 - 31	0.59	4.7	13.0	8.7
- light	9	0.35	2.9	7.6	4.6
Mfa, Field 1	-	1.31	16.0	73.6	58.7
- heavy	45 - 47	1.05	51.0	97.8	60.0
- medium	35 - 40	1.16	9.6	31.3	16.8
- light	8 - 9	0.73	4.8	13.9	9.5
Mfa, Field 2	-	1.18	15.9	69.9	68.8

temperature regimes is associated with the high reactivity of the B2 coal and the low reactivity of the T coal in the course of combustion [10].

The aerodynamic separation was carried out on a laboratory setup, which was described in our previous paper [27]. An fly ash sample 10 cm^3 in volume was charged into the setup in one cycle of its operation. The heavy product remained in the wind tunnel, the medium product accumulated in the lower part of the cyclone, and the light product collected on the filter installed at the exit of the cyclone. The fly ash was separated using the air flow provided by a compressor at linear velocities of 0.051, 0.060, and 0.068 m/s. Table 2 presents the relevant data obtained for the velocity of 0.051 m/s. As the velocity increases, the separation parameters change toward an increase in the yield of the light and medium products with increasing fraction of larger particles. The number of cycles was varied from one to three, and the yield of products was determined in each cycle and was equal to 87-99 wt.%. Then, the identical products were mixed and averaged, the samples were taken for analysis according to the State Standards [32,33].

The granulometric compositions of the fly ashes from the first fields of EPs were determined using dry sieving according to the State Standard [34] on a VP-S/220 vibrodrive equipped with a set of sieves with meshes 0.400, 0.200, 0.160, 0.100, and 0.063 mm in size. The compositions of the major components of the ashes and the losses on ignition (LOI) were determined by the chemical analysis according to the State Standard [35], and the bulk density was determined by the method of measuring containers. The particle size distribution was investigated on a Fritsch MicroTech 22 laser analyzer. In this case, samples of *Bfa* and *Mfa* series were studied using dry and wet measuring cells, respectively. The dispersity and morphology of the ash particles were examined on a Carl Zeiss Axioscop-40 optical microscope equipped with a color digital video camera (Canon).

Results and discussion

Fly ashes from different fields of electrostatic precipitators

The fly ashes studied in this work were obtained from the combustion of coals of different ranks, which differ in the reactivity, temperature conditions of combustion in different boilers, and ash content. In particular, they differ in the content of unburned carbon, which is lower than 1% in the fly ashes from the combustion of the high-reactivity Berezovsky coal (the *Bfa* series) [17] and is considerably higher, i.e., 9.2 and 10.3 wt %, in the fly ashes from the Fields 1 and 2 of the electrostatic precipitators, respectively, in the case of the low-reactivity Kuznetsk coal (the *Mfa* series). Moreover, as follows from Fig. 1, they have a substantially different composition of the mineral part and, according to the classification by the chemical composition [36], belong to different types of ashes. Note also that fly ashes from the combustion of the Berezovsky coal belong to high-calcium ashes of the Calsialic (CS) type and have a high sulfur content (from 6.7 to 15.6 wt % SO_3) [17]. In fly ashes of the Kuznetsk coal, the aluminosilicate component dominates, which is characteristic of ashes of the Sialic (S) type.

One of the technical characteristics used in practice for a dispersed material is the bulk density. It is a complex parameter, which depends on the composition, the shape of particles, and their size distribution. As follows from the data presented in Table 2, the bulk density (ρ_{bulk}) of fly ashes of the *Bfa* series (0.93−0.63 g/cm^3) is substantially lower than that of fly ashes of the *Mfa* series (1.31 and 1.18 g/cm^3). At that the decrease in the bulk density decrease along the gas-and-dust flow, which is more significant for ashes of the *Bfa* series for the Fields 1 and 2 – from 0.93 to 0.69 g/cm^3, respectively,

