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Evaluation of the effectiveness of coal and mine dust wetting

Krzysztof Cybulski, Bogdan Malich, Aneta Wieczorek*

Experimental Mine "BARBARA", Central Mining Institute, Katowice, Poland

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ABSTRACT

Purpose: One of the methods of fighting the risk of coal dust's explosion is its neutralization through washing and misting of mining sediment which lays on the mining excavation and through misting on the organs of hewer machines or on the dumpings and inundations of mining product's output. Coal dust, especially its smallest fractions which create the biggest risk of explosion, is generally the substance which cannot be easily moistened by water. Water solutions of different wetting agents are applied in hard bituminous coal mines in order to enhance the effectiveness of coal dust's moistening during the washing and misting. Therefore it is indicated to conduct research and evaluate the effectiveness of its effects in order to select optimally the type of wetting agents and their concentration in water solutions depending on coal dust's properties (type of coal the particular dust comes from) and on percentage participation of non-inflammable parts which are constant in mine dust.

This paper presents a method to evaluate the effectiveness of coal or mine dust's moistening conducted with the use of water solutions of wetting agents in order to deprive the dust of its volatility, is based on the method of measurement of time of complete moistening of that dust's one-gram samples with the use of "pure" water or water solutions of the particular wetting agent.

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1. Introduction

One of the primary natural hazards occurring in hard coal mines is a risk of coal dust explosion. Coal dust generated during technological processes such as coal getting, loading and haulage of coal, causes significant dustiness of the mine air. In regions of dust emission sources, its coarser fractions precipitate in the lower parts of the mining excavations, while the smallest grains give rise to accumulations of dust in the upper parts. Often small dust grains, carried with the air

contribute to dustiness of mining excavations even in the regions distant from the sources of their formation. Generated in this way sediments of coal dust, in case of blast and initial occurrence, give rise to real danger of the emergence and transfer of coal dust explosion.

A multi-stage system of dust prevention system based on the so-called main lines of defence against coal dust explosions has been implemented for a number of years in coal mining. The principle of the system operation consists in launching the subsequent lines of defence when the previous ones fail. The first two lines of defence, the so-called

* Corresponding author. Tel.: +48 32 324 65 24.

E-mail address: awieczorek@gig.eu (A. Wieczorek).

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preventive ones relate to activities associated with reduction of coal dust formation, its removal, combating its volatility and the possibility of limiting the initial that could set off an explosion or make coal non-explosive through its neutralization (addition of non-combustible substances) (Amyotte, Mintz, & Pegg, 1995; Mitchell & Nagy, 1962). The next two lines of defence, referred to as active defence lines, include tasks aimed at preventing the development of coal dust explosion (maintaining safety zones) and the reduction of the extent of the explosion (use of anti-explosion barriers).

Neutralization of the coal dust with water is a simple solution and above all cheap, but its effectiveness depends on many factors. In the process of coal dust neutralization with water, there are two stages distinguished. The first stage relates to the situation in which the water content which usually amounts to several per cent, in a mixture with coal dust is sufficient for the loss of dust volatility (Prostański, 2013). The second stage determines the state in which the coal dust loses its explosive properties but the required water content in the mixture with the dust is already about 50%. In the anti-explosion prevention against dust realized by means of water it is very important that preventive actions should always lead to the end of the second stage, since the occurrence of a very strong initial (e.g. methane explosion) can lead to stirring up of wet, devoid only of volatility, dust sediments into the air, their drying with the flame of burning methane and coal dust explosion initiation. Coal dust explosion taking place under these conditions, due to the emergence of hydrogen and oxygen as a result of the thermal decomposition of water molecules, proceeds much more rapidly than in the conditions of dry coal dust occurrence.

Past experiences concerning the neutralization of coal dust with water confirm that it is susceptible to water to varying degrees. For example, coal dust with high natural moisture is much more easily moistened than the dust with a lower natural moisture, or coal dust characterized by a large proportion of the finest fraction requires far more water to deprive it of its volatility and explosive properties than coarser dust (Cybulski, 1959, 1995, 2005; You, Yu, Zheng, & An, 2011; Yuan et al., 2014).

The decisive factor, however, about the effectiveness of depriving coal dust of its volatility and the explosive abilities by means of water is its wettability, or the ability to maintain contact with the liquid (water) as a result of intermolecular interactions. In underground mining practice, situations can often be observed in which fine coal particles, because of their property that they are not easily moistened by water, float on the surface of the water present on the floor of the mining excavation. This phenomenon is caused by too intense surface tension of underground mine water. The reason of surface tension is the existence of attractive forces between the molecules of water and the lack of dust wetting under these conditions is explained by the smaller value of adhesive strength (adhesion) at the border of the water–coal dust phase as compared to the value of cohesive forces (cohesion) occurring inside the phase which is water.

Wetting of coal dust with water can be significantly increased by using the so-called wetting agents, whose main component are surface-active compounds, i.e., substances that due to their molecular structure reduce the surface tension of water. This phenomenon occurs when the attractive

forces of water molecules interaction are greater than the forces acting between the water molecules and the molecules of wetting agents and then wetting agent particles are forced out of the depth of water on its surface (positive adsorption), and their presence on the surface reduces the surface tension of water solution with wetting agent (Orszulik & Dudek, 2013).

2. Materials and method

The Department of Dust Hazard Control of the Experimental Mine “BARBARA”, Central Mining Institute as part of its statutory activities of the Institute as well as during its research and service activities studied the effectiveness of wetting coal and mine dust with a view to deprive it of its volatility by using water solutions of wetting agents. Before commencement of these studies, the assumption was adopted resulting from mining practice that only completely wetted coal dust loses its volatile abilities. In these studies, the test method was used in which the time of complete wetting (sinking) of the examined dust samples with water or water solution of a given wetting agent was measured. On the basis of the obtained results the so called wettability curve of the tested dust, depending on the percentage content of wetting agent in water solution, was drawn.

