Present conditions and trends of the development in coal processing at the Kolubara coal mine – Serbia

***Zoran Djordjevic*[1], *Rudolf Tomanec*[2] *and* *Andja Spasic*[3]**

Súčasné podmienky a trendy spracovania uhlia v uholnej bani Kolubara-Srbsko

The economic development of Yugoslavia and later the development of Serbia in the period of economic sanction, have defined the situation in the industrial branch of energy supply and, therefore, the situation in the coal processing at the Kolubara Coal Mine, Serbia.

The accelerated growth of production capacities, the development and the use of devices and machines of ever greater unit capacities,the investigation of the use of coal in other fields, (not only for thermal power plants) is the characteristics of the development until the 1990s. The period of the development of the mine until its restructuring is characteristic for extremely low prices of coal, electric power, wages, and, in consequence of the absence of the development, also the outdated equipment.

The study on the long-term development programme, mining and processing of coal at Kolubara until 2020 has defined the future course of the development of processing, the changed concept of coal valorization and the introduction of new technological processes.

Key words: *coal processing, Wet separation,*

Introduction

The paper gives a retrospective presentation of the coal processing plant (Wet Separation and Drying Facility) in Kolubara - the largest coal mine in Serbia.

Due to the lack of liquid, gaseous and quality solid fuels, a massive winning of brown coal type was turned to, as the basis of the Serbian energy system. With its four open pits and 26 million tons of the annual production, Kolubara supplies coal to several large thermal plants situated in the close vicinity.

A minor portion of the coal is processed and dried, by applying the Fleissner's process, for the needs of the market and industries. In that way, coal of higher quality is obtained in an artificial manner.

By the mid 1990s, during the economic crisis and sanctions imposed on our country, there was stagnation and then a decrease in the production of all the plants. Lacking funds caused the stopping of the development and of the planned investment projects.

At the beginning of 2000, the «Long-term Development Programme of Kolubara Mines until 2020» was adopted, with a special consideration on the development of coal processing plants. The research surveys have shown that the Serbian market required around 2 million tons of quality coals a year, so that this programme foresees an extending of the existing Drier Plant, as well as the building of a new plant for drying of coal.

Wet Separation

The plant for the wet coal purification in Kolubara mine was established by the end of 1956. The technology of French «PIC» Company was decided for, of 450 t/hr capacity of raw coal, where the cleaning of coal was carried out in a dense environment of „DREWBOY"-type facility, with magnetite used as a suspending medium. In the course of the exploitation and some reconstructions, the plant's capacity has been increased to 520 t/hr, and in search of a more economical medium and lesser transport costs, etc., magnetite has been replaced by the quartz sand. In the course of 1986 and 1987, a serious plant reconstruction was carried out so that since 1988 the plant has worked with the capacity of 850 t/hr.

The technological scheme of the plant comprises a double-phase crushing and sifting to the size of 150 mm. The final sifting enables two size classes: - 30 +0 mm which is immediately driven to the thermal plant, and – 150+30 mm which is directed to cleaning, with two products obtained: clean coal and waste. After rinsing, clean coal as a final product is directed to drying. The plant acquired its maximum production capacity by the end of 1980s and of the beginning of 1990s, while later on, the production was decreased due to the difficult economic situation and the sanctions imposed during that time. Thep roduction growth and the gradual reaching of the maximum capacity was commenced at the beginning of 2000.