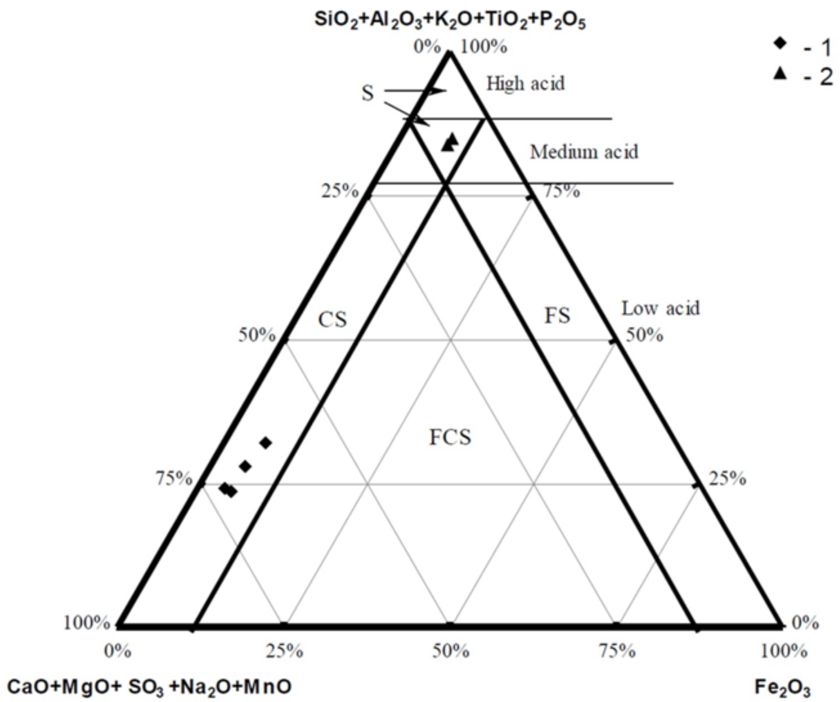


Fig. 1. Classification of the fly ashes according to the chemical composition [36]: 1 – fly ashes taken from Felds 1−4 of the electrostatic precipitators at the BSDPS-1 (Bfa series); 2 – fly ashes taken from Fields 1−2 of the electrostatic precipitators at the MPP-22 (Mfa series)

Table 3. Granulometric composition of fly ashes for **Bfa** and **Mfa** series from the Fields 1 of electrostatic precipitators

Fraction (mm)	Content (wt.%)	
	Bfa	**Mfa**
> 0.40	0.03	0.22
0.2-0.4	0.07	0.7
0.16-0.20	0.2	0.72
0.10-0.16	0.7	4.72
0.063-0.1	3.6	13.0
<0.063	95.4	80.6
∑	100	100

and is less significant for ashes of the *Mfa* series – from 1.31 to 1.18 g/cm^3 for the Fields 1 and 2, respectively.

A comparison of the granulometric compositions of fly ashes of both types taken from the first field of the electrostatic precipitators (Table 3) showed that the fly ash of the *Bfa* series differs by its higher dispersity: the content of the fraction <0.063 mm in this ash is higher than 95%, whereas the content of the same fraction in the fly ash of the *Mfa* series does not exceed 81%. The analysis of the data available in the literature [3,14–16,37] has demonstrated that, according to the content of the fraction <0.063 mm, the fly ash of the *Bfa* series from the Field 1 of electrostatic precipitators is close only to the fly ashes from the first field of EPs from combustion of the Angren brown coal (Angren SDPS) and the Estonian slate (Estonian SDPS) in TP boilers. The content of the fraction <0.063 µm in the other ashes from the first fields of EPs amounts to 35–82%.

A similar conclusion regarding the difference between the sizes of particles in the fly ashes under investigation from the first field of the electrostatic precipitators follows from the data obtained on the laser analyzer (Table 2). In particular, the average diameter of particles in the *Bfa* fly ash from the Field 1 is equal to 9.3 µm and the quantity d90 (the size of particles for which the integral distribution curve corresponds to 90%) is 41.8 µm, whereas these quantities for the *Mfa* ash amount to 16.0 and 73.6 µm, respectively. Furthermore, they differ in the shape of the curve and in the position of the maximum: a unimodal size distribution with the maximum at 21.3 µm and the asymmetry toward submicron particles is observed for the fly ash of the *Bfa* series (Fig. 2), and a bimodal size distribution with the main maximum at 58.7 µm, the secondary maximum at 16.0 µm, and the asymmetry toward micron and submicron particles is observed for the fly ash of the *Mfa* series (Fig. 3).

