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C O N T E N S

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COAL OVER DRYING AND DEDUSTING OF SECTION OF DRIER BRANCH „PRERADA“, PD RB „KOLUBARA“

Mr Zoran Kulić[1], mining engineer, SnežanaVuković[2], master mining engineer

1. INTRODUCTION

Processing and refining of raw coal from surface mines Field "B" and "D" of Kolubara basin, is carried out in order to obtain the required range for the supply of thermal power plants, widespread consumption and industry and heating plants, in the context of branch "Prerada", for more than 50 years.

The process of coal processing begins with the so-called wet separation, raw coal is cleaned in difficult environment, in the suspension of sand and water and is prepared for the drying process. By system of conveyor belt, cleaned coal from Wet separation is delivered in a dryer where coal drying is performed in a cylindrical autoclave (steel vessels) with saturated steam, at high pressure and temperature. The designed capacity of the dryer is 855 thousand tons. After completion of the drying process in the autoclave, coal empties into the bunker for over drying, in which it is being cooled and dried. During the process of autoclave emptying and temporary storage of hot coal in bunkers for over drying, developed steam edges which generate overpressure, thus contributing to the penetration of steam and coal dust, especially at the time of discharge of the autoclave, into surrounding workspace.

The paper deals with the process of dusting of dried coal, which is over dried in bunkers at the end of the drying process in an autoclave. An analysis of the negative and positive experiences are given in organizing prevention activities to reach better, more quality and more efficient solutions with special emphasis on the importance of the quality of installed equipment in order to protect the environmental and health and safety at work, as well as maintenance of equipment during service in the prescribed manner.

2. DESCRIPTION OF THE DRYING OF THE KOLUBARA LIGNITE

The process of the coal drying is based on the Fleissner process, which squeeze water out of coal, carried out under saturated superheated high pressure steam. By Closing the lid of the autoclave begins the drying process of lignite in the narrow sense, which lasts 148 minutes. It is developing through the following technological steps:

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Table 2/1, Technological steps

TECHNOLOGICAL STEP	DURATION OF OPERATION (min)
First preheating, so-called showering with waste water from an adjacent bottle cage.	**29**
Second, preheating via overflow pipe, partially fabricated steam from some of adjacent autoclave.	**8**
Bringing fresh steam into autoclave.	**29+8**
Maintenance of parameters of working pressure, until the extrusion of water from coal process is completed.	**29**
First relief of the autoclave by opening the overflow pipe, by which is partially made steam supplied to some of the neighboring autoclaves.	**8**
Second relief by opening showering pipe, by which the water from bottle cage is directing adjacent to one of the adjacent autoclaves.	**29**
Draining and filling of the autoclaves.	**8**

Coal drying is carried out in a 16 autoclaves, grouped into four working groups. Each autoclave within the group, as shown in figure 1 has an own bunker of washed coal, pendent tank (bottle) and bunker for coal drying.

Once cured in an autoclave, coal empties into the bunker for over drying (DF 301), in which is carried out its over drying and cooling. The cooled dried coal is then, with the help of electromagnetic vibrating feeder, emptying onto a conveyor belt TB 100, which carries out the coal from object “Nova sušara”. Work of the autoclave starts by filling the autoclave with washed lignite size -150 mm + 0. Emptying of the bunker (101 RF), which is pre-filled with about 117 t of washed coal by conveyor (RB 201), is performed by a rod (DR 101). Cease of charging by closing the latch and by lifting the rod with hydraulic cylinders, initiates radiometric probe for the measurement of the upper level of coal in the autoclave.

The designed parameters of dry saturated steam which cures coal are: pressure of 30 bars and temperature of 234.6° C. From 2002, drying parameters have been reduced to the pressure of 25 bars and a temperature of 224° C.

Upon completion of the drying process, the coal is transported to the bunker for over drying, in which is carrying out its over drying and cooling. During the process of emptying the autoclave and temporary storage of hot coal in bunkers for over drying, the edges of the steam is developed and they generate overpressure, thus contributing to the penetration of steam and coal dust in the ambient workspace. In the bunkers for over drying, the coal cooling from temperature of about 110° C to a temperature of about 40-50^{o} C is carried out, which enables safe transportation and storage of dried coal and extraction of the edges of the steam and dust, cleaning the polluted air and his safe release into the atmosphere. All designed parameters of “Nova sušara” have been proven in the first years of exploitation. In recent years, dryer is working with some smaller capacity.

Some stages of the drying process, it is meant primarily to over drying coal in the appropriate bunkers, didn't respect local climatic conditions, leading to a malfunction of this system of coal drying. The problem of dustiness of other parts of the Dryer was solved but unsuccessfully.

"Kolubara – Prerada" has commenced activities in 2005, which ultimate goal was bringing the process of coal over drying in proper condition and dedusting all parts of the plant. A preliminary design was created, and based on that, in the year 2006. Finnish firm Pnneumatic OY, with subcontractors, prepared documentation: "Additional mining project for the reconstruction of the system for coal over drying and systems for wet dedusting in facilities for production, storage and screening coal of section "Kolubara – Prerada". A contract that "Kolubara – Prerada" concluded with the firm Pnneumatic OY was a "key in hand".

3. DESCRIPTION OF THE CURRENT SITUATION OF COAL OVER DRYING AND DEDUSTING INTO DRYER SECTIONS

OBJECT "NOVA SUŠARA"

Plant for coal drying, hereinafter referred to as "Nova sušara", was organized into four groups, with four autoclaves in each group. Under normal conditions, in the automatic mode, all working groups work, that is 16 autoclaves. Each group of autoclaves can work in independent automatic mode. It is possible to work with a group of three autoclaves, in case, for whatever reason, to the loss of an autoclave. In addition to the automatic control of the process there is a possibility of transition to manual control of the process, and quickly restore to automatic operation.

