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Coal Mining and Coal Preparation in Poland

Poland is the largest coal producer in Europe. In 2014 the coal output of steam coal amounted to 60.3 mln t and 12.3 mln t of coking coal. Poland also has the largest coal resources. They amount to 52.0 bln t (resources supposed economic), but the amount of economic reserve base is deemed to be 3.7 bln t.

The developed deposits amount to 19.8 bln t (resources supposed economic) including 3.7 bln t deemed to be economic reserve base. Steam coal resources amount to 11.6 bln t (resources supposed economic), and 2.2 bln t are deemed to be economic reserve base. However, coking coal resources amount to 8.1 bln t resources supposed economic, of which 1.5 mln t are deemed to be economic reserve base. Recoverable resources of Poland are located up to the depth of 1250 – 1300 m. Coal extraction is conducted at depths from 400 to 1050 m.

Coal can be found in two regions in Poland. These are the Upper Silesian Basin and the Lublin Basin (Fig. 1).

The Upper Silesian Coal Basin (GZW) is the largest coal mining centre in Poland. The most productive coal deposits are within mine-field boundary of the coal mines. Coal has been mined in this area for over 300 years. Coal seams with thickness most convenient for mining and located in good mining and geological conditions have already been mostly mined. The Basin constitutes. The Basin constitutes a single entity together with the Ostrava-

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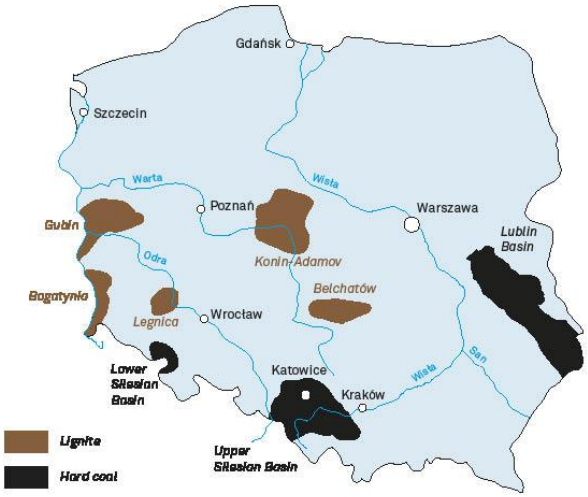

Fig. 1. Poland coal mining location

Karvina area (in the Czech Republic). The entire surface area of the basin is about 5,400 km^2 of which 4,450 km^2 lies in Poland. In the productive series, the seams are 1.0 – 1.5 m thick, but some seams reach thickness ranging from a few meters to more than a dozen meters.

The Lublin Coal Basin (LZW), located in the east of Poland, covers an area of 4,630 km^2. It is about 180 km long and 20 – 40 km wide. The depth of bedding of seams does not exceed 750 m. The productive series contains more than ten seams (up to 18). The thickness of the seams ranges from 0.8 to 2.5 m (and rarely more than 3 m).

The Lower Silesian Coal Basin (DZW) is about 60 km long and 30 km wide. The northern part of the Basin belongs to Poland and the southern part to the Czech Republic. There are up to 50 coal seams in the Basin and they mainly contain coking coal. Coal was once mined from four mines, but due to a very difficult mining and geological conditions and very high costs of coal mining, the mining of coal reserves in this Basin has been abandoned.

In the Upper Silesian Coal Basin the following coal companies operate (the status as in a mid of 2015):

- Kompania Węglowa S.A. (Polish Minig Group) — with its coal mines: „Jankowice", „Chwałowice" „Rydułtowy-Anna", „Marcel", „Bolesław Śmiały", „Piast", „Halemba-Wirek", „Bielszowice", „Ziemowit", „Pokój", „Sośnica";
- Katowicki Holding Węglowy S.A. — with coal mines: „Mysłowice-Wesoła", „Murcki-Staszic", „Wieczorek", „Wujek";
- Węglokoks Kraj Sp. z o.o. — with coal mines: „Piekary", „Bobrek";
- Jastrzębska Spółka Węglowa S A. — with coal mines: „Borynia-Zofiówka-Jastrzębie", „Budryk", „Krupiński", „Pniówek", „Knurów-Szczygłowice";
- Turon Wydobycie S.A. — with coal mines: „Sobieski", „Janina", „Brzeszcze";
- LW „Bogdanka" S.A. — operating on one mine.