Depending on the applied wetting agent and the types of dust, the obtained results allow us to:

- determine whether there is a need for the use of wetting agents in sprinkler systems of combined cutter loaders during coal mining in the given deposits and sprinkler systems on the conveyor belt chutes for run-of-mine transport and areas of shaft insets of coal reservoirs,
- select the most effective wetting agent for coal dust from particular coal seams,
- determine the optimal concentration of water solutions of wetting agent for depriving the volatility of coal dust from coal of different seams,
- determine the optimal concentration of water solutions of wetting agent for depriving the volatility of coal dust,
- comparing the performance of individual wetting agents used in underground mining excavations.

In the course of the study, it was found that in the case of solid wetting agent, obtaining the concentration of water with an accuracy of five hundredths of a percent, because of the way of its dispensing, was not accurate. As a consequence, further studies were carried out solely with the use of liquid wetting agents.

This article presents the selected parts of carried out research, yet those which fully demonstrate the possibility of using the research method in question, and above all, the optimum selection of wetting agent to the present level of coal dust explosion hazard.

The following materials were used for the research:

- one-gram samples of coal dust from the coal type 31, 33 and 35 (coal type 35 was collected from different mines) having 25% content of fractions less than 0.075 mm (the

fineness of coal dust granularity which is most commonly found in the underground mining conditions),

- plain stone dust (that meets the requirements of Polish Standard PN-G-11020:1994. Mining – Anti-explosive stone dust),
- one-gram samples of mine dust (coal-dust mixtures derived from coal type 31, 33 and 35 and plain coal dust of non-combustible solids contents amounting to 50%, 70% and 80%),
- 3 liquid wetting agents available on the market and used in coal mining industry,
- municipal water of temperature about 20 °C (to prepare water solutions of wetting agents at concentrations of 0.05%, 0.10%, 0.15%, 0.20%, 0.25% and 0.30%),
- beakers of 2000 cm³ capacity, in which 1000 cm³ of water solution of the examined wetting agent was prepared,
- instrument for measuring the wetting time (sinking) of dust, which guarantees repeatability of measurements.

Measurement of complete wetting time (sink rate) of the tested dust samples was made using a special tool (see Fig. 1), which consists of a metal frame / 1 / placed on four legs / 2 /. The plate contains a metal cylinder / 3 / closed at the bottom with movable latch / 4 / fixed to the spring / 5 / and the pawl / 6 /.

Apparatus for measuring the time of complete wetting (sinking) of dust was placed on the top edge of the beaker. A pre-weighted one-gram sample was poured into the previously closed cylinder at the bottom with a latch. After levelling the surface of dust, the spring was released, which made the latch move itself fully opening the bottom of the cylinder, and a whole mass of dust particle fell simultaneously on the surface of the examined solution. Time measurements were carried out using a stopwatch from the moment of contact of the given dust with the surface of the solution to its complete wetting (immersion of the entire test sample of dust below the surface of the solution). For each dust sample 7 measurements of time of its complete wetting (sinking) were performed. The average time from 5 measurements (5 samples) after the rejection of two extreme results was calculated to determine the time of wetting of particular sample of coal or mine dust. In the case, when after a period of 120 s, a complete wetting of the dust samples took place, the measurement of time was stopped since it was considered that the concentration of wetting agent in water solution is not sufficient to

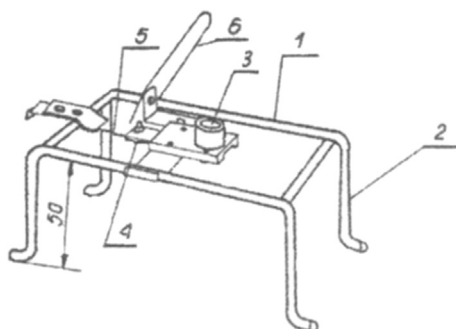


Fig. 1 – Apparatus for measurement of dust wetting (sinking) time.

wet the given sample. Identical measurements were made for “pure” water.

Depending on the duration of complete wetting (sinking) of the examined sample of dust, a scale for assessing the wettability of dust was proposed, which is presented in Table 1.

Table 1 – Assessment scale of coal dust wettability.

Wettability degree	Sinking time, s	Wettability assessment
I	≤10	Very good
II	10–20≤	Good
III	20–50≤	Sufficient
IV	50–120≤	Weak
V	Above 120	Not applicable for wetting

In these studies it was assumed that the water solution of wetting agent effectively wets the given dust, provided that the wetting time of one-gram of the dust sample did not exceed 20 s.

3. Results and discussion

The obtained research results – average times of complete wetting (sinking) of tested dust samples are shown in Table 2 – Average wetting times of coal dust samples and in Table 3 – Average wetting times of mine dust samples.

It should be noted that all attempts of wetting the examined samples with “pure” water, both coal and mine dust ended negatively – in each case the total wetting time (sinking) of these samples exceeded the value of 120 s (therefore in the subsequent analyses these results were no longer referred to). In the case of water solutions of individual wetting agents, all samples of coal and mine dust were completely wetted, and the average times of complete wetting were dependent on the type of coal, which was the source of the sample of the coal dust, the type of wetting agent, and the percentage content of non-combustible solids in the case of mine dust.

The presented data shows the basic relationship that occurs regardless of the type of the applied wetting agent or the type of used dust, whereby the wettability of coal dust with water solutions of wetting agents increases with the increase of concentration of these wetting agents in solutions, whereas the gradual increase in these concentrations entails the reduction of differences in the mean values of the total wetting time of dust samples.

In the first place, the wettability tests of the coal dust samples from coal type 31, 33 and 35 were carried out using water solutions of three types of liquid wetting agents.

The values of average wetting time (sinking) of the above coal dust samples, determined by specific research and relevant calculations, are shown in Fig. 2a, b and c.

For each of the applied wetting agent it was found that the efficiency of coal dust wettability strongly depends on the degree of coalification coal from which the given coal dust originates. In the whole range of concentrations of water solutions of wetting agents, the average time of complete wetting of coal dust samples from coking coal (coal type 35) was in

Table 2 – Average wetting times of coal dust samples.

