INTRODUCTION A NEW SELECTIVE WORKING METHOD IN ODER TO IMPROVE THE RANK OF COAL IN THE "TAMVANA-ISTOCNO POLJE" SURFACE MINE

"TAMVANA-ISTOCNO POLJE" AÇIK İŞLETMESİNDE KÖMÜR KALİTESİNİN İYİLEŞTİRİLMESİ İÇİN YENİ SEÇİCİ KAZI YÖNTEMİNİN TANITILMASI

Dusan STOJANOVIC*

Dragan IGNJATOVIC** Milan STOJANOVIC***

ABSTRACT

The advance of the working face in the mininig operations in the "Tamvana-Istoc'no Polje" surface mine has impaired conditions of mining. This is due to increase in the number and the thickness of dirt bands in coal. Currently, there are four clay beds embedded in coal of an overall three metre thickness. If the dirt and the coal are excavated simultaneously, the calorific value of coal falls rapidly (from 8.000 to 4.000 U/kg), whereas the percentage of ash increases. All this causes big problems in the thermoelectric plant opereation.

OZET

"Tamvana-Istoc'no Polje" açık işletmesinde kazı annının ilerlemesi ile madencilik giderek güçleşmektedir. Bu durum kömürdeki ara kesmelerin sayı ve kalınlığmın artmasından kaynaklanmaktadır. Halen toplam kalınlığı 3 m. olan kömür içersinde dört kil tabakası mevcuttur. Ara kesme ve kömürün birlikte kazılması durumunda, kömürün kalorifik değeri hızla düşmekte (8.000'den 4.000 kJ/kg'a), buna karşın kül yüzdesi artmaktadır. Tüm bunlar termik santralın işletilmesinde büyük problemlere neden olmaktadır.

* Professor Dusan STOJANOVIC, BSc MSc PhD, Min. Eng. University of Belgrade
** Dragan IGNJATOVIC, BSc MSc PhD, Min. Eng. University of Belgrade
*** Milan STOJANOVIC, BSc Min. Eng. Public Company State Electricty Serbia

1. INTRODUCTION

The "Tamnava-Istocno polje" (east field) surface pit is located in the eastern part of the Kolubara coal basin (in Serbia). The designed capacity of the pit is 11,4 x 10^6 tonne of coal per year. It has been constructed in order to supply the thermoelectric plant "Nikola Tesla" of 2 x 615 MW power. Within working limits the coefficient of overburden, that is, the ratio between the coal and the dirt is 1: 0,8 t/m^3 (Figure 1).

In the early period of coal mining (year 1979) certain problems with dirt bands arose. That is to say, there,was a comparatively thick and conspicuous sand pack in the coal. Its distribution being relatively limited, the problem was solved by selective excavation and disposal into the surface waste heap. In the next ten years coal mining was comparatively simple since there were no thick dirt bands in this mining area.

In the present time problems with dirt bands arise again. More exactly, unselective, bulk mining of coal from the roof portion of the seam at the western boundary of the pit is of a quality which does not make possible combustion without the assistance of fuel oil. The problems are particularly pronounced when extraction is carried out in bad weather condition. The method is, therefore, adjusted so that this portion of the seam is being excavated only during summer months.

In this way the problems were temporarily solved. With further advance of the working face towards south, sand packs occur within the whole length of the coal seam. At first, the problems arose only in the western part of the mining field. With the advance of working towards south, dirt band spread up to the eastern boundary of the pit.