For fly ashes from different fields of electrostatic precipitators, there exists a general tendency toward a decrease in the size of particles along the gas-and-dust flow, and the regularities observed in this case for different ash collection facilities are somewhat different. The dispersity can increase monotonically from the first field to the subsequent fields of electrostatic precipitators [14,15], or the size of particles in the fly ash from the second field can decrease rather abruptly with respect to that from the first field [14,39]. There are also examples where the differences between the sizes of particles in the fly ashes from the first and second fields are less significant compared to the third and fourth fields [14].

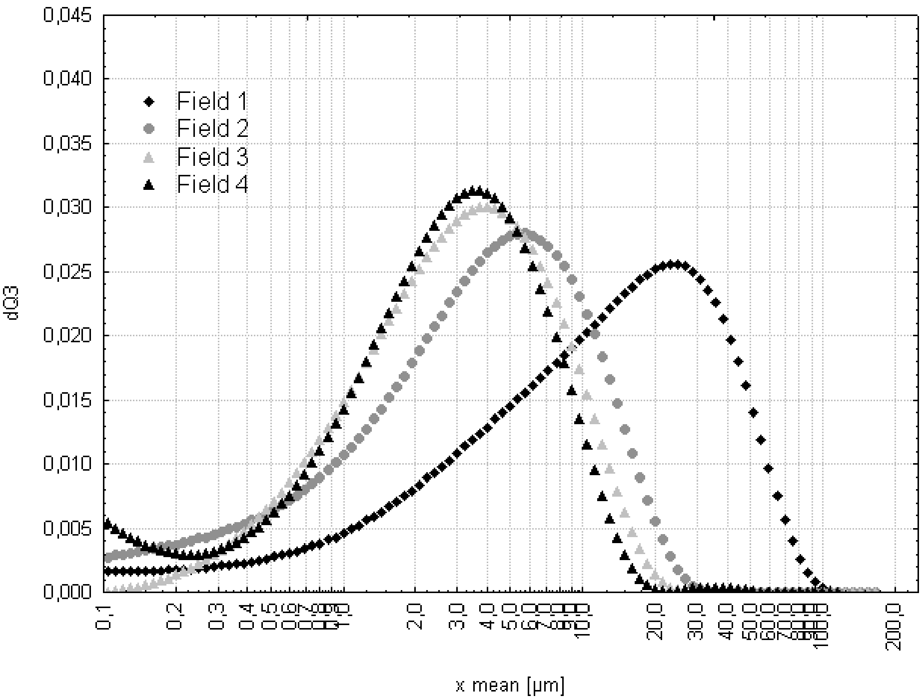


Fig. 2. Differential particle size distributions for fly ashes of the Bfa series from Fields 1−4 of the electrostatic precipitators