After the drying process, the coal is transported to the dried coal bunker and from there to grading where is allocated by assortments. Once cured in an autoclave, coal empties into the bunker for over drying, in which it is being over dried and cooled. During the process of autoclaves emptying and temporary storage of hot coal in bunkers for over drying, the edges of the steam is developed and it generate overpressure, thus contributing to the penetration of steam and coal dust, especially at the time of discharge of the autoclave, in the ambient workspace. In the bunkers for over drying, two progress processes are projected:

- **cooling of the coal from a temperature of about 110° C to a temperature of about 40-50° C, which enables the safe transport and storage of the dried coal;**
- **suction of the edge of the steam and dust, cleaning the polluted air and his safe release into the atmosphere.**

Cooling of coal is carried out in bunkers for over drying, volume of 50 m^3, blowing in about 9800 m^3/h of fresh air. Injection of fresh air is done by ventilator DG 101 through a distribution pipe for the distribution of fresh air. One ventilator was catered all bunkers for over drying for one group of autoclaves. It should be noted that the installation of insertion of fresh air dismantled in 2002, so that the cooling of the dried coal is done no more.

Extraction of the edge of the steam from the bunkers for over drying is carried out through a cyclone for dry dedusting DF 401, with ventilator DG 1, capacity of about 25000 m^3/h.

One ventilator and a cyclone with the appropriate piping and valves serve all four bunkers for over drying of coal inside a group of autoclave. Vapors liberated of coal particles in the cyclone are taken in the fireplace and further in the atmosphere. In the fireplace is scheduled drop in temperature of the outgoing gases and there should be, at dew point, played transition to the liquid phase, which is discharged from the fireplace in the waste water system.

Coal particles separated in the cyclone for dedusting are controlled ejected via cell feeder to the conveyor belt 100 TB and with the dried coal transported to the bunkers. Work of fresh air ventilator and work of the edge of the steam ventilator is synchronized so, that during the process of discharge of coal from the autoclave, performs maximum suction of the edge of the steam and dust. At the time of discharge of the autoclave in the bunker for over drying, as well as discharge of coal on the conveyor belt TB 100, butterfly valve interrupts in-blowing fresh air and working of ventilator for extraction of the edge of the steam creates a vacuum in the bunker, which prevents the penetration of dust and the edge of the steam into the environment.

The designed system for over drying and extraction of the edge of the steam showed many weaknesses. The main reason for the poor functioning of this system lies in its hypersensitivity to the external climatic conditions, as well as unsuitable maintenance due to the lack of expensive imported parts.

In the part dealing with the cooling of coal in bunkers for over drying, firm Voest Alpine has all its calculations based on a constant temperature of fresh air from 20° C. At this temperature, condensation of the edge of the steam was supposed to come only in the fireplace. Taking into account the local climatic conditions, with air temperatures that range between -15° C to +35° C, even higher, the projected temperature of 20° C could be considered as pure coincidence. Elevated temperature of coal, due to insufficient cooling, contributed to an increase in the amount of the edge of the steam, which in turn, caused the wetting of coal dust and its bonding to all elements of the dedusting system. It is indicated increased corrosion of system caused, presumably, by sulfurous acid and a hydrocarbon acid. Elevated temperature of coal increased the risk of spontaneous combustion of coal in bunkers of "Stara sušara". Inserting cold air shifted the dew point, which means it moved condensation place from fireplaces to channels, ventilator and to cyclone of the edge of the steam. This dampened dust glues on the walls of the cyclone and cell feeder, thus preventing it from working properly. Damped dust glued to the blades of the ventilator of the edge of the steam causing not only an eccentric load the ventilator wheel, but also deposited in channels decreasing airflow.

In the facility "Nova sušara" is built system of wet dedusting of conveyors TB 100. His detailed technical information we will not mention because this system is not in operation since 1999. Wet-type separator NAV 2240, manufactured by Standard filterbau, had a capacity of about 30,000 m^3/h, 2000 Pa pressure drop and ventilator power of 75 kW. Dust concentration of 3g/m^3 at the inlet, should reduce to below 75 mg/m^3. There has been sucked all the places of coal ladling from the vibrating feeder to the conveyor belt.

OBJECT "STARA SUŠARA"

In this object were installed two independent wet dedusting systems, which used as the basic unit venturi-scrubere. Closer technical characteristics of the system are not known, nor it is working.

OBJECT "KLASIRNICA"

While classification of dried coal in appropriate assortments, large amounts of airborne coal dust occur. The largest amounts of dust appeared on sieves for sieving R 70a and R 70b and on coal ladling places of rubber conveyor belts and on gravel transporter.

There was implemented a dry dedusting of drive with filter bags with the following characteristics:

- **filter type BETTH – IFJ 45/9-3**
- **capacity 91500 Nm^3/h**
- **pressure drop 3500 Pa**
- **ventilator RM – 100 – N-60**
- **power of electromotor 132 kW**
- **capacity of taking out the dust 0,5 t/h**

Facility of dry dedusting of "Klasirnica" is not in operation since 1998, when the filter is damaged in a fire.

Explanation of the need for reconstruction of the system for coal over drying and the system for wet dedusting in facilities for production, storage and sorting of coal in section "Kolubara prerada", we will illustrate in the best way by overview of the current state of the corresponding systems in facilities of Sušara, as explained in Table 3/1. Description of the current situation of coal over drying and dedusting in the section of Sušara.