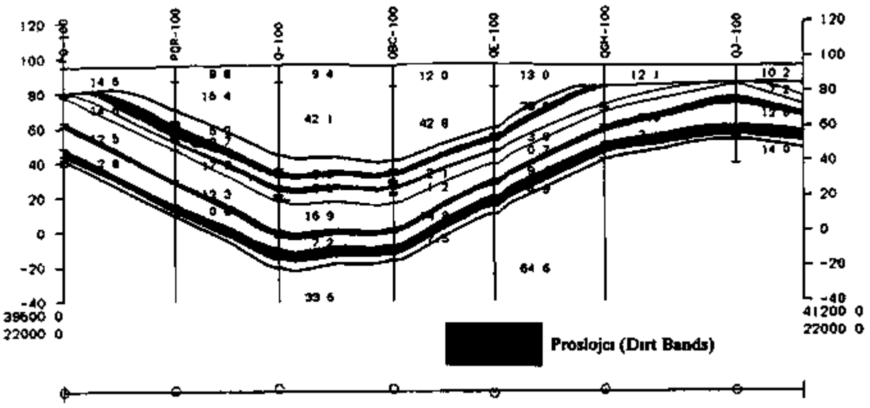

Figure 1. Distribution of dirt bands in the "Tamvana-Istocno Polje" surface mine.

2. MINING OPERATIONS

In such working conditions, without adequate machinery, serious problems arose due to the decrease in calorific value of coal. In electric plants this meant increase in the use of fuel oil, more intensive use of all the mills, and serious troubles in ash-removal. Table 1 gives the trend of coal quality decrease, as well as the ratio between the quality and the specific consumption of coal.

Table 1. Specific consumption and quality of coal for thermoelectric plants
* Start of selective excavation

Year	Specific consumption of coal kg/kWh	Calorific value of coal kJ/kg
1984	1.27	8169.58
1985	1.28	8007.58
1986	1.33	8045.58
1987	1.31	7940.22
1988	1.35	7796.97
1989	1.31	7862.62
1990	1.32	7752.47
1991	1.33	7755.96
1992	1.39	7411.75
1993	1.40	8002.55*
1994	1.42	7932.5
1995	1.44	7509.00

In order to partially compensate for the problem, the coal winning method has been changed.

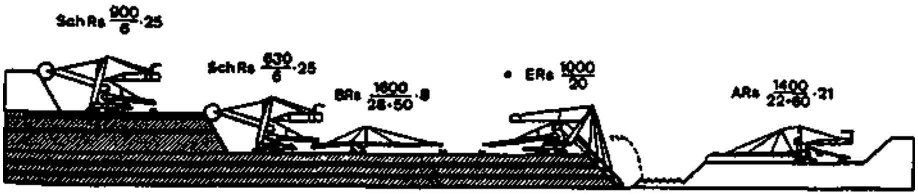

Figure 2. Technological working scheme in the "Tamvana-Istocho Polie" surface mine.

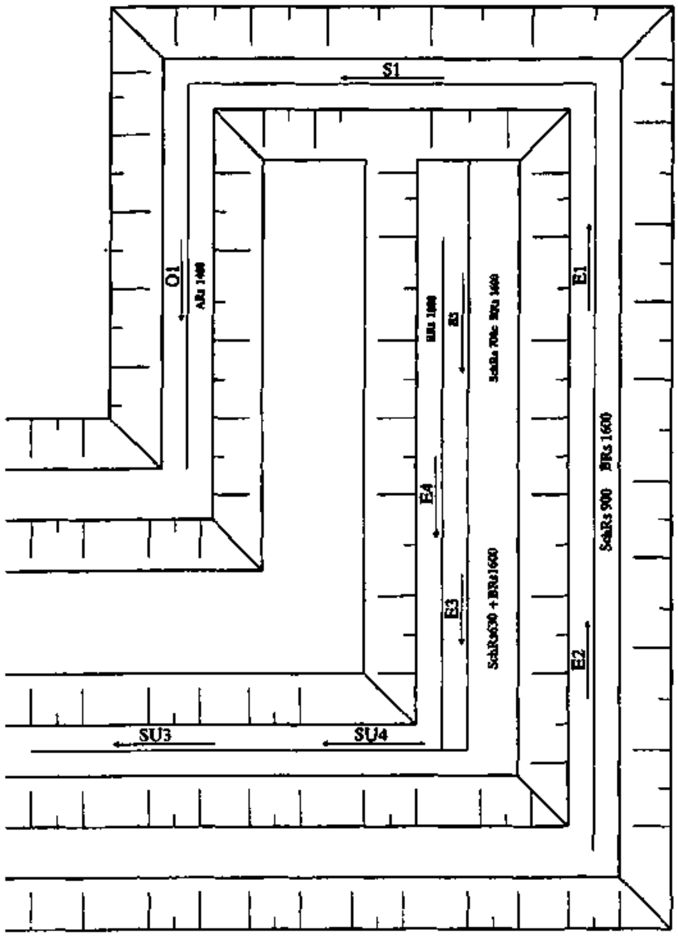

Figure 3. Present machinery distribution in the "Tamvana-Istoc'no Polje" surface mine.

