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ON SOME METHODS FOR SURFACE EROSION CONTROL ON TAILINGS PONDS AND WASTE FLY-ASH PILES

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ABSTRACT
An important issue for the mining, metallurgical and power supply industries is the control of fugitive dust emissions. This paper intends to demonstrate the outcomes of researches, assessment of potential and effectiveness of some dust control methods applied on fine-grained tailings deposited by mineral processors, waste fly-ash resulted from coal-firing at power stations, slimes discarded by steelworks. The attention is paid essentially on the cases concerning creation of protective covering films on industrial waste sites by application of acetate polymer dispersion, sold under trademark Terra-Control SC 823. The long-lasting protective film was formed at a reagent dosage rate 30-50 g/m^2 and was stable exposed up to 20 m/s speed to wind erosion during the period of 6-8 months. Terra-Control SC 823 was used also as a surface layer stabilizer within vegetation of tailings. Terra-Control SC 823 has formed initially three-dimensional permeable matrix at a dosage rate 15-20 g/m^2, allowing germination of tolerant grass species straight on deposited wastes. The seed material was distributed onto tailings at dosage rate 15-20 g/m^2. Terra-Control SC 823 reduces moisture loss and protects plants and wasteland from drying out, along with allowing water and oxygen to penetrate. Terra-Control SC 823 is readily biodegradable, thus enhancing nutritious medium for the species.
The results of conducted modeling trials for preparing long and short-term dust suppression projects are presented in this contribution, and as well conditions and the effect of implementation of erosion control projects on two industrial wastelands.

INTRODUCTION

Exposed surface layers, containing fine grain particles, of wastes discarded from mineral processors, steelworks, coal-fired power stations and other production units, are subject to regular erosion by wind and water, causing in this way the environmental pollution. There are many techniques controlling fugitive dust emissions. The efficient dust suppression methods were analyzed by assessment of efficiency of each one and as well required upkeep maintenance for protective coverings (Hadjiev and Tzekova, 1979). The goal of the investigation is the application of polyvinyl acetate water dispersible latex reagent solely and in combination with vegetation for short-term and long-term erosion control at surface layers of the tailings ponds and waste fly-ash dumps.

METHODS AND MATERIALS

The studies have been conducted on the soil and industrial wastes. Table 1 presents description of the samples.

Sample 1 was taken from the surface layer of the non-operational part of a tailings pond. This part is out of use for the reason that the thermoelectric power station was refurbished of from coal to natural gas firing. The projected filling up capacity of the tailings pond has not been achieved. It is considered that the deposited wastes will be recycled in the near future. The total surface area of the tailings pond is 80 hectares.

Table 1. Description of the studied samples.

No	Name, origin and source of collected sample
1	Slimes generated by wet dust collectors of blast furnace, basic oxygen and electric arc furnace; cinder and fly-ash discarded from thermoelectric power station and other production lines at a steelworks, disposed of on a tailings pond
2	Cinder and fly-ash left behind lignite coal burning at a thermoelectric power station
3	Sample collected from the water slope of the tailings dam of a copper mineral processor
4	Soil used in re-vegetation of the air slopes of the tailings pond of a copper mineral processor

Sample 2 was taken from a surface layer of the non-operational section of a waste fly-ash dump. The surface area of this part is 100 hectares.

Sample 3 was taken from the water slope of a dam of a filled up tailings pond. The lagoon is operated as a return water dam of working tailings pond.

Sample 4 was taken from the topsoil used in re-vegetation of the air slopes of a tailings pond.

The trials have been carried out with a binding agent, sold under trademark Terra-Control SC 823, and a mixture of grass seeds. Terra-Control SC 823 is synthetic resin dispersion based on polyvinyl acetate formulation in water. The product is normally diluted with water in most ratios. It is compostable, medium term biodegradable and non-phytotoxic agent. Non-toxic by-products are produced in its biodegradation. The technical data of Terra-Control SC 823 are density (20°C) 1.1 g/cm^3; solid content 57.5÷1.5%; pH=4÷6; viscosity (20°C) 25000±3000 Pa.S; and processing temperature above 5°C.

Terra-Control SC 823 has been developed and is manufactured by Cognis Corporation in USA.

The polyvinyl acetate dispersion was diluted to 10% with water and sprayed at 15g/m^2 dosage rate onto the wastes by means of a helicopter type Kamov 26. The conditions of the trial were as follow: fly altitude above the treated ground surface 2m; helicopter's velocity during the procedure 40 to 60 km/h; width of the treated surface strip 25 m; duration of operation 6-7 min; reagent tank volume 600 l; optimal solution consumption 20 l/s; flights per one hour 9; spray nozzle diameter 4 mm.