Table 3/1 Condition of equipment

Name	Status
The system for insertion of fresh air in bunkers for over drying	Dismantled in 2002.
The system for extracting of the edge of the steam	Partially in use
Dedusting system of conveyor TB 100	Not in use since 1999.
Wet dedusting in Stara sušara	Not in use
Dry dedusting in object "Klasirnica"	Not in use since 1998, Betth filter burned

The drying process of lignite by Fleissner's method with associated operations is known of large quantities of waste water, steam, gas and dust that are generated in different stages of the process. The safe functioning of the process for the environment and the people employed in it or around it, can be provided only by use of complete protection anticipated for the operation of such section. By realization of the Supplementary mining project, parameters of pollution of human living and working environment, should be brought to the limit.

The unsatisfactory state of the device for dust may corroborate with the results of measurements of emissions of harmful substances from Sušara, performed by the Mining Institute in Belgrade, Zemun (Report on the measurement of harmful substances from Sušara and Toplana JP RB "Kolubara" DP "Kolubara-Prerada", 2003). Taking samples of gas for analysis was performed at fireplaces 1 and 2, and from fireplace 4 was performed taking sample of dust. Table 3/2 gives the results of measurement of mass flow of harmful substances from the fireplace on the basis of their mean concentration.

Table 3/2 Mass flow of harmful substances from the fireplace (results of measurement 2003)

Harmful substances	Mean concentration mg/m^3	Average gas flow m^3/h	The average emission when working one fireplace, kg/h	The average emission when working of all fireplaces is simultaneous, kg/h
SO_2	1,75	18756	0,0328	1,131
NO_x	0,11	18756	0,0021	0,008
Phenol	0,124	18756	0,0023	0,0092
Dust	66,82	18756	1,2530	5,01

By analyzing the measured values of harmful substances and their comparison with the maximum allowable concentration values specified in the Ordinance on emission limit values, methods and timeframe for measuring and data records (Gl. RS 39/97) it can be concluded that the measured values of all harmful substances listed in the table, except dust, are in acceptable limits. Emissions of powdery material in a measurement period exceeded the allowed values for 33.64%. It was concluded that the systems for dedusting are not in function.

Results of testing of physical – chemical hazards in working environments of technological complex DP "Kolubara prerada" in the winter and summer 2000, are shown in Table 3/3.

Table 3/3 A summary review of established conditions in working environments for both winter and summer period of 2000

S U Š A R A				
Parameter	Winter		Summer	
	N^O	%	N^O	%
The total number of surveyed working environment	29	100	29	100
Number of environment with negative score	28	96	29	100
The total number of recorded parameters	174	100	174	100
The number of parameters with negative score	92	53	89	51
Negative evaluations of individual harmfulness				
Dust	22	78.6	16	55.2
Hazardous gases	0	0	0	0
Noise	25	89.3	27	93.1
Vibrations	0	0	0	0
Microclimate	21	75.0	25	86.2
Illumination	24	87.5	21	72.4

In Sušara, therefore was tested 29 working environments, and as far as dustiness, in winter period, 22 or 78.6% did not fulfill conditions anticipated by standard for comfortable work of employees.

The need for reconstruction of dedusting systems in all facilities of Sušara is therefore obvious and necessary.

4. TECHNOLOGICAL – DESIGN CONDITIONS AND SUBSTRATES

When preparing the subjective documentation under name "Additional mining project for the reconstruction of the system for coal over drying and system for wet dedusting in sections for production, storage and sorting of coal in section "Kolubara prerada"", designers have used substrates submitted by the investors, the results of various tests and measurements of their own as well as their wide experience in dealing with similar projects. Because of the size and the different levels of processing of these substrates we will not present them at this point, but will be given in the form of special items, at the end of the book I, Nova sušara, Technology – mechanical project.

Technological substrates provided by investors contained:

- **Technical description of the coal drying process with associated operations such as storage, sorting and loading of coal;**
- **Technological parameters that newly designed system for coal over drying and dedusting should achieve;**
- **Technology – technical characteristics of the equipment that is related to the Additional mining project, such as:**
    - **dimensions and operating parameters of the bunker for over drying;**
    - **design parameters of fresh air ventilator;**
    - **parameters of cyclone;**
    - **characteristics of the edge of the steam ventilator.**
- **Review of ladling points, machinery and equipment as the main causes of pollution by dust and gases;**
- **Review of dedusting system as it once existed in the section of Sušara;**
- **Characteristics of wastewater of Sušara, Wet separation and HPV;**
- **The results and the evaluation of recorded condition of the working environment at the Sušara that included:**
    - **measurement of dustiness;**
    - **measurement of concentration of harmful gases, steam and aerosols;**
    - **measurement of noise;**
    - **measurement of vibration;**
    - **measurement of microclimate;**
    - **measurement of illumination.**
- **Project documentation featured in the Main mining project of construction of Sušara.**

The project designer himself accomplished recording of hovering dust in facilities of Nova sušara, Stara sušara and Klasirnica, and gave it in a separate report. The project designer also gave a series of analyzes of granulometric composition which enclosed in a separate written report.

Project designer and supplier of equipment prescribed the consumption of fresh water on enter of centrifugal wet separators of at least 2.2 m^3/h (0.7 bar) up to max. 5.7 m^3/h (4 bar) at the separator.

Air consumption norms used in the calculations in this project take into account the characteristics of the equipment to be dedusted (width of the conveyor belt, its speed, size of the material, capacity and height of the fall of the material).