[1] *Zoran Djordjevic, B.Sc. Eng.*, "JP Kolubara" 11550 Lazarevac, Serbia & Montenegro, djtamara@EUnet.yu
[2] *prof. Dr. Rudolf Tomanec*, Faculty of Mining and Geology, Belgrade University, 11000 Belgrade, Serbia & Montenegro, tomanec@rgf.bg.ac.yu
[3] *Andja Spasic B.Sc. Eng..*, "JP Kolubara" 11550Lazarevac, Serbia & Montenegro, majana@absolutok.net
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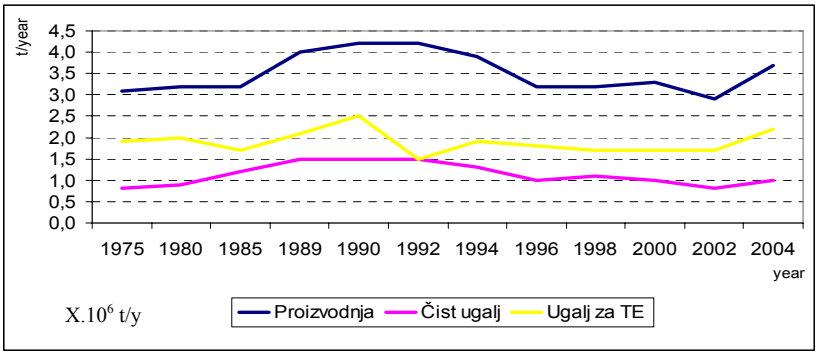

Fig. 1. Wet separation production in the period 1975 – 2004 X10⁶ t/y

Tab. 1. as well as Diagram 1. show the Wet Separation production in the previous years, with quantities of clean coal for drying purposes and small-size coal for thermal plants' needs. By the end of 2002, the overhaul of a 110 MW block in Kolubara thermal plant was completed. It was damaged during the bombing in 1999, and the overhaul caused an increase of the production in that period.

Tab. 1. The production X.10⁶ t/y of Wet Separation in the period 1975 – 2004

Year	1975	1980	1985	1989	1990	1992	1994	1996	1998	2000	2002	2004
Production	3,1	3,2	3,2	4,0	4,2	4,2	3,9	3,2	3,2	3,3	2,9	3,7
Clean coal	0,8	0,9	1,2	1,5	1,5	1,5	1,3	1,0	1,1	1,0	0,8	1,0
Coal from TPP	1,9	2	1,7	2,1	2,5	1,5	1,9	1,8	1,7	1,7	1,7	2,2

Coal Drying

The process of coal drying was initiated in September 1957. Drying of larger class coal (-150+30 mm) has been performed according to Fleissner's proceeding, in closed vessels – autoclaves. This technological process was achieved at lower temperatures and pressures, so that the quality of dried coal was poor. At the end of 1986, the building of a new drying facility with 16 autoclaves of 855.000 t/hr capacity was completed. It had different operating parameters (30 bar pressure and 234°C temperature) which had an effect on the quality of the dried coal (i.e. the damp content was reduced to 23%).

In the first years of the operation, the plant used to reach its designed capacity but at the beginning of 1990s, the production started decreasing due to the same reasons as in the wet separation plant. In 2001, the replacing of the worn-out equipment was initiated, so that, among other items, all 16 bidons, delivered by the Slovakian «SES» company, have been replaced.

The plant reconstruction phase to follow, envisaged extension of the capacity to 1.0 million tons per year, as well as installation of four new autoclaves so that the number of autoclaves would be increased from 16 to 20. A change of the plant control manner is also envisaged (replacement of the automatic and electronic systems). Tab. 2. and Diagram 2. show the dried coal production in previous years, giving also the quality of dried coal in that period.

