Preparation of coal slurries deposited in ground settling ponds

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Úprava uholných kalov uložšných na odkaliskách

As a result of the hard coal washing process, considerable quantities of coal slimes are generated. They belong to grain size classes below 1, 0 mm (with the majority of grains below 0,035 mm) and are often sold in order to prepare blends for the power generation. It is assessed that in Poland about 11 mln tons of such slimes were deposited. The slimes of a low ash content can be exploited and sold. The slime of high ash content must be washed. In Poland there is one coal preparation plant for slurries. The article describes the technology and presents the results of a simplified economic analysis of exploitation of the slurries and their washing.

Key words: *Coal slurry, ground settling ponds, washing*

Introduction

Coal slurries with a grain size below 1 mm are generated during the coal washing in coal preparation plants. They are separated during dewatering of coal washing products and then, after thickening, can be either the commercial produkt or go to ground settling ponds as the waste product. That depends mainly on their quality parameters. Provided the quality parameters (ash, sulphur content and calorific value) are favourable, the slurries are blended with fine coal, creating a mixture for the power generation. Less often it is the case that coal slurries are purchased as a separate product, although in recent years they find more and more customers. In recent years, a majority of slimes was accumulated in settling ponds since there was no interest of users. The deposited slimes were treated as wastes from coal washing processes. In reality most of those wastes are a fuel for the power generation. Waste rocks consist mainly of silt minerals, sandstones and slates. Depending on the share of coal and the waste rock the slimes can present various utilisation values. With the little share of waste rock and thus a comparatively high calorific value the slurries can find the application directly in combustion processes. With the high ash content (waste rock) the slimes can be prepared or also directed for the management as the mineral raw material (provided customers can be found).

Coal slurries accumulated in ground ponds are wastes from the legal point of view. The slurries from a current production on the other hand (if not deposited in ponds and sold directly) are legally the fuel for the power generation. It is interesting that this does not depend of the quality parameters of slurries.. Very often slimes deposited in settling ponds have better quality parameters than slurries from the current production. In the first case the wastes are subjected to the principles of waste management and in the second case it is a commercial product. These legal limitations result in considerable difficulties while planning the methods of utilising slurries deposited in settling ponds. Technological and legal aspects of those slurries' utilisation were discussed in a number of publications [4 – 6, 8 – 11]. In this paper, the problem preparation of the coal deposited in settling ponds will be discussed.

Preparation of coal slurries in Poland.

In Poland, one plant POLHO Ltd Co. located in Czerwionka – Leszczyny deals with the preparation of slurries [3, 7]. The plant is adjusted to prepare post flotation slurries produced as a waste product at coal preparation plants. [12, 13, 14]. The plant is based on the technology by prof. H. Hölter. The technology of coal scurries washing was implemented into practice in 1988 in Lünen near Dortmund. The plant's objective, in principle, consisted in the liquidation of the accumulated post flotation slurry. The slimes collected in outdoor settling ponds for tens of years created a barren land. The land was degraded, ecologically lost and formed a moonlike landscape. Thus a technology was elaborated enabling to retrieve a coal concentrate of high utilisation value from those wastes. Positive results that were accomplished at a plant in Lünen allowed for the transfer of this technology to Poland...

In 1990 a contract was signed for the implementation of this technology by the then Central Planning Authority and the Polish-German International Committee. The construction started in August 1991 and was completed on October 1993. The investment was initially a Polish-German company. Then, the German

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party resold its shares to an Australian company and this, in turn, sold tem to private investors. The plant operates till today. In previous years the plant was awarded prize as the Construction of 1992, and awards by Minister of Spatial Management and Building, Minister of the Central Planning Office, award of Journalists, and the award by the Polish Association of Mining Engineers and Technicians.

The adjustment of the technological layout of slurries preparation is done for grain sizes coming from waste products of the coking coals flotation process. Therefore, the application of the flotation process was useful for the retrieval pf carbon substance. In the case of washing of steam coals this solution is also feasible to be applied although the volume of floatation reagents must be considerably greater. Steam coal floats weakly and thus the flotation process is very expensive. In recent years the plant carried out trials on the industrial scale to wash slimes deposited in other ground settling ponds [10, 20]. Positive results of theses experiences indicate that there is a possibility of washing of slurries coming from other, (currently not exploited), settling ponds.