The wettability of coal dust from various types of coals with liquid wetting agents, s

Wetting agent concentration [%]	Wetting agent no. 1				Wetting agent no. 2			Wetting agent no. 3		
	Type 31	Type 33	Type 35a	Type 35b	Type 31	Type 33	Type 35	Type 31	Type 33	Type 35
Water	>120	>120	>120	>120	>120	>120	>120	>120	>120	>120
0.05	17.2	31.8	43.2	35.8	17.6	41.0	54.2	22.0	28.0	33.2
0.10	14.2	24.8	39.4	31.6	14.0	33.4	42.4	18.6	23.4	28.0
0.15	10.0	18.6	34.0	25.0	9.2	22.0	28.0	10.4	14.8	24.2
0.20	9.6	14.0	31.0	21.4	8.4	20.4	25.2	9.0	12.4	22.0
0.25	9.0	12.2	24.0	16.4	7.8	19.4	23.0	8.6	11.6	16.0
0.30	8.2	11.6	20.8	14.6	6.8	15.0	19.8	8.2	11.2	15.0

each case more than twice greater than that of the coal dust from flame coal (type 31). In any case, the wettability of coal dust from gas coal (type 33) ranged between the wettability of two previously described coal dust types.

With the use of:

a) wetting agent no. 1, the following average time of complete wetting was found:

- from 17.2 s to 8.2 s for coal dust (coal type 31), which in the concentration range of wetting agent from 0.05% to 0.15% classifies it as well wettable (second degree of wettability), and in the range of from 0.20% to 0.30% classifies it as very well wettable (I degree of wettability),
- from 31.8 s to 11.6 s for coal dust (coal type 33), which in the concentration range of wetting agent from 0.05% to 0.10% classifies it as sufficiently wettable (III degree of wettability), and in the range of from 0.15% to 0.30% classifies it as well wettable (II degree of wettability),
- from 43.2 s to 20.8 s for coal dusts (coal type 35), which for all tested concentrations of wetting agent classifies it as sufficiently wettable (II degree of wettability),

b) wetting agent no. 2, the following average time of complete wetting was found:

- from 17.6 s to 6.8 s for coal dust (coal type 31), which in the concentration range of wetting agent from 0.05% to 0.10% classifies it as well wettable (II degree of wettability), and in the range of from 0.15% to 0.30% classifies it as very well wettable (I degree of wettability),

- from 41.0 s to 15.0 s for coal dust (coal type 33), which in the concentration range of wetting agent from 0.05% to 0.20% classifies it as sufficiently wettable (III degree of wettability), and in the range of from 0.25% to 0.30% classifies it as well wettable (second degree of wettability),
- from 54.2 s to 19.8 s for coal dust (coal type 35), which at concentration of wetting agent of 0.05% classifies it as hardly wettable (IV degree of wettability), and in the range of from 0.10% to 0.25% classifies it as sufficiently wettable (III degree of wettability) and at a concentration of wetting agent of 0.30% classifies it as well wettable (II degree of wettability),

c) wetting agent no. 3, the following average time of complete wetting was found:

- from 22.0 s to 8.2 s for coal dust (coal type 31), which at a concentration of wetting agent of 0.05% classifies it as well wettable (II degree of wettability), and in the range from 0.10% to 0.30% classifies it as very well wettable (I degree of wettability),
- from 28.0 s to 11.2 s for coal dust (coal type 33), which in the concentration range of wetting agent from 0.05% to 0.10% classifies it as sufficiently wettable (III degree of wettability), and in the range of from 0.15% to 0.30% classifies it as well wettable (II degree of wettability),
- from 33.2 s to 15.0 s for coal dust (coal type 35), which in a concentration range of wetting agent from 0.05% to 0.20% classifies it as sufficiently wettable (III degree of

Table 3 – Average wetting times of mine dust samples.

Wettability of mine dust with liquid wetting agents, s

Wetting agent concentration [%]	Wetting agent no. 1						Wetting agent no. 2			
	Coal type 31			Coal type 35			Coal type 31			Coal type 35
	50%	70%	80%	50%	70%	80%	50%	70%	80%	50%
Water	>120	>120	>120	>120	>120	>120	>120	>120	>120	>120
0.05	21.4	16.4	14.6	39.2	25.0	19.8	24.8	20.2	18.0	42.4
0.10	19.6	15.2	12.8	30.8	21.4	15.4	22.4	18.2	15.6	35.6
0.15	14.4	12.2	10.8	21.4	18.4	13.6	16.0	15.8	11.6	30.6
0.20	11.2	10.4	9.8	16.8	16.6	12.0	14.4	12.8	8.8	26.6
0.25	10.6	9.7	9.2	14.8	15.2	10.8	12.2	10.0	8.2	21.4
0.30	9.6	9.1	8.8	14.0	12.6	9.8	10.6	8.8	7.2	17.0

Note: designations 50%, 70% and 80% determine the percentage content of non-combustible solids in the tested mine dust.