Selective coal winning has been started both on the high bench and on the deeper bench. At the high block, with two SchRs 630x25 and SchRs 700c bucket wheel excavators, selective mining of bands were carried out only from time to time and were always forced after the thermoelectric plant had warned that the coal was of poor quality. In the cases when the working was not selective, dirt bands were divided into two parts and excavated in two sublevels. When, on the contrary, it was selective, the waste was disposed on the working level.

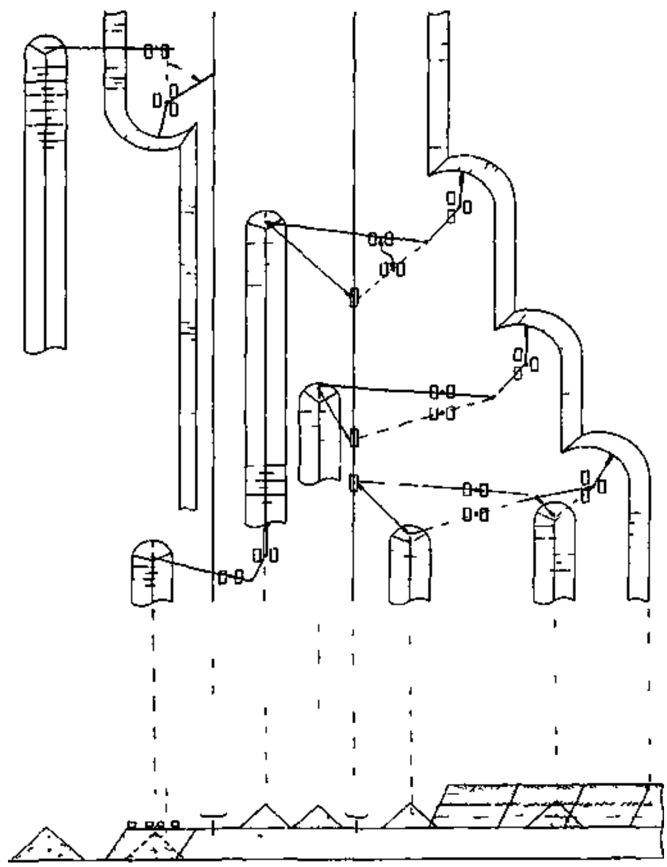

Figure 4. Technological scheme of working with multiple dumping.

This method of disposing of the waste from the band into the working level resulted in the considerable complication of the technological scheme. Up till then it was very simple and provided a great number of free combinations of machine operation, owing to favorable geological canditions. Dirt bands from the first and the second blocks were mamly dumped between bench conveyor belts. The dirt band from the third block was dumped into the excavator bench (Fig.4). This selective working implies multiple dumping of wastes till their disposal into the excavated area by the use of one excavator and one automotive conveyor (Fig. 4).

The greatest problem in dumping arises when the disposed amounts of dirt are exposed to weather for a longer time. Then their stickiness increases due to the increase of moisture, and the excavation and disposal are made by considerably more difficulty, while the excavator's utilisation of time and capacity drops significantly. Table 2 gives information on the SchRs 700 excavator operation of overburden stripping and dirt bands excavating and dumping.

Tabic 2. Indicators of SchRs 700 excavator extracting and dumping of bands

Excavated material	Average capacity (m^3/h)	Coefficient of utilisation time
overburden	1.600	0.51
coal	1.100	0.48
embedded dirt bands and dumping of excavated material	390	0.13

3. IMPROVEMENT OF THE COAL QUALITY

Drop in excavator capacity is caused by the sticking of the material to the buckets and the great amount of spillage of the excavated material into the excavator working level. The coefficient of time utilisation is much smaller than the technologically acceptable one, due to frequent delays for cleaning the excavator which gets extremely soiled in such conditions.