The introduction of technologies of fliudised bed combustion of coal enable to utilise the post coal slurries in a direct way – without the necessity of their preparation. The volume of slurries utilised in this way depends on the capacity of fluidised bed boilers. There is a limited number of such boilers in Poland as far as now. The remaining slimes can be added up to fine coals forming thus power generation mixtures. Very impure slimes, in the case of the necessity of their removal from the ponds [18], must undergo a washing process.

Economic reasons, and in fact high costs of the construction of sequent plants of slurries' preparation, practically do not encourage new investments. Unless such a plant would have been constructed by a large coal producer that could secure a long term receipt of concentrates, at least by the time the investment pays off (amortises).

Technology of washing of post flotation slurries.

Post flotation rejects is the raw material for washing which is extracted by excavators from the ground settling ponds and transported by trucks to the storage site of the feed wherefrom after blending they are fed by a loader onto the spiral feeder which, in turn, transports the rejects onto the belt conveyor and then to washing out drum. In the washing out drum, the first classification takes place in the result of which mechanical impurities and barren rock of grain size > 30 mm are removed from the mixture of water and slimes.

The layout of classifying screens allows for obtaining of three different grain size classes > 2,5 mm, 2,5 – 0,4 mm, < 0,4 mm.

The grain size class > 2,5 mm is treated as, class 2,5 – 0,4 mm is directed for the preparation in spiral separators where a concentrate is obtained of low ash content 7,0 – 9,0 % a d rejects with the ash content of 70,0 – 80,0 %.

The concentrate from spiral classifiers is directed to initial dewatering on bend sieves and vibration screens with the mesh size of 0,4 mm by Schauenburg Company, and is dewatered finally on belt, vacuum filters.

The grain class < 0,4 mm is meant for a basic process of washing. e.g. foam floatation (EKOF Company) providing rejects with a high ash content and a maximum volume f the concentrate from the flotation pulp. Flotation reagent is supplied before each stage of flotation. In order to accomplish a better degree of dewatering of the concentrate, a respectively prepared flocculent is dosed to a collecting trough.

Dewatering of the concentrate from the first flotation, mixed with the concentrate from a spiral separator take place on vacuum belt filters by O&K company. The concentrate from the second stage of flotation is dewatered on vacuum filter drums by Sala company.

On the first stage of floatation, one obtains a concentrate with the ash content of 9 % – 12 %, where as on the second stage of washing, the concentrate with the ash content of 15 % – 20 %. Rejects obtained in the process of two-stage flotation have ash content of 65 % – 70 %. The total retrieval of coal amounts to about 40 – 50 %, depending on the quality of the raw material.

The flotation rejects are directed to a radial lamella thickener (φ 15 m) with SALA inserts. PREASTOL flocculent is used for the flocculation process. The clarified water is returned to the technological process. The thickened flotation rejects (450 – 650 g/l) are dewatered in chamber presses of PF-ROW-1/570 type. The dewatered floatation rejects are meant for the reclamation of the ground settling pond from which the reject slurry was extracted. The water – slurry circuit is closed within the coal preparation plant.

The washing process is completely automatised and computer controlled from a control room. Thanks to the installation of the measuring-adjustment system a remote control is possible as well as the adjustment of equipment operation and, in case of a failure's occurrence, the failure site is rapidly detected. Besides, the installation is provided with the station of preparation and dosing of the flocculant which is controlled by a microprocessor co-operating with the main computer.

The dewatered concentrates from the first and the second floatation, with a mean moisture content of 24,0 % to 28,0 %, are supplied to the thermal drying in a drum drier.

The hot flue gases from coking gas delivered from the nearby „Dębieńsko" coking plant are the drying medium. The flue gases after drying of the product are treated on an electrofilter the effciency of which is 99,92 %. The purified flue gases are vented into the atmosphere via a stack.

In the result of the drying process, a commercial product is received with the mean moisture content of 12,0 – 13,0 % and the ash content from 12,0 % to 24,0 % (according to agreements with the customer). Thanks to the fact that the concentrate are supplied to the drier by a loader, the commercial product can be prepared by blending in various quality classes. The dried product is loaded onto the railway wagons at the plant's own loading station equipped with Schenck's scales.

Quality parameters of the plant's products.

The applied technology allows for washing of reject coal slurries and obtaining of qualified coal concentrates from them.

In the course of washing, a considerable reduction of sulphur content in the concentrate also takes place.

Quality results obtained in the washing process are presented in tab. 1.

Tab. 1.