The mix of grass seeds, cultivated and produced by company DSV in Germany, consists (in %) of species Festuca rubra rubra 25, Festuca ovina 20, Lolium perenne 15, Festuca rubra trich. 15, Poa pratensis 20, Agrostis capillaries 5.

Both the binding agent and the mix of grass seeds were supplied by Gea International in Bulgaria.

The investigations have been performed taking into account the previous published methodical considerations (Hadjiev and Hadjiev, 1996). The vegetation trials have been performed after the well-known technique (Voznuk et al., 1985).

RESULTS

Table 2 presents the results of sieve and sedimentation analysis performed on the studied samples.

Table2. Granulometric analysis of the studied samples.

No in order	Fractional assay, %			
	Grain size, mm			
	> 1.0	1.0 - 0.4	0.4 - 0.01	< 0.01
1	0.00	16.07	59.36	24.57
2	0.00	14.00	85.32	0.68
3	1.67	17.37	80.48	0.48
4	11.35	15.65	45.70	27.30

The vegetation experiments have been carried out at a fixed dosage rate of grass seeds and dosage rate of a binding agent from varying 15 g/m^2 to 100 g/m^2. Table 3 presents data concerning the highest germination of the seeds and period to achieve maximum value, applying smallest amount of a binding agent.

Table 3. Period for achievement of maximum germination, applying 15 g/m^2 Terra Control SC 823.

No in order	Maximum germination, %	Period, days
1	61.11	30
2	72.22	35
3	52.83	48
4	92.45	28

The germination of the sown seeds into the sample 3 was raised by capping with soil and addition of water-based fertilizer.

Based on the assessment of local climatic factors and results obtained from laboratory scale investigations two projects were prepared. The company Gea International Ltd bid two tenders for dust suppression control on two waste sites offering these projects and undertook contracts for both of them. Both contracts were completed successfully.

Project 1 for long-term dust suppression of the wastes deposited into the non-operational part of the tailings pond of Kremikovtzi ShH Company

The slime generated from wet dust cleaning installations of blast, basic oxygen and electric arc furnaces, coke plant and other production lines are dumped into the tailings pond of the Kremikovtzi ShH Company. Lignite coal was combusted at the company's power plant until 1988 year, and waste fly ash and cinder were dumped into the part of the pond, which is non-in use now.

For the completion of the project, 14.170 tons binding agent Terra-Control SC 823 and 10 tons grass seeds were spent. The application dosage rates of the binding agent and seeds were respectively 17.71 g/m^2 and 12.5 g/m^2. It has been guaranteed long-term protection of the covering layer. For comparison, according to the second placed offer in the tender, it was proposed 40 tons water dispersible acrylic-based formulation binding agent to be used at dosage rate 50 g/m^2. It has been guaranteed providing up to 12 months of holding power and suppression dust.

Since July 1996 year, the project of Gea International Ltd is being put into effect. From that point to the present time (2003 year), it is not observed any dust drifting over the area around the tailings pond of Kremikovtzi ShH Company. The vegetated spot of the tailings site is not allowed for livestock grazing. There are examinations to establish commercial production of grass seeds from that site.

Project 2 for treatment of the dry section of the waste fly-ash pile of coal-firing power station Mariza Iztok 2

Table 4 presents some figures contained in the offers of four bidding companies in a tender for dust suppression treatment of the waste fly-ash pile of coal-firing power station Mariza Iztok 2. Number one is the offer of Gea International Ltd.

Table 4. Data offers of participating companies in the tender

No in order	Total sum (reagent and treatment), USD	reagent dosage rate, g/m^2
1	113 927	30.16
2	230 000	-
3	260 000	96.00
4	400 000	100.00

The project was implemented as the waste fly-ash pile surface was treated with 30.16 tons polyvinyl acetate dispersion Terra Control SC 823 to prevent dust drifting. The product was applied via helicopter at a rate of 30 g/m^2 and a 1:10 dilution rate. The dust was completely suppressed for the period to the next following put into operation. The requirements of the client were fulfilled completely. They included a usage of non-hazardous chemicals, creation of a short-term protective permeable covering film.

CONCLUSION

The performed investigations provide appropriate solutions for prevention of dust emissions triggered by wind erosion on tailings ponds and waste fly-ash piles in the following cases:

- It is necessary to apply temporary protective covering films on surface sections non-in use on waste disposal site.
- Protective covering layer has to establish long-term dust suppression action and there is soil available for disposal
- There is large amount of particles below 0.01 mm in the surface layer on the wasteland, and vegetative species are tolerant to the containing compounds.

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