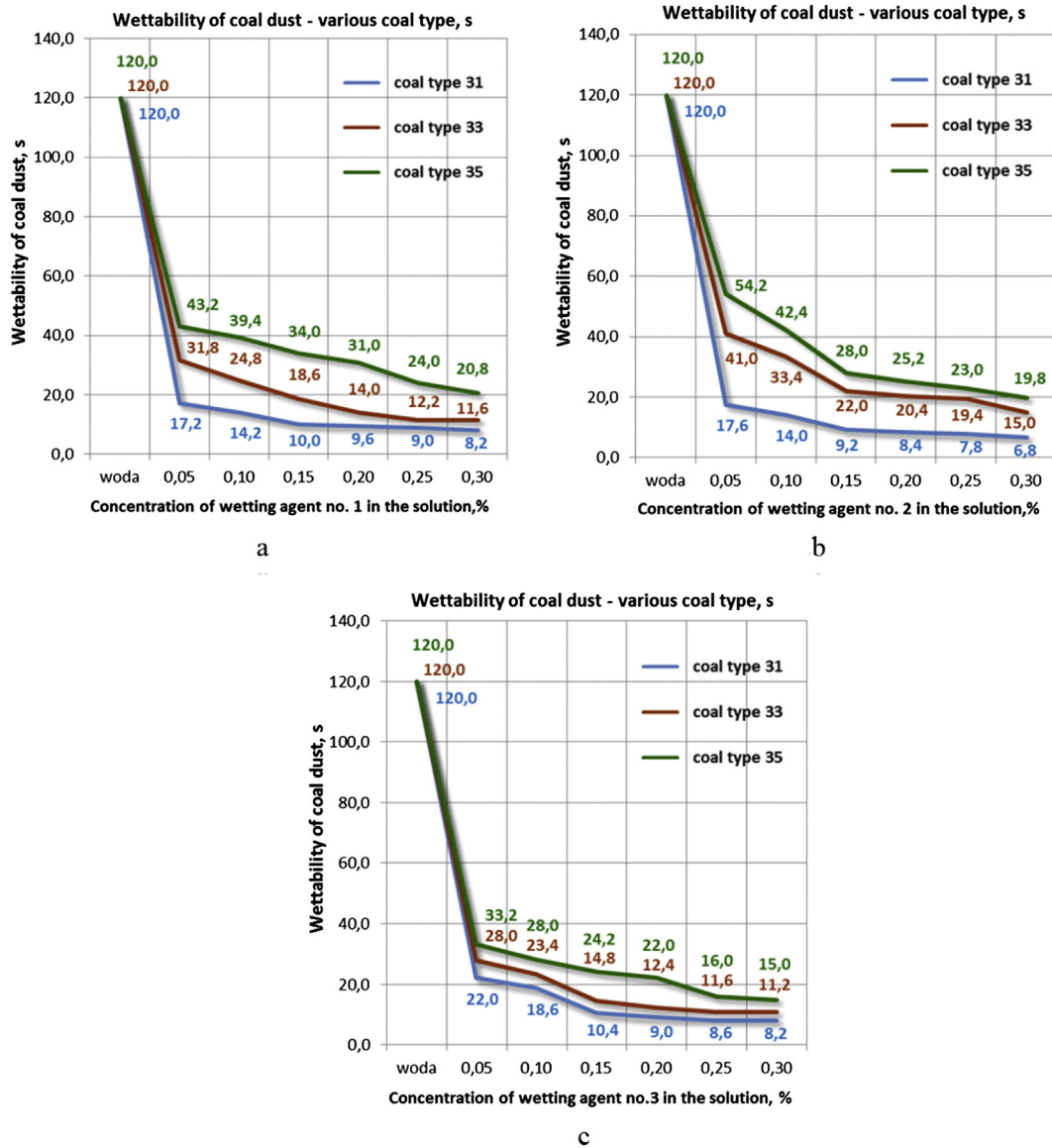


Fig. 2 – a – Wettability curves of coal dust for various types of coal with water solution of wetting agent no. 1. b – Wettability curves of coal dust for different types of coals with water solution of wetting agent no. 2. c – Wettability curves of coal dust for different types of coals with water solution of wetting agent no. 3.

wettability), and in the range of from 0.25% to 0.30% classifies it as well wettable (II degree of wettability).

The obtained test results made it possible to illustrate graphically data on the effectiveness of humidifying various types of coal dust from coal types 31, 33 and 35 with water solutions, which is shown in Fig. 3a, b and c.

In the case of coal dust from the coal type 31, there were no significant differences in the effectiveness of wetting the dust with water solutions of applied wetting agents. Starting with a concentration of 0.20%, the average time of complete wetting were less than 10 s, which indicates a very good wettability of these types of coal dust (I degree of wettability).

For the coal dust from the coal type 33, the emergence of differences in the effectiveness of wetting the dust was observed between water solutions of adopted wetting agents,

whereas none of the wetting agents achieved very good efficacy of wetting. Wetting agents no. 1 and no. 3 were characterized by good wettability (II degree of wettability) in their concentrations in water solutions contained within the range from 0.15% to 0.30%, and the wetting agent no. 2 has reached such a degree of wettability only in the concentration range from 25% to 30%.

The effectiveness of wetting coal dust from the coal type 35, followed a similar pattern as for the coal dust from the coal type 33, with the difference that the wetting agents no. 1 and no. 3 reached good wettability (II degree of wettability) only in their concentrations in water solutions contained respectively in the ranges above 0.20% and from 25%, while the wetting agent no. 2 virtually in the whole range of concentrations was characterized only by sufficient wettability (II degree of wettability).