There are exist also the following small mines:

- PG„Silesia" Sp. z o.o. — property of a Czech coal company;
- Siltech Sp z o.o. — private mine;
- ECO-PLUS Sp. z o.o. — private mine;
- Spółka Restrukturyzacji Kopalń S.A. — preliminarilly aimed for liquidation of unprofitable coal mines, nevertheless currently operates 4 mines: „Centrum", „Makoszowy", „Mysłowice", „Kazimierz Juliusz", for which there is no final decision about their future.

1. Basic Production Statistics

1.1. Overall coal production

The coal production in the Poland has been decreasing for the past four years.

As shown in Table 1, coal production over the last 4 years (2012 – 2015) has decreased 9% from nearly 79,2 mln t to 72,2 mln t. Further reductions of 4 – 6% are forecast for next year (2016). Table 2 shows structure of steam coal production and table 3 sale data for polish coal industry.

1.2 Washed production

Approximately 60% of the Polish coal production is washed with some form of coal preparation (see Table 4).

Table 1. Production data for Polish Coal Industry

Year	2011	2012	2013	2014	2015 (I-XI)
Total production [Mg]	**75 668 000**	**79 234 000**	**76 466 000**	**72 514 000**	**65 685 000**
Steam coal [Mg]	64 232 000	67 496 000	64 351 000	60 226 000	53 702 000
Coking coal [Mg]	11 436 000	11 738 000	12 115 000	12 288 000	11 983 000

Table 2. Structure of steam coal production

Year	2011	2012	2013	2014
Steam coal [Mg]	**64 232 000**	**67 496 000**	**64 351 000**	**60 226 000**
Coarse coals	6 770 000	5 957 000	6 214 000	5 164 000
Medium size coals	2 842 000	2 541 000	2 719 000	2 317 000
Fine coals	52 558 000	57 846 000	53 679 000	51 644 000
Others	2 061 000	1 152 000	1 738 000	1 101 000

Table 3. Sale data for Polish Coal Industry

Year	2011	2012	2013	2014	2015 (I-IX)
Total sale [Mg]	**76 215 000**	**71 936 000**	**77 496 000**	**70 305 000**	**67 032 000**
Steam coal [Mg]	64 945 000	60 538 000	64 938 000	57 998 000	55 074 000
Coking coal [Mg]	11 270 000	11 398 000	12 558 000	12 307 000	11 958 000

Table 4. Coal preparation in coal companies

Coal companies	Number of CPP	Capacity [tph]	Range of size mm	Washed production [mln Mg]	Type/Distribution of circuits
Kompania Węglowa S.A. (Polish Mining Group S.A.)[1)]	20	600 – 2.100	20 – 0 (85%) >20 (15%)	~14.4	vibration screens, jaw crushers, (20), dense medium washer (18), grain jigger (2), jig washer (14), dense medium cyclone (1), hydrocyclone (6), spirals separator (4), flotation (7)
Katowicki Holding Węglowy S.A.[1)]	5	600 – 1.600	20 – 0 (78%) >20 (22%)	~3.2	vibration screens, jaw crushers (5), dense medium washer (5), jig washer (1),
WĘGLOKOKS KRAJ Sp. z o. o.	2	1.500	20 – 0 (90%) >20 (10%)	~0.5	vibration screens, jaw crushers (2), dense medium washer (2), jig washer, Barrel washer (2)
JSW S.A.	8	800 – 1.600	20 – 0 (98%) >20 (2%)	~12.3	Bradford drum crushers, dense medium washer (8), jig washer (8), flotation (8)
TAURON Wydobycie S.A.	2	900	20 – 0 (80%) >20 (20%)	~2.9	vibration screens, jaw crushers (2), dense medium washer (2), jig washer (2), spirals separator (2)
LW "Bogdanka" S.A.	1	2.400	20 – 0 (85%) >20 (15%)	~7.4	vibration screens, jaw crushers (2), dense medium washer (2), jig washer (2)
PG "Silesia" Sp. z o.o.	1	575	20 – 0 (82%) >20 (18%)	~1.2	vibration screens, jaw crushers (1), dense media washer (1), dense medium cyclone (1)
TOTAL	39	~ 1.000	—	~41.9 (~60%)2)	vibration screens, jaw crushers (40), dense medium washer (38), grain jigger (2), jig washer (29), dense medium cyclone (2), hydrocyclone (6), spirals separator (6), flotation (15)

[1)] estimates data

[2)] depends on quality of raw fine coal and demands quantity of energy producers

The saleable coal has the following quality parameters:

- coking coal — ash content varies from 5.4% to 8.8% (average 6.8%) and sulphur content varies from 0.51% to 0.89% (average 0.67%);
- steam coal for the power industry — the net calorific value ranges from 15.4kJ/kg to 25.4kJ/kg, ash content ranges from 9.9% to 30.1% (average 22.4%) and sulphur content from 0.56% to 2.59% (average 0.83%);

In Poland some power stations are adapted to burn raw coal (non-prepared coal) — its net calorific value can be 19.2 MJ/kg, and sometimes even less whereas the ash content can be up to 26%, and the sulphur content of 1.57%.