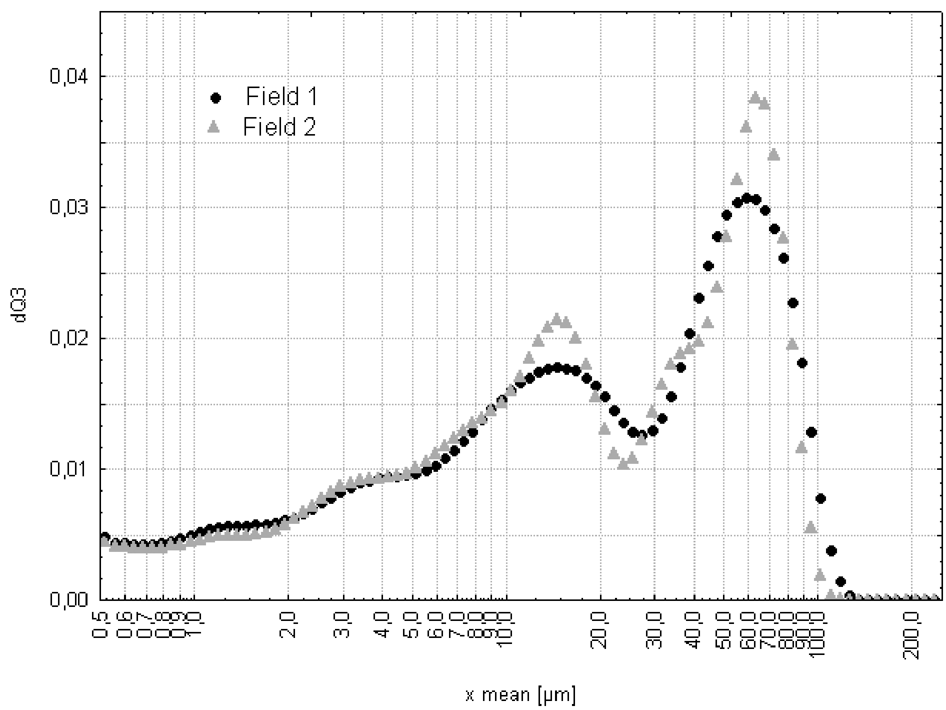


Fig. 3. Differential particle size distributions for fly ashes of the *Mfa* series from Fields 1 and 2 of the electrostatic precipitators.

For ashes of the *Bfa* series, the average diameter of particles decreases from 9.3 μm to 2.4 μm when changing over from the Field 1 to the Field 4 of the electrostatic precipitators, respectively, while the maximum shifts from 21.3 μm to 3.4 μm and the quantity d90 changes from 41.8 μm to 7.9 μm, respectively (Table 2). The contribution from the particles with a submicron size increases in the same order (Fig. 2). It follows from these data that the largest decrease in the sizes of the particles is observed when changing over from the first field to the second field of the electrostatic precipitators.

For fly ashes of the *Mfa* series, the dispersities of the ashes from the Fields 1 and 2 of the electrostatic precipitators differ insignificantly: the average size of the particles changes from 16.0 to 15.9 μm, and the quantity d90 changes from 73.6 to 69.9 μm. The positions of the maxima differ more significantly; i.e., the maxima are observed at 58.7 and 68.8 μm, respectively (Table 2), and become more pronounced for the fly ash from the Field 2 (Fig. 3).

Therefore, fly ashes of the *Bfa* series sampled from different fields of electrostatic precipitators at the BSDPS-1 differ significantly in the bulk density and size of particles, which is especially true for the fly ashes from the first and second fields of the electrostatic precipitators. By contrast, fly ashes of the *Mfa* series sampled from the first and second fields are rather close in size. Moreover, they have a substantially higher bulk density and a lower dispersity as compared to fly ashes of the *Bfa* series of the same sampling.

Fly ash products of aerodynamic separation

The aerodynamic separation makes it possible to more finely separate fly ashes, thus providing a means for effectively isolating small and light particles from larger and heavier particles, and leads to the formation of products with a stable composition. Kruger [6] described the air classification of ashes of the aluminosilicate composition (class F) and obtained fractions <45 μm and <10 μm, which have close chemical compositions but exhibit different properties. The use of the fraction <45 μm as a 30% additive to the Portland cement does not lead to a deterioration of its strength characteristics, and the ultrafine fraction <10 μm, which is characterized by a higher pozzolanic activity, makes it possible to produce cements for high-strength concretes. Fisher et al. [38] used the aerodynamic separation of fly ashes to prepare four fractions with average particle diameters of 20.0, 6.3, 3.2, and 2.2 μm and demonstrated that, with a decrease in the size of the fraction, the contribution from massive homogeneous microspheres to this fraction increases, whereas the contribution from particles of a different morphology, especially from cenospheres, decreases. Fractions <5−10 μm, which were prepared by the air classification of fly ashes, are intended for the use as fillers in thermoplastics, rubbers, and asphalt, as well as for manufacturing paints [5−7,9,39].

The aerodynamic separation with the formation of three (heavy, medium, and light) products was performed for the fly ash of the *Bfa* series from the Fields 1 and 4 of the electrostatic precipitators and for the fly ash of the *Mfa* series from the Field 1 of the electrostatic precipitators. For the fly ash of the *Bfa* series (Table 2), the bulk density substantially decreases when changing over from the heavy product to the light product: from 1.13 g/cm^3 to 0.79 and 0.58 g/cm^3 for the Field 1 and from 0.72 g/cm^3 to 0.59 and 0.35 g/cm^3 for the Field 4, respectively. It follows from the data obtained on the laser analyzer that the fly ash of the *Bfa* series from the Field 1 of the electrostatic precipitators is effectively separated and that the products differ significantly in the dispersity (Table 2, Fig. 4). In particular, the average diameter of particles in the heavy product is equal to 26.2 μm and decreases to 7.5 and 2.8 μm