	Feed	Concentrate 1	Concentrate 2
Granulation [mm]	2,5 – 0	2,5 – 0	0,4 – 0,0
Ash content A^r	35 – 50	9,0 – 12,0	15,0 – 20,0
Moisture content W_t^r	28 – 40	24,0 – 26,0	26,0 – 28,0
Sulphur content S_t^d	1,0 – 1,40	0,70 – 0,85	0,80 – 1,00
Calorific value Q_i^r	–	abt. 26 [MJ/kg]	abt. 24 [MJ/kg]

Economics of the slurries' washing

The problem of utilisation of the slurries disposed at ground settling ponds in Poland is serious. It is assumed that the total amount of slimes is about 11 mln tons. The slimes hale various quality parameters. The calorific value Ganges from 2 MJ/kg to 15 MJ/kg, the ash content from 19 % to 51 %, and the sulphur content from 1,0 % to 5 % [6, 15, 17]. Depending on the real quality parameters of the slurry from each of the settling pond, it can be directed to customers; it can be prepared or be left in the pond as the final reject. The profitability of washing of coal slurries will depend on the obtained price of the concentrate, its yield (as against the feed) and the costs of washing process. One must also mention the problem of the price at which the owner of the settling pond will be willing to sell the deposited material. Such analyses are the individual problem for each of the settling ponds. Such an analysis was carried out for a selected slurry from one of the settling ponds [1, 2, 16, and 19].

In the POLHO plant, an industrial trial [20] was carried out on the washing of slurry from that analysed pond. Quality parameters of the feed were in the range of: the calorific value 11 587 – 12 946 kJ/kg, and the ash content 27,0 – 29,9 %. As the result of the slurry's washing, the concentrates were obtained with the following mean parameters: the calorific value 22 160 – 22 585 kJ/kg, and the ash content 7,47 – 9,3 %. The yield of the concentrate was about 41 %.

On the basis of the carried out industrial trial, and taking the account of quality of the supplied slimes (especially its heterogeneity), the POLHO company (an opinion of the management) can offer the amount of 14 zł per each ton of the slurry. The amount is a difference between the possible price to be obtained for the produced concentrate and the cost of all the technological operations, taking the account of the fact that the yield of the concentrate is 40 %. Such a calculation shows that his is the amount which is a useful value of the slurry for the Polho at its gate. Accepting this amount as the initial point for further analyses, one should subtract from this price the cost of the exportation and the preparation of the slurry as well as its transportation to the POLHO plant. The estimate costs of the exploitation and the delivery of the slurry were determined by a specialised transportation unit. It was accepted that about 640 Thos. tons of slurry will be extracted.

With this assessment, the cost elements were as below:

- Preparation of the settling pond for the exploitation (opening up, removal and storage of overburden, removal of part of the flora, etc...) – 0,53 zł/t
- Preparation of access roads and the crown of the settling pond (hardening) preparation of storage site, etc. – 2,00 zł/t
- Exploitation of the slurry and delivery to the storage site (for dewatering) – 0,45 zł/t
- Transfer of the slurry on the storage site (blending, moisture removal) etc. – 0,52 zł/t
- Remaining costs (Administration, taxes, fees, margin, etc.) – 1,85 zł/t
- supply of the slurry to the user (transport with loading and discharging between the storage site and POLHO plant) – 6,00 zł/t

Total, estimated costs amount to – 11,35 zł/t.

Accepting that an useful value presented by the slurry for the user is, according to POLHO, 14 zl/t (at the storage site of the plant) and that the estimate cost of retrieval of the slurry (accumulated cost to the storage site at the POLHO plant) amount to 11,35 zl/t, then the useful value of the slurry deposited in the settling pond for the exploitation unit will amount to 2,65 zl/t. The accurate calculation of the useful value would, anyhow, require the preparation of a business plan of such a venture.

Summary

Coal slurries deposited in the ground settling ponds in cases they contain large quantities of barren rock elements must undergo washing process. The only technology in this respect applied in Poland is the technology by the Polho preparation plant. The plant washes at present coking coal flotation rejects. On the basis of conducted experiments It was determined that it is possible to wash the slurries also from other settling ponds. An economic analysis indicated that the process can pay off both in case of the owner of the settling pond, its exploitation unit and the slurry preparation plant. This, anyhow, regards a particular, already investigated case. In case of the slurry from other settling ponds, similar technological investigations and economic analyses should be carried out.

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