For multiple dumping of dirt bands from the bench level a compact SchRs 700(c) excavator is used, with a short bucket wheel boom. Therefore, buldozers pushing the material from both sides cannot stand under the boom to form the route of the excavator while it is working. Thus the operation of the excavator is frequently stopped while it pulls back to allow the bulldozers make the route. This also results in a significant decrease of the excavator's utilisation of time. For such an operation of the excavator, when the dampness of the disposed heaps of dirt increases, two bulldozers are required.

This method of working requires fullfilmentof one condition. In order to dump the dirt into the excavated area, the bucket chain excavator first has to create the area; that is; to extract the coal while dumping the dirt in the direction of its advance.

Deep block is excavated by the Ers I00/200 bucket chain excavator with the aid of the BRs 1600 (28 + 50) x 15 automotive conveyor dumping two dirt bands direct into the excavated area {Figure 5).

This method of working with multiple dirt dumping slightly improves the quality, while also resulting in the consequences described above (reduced use of the SchRs 700 (c) bucket wheel excavator to mine coal while dirt is being dumped). In a way, this method manages to handle large and clearly defined dirt bands without using additional equipment. However, excavation of the roof portion of the coal seam, 2 to 6 m thick, with several alternating bands of coaly clay and clayey coal, still remains a problem. The quality of this composite seam is insufficient for normal combustion in a thermoelectric plant. Fuel oil must be additionally used, especially in adverse weather conditions when the percentage of moisture increases during transportation. In solving the problem the possibility of selective working should be excluded as technically unfeasible. Equally, dumping of the heaps into the excavated area should be avoided, because they mean large amounts of combustible material which form the balance mine reserves. Therefore the solution of the problem comes to homogenization which is now typical (finding the way to clean the coal in future).

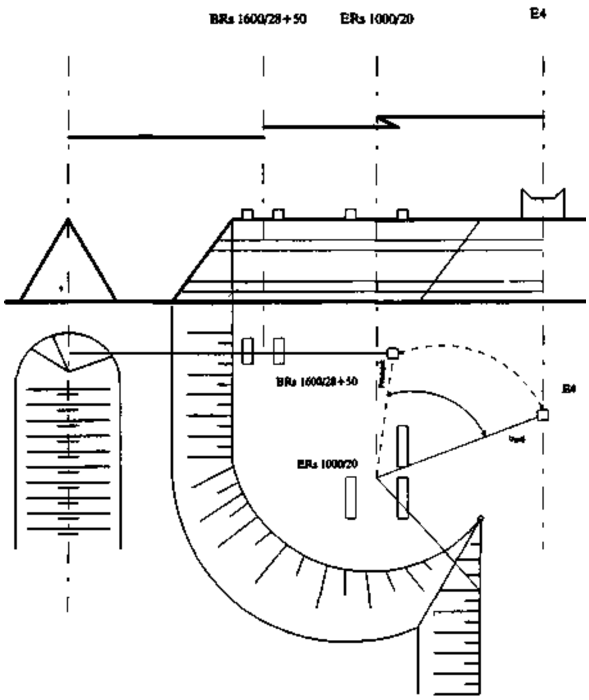

Figure 5. Technological scheme of bucket chain excavator.

Homogenization implies simultaneous excavation of the mentioned thin part of the coal seam with one excavator (usually SchRs 630 25/6) and excavation of a better quality coal portion with another excavator or excavators. In this kind of work it is necessary to match the excavator capacity in order to achieve satisfactory coal quality, that is, the calorific coal value of 6000 KJ/kg.

