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PRODUCT AND WASTE BALANCE OF METALLURGICAL COAL PREPARATION PLANT

20.1 INTRODUCTION

The production of metallurgical coal is associated with generation of large amounts of mining and processing refuse. Polish and European Union's regulations force the company to maintain efficient waste management in order to avoid disposal of gangue. In case of flotation waste the disposal charge is up to 10 euro per tonne what makes it unreasonable instead of alternative utilization. The most optimal solution is to find the application of by – product even in the colliery. Because of complete range of coal processing the generated refuse occurs in all size fractions. For the purposes of the article there has been chosen coking coal preparation plant equipped with infrastructure capable of all fraction washing. The balance contains the products, mineral as well as waste of anthropogenic origin. Polish underground coal mining produces each year approximately 28 million of tonnes of waste (reaching approximately 40% of total extracted mass). About 85% of generated refuse finds application in the economy.

20.2 COKING COAL PREPARATION PLANT

For the balance elaboration there has been chosen one exemplary processing plant equipped with following infrastructure described in the Table 20.1. The coal preparation plant daily gross capacity reaches up to 12000 tonnes of gross input. The separation is carried out in 3 enriching sizing fractions: over 20 mm – in the dense media washery; up to 20 mm – in jigs; below 0,5 mm – in flotation cells [7]. All coarse product is crushed down to 20 mm to meet the market standards.

Due to the economic analysis the colliery has ceased separation of middlings because of their low quantity and lack of application and customers. This may result in raised level of carbon in waste increasing the risk of endogenous fire. The unused separation infrastructure has been already dismounted. The chosen plant was the first one of the first coking coal preparation washeries in Poland to introduce dewatering of flotation concentrate using centrifuges instead of thermal dryers.

Thanks to the innovative use of filter press, the recovery of sedimentary product in effluent has reached even 150 tonnes daily.

Table 20.1 Coal mine and its processing plant description

Gross run-of-the-mine output tonnes/day			**6000-12000**
Unit	Capacity t/h	Number of systems	Description
Primary screen	1600	2	Feed over 200 mm is directed to manual separation of undesired items, then to Bradford breakers to discharge coarse sandstone.
Preliminary classifier	900	4	Division of feed into sizing classes < 20 mm and > 20 mm
Dense media separators	325	2	Gravity separation in solution of water and magnetite. Dewatering carried out in sieves.
Jigs	475	2	Dewatering carried out in centrifugal sieve and centrifuges.
Flotation cells	140	6	Dewatering in screenbowl centrifuge
Sedimentary product recovery	10	1	Recovery of sediment in water discharge from flotation concentrate dewatering
Loader	1200	1	Railway and road transport

Source: Own elaboration.

The main product of plant is characterized by low ash content (up to 8%), moisture (up to 10,5%), sulfur (up to 0,5%) and good coking parameters according to global market. The sizing fraction of final product is below 20 mm. Recovered sedimentary product due to its higher ash content (more than 12%) is not intended to use in metallurgical coal blend. Only 2 basic products offered on market allow to simplify the balance of concentrate and waste which is more complicated in case of thermal coal mines in Poland. This is caused by different needs of individual customers on market. Balance is simplified only to solid material, so the water flow and discharge as well as hydraulic infrastructure has not been considered [9, 10].

Beside the conventional coal products, the colliery additionally sells certified construction aggregates produced from refuse generated by dense media separators and jigs. The biggest benefit of this activity is not the profit but avoiding the landfill charges. The next chapter shows the input and output data from the mentioned coal preparation plant.

20.3 PRODUCT AND WASTE BALANCE

The Figure 20.1 presents the conducted product and waste balance including their flow. Because of run-of-the-mine coal variability the quantities and its quality of streams may differ in time.

Usually the coarse and middle-sized waste tailings are delivered by trucks to final destination. In this colliery fine-grained flotation rejects are returned to the excavations where they are used as a filling of gob areas. The injection installation utilizes also the fly ashes from power plants to produce the seal blend intended for underground use [3]. The description of components presented in the Figure 20.1 is

included in the following Table 20.2. For the balance purposes – the daily run-of-the-mine output has been defined as 10000 which is the ordinary value.