2. Significant Industry Changes in Last 3 Years

2.1. Technological, Environmental + Economic Developments

The main changes in last 3 years:

- setting in order and improvement of particular process circuits:
  - reconstruction of the raw coal preparation station,
  - modernisation heavy-media separation system,
  - modernisation of the jig wash,
  - elimination of the flotation concentrate drying plant
  - construction of a flocculator measurement installation,
  - modernisation of the dispatcher system,
  - modernisation of the dust separation system,
- implementation of more efficient dewatering technologies for fine coal to improve the quality of the products and maximise the reduction of slimes disposal outside the water-slurry circuits,
- modern arrangements for preparation of power mixtures,
- up to date instrumentation of key technological circuits with electronic monitoring measurement equipment:
  - construction of electronic samplers for saleable coal,
  - construction of electronic analysers for qualification of basic qualitative parameters.

2.2. Impact on coal preparation segment in future

Quality parameters of coal depend of properties of seems being worked, coal quality in seems and applied exploitation system. Extraction of coal in future from mining reserves off deep coal seems increasing impurities in ROM and changing legal environment regulation, obligatory control of parameters of solid fuels

undertaken by government are the main factors which have a major impact on coal preparation sector.

3. Improvements

3.1. R & D Needs

- Developing new analyzers of ash, sulphur and moisture contents, which are more accurate for measuring on clean coal, middlings and wastes.
- Automation and process control systems for devices of coal preparation technologies to increase productivity and efficiency.
- Developing a new method to achieve a quick and accurate date of characterization of coal quality in terms of washability.
- Improving dewatering of finest grains coal (below 0,063 mm) to reduce the load on closed water-slurry systems.
- New alternative utilization waste of mining.

3.2. Efficiency

Technological possibilities of reducing the cost of preparation through the implementation of CMMS (Computerised Maintenance Management System) and PIMS (Production Information Management Systems), which includes: area of forecasting the quality of production, planning and integration of the extraction process with the preparation and sales process.

3.3. Productivity

Further activities for mechanization and automation of operations and processes in order to reduce labour expenses and improve process performance.

3.4. Safety

- reduce the risks related to exposure to harmful and dangerous factors by reducing the emission of noise, dust, vibration, etc. derived from the use of machines and other means of production,
- reducing the exposure time of these factors on workers.

3.5. Water Usage

- further reduce water consumption by simplifying the water-slurry circuits,
- improving the efficiency of processes especially clarifying water, thickening and dewatering of products,
- reduction of water losses related to the operation of the settling ponds,
- reduction of the duration of wet processes limiting the grains contact with water,
- use of the underground water as the medium for conducting wet processes in a closed water-slurry system,
- implementing of dry separation technology of raw coal.

4. Plant Design

Actually many preparation plants in many cases are modernized. The main goals are to improve and modernize the entire coal processing technology (transport systems, enrichment in jigs washer, enrichment in dense medium washer etc.) for ensuring production high quality coal.

4.1. Typical circuits

A typical flowsheet of washing +20 mm steam coal is presented in Fig. 2.

Fig. 3 presents the flowsheet of a modern plant for washing and desulfurization of fines.

A typical technological flow sheet of coking coal washing with is presented in Fig. 4.

4.2. Latest trends

- replacement of thermal drying for mechanical dewatering, which reduce the emission of dust and gases into the atmosphere and consumption of coal or other fuels for their own needs or to reduce employment,
- automation of coal preparation process for the regulation parameters enrichment, changing transport system and method for storing (system of selective storage saleable coal),
- increased production of environmentally friendly coal,
- employment optimization,
- automation and visualization of production processes to help reduce employment and cost of processing.

5. Conclusions

Coal preparation plants existing in the mines fulfil their task with regard to efficiency and technology. However, they require successive modernisation activities and investments to improve particular process circuits and reduce production costs. There is need to improve coal quality monitoring and stability of the feed quality and products of coal preparation with particular attention paid to the variety of marketable grades.