The capacity of a bucket wheel excavator working the poor quality coal is usually reduced to under 1/2 of the nominal. In this operation the following relations must be satisfied:

$$k = \frac{Q_l T_l + Q_d T_d}{Q_l + Q_d} \geq 6000 kJ / kg$$

where:

Qi- excavator capacity when working poor quality coal (t/h)

T_r calorific value of poor quality coal (KJ/kg)

Qd - good quality coal (t/h)

T_d - calorific value of good quality coal (KJ/kg)

T_k - calorific value of the composite (KJ/kg)

If we take that Tj and T_d are relative constants for the duration of one excavator feed, and that Q_d is the technical capacity of the excavator that can also be taken as a constant, by solving the Qi of the equation we can determine the required excavator capacity in poor quality coal in order to obtain the given value of the camposite seam.

To solve the problem by means of the SOL programme package, mathematical model of the "Tamvana-Istocno Polje" surface mine has been made. It describes distribution of dirt bands and the quality of coal depending on the method of selective working (5 variants - from bulk mining to selective mining of smallest bands). The coal seam has been divided vertically into the upper and the lower parts. The lower part is worked by the Ers 1000/20 bucket chain excavators; the upper part is worked by the SchRs 630 and SchRs 700 bucket wheel excavators. A miniblock chart has been made (20 x 50 m). The following data have been shown for the each block: block number, volume, coal quantity, dirt quantity, moisture, ash, bottom calorific value (Fig.6). By the use of this programme it is possible to determine the quality of coal from each cut or section in any part of the deposit. Application of the above farmulae and the SOL programme enables obtaining of the composite seam of a required quality by determining the capacity of the excavator working in poor quality coal by means of the elements of cut or section.

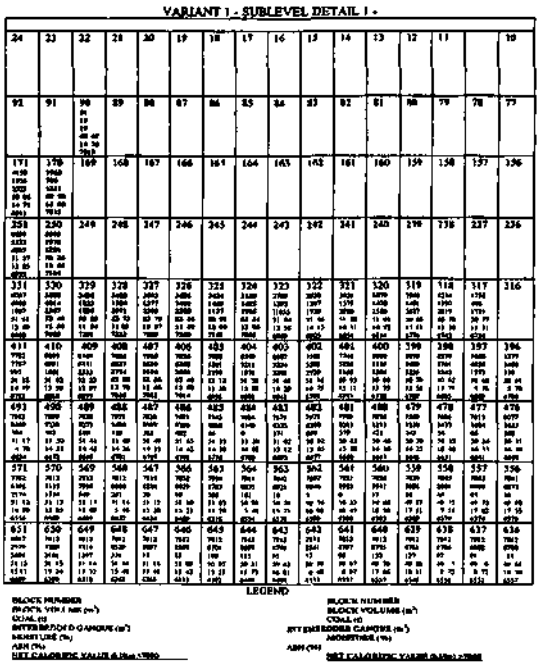

Figure 6. Miniblock chart.

The preceding presentation of the development of excavating technology and the ptesent method of operation shows that the simple and flexible present method is obsolete due to impaired geological conditions in the deposit. It has become a complicated and a very dependable techonology. In other words, the degree of technological freedom in determining the most favourable method of coal mining has been considerably reduced. It was, therefore, necessary to develop the method of selective working on one side, and of coal homogenization, on the other. This solution had to be simple, functional and had to avoid longer delays in coal mining. The standard solution introducing deflecting belts or distribution stations implies a long period of time, a lot of money and a delay for reconstruction and supply of at least one more belt. Besides, one of the two drives in the "Tamnava-istok" would be redundant. As a solution, construction of one comparatively small conveyor belt has been proposed. With the introduction af another small canveyor belt into the system and a somewhat modified technology, it would satisfy the requirements. Construction and method of operation of the belt are shown in Figure 7. Figure 7 shows the first stage of the selective working method; Figure 8 shows the final stage of the selective working.

As shown in Figure 8, in the first stage the deflecting belt would be located between E3 and E6 conveyor belts. When the coal is on the E3 floor conveyor belt, it would be switched out and the coal would be dumped into the SU4 collecting belt convoyor. When the dirt is on the E3 bench conveyor belt, the deflecting belt put under the E3 bench conveyor belt which conveys the dirt to the E6 belt. From the E6 belt the dirt is dumped to the tow of the western end overburden slope. According to the reclamation plan, a 15 m high, 70 m wide and about 700 m long overburden block, is to be disposed there.