They are the result of adequate estimate, ways of pressurization and measurements performed on variety installations, developed by the company.

The project designer was committed that the dedusting system which would be designed and installed must meet the requirements of EU standards concerning:

- **dust concentration in the fresh air after a wet dedusters;**
- **concentration of floating dust in the work area;**
- **noise pollution by EU standards;**
- **pressurization of intake places.**

DESCRIPTION OF THE TECHNOLOGICAL PROCES SCHEME

DESCRIPTION OF SCHEME OF NEW TECHNOLOGICAL PROCESSES OF COAL OVER DRYING AND DEDUSTING IN FACILITY NOVA SUŠARA

Description of the existing coal over drying process and dedusting in facility Nova sušara, how it is supposed to work and what his condition is now has already been previously described in the relevant section of the NDP.

Plant for drying coal drying, Nova sušara, is organized into four groups, with four autoclaves in each group. To each autoclave belongs bunker for coal over drying with the following characteristics:

- **volume** **50 m^3**
- **diameter** **3900 mm**
- **height** **7900 mm**
- **quantity of coal** **17 t/batch**

Characteristics of coal after the drying process are:

- **size of the dried coal** **-150+0 mm**
- **volumetric mass of coal** **550 -600 kg/m^3**
- **the project temperature of coal** **enter/exit 110^o C/<50^o C**
- **moisture content in the dried coal** **23 – 28 %**

In previous work of coal over drying system, we have concluded a lack at the beginning stages of over drying, namely, the fresh air has been thrown into for over drying which temperature ranged from - 15° C in winter to + 35° C in summer, while neither technical nor technological parameters have been customized to this temperature changes, and thereby dried coal of temperature 86˚ C could not be chilled to the temperature required by the project.

New technological scheme of coal over drying and dedusting respects this fact and introduces unit to maintain the temperature of fresh air at 22° C.

To each group of autoclave is entitled a unit to maintain the temperature of fresh air at 22° C. Each group of autoclave in Nova sušara has its own independent system for dedusting and extraction of the edge of the steam.

The main components of each system are: ventilator of fresh air, centrifugal water separator, the tank for sludge precipitation and water recirculation, ventilator for suction of the edge of the steam, different flaps for air manipulation, units to maintain a constant temperature of fresh air and associated piping. In Nova sušara, are therefore embedded four of these independent systems and to each of these systems is, besides dedusting of certain groups of autoclave with bunkers for coal over drying, entrusted and dedusting of the part of the conveyor belt TB 100. In this way, the need for a separate dedusting system of conveyor belt TB 100 as it once existed is gone. In order of clearer presentation of a new process, its description we will start by describing the cooling of coal and pulling out the edge of the steam from bunkers for coal over drying of one group of autoclave. We selected a group whose bunkers for coal over drying are positioned by marks from DF 301 to DF 304.

The suction of fresh air outside the object for this group of bunkers shall be a ventilator DCV 201. Each group of bunkers for coal over drying, therefore, has its own ventilator of fresh air whose positions are marked from DCV 201 to DCV 204. The air on the way to the ventilator passes through the regulatory grid, filter for purification, battery for heating the air HE 101 and battery for cooling the air CO 101. The thrust pipe of ventilator D 550 branches into four branches and each branch D 550 enters into certain bunker for coal over drying. The flow of fresh air in bunkers is regulated by the flaps FPK 201 – FPK 204, installed on each of the aforementioned branches. Entering the bunker in the area of the cone, pipe D 550 goes vertically to its peak, where by semicircular curve changes direction for 180° and is directed vertically downward, to the bottom of the bunker. On the existing pipe D 550 mm there will be upgraded three branches of diameter D 330 mm, with holes on the surface of the pipe, which also reaches the bottom of the bunker for coal over drying. From possible damages and clogging of the holes on the surface of the pipe that could happen to the impact of coal while discharging of autoclaves, pipes are protected by a thick metal steel sheet. In this way, a more equal distribution of fresh air with constant temperature of 20-22^{o} C will be achieved, throughout the volume of the bunker. This solution will provide fulfillment of request that coal, while discharge of on the conveyor belt TB 100, has temperature below 50^{o} C, thus the risk of self-combustion of coal is reduced to the minimum. Radiometric probe at the bottom of the bunker provides information on whether a particular bunker is full or empty. Dust shields DX, set between the autoclave and bunkers for coal over drying, prevent the penetration of dust and the edge of the steam while emptying the autoclave.

The edge of the steam and dust which develop during the autoclave discharge process and coal over drying in the bunkers DF 301 to DF 304, are sucked by the ventilator DCV 101. To each group of bunkers belongs a ventilator, which positions are marked with DCV 101 – 104. The edge of the steam and sucked dust before entering the ventilator are subjected to the cleaning process in a centrifugal water separator, but this stage of the technological process will later be explained in more details.

On the suction pipes of each of the bunkers for coal over drying is installed a flap for regulating the flow of the edge of the steam. On the group of bunkers whose work we describe these flaps are marked with FPK 101 – FPK 104. The position of the flap is regulated by a pneumatic cylinder.

The greatest amount of dust in bunkers for coal over drying are developed while discharging of autoclave, when coal falls in the bunkers from a considerable height.

Dust is also generated during the coal discharge process from the bunker for coal over drying on the conveyor belt TB 100. The edge of the steam, however, are developing during the whole process of coal over drying with different intensity, which all suggests to the need for conditions setting in bunkers for coal over drying, depending on the operation being performed at a given time. The harmonized operation of fresh air flaps and flaps for regulating the edge of the steam is therefore essential.