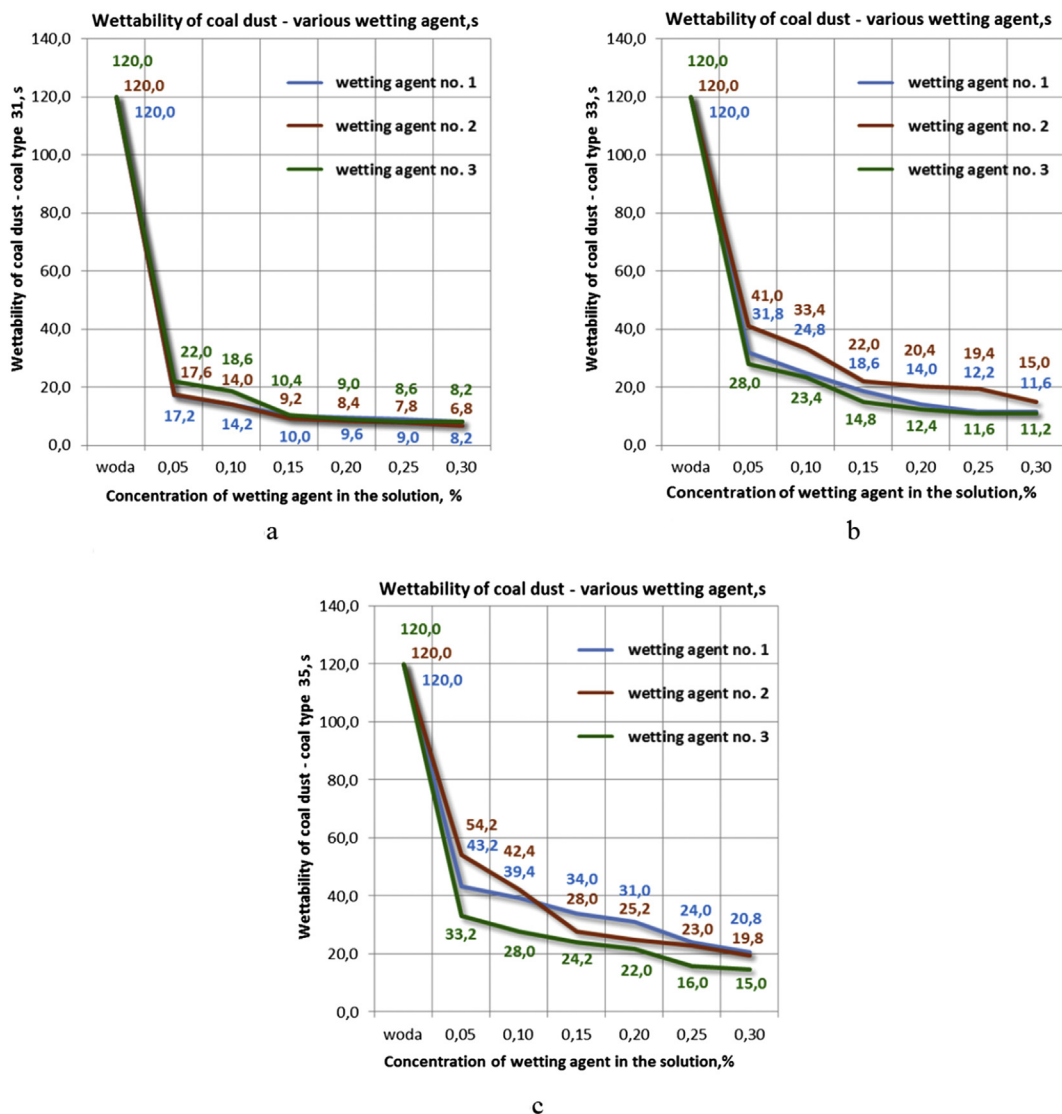


Fig. 3 – a – Wettability curves of coal dust (coal type 31) for different types of wetting agents. b – Wettability curves of coal dust (coal type 33) for different types of wetting agents. c – Wettability curves of coal dust (coal type 35) for different types of wetting agents.

Furthermore, studies were conducted on the effectiveness of wetting coal dust from the coal type 35, but obtained from different mines. Water solutions of wetting agent no. 1 were used for the study. The obtained results show conclusively that there is a significant difference between the effectiveness of wetting these types of coal dust, as shown in Fig. 4. Coal dust from the coal type 35 obtained from mine no. 2, reached good wettability (II degree of wettability) in the range of their concentrations in water solutions above 0.20%, whereas the identical dust, but derived from the mine no. 1 did not obtain such wettability as in the entire range of tested concentrations it was characterized by only sufficient wettability (III degree of wettability).

After completion of the tests on the efficacy of wetting of coal dust, a mixture of mine dust with the content of non-combustible solids amounting to 50%, 70% and 80% was

prepared from these types of dust (coal type 31 and type 35) and the plain stone dust.

The results of the efficacy study of wetting these types of mine dusts using water solutions of wetting agents no. 1 and no. 2 are shown in Fig. 5a, b and c.

For water solutions of wetting agent no. 1, the effectiveness of wetting mine dust samples (coal dust derived from coal type 31), ranged within the scope of very good wettability (I degree of wettability) at concentrations of water solutions of the wetting agent of 0.20% (for 80% of the non-combustible solids), from 0.25% (for 70% of non-combustible solids) and from 0.30% (for 50% of non-combustible solids). At other concentrations of water solutions of this wetting agent, good wettability was found (II degree of wettability), except in the case (50% of non-combustible solids at a concentration of 0.05%), for which only sufficient efficiency (III degree of wettability) was found.

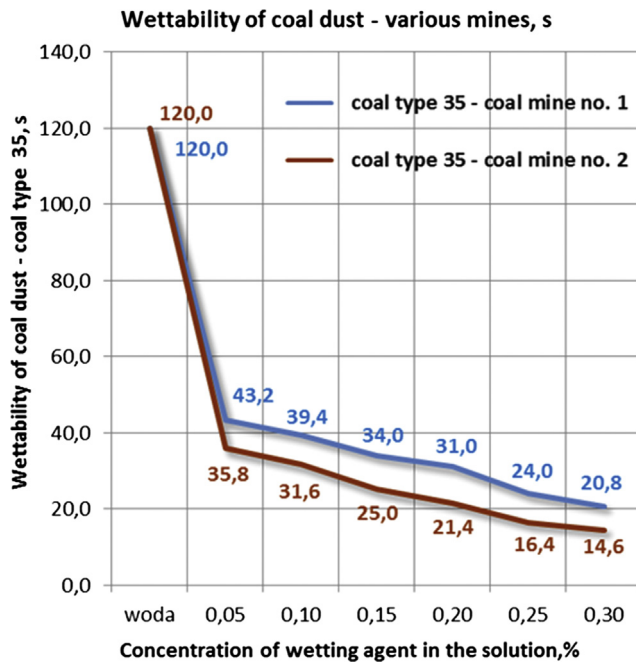


Fig. 4 – Wettability curves of coal dust (coal type 35 from various mines).

Similar studies performed using the wetting agent no. 2 showed almost identical relationships.

When the mine dust was derived from the coal dust of coal type 35, rather obvious differences emerged in the effectiveness of wetting subsequent mine dust differing with each other in the percentage content of non-combustible solids. Very good efficiency of wetting (I degree of wettability) was obtained only for mine dust with the content of non-combustible solids of 80% at the concentration of the wetting agent equal to only 0.30% in its water solution.

Fig. 6a, b and c present the results of the comparative research on the effectiveness of wetting mine dust samples of the previously discussed contents of non-combustible solids with water solutions of wetting agents no. 1 and no. 2.