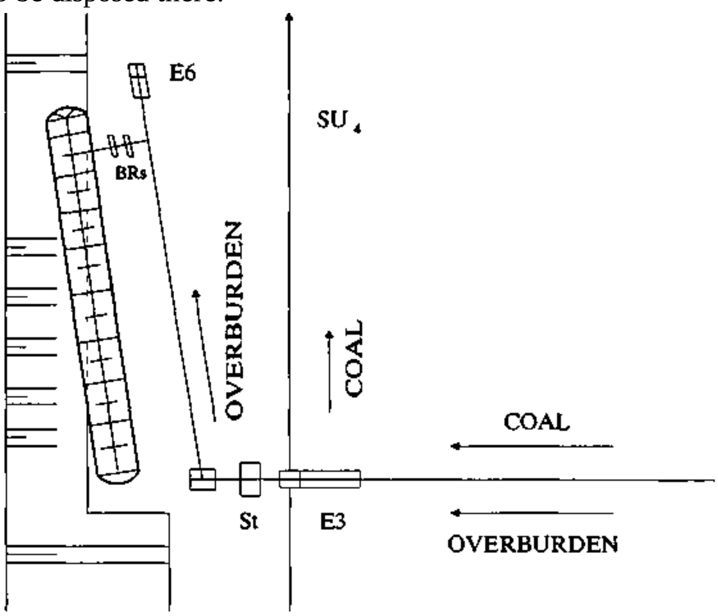

Figure 7. The first stage of selective working with a deflecting belt.

In this way, the problem of selective woiking is solved for a certain time by only one conveyoi belt (E6). This is presently the only possible solution, since "Tamnava-istok" has only one free belt, while time and money would be needed to provide a new one. This method of selective working also settles the question of reclamation of the western slope which slipped in 1993 and is still unstable constantly threatening to imperil the main haulage road.

The deflecting belt has been constructed with its own pontoon which makes it flexible. Being connected to the bench conveyor belt with supply and blockage cables only, it can be easily removed separately, wherever and whenever necessary. In the second stage,, use of two deflecting belts and two belt conveyors has been planned, as shown in Figure 8. This means that, upon dumping to the tow of the western slope has been finished, dumping of the material into the excavated area begins. During the first stage of working it is necessary to set another bench conveyor belt and another deflecting belt. Only after this can reconstruction of the conveying and dirt disposal system be done as a part of annual overhaul.

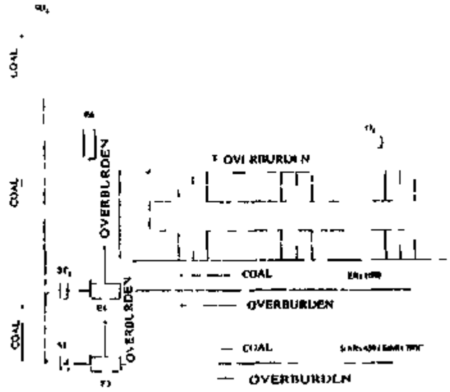

Figure 8 The second stage of selective working with a deflecting belt

In the course of stage II the deflecting belt is always in operation when coal is conveyed by the bench conveyor belt, which requires reliability of the new construction. It is necessary to remove all the shortcomings of the new solution during stage I, because then they still do not essentially hamper the winning of coal. During the first stage the Brs 1600 (28 + 50) x 15 automotive conveyor working together with the SchRs 630 25/6 bucket wheel excavator would be used for dumping. This would result in moving the bench conveyors after each excavated block. In the second stage, when the deflecting belt is introduced along with the E4 bench conveyor belt, the need to connect the automotive conveyor to the bucket chain excavator ceases.

3. CONCLUSION

Introduction of a new technology for selective working currently solves numerous problems. That is, the new technology enables peak utilisation of excavators, avoids problems related to the rank of coal, ensures a part of the western slope, makes possible homogenization of coal in the pit itself. All this is possible to achieve by using the existing equipment and with little money required for two deflector belts.