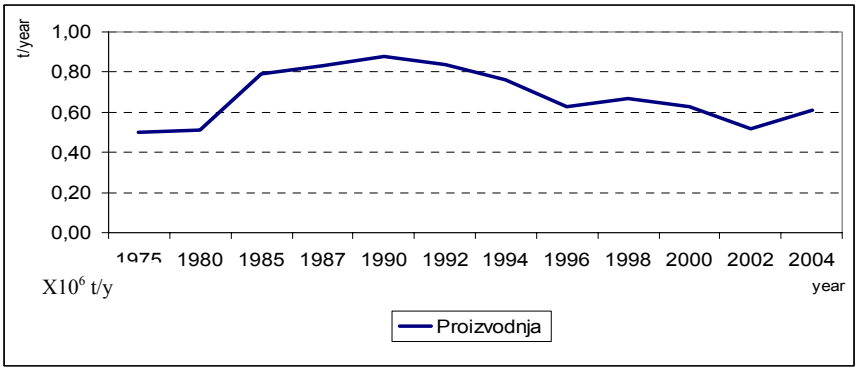

Fig. 2. Drying plant production

Tab. 2. The production of Drying plant in the period of 1975 – 2004

Year	1975	1980	1985	1987	1990	1992	1994	1996	1998	2000	2002	2004
Production [X10⁶ t/y]	0,50	0,51	0,79	0,83	0,88	0,84	0,76	0,63	0,67	0,63	0,52	0,61
W [%]	31,17	32,49	31,19	30,94	27,90	22,55	22,80	23,20	27,10	27,30	25,90	23,50
DTE, [kJ/kg]	15,830	14,566	15,274	15,328	16,355	18,076	18,010	17,952	16,413	16,514	16,877	17,755

The Long-term Development Programme to 2020

Extending of the Existing Drying Plant

In 1995, an investment programme was brought for extending the existing drying plant to 1,0 million tons per year. The programme envisages completing of the fifth group of autoclaves, which requires the completion of the existing building, the replacement of the electric equipment for the automatization and control, and provision of new technological-machinery equipment. According to this programme, the required investment is 8,6 million euros, excluding the issue of the waste waters purification. In 1994, a study was elaborated for extracting of solid particles from waste waters, while in 1997 the main project was made foreseeing a 1,5 million euros investment, with additional 1,4 million euros for the process of phenol removal by the biological treatment.

Alternative Technologies of Coal Drying

The energetics development strategy the foresees production of 2,0 million tons a year of dried coal, which implies the building of a new drying plant of 1,0 million tons per year.

The basic criteria established for the future process are as follows:

- the drying process selected should produce an array suitable for the combustion processes in both the industry and homesteads
- the selected process should also use coal classes smaller than 30 mm
- high ecological criteria should be satisfied, especially the waste waters treatment.

Three technological coal-drying procedures have been considered:

a) MTE – the mechanical-thermal procedure
b) Convective drying in rotational driers
c) Drying in rotational tube driers

a) *MTE – Mechanical-thermal procedure* shown in Fig. 1, represents an interesting option to the present-day coal drying processes. The coal damp is removed in the form of liquid by a combined application of heating and mechanical pressure. Such a proceeding requires a far less energy, while higher economical effects are achieved by the following process phases:
   - o Preheating of coal by water from the phase of mechanical displacement and collecting of the produced cold water
   - o Coal heating by the saturated low pressure vapour condensate to the temperature of about 200 ^{o}C
   - o Water displacement by applying a mechanical pressure of up to 60 bar collecting of the produced hot water into the storage tank.

The specific advantage of this procedure is that it also enables drying of small-class coal particles of below 30 mm.

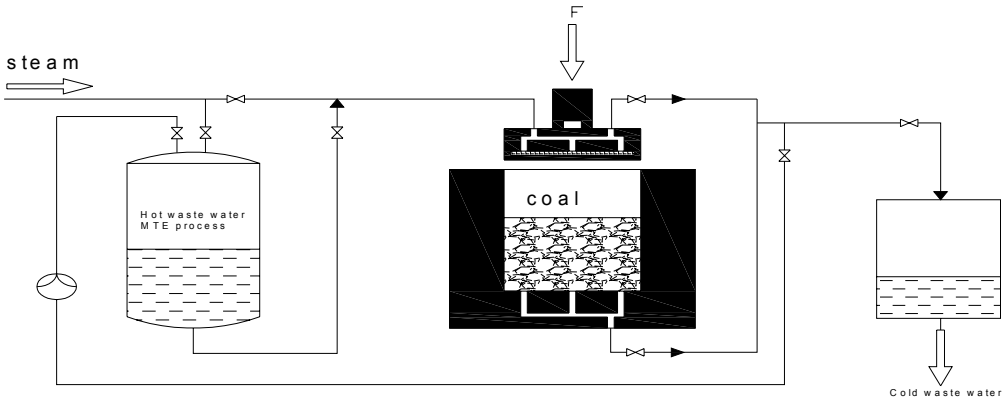

Fig. 1. Mechanical-thermal procedure drying coal

In 1996, a complete building of drying plant, based on the MTE process of 170.000 t unit capacity, was offered at 12,5 million euros.