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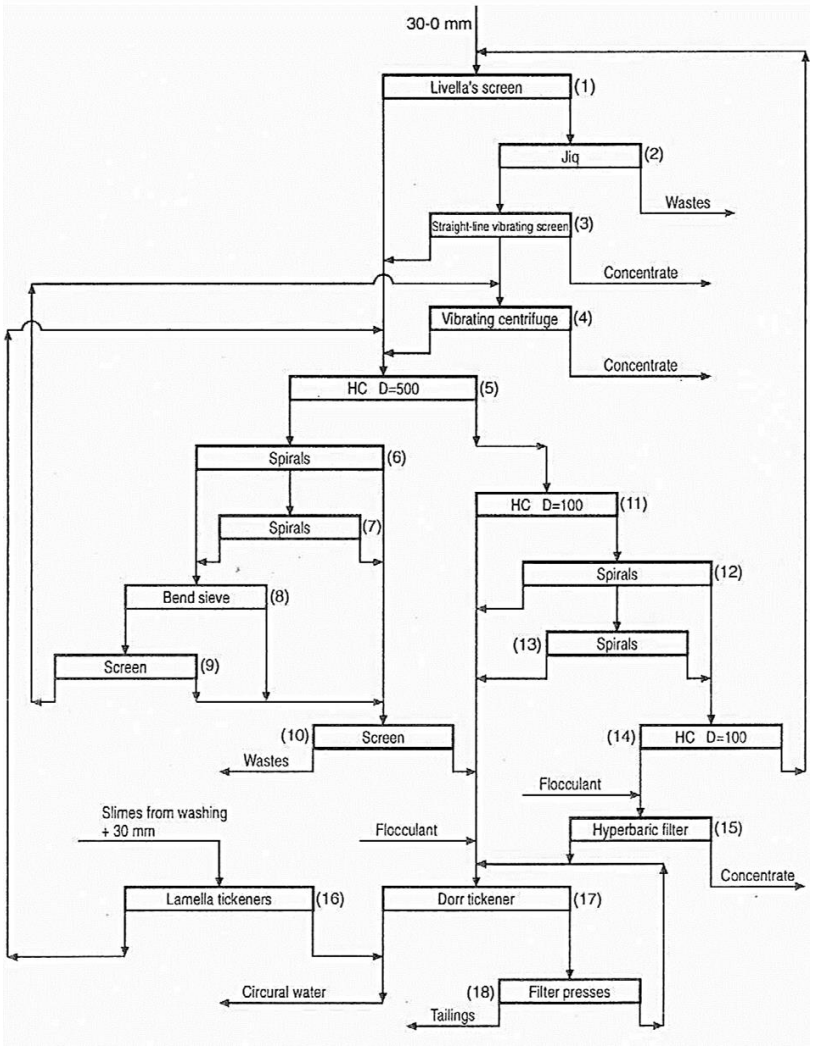