These data show that with the increase in the content of non-combustible solids also the effectiveness of wetting of these types of dust increased. With the contents of non-combustible solids of 50% and 70%, and also in the concentration range from 0.05% to 0.15% of the content of non-combustible solids of 80%, the wetting agent no. 1 proved to be more effective.

Mine dust samples of non-combustible solids content of 50% obtained very good percentage of wetting (I degree of wettability) only by using 0.30% water solution of wetting agent no. 1. Good efficiency (II degree of wettability) was found at concentrations ranging from 0.10% to 0.25% (for the wetting agent no. 1), and from 0.15% to 0.30% (for the wetting agent no. 2).

In other ranges of water solutions concentrations of these wetting agents, the efficiency was only satisfactory (III grade of wettability).

Mine dust containing non-combustible solid parts equal to 70% achieved very good wetting efficiency (I degree of wettability) only in the range from 0.25 to 0.30% water solution of

wetting agent no. 1 and at a concentration of 0.30% of aqueous solution of wetting agent no. 2. Good efficiency (II degree of wettability) was found at concentrations ranging from 0.05% to 0.20% (for the wetting agent no. 1), and from 0.10% to 0.25% (for the wetting agent no. 2). Sufficient efficiency (III degree of wettability) was found only at a concentration equal to 0.05% of water solution of wetting agent no. 2.

The final phase of the study was to analyse the effectiveness of the mechanism of the wetting ability depending on the type of coal from which coal dust originated and percentage content of non-combustible solids. The results of these tests are illustrated in Fig. 7a, b and c.

On the basis of the obtained results it was observed that the effectiveness of wetting mine dust decreases with the increase of coal rank while this efficacy increases with the percentage share increase of non-combustible solids.

When the content of non-combustible solids equals 50%, mine dust resulting from coal dust from coals type 31 received a very good wetting efficiency (I degree of wettability) at a concentration of the wetting in its water solution equal to 0.30%, a good wetting efficiency (II degree of wettability) in the concentration range of 0.10–0.25%, and a sufficient efficiency (III degree of wettability) at a concentration of 0.05%. With the same content of non-combustible solids, mine dust mixed with coal dust from coal type 32 achieved good wetting efficiency (II degree of wettability) at a concentration of wetting agent in the range of 0.20–0.30%, and a sufficient efficiency (III degree of wettability) in a concentration range from 0.05 to 0.15%.

Increasing the content of non-combustible solids to a value equal to 70% resulted in that the mine dust originated from coal dust from coal type 31, a very good percentage of wettability (I degree of wettability) obtained in the range of 0.25–0.30% concentrations of water solutions of wetting agent and good effectiveness (II degree of wettability) in the remaining range of the concentrations used. Samples of mine dusts resulting from coal dust from coal type 35, obtained a good percentage of wettability (II degree of wettability) in the range from 0.15 to 0.30% of water solutions of wetting agent, while in the remaining range of tested concentrations it obtained sufficient efficiency (III degree of wettability).

After increasing the content of non-combustible solids by a further 10%, to a value of 80%, the effectiveness of wetting increased to such a level that regardless of the level of coal rank, from which coal dust originated, there was no longer sufficient wetting effectiveness observed, but solely a very good efficacy (I degree of wettability – in the range from 0.20% to 0.30% concentration of water solution of wetting agent at coal type 31 and at a concentration equal 0.30% of coal type 35), and a good efficiency (II degree of wettability – in other concentration ranges).

4. Conclusions

Based on the analysis of the presented above efficacy results of wetting mine and coal dust with water solutions of wetting agents it should be explicitly stated that in the case of coal dust, application of such solutions with relation to the use of “pure” water, reduces considerably the time of wetting regardless of the level of coalification of coal.