DESCRIPTION OF SCHEME OF NEW TECHNOLOGICAL PROCESS OF DEDUSTING IN FACILITIE STARA SUŠARA

DESCRIPTION OF COAL PREPARATION

The name of this object, Stara sušara, is dating back to the time when there was placed first Kolubara's dryer. By dismantling of old equipment, within the existing buildings were built two bunkers capacity of 2500 m^3 each. Inside them, temporarily is storing the dried coal, until it is of dispatched to the sorting.

Technological scheme of manipulation of dried coal inside the facility Stara sušara will be understood in the best way by following drawings 02-101.

Transport of coal from Nova sušara to the facility Stara sušara is done by conveyor belt TB 100, a width of 1000 mm and the speed of 1.7 m/s. By partial funnel, dried coal size -150+0 mm can be directed to the conveyor belt TB 200 or alternatively, to the conveyor belt TB 300, placed at the elevation 12.280.

Conveyor belt TB 200 is movable and reversible, so that, if necessary, can transfer dried coal can switch on any of the transporters TB 301, TB 302 and TB 304, by which are filled the appropriate bunkers. The mentioned transporters are movable and reversible, allowing full charge of volume of bunker with coal.

Transporter TB 300 has the same characteristics as the previous three listed and has the same role, filling one of the bunkers with dried coal. The only difference is that it receives coal directly from the transporter TB 100 and that in his supply with coal does not participate transporter TB 200.

Extraction of dried coal from the bunker of Stara sušara is done on elevation 0, with starlike feeders. Starlike feeders I 157 and I 158 feed conveyor belt T 151 and starlike feeders I 159 and I 159a feed conveyor belt T 152. Both conveyor belts are pouring coal on the conveyor belt T 306 which disposes coal in the sorting room.

DESCRIPTION OF DEDUSTING SYSTEM

Measurements of dustiness in the facility Stara sušara, which have shown a tenfold increase in the dusting of maximum allowed, according to both and local and European standards, were expected due to the poor performance of technological equipment, insufficient pressurization of transporters, as well as absence of any system of dedusting in this facility.

Overall dedusting of this facility will be done by one dedusting system. This system of dedusting, however, will have more favorable conditions than the current conditions in facility Stara sušara.

Process improvement in bunkers for coal over drying of Nova sušara, lower temperature and humidity of coal, as well as dedusting of conveyor belt TB 100 which should bring the projected system in Nova sušara, will contribute that to the facility of Stara sušara arrives coal with more favorable characteristics.

Technological equipment in Stara sušara is generally grouped into two height levels, around elevation 12.280 and elevation 0. The complexity of manipulations of coal at these elevations conditioned that in the wet centrifugal separator comes dusty air from each level separately.

Selection and location of the extractor places, as shown in Table 5/1 was made on the basis of harmonized opinions of project designers and requests of members of the professional team of investors. Location of suction hood and pressurization of ladling places of conveyor belts, were determined in accordance with the characteristics of the equipment (speed, width, capacity of conveyor belt). Coal ladling from conveyor belt TB 100 to conveyor belts TB 200 and TB 303 is done according to standards that take into account the width, speed and capacity of conveyor belt. Transporters TB 200, TB 301, TB 302, TB 303 and TB 304 are movable and reversible. It virtually disabled their fixed attachment to aspirational system, and that approached to another solution.

Table 5/1: Characteristics of transporters in Stara sušara and the location and number of extractor places

Position	Name	Width mm	Speed m/s	Capacity t/h	Number of extractor places
TB 100	Coal conveyor belt –150+0 mm	1000	1.38	250	1
TB 200	Coal conveyor belt –150+0 mm	1000	1.42	250	3
TB 301	Coal conveyor belt –150+0 mm	1000	1.42	230	3
TB 302	Coal conveyor belt –150+0 mm	1000	1.42	230	3
TB 303	Coal conveyor belt –150+0 mm	1000	1.42	230	3
TB 304	Coal conveyor belt –150+0 mm	1000	1.42	230	3
TB 151	Coal conveyor belt –150+0 mm	1000	1.42	250	0
TB 152	Coal conveyor belt –150+0 mm	1000	1.42	250	0
I 157	Starlike feeder			200	1
I 158	Starlike feeder			200	1
I 159	Starlike feeder			200	1
I 159a	Starlike feeder			200	1
T306	Coal conveyor belt –150+0 mm	1000	2.75	350	4

At both ends of these transporters are built suction hoods with rubber hoses length of 4 m and quick connections. Above or beside lanes were installed stationary suction pipes with mechanical flaps for quick connection. Their number and arrangement is such that it covers the entire operational workspace of certain lane. When the conveyor belt with command from the drop counter is brought to the desired position, whether it is transporter TB 200 or transporters TB 301, TB 302, TB 303 and TB 304, which pour a coal into bunker, dedusting operator joins the nearest flexible rubber hose with the nearest suction pipe with mechanical flap for quick connection of the conveyor belt TB 200. The three stationary suction pipes with mechanical flaps for quick connection are installed.