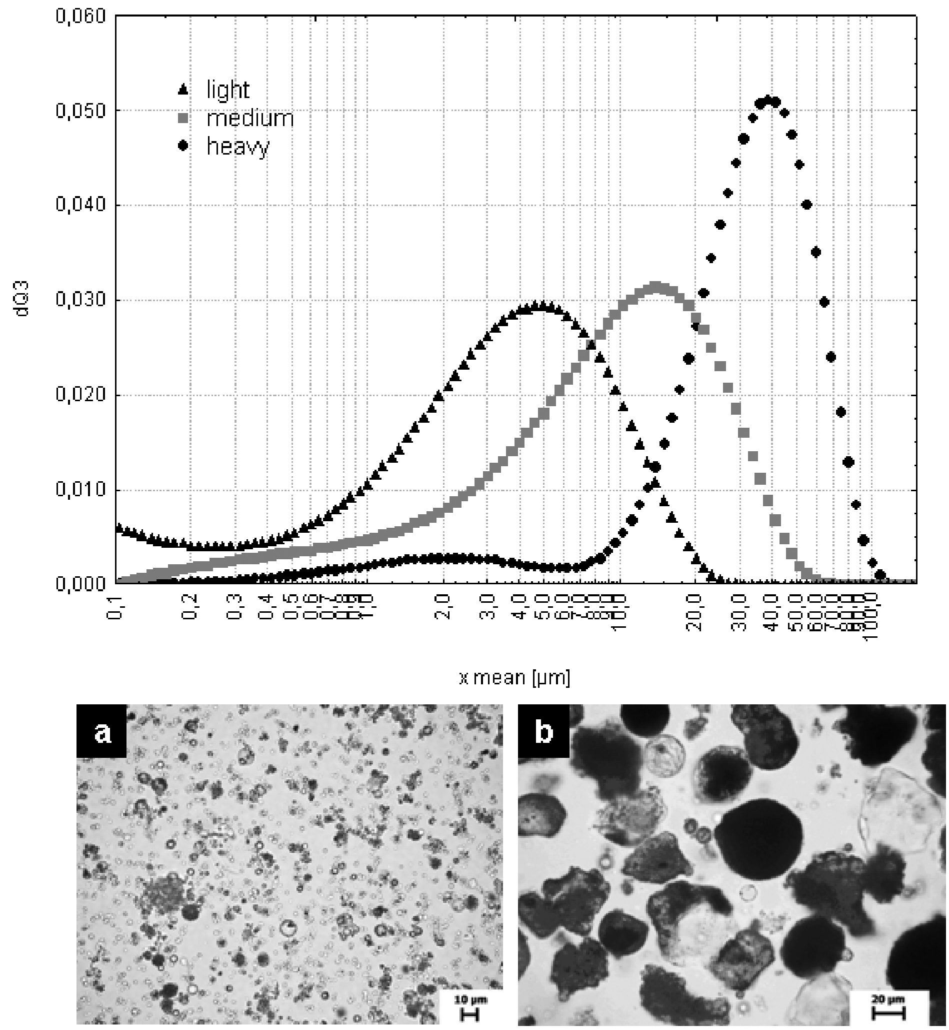


Fig. 4. Differential particle size distributions for products of the aerodynamic separation of the fly ash of the Bfa series taken from Field 1 of the electrostatic precipitators (at the top) and optical images of the (a) light and (b) heavy products

in the medium and light products, respectively; in this case, the quantity d90 decreases from 62.2 µm to 26.5 and 10.2 µm with a shift of the maximum from 37.9 µm to 13.6 and 4.3 µm, respectively.

A different conclusion follows from the separation of the fly ash of the *Bfa* series from the Field 4 of the electrostatic precipitators. The size characteristics for the heavy and medium products are very close to each other, and those for the light product change to a lesser extent as compared to the corresponding parameters for the fly ash from the first field of the electrostatic precipitators (Table 2, Fig. 5). The fly ash from the Field 4 of the electrostatic precipitators is characterized by the highest dispersity and contains micron and submicron particles that are prone to aggregation, which, in turn, hampers their separation in air flow. Moreover, according to the size of particles, this fly ash without an additional air separation satisfies requirements for many applications.