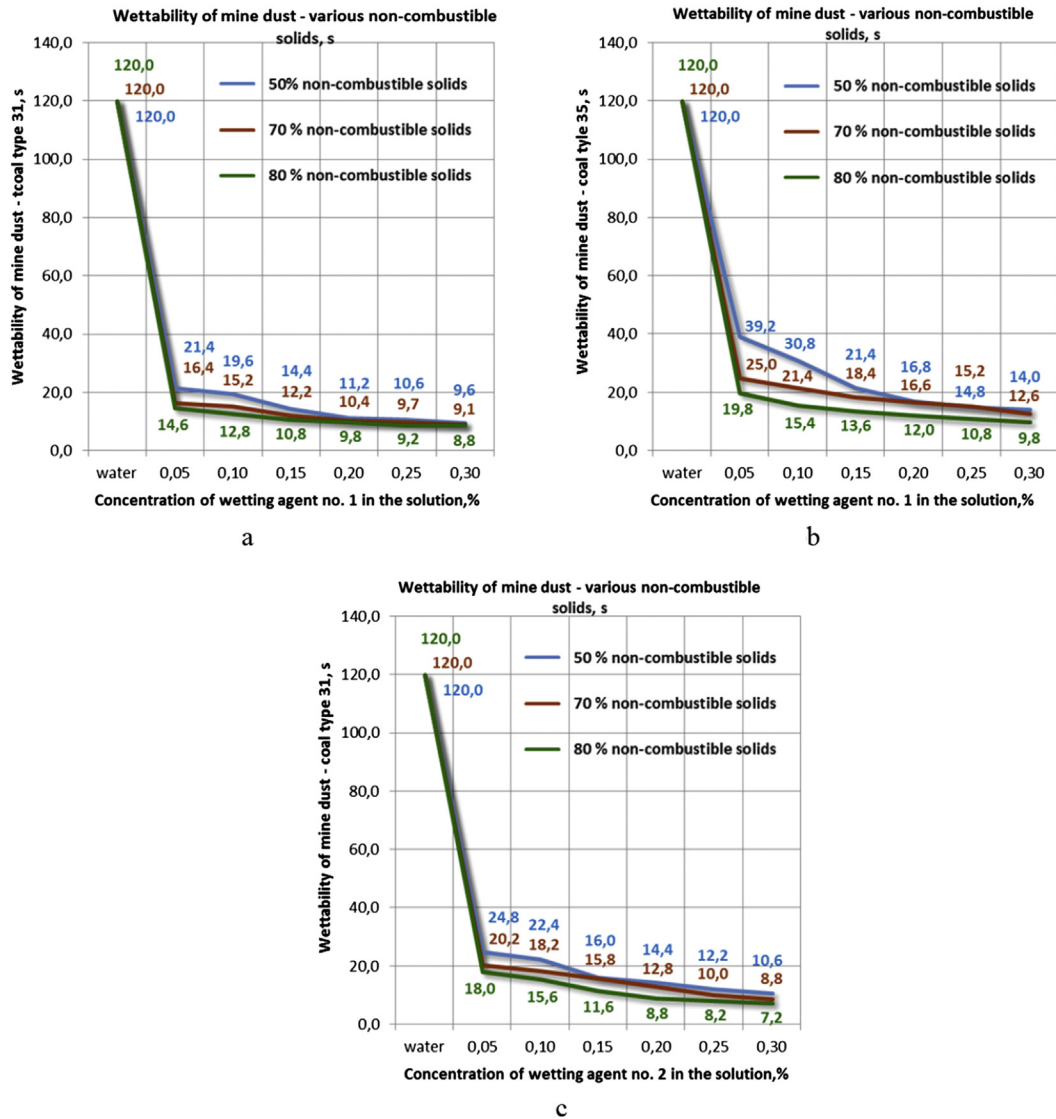


Fig. 5 – a – Wettability curves for mine dust (coal dust from the coal type 31) for different shares of non-combustible solids using a wetting agent no. 1. b – Wettability curves of mine dust (coal dust from the coal type 31) for different shares of non-combustible solids using a wetting agent no. c – Wettability curves of mine dust (coal dust from coal type 35) for different shares of non-combustible solids using a wetting agent no. 1.

The performed study showed in each conducted experiment that, for the concentrations of used in the study of water solutions of wetting agents, the increase in the concentration of the solution entailed an increase in the effectiveness of wetting the tested dust samples.

The obtained results clearly showed that the average time of wetting coal dust to a large extent depends on the level of coalification of coal, from which the dust originates. In the case of coal dust from flame coals (coal type 31) this time was two to three times shorter than for coal dust from coking coal (coal type 35), regardless of the type of adopted liquid wetting agent.

The obtained results allowed us to compare the efficacy of the tested wetting agents, which in mining practice enables the selection of the best wetting agent and its optimum concentration in water solutions for particular underground conditions. On the basis of these results, it was also found that with increasing coal rank, more significant differences start to occur in the effectiveness of wetting coal dust between the applied wetting agents.

The carried out research has also shown that differences in the effectiveness of wetting become visible also for coal dust derived from the same types of coal, but obtained from different mines, which leads to the conclusion that even for

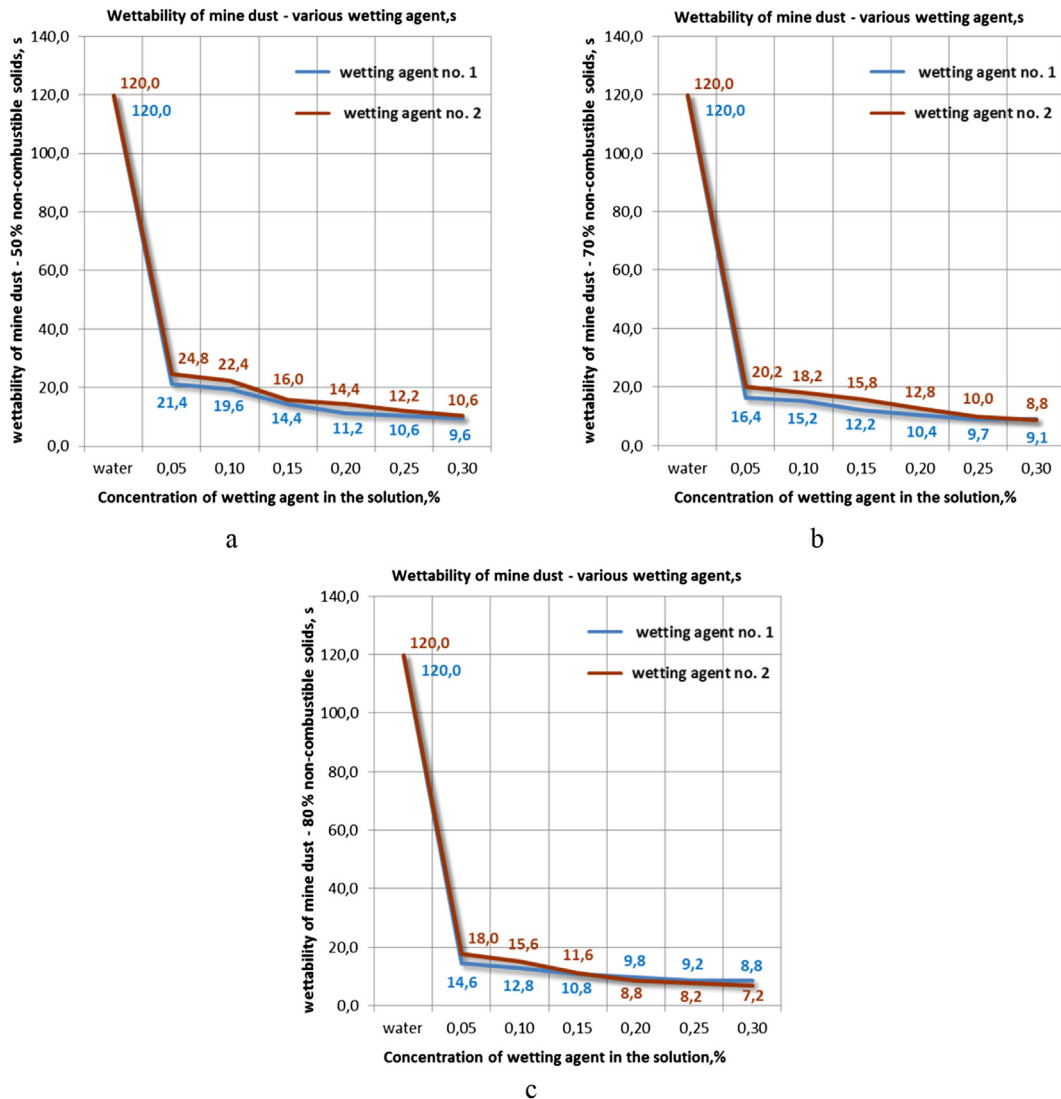


Fig. 6 – a – Wettability curve for mine dust (coal dust from coal type 31) with a 50% content of non-combustible solids using wetting agents no. 1 and no. 2. b – Wettability curves of mine dust (coal dust from coal type 31) at 70% content of non-combustible solids using wetting agents no. 1 and no. 2. c – Wettability curves of mine dust (coal dust coming from coal type 35) with the 80% content of non-combustible solids using wetting agents no. 1 and no. 2.

