Annual of the University of Mining and Geology "St. Ivan Rilski"
vol. 44-45, part II, Mining and Mineral Processing, Sofia, 2002, pp. 89-91

NEW FERRO-MAGNETIC HEAVY MEDIA FOR SUSPENSIONAL DRESSING OF COALS

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ABSTRACT
There is offered a new heavy media, like substitute of magnetite. There are shown grain-size and magnetic characteristics of new ferro-magnetic heavy media. The priorities of heavy media are proved. It is cheap, with suitable grain-size; high content of magnetic fractions, low residual and it is easy to downward magnetization. It is established that containing under 60% iron, it can make divided density of the suspension 1800 kg/m^3, by bulk content of ferro-magnetic oxides under 30%.

Traditional ferro-magnetic heavy media for suspensional dressing of coals is magnetite. In Bulgaria for dressing coals from Central Dressing Factory "Pernik" and Central Dressing factory "Bobov dol" for a long time was using ferro concentrate from Dresssing Factory "Martinovo". After closing that factory, coal-dressing factories in Pernik and Bobov dol have serious problems, because of lack of magnetite's heavy media. The schemes of regeneration for both gravitational factories use magnetic separation and can`t use non-magnetic heavy media (for example baryte).

Using of foreign magnetite`s concentrates for heavy media is making problems and uncertainty with supplying of production and heavy media is becoming more expensive. We import ferro-magnetic heavy media from Ukraine and Macedonia. Some of them are nonstandard by size of grains and need to be grinded. That makes difficult additionally factories, because demand construction of installation for grinding, classification and compressing of heavy media till suitable density for suspension.

The problem of supplying our factories, which are dressing energetic coals in heavy suspensions, with suitable heavy media – Bulgarian production is very topical and urgent.

In laboratory for magnetic methods in University of Mining and Geology were made trials of ferro-magnetic heavy media, imported from Ukraine and Macedonia and were compared with new ferro-magnetic heavy media, produced from the scrap of Bulgarian dressing factory. Ferro-magnetic concentrate was separated from the scrap with original magnetic separator (patent application № 104941/3.11.2000), which makes suitable magnetic fields with definite intensity (H = 55 κA/m), succession and duration of the impulses.

The scheme of dressing included one basic and one refining technological operations, with desliming of magnetic concentrate, which is quickly getting compressed, by sedimenting till 75 – 80% hard. A part of the concentrate was drown and was divided by classes. It was definited by density, containing of commonly iron and was researched for magnetic hysteresis characteristics of heavy media. The last part of the suspension was standardizing by density and was used for suspensional separation of energetic coals. In table 1 and 2 are shown characteristics of the grain-size, composition and density of suggested and already used heavy medias.

If we compare data of tables 1 and 2 for different heavy medias we will establish, that the sample of Macedonian coarse - grained concentrate doesn`t reply on requirements for grain-sizes, because content of class + 150 μm is over 10%, and weight of class + 1 mm, without extra grinding range from 6 to 16% and contain 81% magnetic fractions. The high content of magnetic fractions in the class – 1 + 0,16 mm (till 94 – 95%) can be used, but it need to be extra grinded, about the standard of coarse (under 0,15 mm). The class – 0,16 mm contains 90% magnetic fractions. After extra grinding of the sample, the average content of magnetic fractions is becoming about 92%, so it is replying of the requirement to be over 86%.

The content of magnetic and commonly iron is the highest in Ukrainian magnetite`s concentrate, which has the highest density too. The problem is that Central Dressing factory "Pernik" use only 3000 t concentrate for an year, and Ucraina is not interested in deals for quantity less than 15000 – 20000 t and is making deals only with serious consumers.

For using of coarse-grained concentrate, coal-dressing factory need to have grinders, classifiers and magnetic deslimators, that confuses the scheme of the factory.

The researched sample about magnetic heavy media is fine-grained and has high contents of magnetic fractions, for average content of commonly iron and acceptable density. It does not require extra grinding.

A part of researched product was separated, drown and was subjected to magnetic researches.