The fly ash of the *Mfa* series was also separated in our setup with a high efficiency. From the fly ash of the Field 1 with a bimodal particle size distribution, we obtained three products with unimodal size

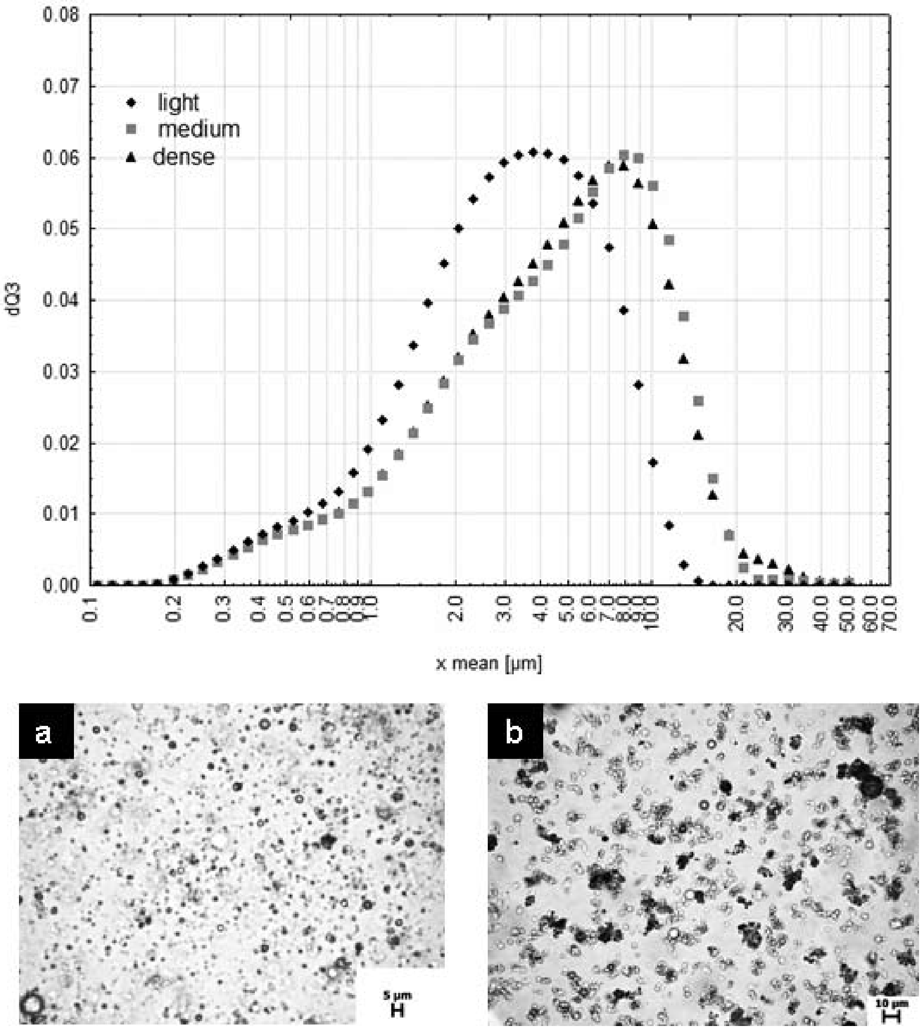
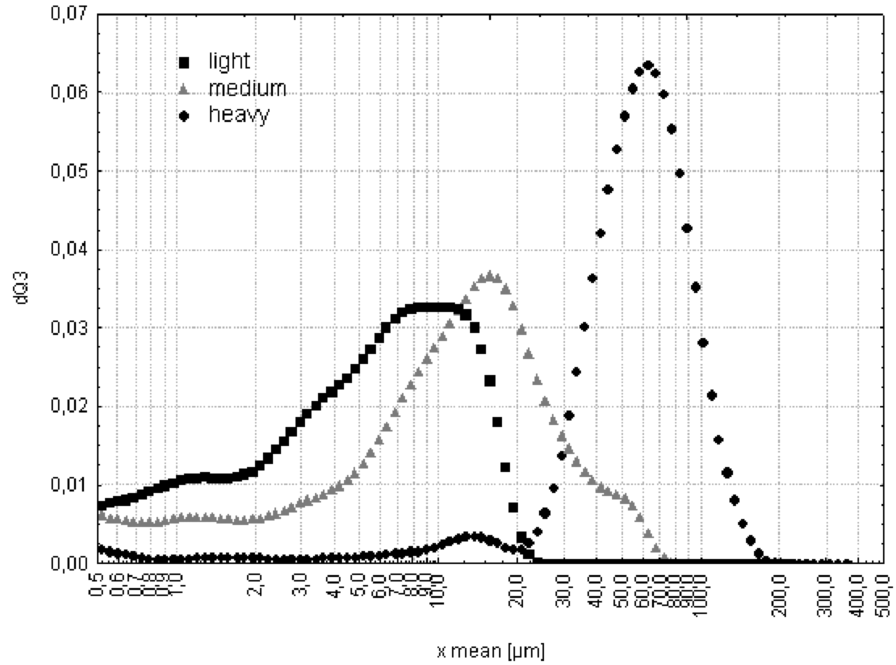