OBJECT KLASIRNICA (SORTING ROOM)

In technological process of coal sorting a basic component of working environment pollution is coal dust, created at ladling places of conveyor belts, bunkers, sieves and other processing equipment in the sorting room. After a few touring, recording and measurement of dustiness in sorting room, we came to the conclusion that the dusting in the work area exceeds tens of times greater value than the allowable value is. Dedusting in the facility Klasirnica we have solved with two autonomous systems of wet dedusting:

1. **System for dedusting of resonant sieves and R 70A and R 70B, with proper pressurization, which has its own wet centrifugal separator;**
2. **System for dedusting other technological equipment, with its own wet centrifugal separator and associated equipment for pressurization.**

Common to both dedusting systems is the tank for sludge subsidence and water recirculation. Work of centrifugal water separators that represent the basic unit for removing dust from exhausting gas will be better understood by following enclosed drawings 4025-C-101 and 101787. The centrifugal water separator type FPS 2500 that will clean the waste gases is a cyclone-type device, in which the separation of dust particles from the gaseous components is performed under centrifugal force and under pressure which is created by the appropriate ventilator. Introducing dusted air in the conical part of the separator diameter D=2500 mm shall be tangential. With two spray nozzles of diameter 25.4 mm (1 in.) is performing, under the pressure of 0.7 bar, injection of 2.2 m^3/h of fresh water, and if necessary, the consumption of fresh water can be as much as 5.7 m^3/h, whereby the pressure of 4 bar is necessary. Rinse is supported and with three spray nozzles of diameter 19.05 mm (3/4 in.), over which in the separator is distributed about 16.2 m^3/h of recirculation water. The conical part of the separator ends with counterweight valve through which the contaminated water is discharged into the tank for sludge subsidence.

In the tank for sludge sedimentation continues with the further densification of waste water. Relatively clarified overflow water returns, with the help of the recirculation pump through spray nozzles of recirculation water, in centrifugal water separator, and the thicken sludge through the intestinal valve at the bottom is sent to the sludge pump FPP 302.1 (or FPP 302.2, depending on what is working and what a spare pump) and further into the existing pipeline D 200 mm for drain of waste water of dryer in concrete depositional pools. Probe for measuring the maximum and minimum levels built-in on the tank will provide circulation pumps from the eventual disappearance of the gradient. There will be built into the overflow pipe in case of blockage of the valve for drain the water.

Both separators built-in Klasirnica are protected from frost with glass wool insulation thickness of 75 mm, protected with aluminum sheet. The lower part of the cone is heated by electro conductor. Water pipes will also be protected by a layer of glass wool thickness 75 mm, protected with aluminum sheet, and will further be heated with electro-resistive conductor.

And the tank for sludge subsidence and recirculation water will be protected from freezing in the same manner as the centrifugal water separator.

Each of sieves (griddles) is covered by their armor of steel sheet thickness of 4 mm, which is welded to the rectangular frame structure made of steel pipes. On the back side of the shield are integrated service doors that allow easy change of griddles.

The front side of sieve, with the help of steel sheet and rubber curtain, is hermetic so as to allow easy maintenance of equipment.

Four hoods are sucking out dusty air from the upper surface of the shield of sieve. All exhausting hoods of a sieve are linked by a common pipeline, and pipelines of both sieves are merged into main pipeline, which leads dusty air to the centrifugal wet separator FPS 302. Required under pressure for this separator is produced by ventilator DCV 302. The dirty water through a valve with counterweight goes into the tank for sludge sedimentation and recirculation water FPV 301.

Technological description of other independent dedusting systems in sorting room we will start by reviewing dedusting places that this system covers. Selection and location of the extractor places, as shown in Table 5/2 was made based on an analysis of the technological process of loading coal from one part of technological equipment to another, according to the proposal of an expert team of Investors. Location of suction hoods and pressurization of ladling places of conveyor belts, were determined in accordance with the characteristics of the equipment (speed, width, capacity of conveyor belt).

Pressurization of ladling places of conveyor belt was made with steel sheet thickness of 4 mm, and suction hoods and pipes are made of steel sheet DIN 14301, thickness 2 mm. Pressurization and pipeline in the facility Klasirnica and in other facilities are made so that they take up less free space, in order not to hamper the normal maintenance of technological equipment.

Table 5/2 Characteristics of transporters in sorting room and location and number of extractor places

Position	Name	Width mm	Speed m/s	Capacity t/h	Number of extractor places
T 306	Coal conveyor belt –150+0 mm	1000	2.75	350	1
T 308	Coal conveyor belt –150+0 mm	1000	2.75	350	2
T 71a	Transporter of grah –15+5 mm	650	1.75	50	2
T 71b	Transporter of grah –15+5 mm	650	1.75	50	2
T 72	Transporter of cube –60+30 mm	650	1.50	120	1
L 73	Chain transporter prah –5+0 mm	390	0.46	55	1
L 74	Chain transporter prah –5+0 mm	390	0.56	62	1
T 78	Transporter for loading cube –60+30 mm	1000	1.5	140	1
T 79	Transporter for loading orah –30+15 mm	1000	1.5	140	1
T 80	Transporter for loading komad–150+60 mm	1000	1.5	140	1
T 76a	Transporter for loading graha –15+5 mm	1000	1.5	140	
T 44	Binding transporter	1000	1.98	252	
T 403	Transporter of dried coal assortment	1000	1.86	252	

Dusty air sucked in locations from Table 5/2, by main pipeline is drained into centrifugal wet separator FPS 301, and clean air is sucked with ventilator DCV 301.

Through valve with counterweight dirty water goes into the tank for sludge sedimentation and recirculation water FPV 301, which is common for both dedusting systems. Thicken sludge through the intestinal valve at the bottom is sent to the sludge pump FPP 302.1 (or FPP 302.2, depending on what is working and what a spare pump) and further into the existing pipeline D 200 mm for drain of waste water of dryer into concrete depositional pools.