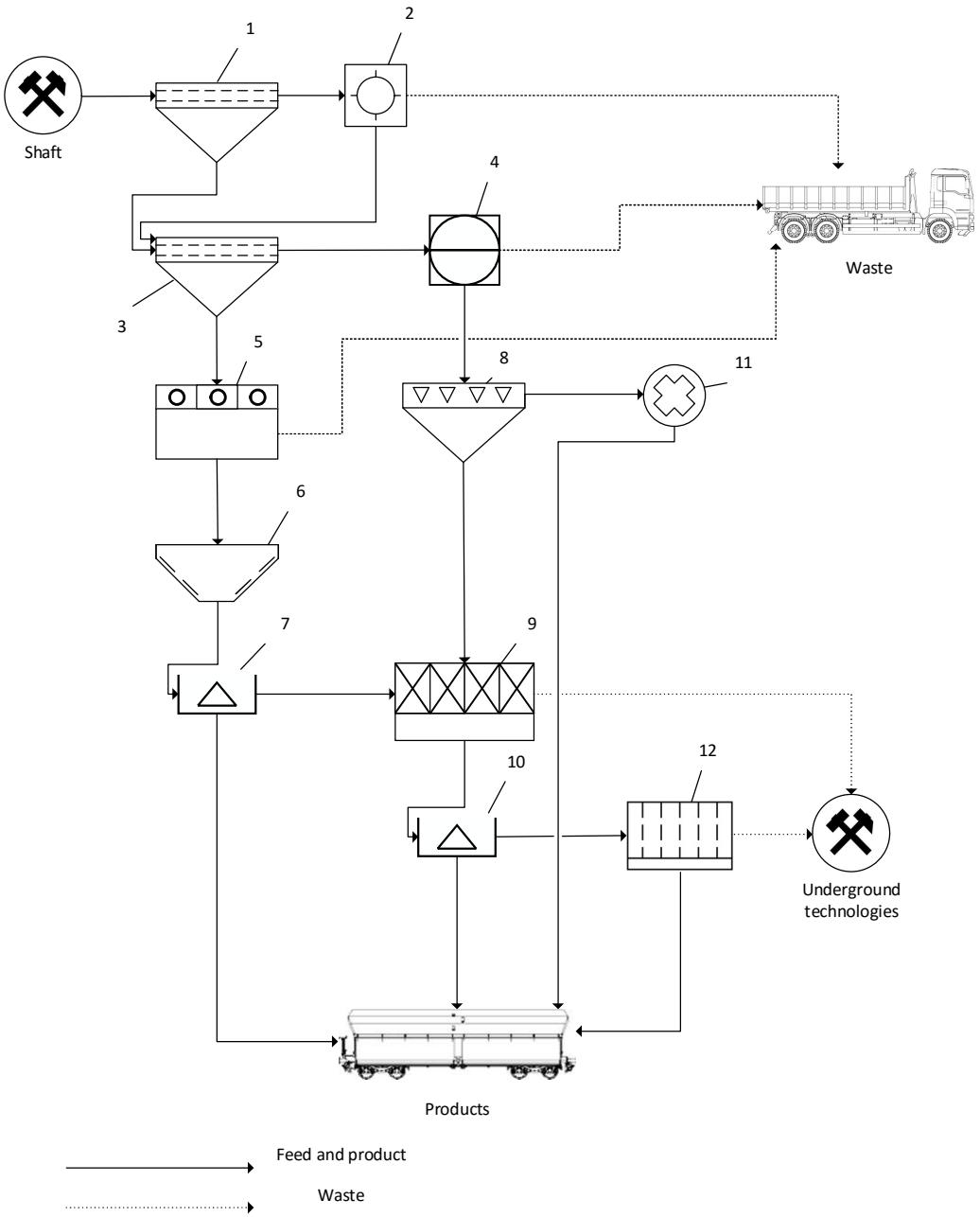

Fig. 20.4 Product and waste balance scheme in exemplary metallurgical coal mine
Source: Own elaboration.

In this case the product/waste ratio is about 80/20, the run-of-the-mine coal is reported to contain from 15 to 25% of tailings which seems to be good result in longwall mining. The annual mass of generated tailings reaches 50 thousand tonnes during production of circa 200 thousands of tonnes. There are three types of generated waste in underground coal mining in Poland is divided into codes [1]:

- 01 01 02 – wastes from mineral non-metalliferous excavation,

- 01 04 12 – tailings and other wastes from washing and cleaning of minerals other than those mentioned in 01 04 07 and 01 04 11 (hazardous waste, rock salt and potash),
- 01 04 81 – waste from flotation.

Table 20.2 Description of the Figure 1 and quantitative product/waste balance

No.	Processing unit	tonnes/day		
		Feed input	Final product output	Final waste output
1	Preliminary screen	10000	-	-
2	Bradford breaker	-	-	200
3	Classifier	9800	-	-
4	Dense media separator (2-product)	2800	-	700
5	Jig (2-product)	7000	-	800
6	Centrifugal dewatering screens	6200	5000	-
7	Dewatering centrifuge			
8	Dewatering screens of dense media product	2000	-	-
9	Flotation cells	1300	-	300
10	Flotation concentrate dewatering centrifuge	1000	800	-
11	Dense media product breaker	2000	2000	-
12	Filter press – flotation product dewatering filtrate recovery	200	150	50
Summary		-	7950	2050

Source: Own elaboration.

