

## EXPLOITATION TESTING FOR SEPARATION OF “MAXIM” WASTE DUMP MATERIAL IN AN AUTOGENOUS SUSPENSION

*L. Kuzev*

Department of Mineral Technologies, University of Mining and Geology, 1700 Sofia, Bulgaria

### ABSTRACT

An exploitation testing for separation of Maxim dump material having ash content 70 % has been performed. The material has been generated over the past 40 years as a result of Pernik basin brown coal underground mining. The testing has been performed on industrial type installation in the vicinity of Charleroi in Belgium. The experimental installation is designed with the aim of separation of dump materials generated from hard coal preparation. The concentrates obtained is suitable for coke making. The principal separation process has been realized inside a hydrocyclones with autogenous suspension. The throughput of the installation under a single batch is from 120 to 150 t/hours. The tests have been performed under 1.44 g/cm<sup>3</sup> separation density of the suspension. The coal concentrate obtained has yield 21.43% with 21.5 % ash content.

The results from the exploitation testing performed suggest that real opportunity for processing of Maxim dump material and achieving acceptable technological parameters exists.

### INTRODUCTION

The wastes generated during underground coal mining are one of the principal contaminants of the environment. Their re-processing and detoxification are a real problem facing all developed countries with intensive both past and present coal activities. One of the major directions for coal waste utilization is the possibility for re-processing and obtaining useful products with different calorific content. These products are most commonly utilized as a fuel for the thermo power stations.

During the years gone in a countries like Belgium, UK, USA, Poland and others known by developed coal industry in the past, a variety of separation technologies mainly based on the gravity

principles are elaborated and implemented (Efremov and Pahomov, 1988; Shpirt,1986). Due to the high cost of deep coal mining in Belgium at present the underground coal mining is totally suspended. The waste materials generated from this activity present an economic challenge at present. The effectiveness for waste material re-processing and coal concentrate obtaining is similar to this associated to mining coal from new pits. The number of waste dump sites only in Southern Belgium reaches the figure of 390. At present about 28 % of these sites are feasible for re-processing owing to the established customer requirements. It is accounted that about 121 mln tones of black coal are contained in these tips.

### EXPERIMENTAL

#### The Maxim waste dump

The Maxim waste dump is located in the vicinity of the city of Pernik - Northern part, in proximity with the “St. Ana” coal mine and the town district. The Maxim waste dump has been generated during the 1926 - 1960 period by the means of storing various materials: chalky clays, clay shale with coal impurities, ash impurities and other materials known in the Pernik coal field.

The presence of significant amount of coal particles has led to fires in the tips. A totally burnt sectors of the tip are met. A forestry/biological recultivation has been performed in 1974. At the present time young not very well developed plantations remained only at about 30% of the tip surface mainly on its northern part. On the remaining part of the tip the wood plantations are dried as a result of the processes occurring inside the tip. The outside view of the tip is a non-uniform cut cone having axis dimension 390 x 240 m with 28 m mean height. There are slopes reaching 40° tilt. The upper surface is flattened at 0.5 - 2<sup>0</sup> elevation.

## Method for exploitation testing

In order to verify the practical possibilities for processing and utilization of the Maxim dump material an exploitation testing in an industrial installation has been deemed necessary. This is due to the need to combine the anticipated environmental benefits with the economic feasibility.

The method we have chosen is based on comparative-simulation principle. It envisage processing of a Maxim dump material coming from underground colliery on an industrial installation with proven and optimized technological characteristic working normally with dump material deriving from black coal separation. In order to avoid mixing of both materials a five minute interval has been left between switching from one material to another. Due to the fact that both the amount of material processed and its residence time in the separator was not sufficient to generate an auto suspension, a clay-shale suspension has been used. Its density has been monitored in every two minutes in due course of investigation and on each fourth minute a sample has been collected. The following streams were sampled by a cut method – feed, coal concentrate and tailing.

The approach we have chosen is based upon the fraction analysis and upon the beneficiation curves obtained for the Maxim dump material, which have suggested that the material is well separated within 1.65 – 1.7 g/cm<sup>3</sup> density range. Such a density is usually maintained in the Belgian hydrocycloning separation installation working with clay-shale suspension. The actual suspension density is 1.45 – 1.5 g/cm<sup>3</sup>, but in dynamic conditions this corresponds to 1.65 – 1.7 g/cm<sup>3</sup>. In order to quantitatively evaluate the separation process the following parameters are estimated: quantity of material processed;

- quantity of concentrate yielded;
- ash and moisture content of the concentrate.

The method for exploitation testing involves the following steps:

- a) preparation of a mean representative sample (more than 120 tonnes) from the original dump material
- b) determination of efficiency curves, ash content and moisture under laboratory scale
- c) running the coal separation installation with the Maxim dump material for 20-30 minutes
- d) qualitative and quantitative assay of the end products obtained from the Maxim dump waste separation in Belgium.

## Test installation

The experimental installation used is given at Figure 1. It presents the apparatuses flow sheet with indication about flows directions needed for realization of coal particles separation. The principal units securing coal/waste separation are drum type washers "Barrel" type and horizontally placed hydrocyclones  $\Phi$  250 mm. The installation has been realized on a modular principle. Parallel two separate modules are operating having common friction and each of them has a capacity of 120-150 t/h giving an overall installation capacity of 240-300 t/h. The auto-suspension is generated in-situ from the fine fractions of the coal shale processed. The cut-off density of the suspension is maintained automatically.