Table 1. Characteristic of grain-size of concentrates, used for heavy medias in Central Dressing factory "Pernik"

Classes μm	Summary weight, %		
	Ucrainian concentrate	Macedonian coarse-grained c-te	Offered heavy media
+ 150	3,00	34,00	1,22
- 150 + 80	29,00	50,00	10,72
- 80 + 40	69,50	69,00	24,30
- 40 + 20	81,50	82,00	48,00
- 20 + 10	90,00	90,00	82,50
- 10	100,00	100,00	100,00

Table 2. Phase, chemical composition and density of heavy medias

Indicators	Summary weight, %		
	Ucrainian concentrate	Macedonian coarse-grained c-te	Offered heavy media
Content of magnetic fractions %	94	92	92,5
Content of commonly iron %	68,2	61	49,3
Density κg/m^3	4200	3850	3770

Hysteresis properties were researched by method of Ghuie. It was measured variation of magnetic force of drawing long rode-like body from the sample, formed in long glasses test-tube, hanged so it as one end hang in solenoidal, controlled for intensity magnetic field. In the area of hanging, intensity of field is equal to zero.

The magnetic force was valuated, by measuring variation of the mass of rode-like body, which contains ferro-magnetic phases, under influence of intensity of gradiented magnetic field.

The intensity of magnetization of the sample and it magnetic susceptibility were definited by known formulas.

CONCLUSIONS

1. Magnetic phases in researched product possess hysteresis properties, similar to natural and unnatural magnetite and they can be dressed in weak magnetic fields.
2. The resistance force of the researched magnetic phases (H = 2,5 κA/m) is closer to magnetite (H = 3,2 κA/m), than to magnetic hematite (H = 9,2 κA/m).
3. The residual intensity of magnetization of researched magnetic phases (J = 3 kA/m) is seven times lower than this of magnetite (J = 20 kA/m) and fourteen times lower than this of magnetic hematite (J = 42 kA/m).
4. The intensity of magnetization by saturation of experimented magnetic phases is J = 36 kA/m and it is 5,4 times lower than this of natural magnetite (J = 196 kA/m) and 3,3 times lower than this of magnetic hematite (J = 120 kA/m).
5. The magnetic susceptibility of researched phases is 5,5 times lower than magnetite and 3,9 times lower than magnetic hematite.

Table 3. Data for hysteresis and magnetic susceptibility of magnetic phases in the sample

Elec-tricity	Intensity of the field	Variation of the mass ΔP	Intensity of magnetization		Magnetic susceptibility	
A	A/m	g	relative	volu-metric	relative	volumet-ric
0,5	4400	0,008	0,476	1,80	1082	0,408
1,0	8800	0,039	1,150	4,34	1307	0,493
2,0	17600	0,193	2,872	10,83	1632	0,615
4,0	35200	0,694	5,163	19,46	1467	0,553
8,0	70400	2,402	8,935	33,68	1269	0,478
14,0	140800	5,132	9,545	35,98	678	0,256
8,0	70400	2,596	9.657	36,41	1372	0,517
4,0	35200	0,988	7,350	27,71	2088	0,787
2,0	17600	0,387	5,758	21,71	3271	1,233
1,0	8800	0,111	3,310	12,48	3761	1,418
0,5	4400	0,039	2,030	7,65	4614	1,739
-0,5	-4400	0,025	-1,502	-5,66	3414	1,287
-1,0	-8800	0,087	-2,589	-9,76	2942	1,109
-2,0	-17600	0,234	-3,482	-13,13	1978	0,746
-4,0	-35200	0,736	-5,476	-20,64	1556	0,587
-8,0	-70400	2,396	-8,913	-33,60	1266	0,477
-14,0	-140800	5,172	-9,620	-36,27	683	0,257

Consequently researched magnetic phases can be characterized like low residual, weakly flocculated and easy lose of magnetization. This magnetic properties favour technology of magnetic separation for receiving of pure concentrates.

Lower magnetic susceptibility and intensity of magnetization probably are obliged to silicon, included in crystal lattice of magnetic phases. Lower magnetic properties in wet magnetic separation will reflect on the recovering and it will require magnetic fields with higher intensity or closing of magnetic particles to magnetic poles to be holder there.

In laboratorial attempts for suspensional dressing of energetic coals from Central Dressing factory "Pernik", with new heavy media was established, that dividing density of 1800 kg/m^3 is received at 29 volumetric per cents of heavy media, which is in rates (25 – 30 volumetric per cents).

The regeneration of heavy media, by magnetic separation doesn`t require downward magnetization. That lightens technology and suspensional density become stable.

At the moment we develop industrial models of separator. Then we are going to test technology of dressing in industrial conditions.

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Recommended for publication by Department of Mineral Processing, Faculty of Mining Technology