Because of integrated conveyor transport underground the 01 01 02 is not present in this colliery (In Polish mining waste of this genre represent only a few percent of whole). The vast majority is classified as 01 04 12 tailings. It is good to mention that in addition to mineral waste during the coal treatment processes and the manual beneficiation following metal and non-metal materials are being collected:

- wood – 20 tonnes/month,
- steel – 15 tonnes/month,
- rubber and plastics – 15 tonnes/month.

Such impurities may cause severe damage and breakdown of infrastructure if they are not removed from the final product – they are responsible for instance for blocking chutes. The non-mineral waste collection is organized by external companies. As it was mentioned before the mining companies are forced to deal with generated tailings. In the best scenario they avoid producing them or find the right application in the economy.

20.4 APPLIED WAYS OF UTILIZATION OF GENERATED WASTE

The Table 20.3 presents the chosen ways of utilization of generated rejects in the metallurgical coal mine. Some of them used to be applied in the industry but has been discontinued especially for economic and technological reasons.

Table 20.3 Chosen ways of utilization of generated rejects in a colliery

Group	Ways of utilization	Waste code	
		01 04 12	01 04 81
Underground technologies	Backfilling the excavations	◙	■
	Longwall gobs sealing	□	■
	Dry backfilling	◙	□
	Hydraulic backfilling	□	◙
Civil engineering	Civil works (railroads, highways)	■	□
	Hydrotechnical engineering	■	□
	Remediation and reclamation	■	□
Construction and industrial materials	Aggregate production	■	□
	Cement production	□	□
	Building ceramics	◙	◙
	Sulfur recovery from pyrite	□	□
Fuel recovery	Waste incineration	□	□
	Waste coal recovery	□	□
	Alternative fuel	□	□
Disposal	Landfilling	■	□
	Disposal in settling ponds	□	◙

Source: Own elaboration based on [2, 4, 5, 6, 8].
Legend: □ – not applied, ■ – applied, ◙ – discontinued

In this example the majority of coarse and middle-sized waste is utilized in civil engineering. The fine rejects are returned underground to backfill already fallen gobs preventing from endogenous fire.

20.5 SUMMARY

In presented case there are hardly any deposited waste in the surroundings of mine. Processing of all sizing fractions of coking coal contributes into generation of fine waste which seems to be convenient to use in underground technologies. The thermal coal mines in Poland use external industrial waste to do so. Lack of middlings separation increases the coal content in waste what may cause serious problems if there are applied in civil engineering. The same issue is regarding to flotation waste which is rich in carbon. Anyway the coal companies should be looking for any new ways of waste utilization not only to get away from the fines and charges. The presented balance is the quantitative/qualitative analysis of waste management in particular plant.

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PRODUCT AND WASTE BALANCE OF METALLURGICAL COAL PREPARATION PLANT

Abstract: Extraction of coal deposits contributes to generation of large amounts of mining and processing waste. The issue of waste management in case of metallurgical coal washing is even more serious because of requirements of customers demanding low ash content in final product. In case of thermal coal more mineral matter is delivered to final user. The aim of the article is to present product and refuse intelligent output balance based on data acquired from an exemplary colliery. Because of the fact the whole feed is being washed, the company is forced to look for alternative and innovative ways of waste utilization in order to avoid waste disposal charge. The included balance diagram presents the current application means of by-product recovery in a coal mine and the market. The gangue, coarse and fine processing waste, other refuse are used in underground technologies, civil and power engineering reducing the company loss caused by generation of undesired products.

Key words: coal preparation, mining waste, metallurgical coal, waste recovery, reduction of waste disposal, waste management

BILANS PRODUKTÓW I ODPADÓW ZAKŁADU WZBOGACANIA WĘGLA KOKSUJĄCEGO

Streszczenie: Eksploatacja pokładów węgla kamiennego wiąże się z powstaniem znaczących mas odpadów wydobywczych oraz przeróbczych. Wzbogacanie węgla koksującego wymaga głębokiego oczyszczenia produktu ze względu na wymagania jakościowe odbiorców. W przypadku węgla energetycznego większy ładunek frakcji mineralnej trafia do odbiorcy finalnego. Celem artykułu jest prezentacja bilansu produktów i odpadów na wyjściu przykładowego zakładu wzbogacania węgla koksującego. Pełny zakres wzbogacania zmusza przedsiębiorstwo do poszukiwania alternatywnych oraz innowacyjnych metod zagospodarowania powstających odpadów dla uniknięcia kosztów ich składowania. Zawarty w publikacji diagram wskazuje obecne kierunki zagospodarowania odpadów w zakładzie górniczym oraz poza nim. Skała płonna, odpady przeróbcze oraz inne są stosowane w technologiach podziemnych, budownictwie, energetyce powodując zmniejszenie strat związanych z produkcją niepożądanych produktów.

Słowa kluczowe: przeróbka węgla, odpady pogórnicze, węgiel koksujący, odzysk odpadów, zmniejszenie składowania odpadów, gospodarka odpadami

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