CONCLUSION

In the previous analysis of the system for coal over drying we noted a lack already in the beginning stages of coal over drying, namely, fresh air for coal over drying was thrown in and its temperature vary from -15˚ C in the winter, to +35˚ C in the summer time, while no technical nor technological parameters are adapted to these temperature changes. Thereby, dried coal of temperature 86˚ C could not have been chilled to the temperature required by project.

New technological scheme of coal over drying and dedusting respects this fact and introduces unit to maintain the temperature of fresh air at 22° C.

Each group of autoclave in Nova sušara has its own independent system for dedusting and extraction of the edge of the steam.

In Nova Sušara were installed four of these independent systems and to each of these systems is, besides dedusting of certain groups of autoclave with bunkers for coal over drying, entrusted and dedusting of part of conveyor belt TB 100. In this way, the need for a separate dedusting system of conveyor belt TB 100 as it once existed is gone.

The entire dusting in Stara sušara will be done by one dedusting system. This dedusting system, however, will have more favorable conditions than the current conditions in facility Stara sušara. Process improvement in bunkers for coal over drying of Nova sušara, lower temperature and humidity of coal, as well as dedusting of conveyor belt TB 100, which should bring the designed system in Nova sušara, will contribute that in facility Stara sušara arrive coal with more favorable characteristics. After a few touring, recording and measurement of dustiness in sorting room, we came to the conclusion that the dusting in the work area exceeds tens of times greater value than the allowable value is. Dedusting in the facility Klasirnica we have solved with two autonomous systems, as presented in section 5.2.3. Both separators built-in Klasirnica are protected from frost with glass wool insulation thickness of 75 mm, protected with aluminum sheet.

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UDK:622.01:628.38:66.06(045)=20

PROTECTION FROM GROUNDWATER IN "SOKO" COAL MINE

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Abstract

Water inflows into mining works of Soko coal mine were very rare till 2006. That year, during development works in northern wing of western sector, water came into drifts through dolomites and limestone. Water inflow reached 25 to 30 liters per second, and that was the endangerment not only for northern wing, but also the entire mine. Since then, dewatering is a constant problem for the mine and a challenge for mining experts.

Key words**: water inflow, hydrogeological researches, drain, submersible pumps.**

1. INTRODUCTION

HYDROGEOLOGICAL PROPERTIES OF SOKO COAL MINE

Tectonics is a very important factor in prediction of water inflow. Special attention should be paid to faults with meridian directions, which cut both the coal deposit and limestone of Devica Mountain. These faults are potential flow lines for groundwater, coming from limestone aquifers into mining works.

Amount of water inflow also depends on mining technology. During development and extraction, natural state of the deposit and surrounding rock is disturbed. System of cracks and fissures is spreading through the seams, while subsidence occurs at the surface. Water is accumulated at the surface and infiltrates through cracks into underground mining works.

Until January 2006, amount of monthly water inflow varied from 2,090 m^3 to 9,540 m^3 (0.8 to 3.6 l/s). This was determined based on operation of dewatering pumps. Water inflow factor varied from 0.25 to 0.65, which meant that it belonged to group of low watered deposits, according to classification by M.Sirovatka. So, there were no difficulties with groundwater in mining operations, regardless on complicated hydrogeological properties of the deposit. [1]

OCCURRENCE OF INCREASED INFLOW OF GROUNDWATER

Fact that hydrogeological properties in this deposit are very complicated was proven right during development of new wing, through TH-1z and VH-1z drifts. They were driven through dolomite limestone when water inflow started to rise rapidly, at levels K+12 m, K+26 m and K+39 m.

Transport slope TH-1 was driven through sandstone and shale, before it entered dolomite limestone at K+55 m level. Groundwater first occurred at K+35 m, near small local faults, dripping from drift walls. Serious rise of inflow occurred through geological drillhole, drilled from TH-1z, at 11.5 m depth and 122^{o} inclination. On February 8 2006, inflow reached 1.7 l/s. Two days later, it was 4 l/s. By February 20, inflow in TH-1 increased to 7 l/s. At K+26 m, in a drift driven from TH-1, after 12 m, inflow increased to 15 l/s on July 10.

During the advance of VH-1 slope, water came from PVU-4 access, at 4 l/s flow, while in ETH-12 drift it exceeded 4 l/s. Groundwater came through R-9 fault, from limestone aquifer of Devica Mountain.

Mean water pumping capacity, according to data from the pumps, reached 30.9 liters per second in a period between March 25 and 29 in 2006. [1]

Groundwater origin was confirmed by chemical analyses on specimens from TH-1z and ETH-12. The analyses were performed in Institute for Hydrogeology in Belgrade.

2. TECHNICAL DESCRIPTION OF DEWATERING IN SOKO MINE

Groundwater from development works of OP-4 is collected in temporary water basins at each level and in three auxiliary water basins. In EH-6 drift, there is a temporary water basin of larger capacity PrVS, used for collection of water from gob at higher levels. Volume of this water basin is approximately 200 m^3 and centrifugal pumps VPN-101-7 are installed in it. From this water basin water is pumped directly into auxiliary water basin PVS-2, located in TN-2z slope. Submersible pumps VCG 525 R1 and pipeline Ø50mm are instaled in smaller water basins. From smaller water basins water is pumped into PrVS and PVS-2. In the operating area of OP-4 there are three auxiliary water basins: PVS-1 located in TN-1z, PVS-2 located in TN-2z and PVS-3 located in IN-124/VN-85.