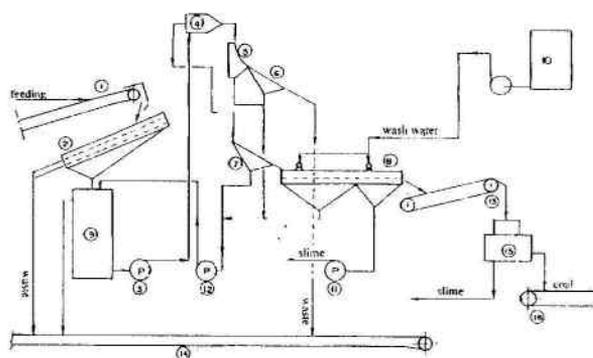


Figure 1. Black coal waste separation flow-sheet-unit sequence

- 1- feeding belt; 2- double deck vibration screen; 3- pump; 4- hydrocyclone; 5- arc screen; 6- drainage screen for waste;
- 7- drainage screen for hydrocyclone overflow; 8- wash screen; 9- wash drum "Barrel"; 10- wash water tank; 11- slime pump; 12- recycled water pump; 13- rubber transportation belt for washed coal; 14- rubber transportation belt for waste material; 15- drainage centrifuge; 16- rubber transportation belt for coal concentrate to storage.

## Experimental results

For the purposes of realization of the exploitation testing, one of the installation modules has been used at a minimum technological throughput of 120 t/h. The cut-off density of the suspension has been kept at 1.44 g/cm<sup>3</sup>. The results obtained from the testing are presented in Table 1.

Table I – Results from the experimental testing

Parameters	Raw material - "Maxim" dump waste	Coal concentrate
Ash content, %	70.0	21.5
Moisture, %	18.0	15.3
Quantity, tones	56.0	12.0
Max. size, mm	150.0	40.0

## DISCUSSION

The exploitation testing has been performed with the objective to evaluate the principal possibility for gravity separation of waste material derived from hard coal mining and obtaining of marketable product. The installation chosen for the tests has been tuned for separation of material from hard coal waste tip by the means of separation via hydrocyclones working with autogenous suspension.

The chosen method for exploitation testing has offered the possibility for one to obtain realistic quantitative and qualitative separation results. The sample subjected to separation was in sufficient quantity - 120 tones. It has been generated by sampling in six points from the tip surface. The material has been collected by the help of excavator - digging holes up to 6 m depth. The material has been homogenized by piling and horizontal leveling with bulldozer. The material collected has been divided and about half of it (60 tones) has been transported to Belgium for processing at the installation chosen there in the vicinity of the city of Charleroi.

From the mean sample a small amount has been collected also for efficiency curves, ash content and moisture determination at laboratory scale. The efficiency curves designed have suggested that this coal derived material is easily beneficiated. These data provide a sufficient argument for expectation of yielding low ash content coal concentrate during the exploitation testing. The amount of the material tested - 60 tones offers the possibility for one to determine the principal two streams - concentrate and waste, as well as to quantitatively evaluate the characteristics of the coal concentrate.

The material from the Maxim dump and the material from the hard coal waste tip have been fed into the receiving bunker with an interrupt interval of 3-4 minutes between both materials, thus to enable a sort of buffer to be formed between both. Regardless of this a

partial mixing of both materials was observed at the beginning and at the end of the separation process. These quantities have been visually estimated and are not calculated into the overall amount of coal concentrate yielded from Maxim dump material. The particles greater than 40 mm in size were rejected before separation in the installation, on the assumption that no easy-burn particles are associated with them. Few percent 40 mm oversize is characterized for the Maxim dump material. The rejection of 40 mm oversize is leading to decrease of the concentrate produced.

The suspension existing in the installation has been used as an autogenous suspension, since for several working hours are required for such a suspension to be formed from the Maxim dump material. The density of the suspension has been taken as a most important technological factor and it was assumed that no significant density variations could be expected from the minerals in the various deposits and the suspension used is predominately formed from fine clay and sand fractions. Obviously similar suspension could be produced on a basis of Maxim dump material. The measured density of the suspension was 1.44 g/cm<sup>3</sup>.

Technological samples for monitoring the separation products has been taken in 4 minutes interval. The duration of separation process control has been kept to 24 minutes.

The experimental results concerning the coal product obtained from the exploitation testing of Maxim dump material are presented in Table 1. The coal concentrate obtained under industrial conditions - 12 tones with 21.5 % ash content could be further improved by technological process optimization resulting in:

- precise determination and maintaining of exact cut-off density
- determination of the size range of the treated material owing to the maximal coal particles size
- improvements in the washing parameters aimed at removal of the clay fractions from the coal particles.

## CONCLUSIONS

The performed exploitation testing with the aim of separation of the Maxim dump material by the means of hydrocyclone separation in autogenous suspension could be considered as a positive attempt. The technological results obtained are suggesting that such an option is suitable and economically feasible. The obtained coal concentrate is characterized by low ash content and thus could be realized in various industrial

sectors or as a fuel for a thermo power stations. The fine "tuning" of the installation could optimize the quantity and the quality of the concentrate according to customer requirements.

The reprocessing of Maxim dump material could facilitate overcoming of a mounting environmental problem in the region, i.e. the contamination of the locally inhabited area with air-born toxic particles. The initial economic data suggest that the realization of the coal concentrate produced from reprocessing of the tip could provide an installation pay-back in a short period.

### **REFERENCES**

- Efremov L. V., V. A. Pahomov. Economic effectiveness of utilisation of mine wastes, Moscow, Nedra, 1988(in Russia)
- Shpirt M. J. Utilization of the wastes from the production and processing of a solid type energy resources, Moscow, Nedra, 1986 (in Russia)