such dust both, the concentration of water solution of wetting agent as well as the most suitable in terms of effectiveness wetting agent, should be selected individually.

In conclusion it should be stated that in practice the most appropriate action would be to determine and select the most effective wetting agent with its optimal concentration in the water solution individually for each type of coal dust.

In case of mine dust it was found that the efficiency of its wetting with water solutions increases with the increase of its percentage share of non-combustible solids, i.e. with the decrease of the percentage share of coal dust.

Efficacy of wetting mine dust, similarly as in the case of “pure” coal dust is dependent on the level of coalification of coal (coal type), from which the coal dust forming the mixture with stone dust originates, although this correlation decreases

with an increase in the percentage content of non-combustible solids in mine dust.

Therefore, in mining practice, it is advisable that the selection of proper wetting agent and its optimal concentration for wetting mine dust was adopted as for the “pure” coal dust contained in mine dust.

Neutralization of coal dust with water, using sprinkling on shearer drums of longwall shearers and roadheaders or on dumpings or inundations is in Polish coal mining industry amounts to approximately 25% of all activities related to the prevention of dust. If in these conditions there is a need to apply wetting agents, the costs of such preventive measures increase significantly. Therefore, both the selection of the right type of wetting agent and its optimal concentration in water solutions for existing dust conditions in the given area are of such an importance.

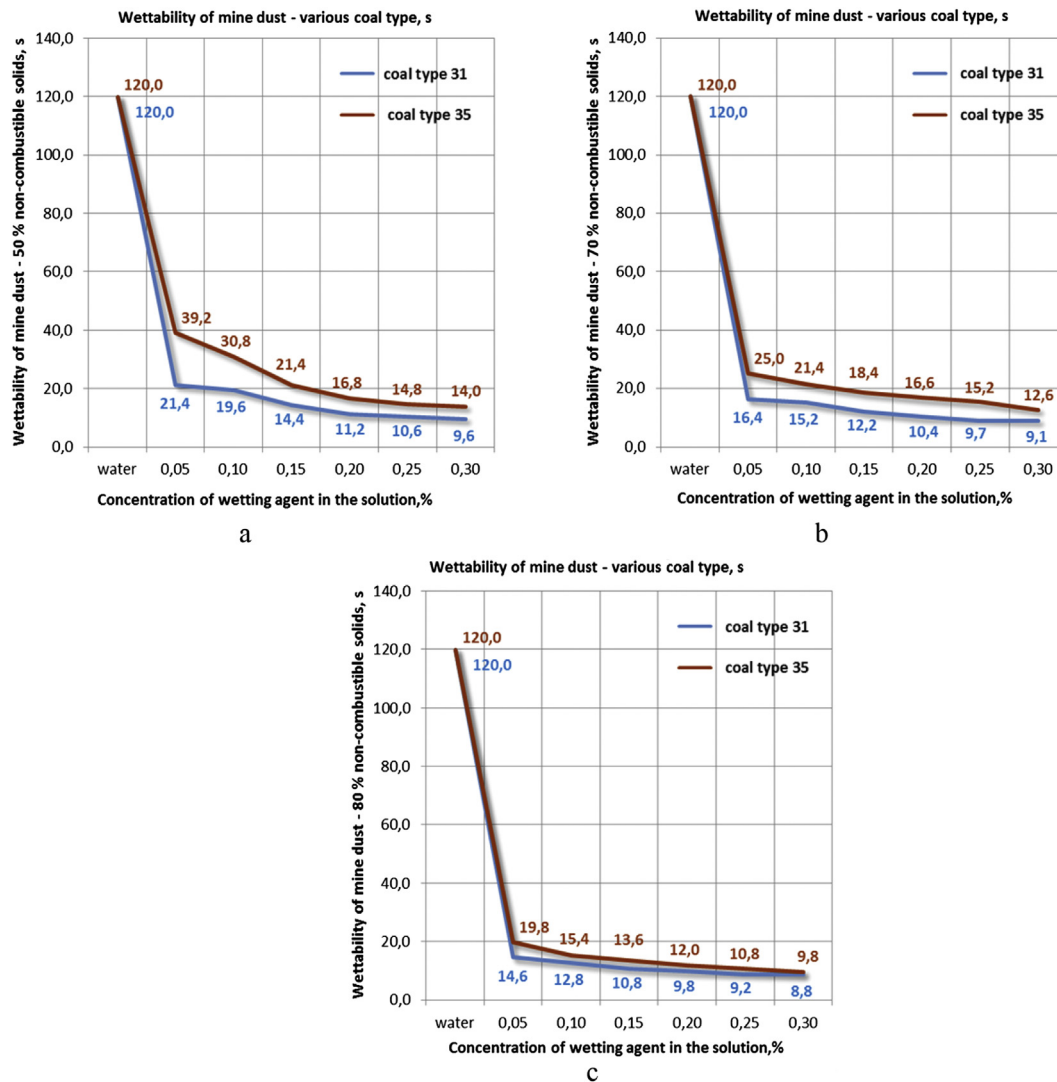


Fig. 7 – a – Wettability curves of mine dust – 50% of non-combustible solids. b – Wettability curves of mine dust – 70% of non-combustible solids. c – Wettability curves of mine dust – 80% of non-combustible solids.

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