Fig. 5. Differential particle size distributions for the products of the aerodynamic separation of the fly ash of the Bfa series taken from Field 4 of the electrostatic precipitators (at the top) and optical images of the (a) light and (b) heavy products

distributions; in this case, the average diameter of particles decreases from 51.0 μm in the heavy product to 9.6 and 4.8 μm in the medium and light products, respectively (Table 2). Considerable variations are observed in the quantity d90, which changes from 97.8 μm to 31.3 and 13.9 μm, respectively, and in the position of the maximum in the differential distribution curve, which changes from 60.0 μm to 16.8 and 9.5 μm, respectively (Fig. 6). Unlike the fly ashes of the *Bfa* series, the bulk density ρ_{bulk} in this case reaches a maximum value for the medium product.

The examination of the optical images of the heavy and light products obtained by the separation of fly ashes of both series (examples of these images are shown in Figs. 4–6) confirms the laser analyzer data on the differences in the dispersities of the products.

The analysis of the images obtained with an optical microscope in transmitted light allows us to conclude that the heavy product formed from the fly ash of the *Bfa* series from the Field 1 (Fig. 4) predominantly contains particles with sizes ranging from 20 to 60 μm, including transparent and opaque



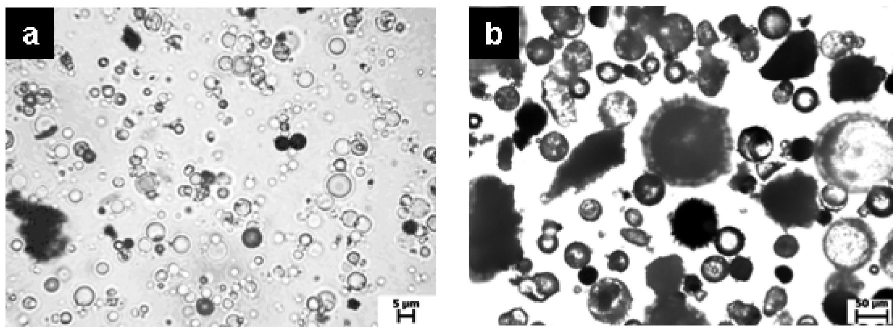


Fig. 6. Differential particle size distributions for the products of the aerodynamic separation of the fly ash of the Mfa series taken from Field 1 of the electrostatic precipitators (at the top) and optical images of the (a) light and (b) heavy products

angular large particles, black opaque magnetic microspheres, and spherical particles with different sizes and transparencies. The light fraction predominantly contains particles with sizes smaller than 10 µm, among which the number of microspheres, especially transparent species, increases and the number of black opaque microspheres and angular particles is considerably smaller. Moreover, the fraction contains a number of aggregates consisting of micron and submicron particles, which partially disintegrate during the preparation of samples for microscopic investigations in an emulsion oil or glycerol.

The aggregation of particles is observed to a greater extent in products of the separation of fly ashes of the *Bfa* series from the Field 4 of the electrostatic precipitators, which decreases the efficiency of the separation process. It can be seen from the images shown in Fig. 5 that these products contain even a larger number of microspherical particles and that the number of transparent microspheres increases as compared to their number in the products obtained from fly ashes of the same series from the Field 1.