Fig. 2. Flowsheet of coal fines preparation and desulphurization process

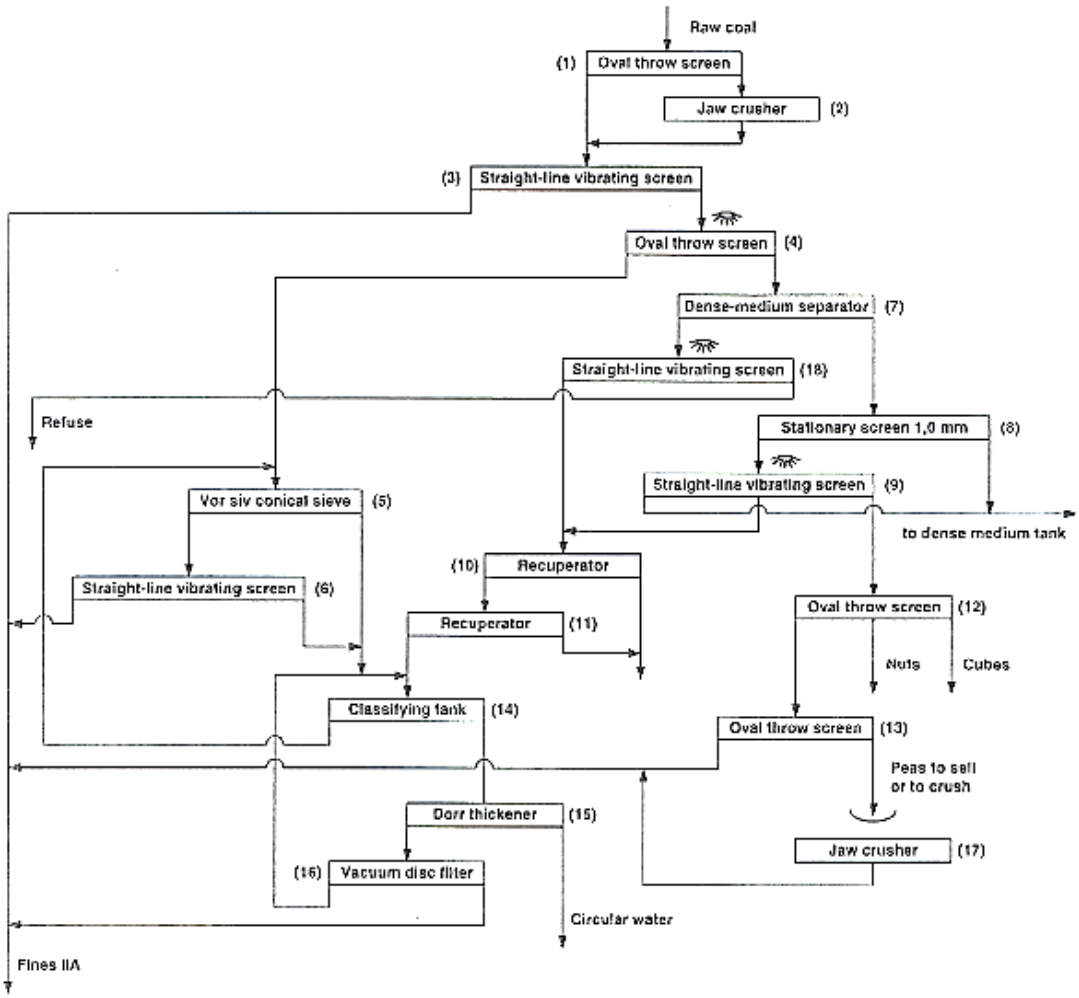

Fig. 3. Flowsheet of a Polish steam coal preparation plant

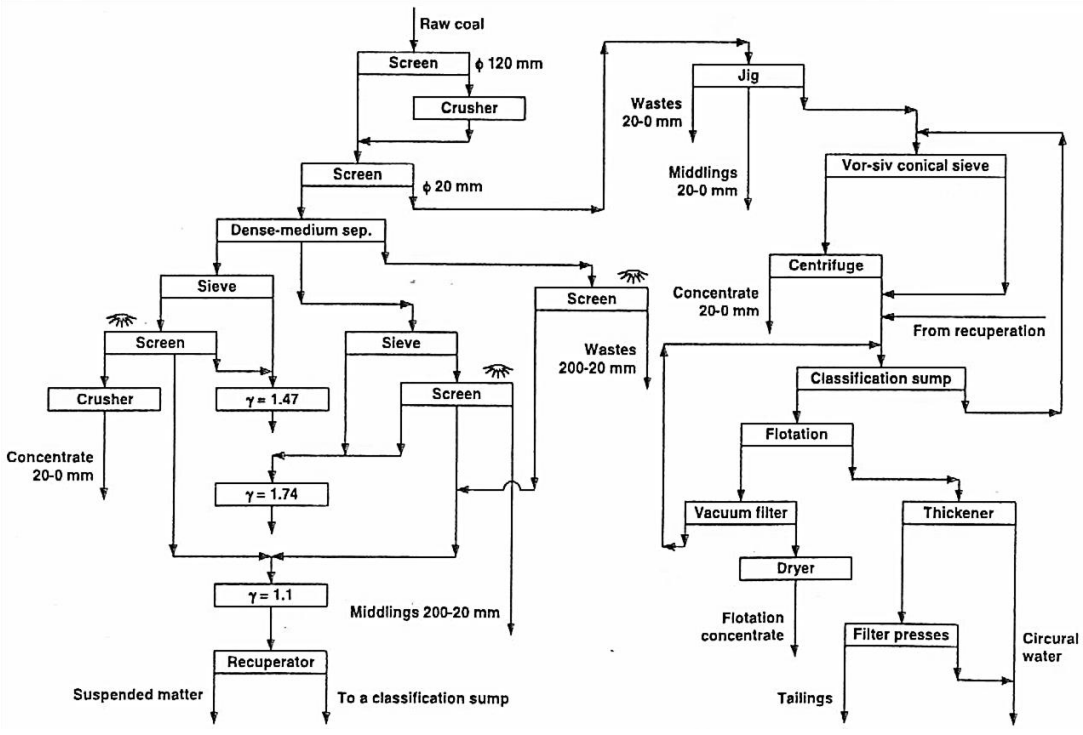

Fig. 4. Flowsheet of the coking coal preparation plant