A major shortcoming of the described process is that no industrial-size plants have been built so far, leaving us without the possibility to get experiences obtained in such a plant exploitation.

b) *Convective Drying in Rotational Driers*

In case of convective drying, the energy required for vaporizing water is transmitted to coal by hot gases. In the process, hot gases are cooled, taking vaporized water into the atmosphere. This is a highly applied process of brown coal drying. The experiment of convective drying in «CER» - Serbia rotational drier was conducted on two size classes: -120+80 mm and -80+30 mm. Dried coal was obtained with about 50 % of -5 mm class. Although the average content of damp in the dried coal was about 22 %, it was noticed that in larger size classes (-80+40 mm), the damp content remained at even 48 %.

It may be necessary to combine such a process with some of the coal particles augmenting processes (briquette forming), as shown in Fig. 2.

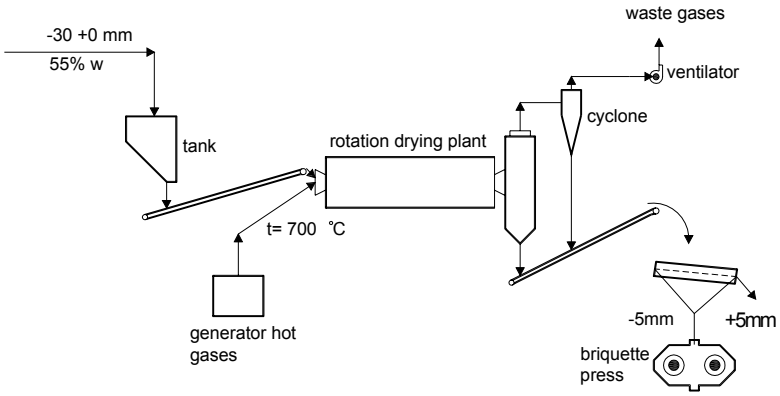

Fig. 2. Convective Drying in Rotational Driers

c) *Drying in Rotational Tube Driers*

This drying process holds a dominant place. The energy required for drying is provided by the low pressure vapor which condensates on the outer surface of the tubes through which small-size coal runs, while slightly slanted drum rotates around its vertical axis. Vaporized water is taken away by the air in the direction of the coal movement.

High capacity driers of 4,100 m^2 heating area capacity are introduced today. Their diameter is 5,6 m, with 8 m length and about 280 t mass. There are 1600 tubes of 100 mm diameter in the cylinder.

Mainly the 10 mm size coal or smaller is dried there. An implementation of rotational driers in Kolubara would open the possibility of drying small-sized brown coal classes, which would be transformed, (after briquette forming), into a high quality product.

The technology of this kind (implemented in Germany), has fulfilled the high ecological standards set for the environment protection.

Dried Brown Coal (-5 + 0 mm) Briquetting

Due to the problems in the selling of this assortment, obtained by classifying dried coal, (produced in the quantity of 70.000 tons a year), the long-term plan envisages the building of a briquette-forming plant.

This project is in the phase of internal audit, while the estimated investment, including imports of a second-hand equipment, is 4,0 million euros for the construction buildings and about 2,5 million euros for the technological equipment and machinery.

Conclusion

Extending of the production capacities of the existing drying plant and building of the new one, is the main objective of the further coal processing process, with a special consideration given to the selected technological procedure, bearing in mind both the rendered assortment of products and the manner of the resolving the waste waters purification issue.

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