The products of separation of fly ashes of the *Mfa* series predominantly contain microspherical particles of different hues and transparencies; moreover, they include a considerable number of opaque angular particles of unburned carbon (Fig. 6). It should be noted that the size of particles in the heavy products exceeds their size in the light product by a factor of more than 10. Moreover, the light products contain a larger number of transparent microspheres.

Therefore, the performed investigations have demonstrated that the aerodynamic separation makes it possible to prepare products from fly ashes that differ significantly in the density and size of particles. Selective sampling of fly ashes from the ash collection facility and variations in the parameters of the setup for aerodynamic separation allow one to prepare narrow fractions with a controlled density and a controlled dispersity for the use as additives and fillers in manufacturing cements with improved properties, concretes, high-quality plastic materials, rubbers, road pavements, paints, and ceramic goods.

Conclusions

A comparative study has been carried out of fly ashes from the pulverized combustion of coals of two ranks, i.e., the B2 (sub C) rank, which is taken from Fields 1–4 of the electrostatic precipitators at the BSDPS -1 (the *Bfa* series), and the T (sa) rank, which is taken from Fields 1 and 2 of the electrostatic precipitators at the MPP-22 (the *Mfa* series).

It has been shown that fly ashes of the *Bfa* series exhibit a lower bulk density, a higher dispersity and a unimodal particle size distribution. The latter parameter considerably increases along the gas-and-dust flow from Field 1 to Field 4 of the electrostatic precipitators. In particular, the average diameter of particles decreases from 9.3 μm to 2.4 μm and quantity d90 changes from 41.8 μm to 7.9 μm for fly ashes from the Fields 1 and 4, respectively. The strongest change of density and size of particles occurs at transition from 1 to 2 field of the EPs.

Fly ashes of the *Mfa* series are characterized by a higher density, a substantially lower dispersity, and a bimodal particle size distribution and have rather close size characteristics for fly ashes from the Fields 1 and 2 of electrostatic precipitators. In particular, the average diameter of particles changes from 16.0 to 15.9 μm and the quantity d90 changes from 73.6 to 69.9 μm for fly ashes from the Fields 1 and 2, respectively.

The use of the aerodynamic separation has made it possible to obtain three products from fly ashes of both series which differ significantly in the bulk density and size of particles. In particular, for fly ashes of the *Bfa* series from the Field 1, the average diameter of particles decreases from 26.2 μm in the heavy product to 7.5 and 2.8 μm in the medium and light products; in this case, the quantity d90 decreases from 62.2 μm to 26.5 and 10.2 μm, respectively. For fly ashes of the *Mfa* series from the Field 1, the average diameter of particles decreases from 51.0 μm in the heavy product to 9.6 and 4.8 μm in the medium and light products, while the quantity d90 changes significantly from 97.8 μm to 31.3 and 13.9 μm, respectively. Thus, the selective sampling and aerodynamic separation of the fly ashes from the pulverized combustion of coals are promising techniques for manufacturing ash products with a controlled density and a controlled dispersity.

Acknowledgments

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Аэродинамическое разделение летучей золы селективного отбора от пылевидного сжигания разных марок углей

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Изучены летучие золы от пылевидного сжигания двух марок углей – марки Б2, отобранные с полей 1-4 электрофильтров на БГРЭС-1 (серия Bfa), и марки Т, отобранные с полей 1 и 2 ЭФ на Московской ТЭЦ-22 (серия Mfa).

Показано, что летучие золы серии Bfa имеют пониженную насыпную плотность, более высокую дисперсность и мономодальное распределение частиц по размеру. При этом размер частиц значительно уменьшается по ходу газопылевого потока, в особенности от 1-го ко 2-му полю ЭФ. Золы серии Mfa отличаются более высокой плотностью, имеют существенно меньшую дисперсность, бимодальное распределение частиц по размеру и достаточно близкие размерные характеристики для зол поля 1 и 2 ЭФ. Аэродинамическое разделение позволило получить из летучих зол обеих серий три продукта, существенно отличающиеся по плотности и размеру частиц. Комбинирование селективного отбора и аэродинамического разделения летучих зол от пылевидного сжигания углей является перспективным способом для получения зольных продуктов заданной плотности и дисперсности.

Ключевые слова: летучая зола, электрофильтры, дисперсность, аэродинамическое разделение.