Volume of PVS-1 water basin is 100 m^3. There are two centrifugal pumps in it, VPD 100-3 and VPD 100-4. Volume of PVS-2 is 630 m^3, with two centrifugal pumps VPN-101-7. From PVS-1 and PVS-2, water is pumped through steel Ø100mm pipeline into PVS-3. This water basin has a 900 m^3 volume. There are two high-voltage pumps VS25-12,5/6 installed in it. From PVS-3, water is directly pumped to the shaft at K+170 m, and then throuth the shaft by Ø125mm pipeline to the surface. Main water basin, with 350 m^3 volume, is situated near the shaft at K-240 m and it is used for collecting water from the sump.

Pump water from the mine is directed into Citlucki Stream, and then into River Moravica near the mine.

Locations and properties of axiliary water basins are given in following table:

Table 1. **Auxiliary water basins and pumps**

Pump mark	Location	Volume of water basin (m^3)	Pump type	Q (l/s)	H (m)	h (m)	P (kW)
P1	PVS-1, TN-1Z	100	VPD 100-4	16-30	132-192	125	132
P2			VPD 100-3	16-30	132-192	125	75
P3	PVS-2, TN-2Z	630	VPN-101-7	14-30	90-203	135	75
P4			VPN-101-7	14-30	90-203	135	75
P5	PVS-3, IN-124	900	VS25-12,5/6	25-30	470	280	200
P6			VS25-12,5/6	25-30	470	280	200

Groundwater pumping is performed constantly, 24 hours a day, with shifts of pump operators at the spot. In the main pump room, there is a Book of operations, where the operation of each pump is evidenced. Based on the data from this book, inflow of groundwater for entire mine is calculated.

According to data from the pumps, mean volume of groundwater pumped from the mine is 25 l/s (64,800 m^3 per month) in a period between 2006 and 2014, without major variations. [1]

3. RESULTS OF CHEMICAL ANALYSES

Tabela II. 10

RGF
Hidrogeologija

Broj strana: 1

Predmet: *Izveštaj o urađenim hemijskim ispitivanjima vode TN – 1Z*

R E Z U L T A T I

UZORAK: *voda TN – 1Z* **VREME UZIMANJA UZORKA:** 04.03.2008.

1. OSNOVNE FIZIČKO-HEMIJSKE VELIČINE

	Izmereno	Voda za piće
Temperatura (^0C)		-
pH	7.4	6.8-8.5
Elektroprovodljivost (uS/cm)	380	1000
Mineralizacija (mg/L)	440	-
Suvi ostatak – 180 C (mg/L)	300	-
Ukupna tvrdoća (nem.gradi)	15.1	-
Utrošak $KMnO_4$ (mg/L)	3.2	8.0

2. MAKROKOMPONENTE (mg/L)

KATJONI	Izmereno	Voda za piće
Kalcijum (Ca^{++})	97.0	200.0
Magnezijum (Mg^{++})	7.8	50.0
Natrijum (Na^{+})	0.2	150.0
Kalijum (K^{+})	0.5	12.0
ANJONI		
Hidrokarbonati (HCO_3^-)	300.0	-
Hloridi (Cl^-)	7.0	200.0
Sulfati (SO_4^{--})	18.0	200.0
Nitrati (NO_3^-)	4.3	50.0

3. MIKROKOMPONENTE

METALI	Izmereno	Voda za piće
Gvožđe (Fe)	0.01	0.30
Mangan (Mn)	0.005	0.05
Cink (Zn)	0.002	3.0
NEMETALI		
Amonijak (NH_4^+)	< 0.05	0.10
Nitriti (NO_2^-)	< 0.005	0.03
Fosfor (P)	0.020	-

Odgovorni analitičar

Branislav Potkonjak,dipl.fizikohemičar

Figure 1 - Results of groundwater analyses

In order to understand the process of water inflow in Soko mine, two complete and 18 short chemical analyses were performed between 2006 and 2008. Also, results of hydro-chemical analyses from 1991 and 1992 were re-interpreted. Chemical analyses of groundwater were performed at University of Belgrade, Faculty of Mining and Geology, Institute for Hydrogeology.

During 2006, groundwater from karst aquifers is starting to inflow into mining works. Chemical composition of this water differs drastically from the previous.

Groundwater inflowing from dolomite limestone are low-mineralized, with mineralization below 0.5 g/l. By chemical composition, it is hydro-carbonated water of Calcium group, with presence of Sodium ions (Na^+) below 10 g/l.

In Figure 1, there is a comparison data of main physical-chemical parameters related to criteria of drinking water. [2]

4. INFLUENCE OF GROUNDWATER FROM SOKO MINE ON MORAVICA RIVER

There are lot of problems and unsolved dilemmas related to determination of necessary level of water flow in rivers. Parameters like Biological Minimum or Ecologically Acceptable Flow (EAF) are used for determination. There are numerous approaches and methods developed for determination of these parameters.

Most commonly used term in Serbia is Biological Minimum, while EAF is the most dominant globally.

Criteria for determination of EAF are not only related to ecology, because preservation of aquatic flora and fauna is not the only goal. There are other users of water resources whose demands also have to be matched.

According to data from JKP Sokobanja, the town uses water from following sources:

- **Three natural founts,**
- **One well (Lepterija) and**
- **Water Factory at Moravica River [3].**

Total amount of water necessary for town of Sokobanja is 35 l/s. However, 75 l/s of water is entering in the system, which means that the losses in water pipeline system are huge.

In Moravica River, defined Biological Minimum is 115 l/s. However, in summer, amount of water in the river is sometimes way below the minimum, because it goes down to 70-80 l/s. [3]

This means that pumping of groundwater from Soko mine into Moravica River is of great significance, because it brings up to 40% of total amount of water in the river.

Wastewater from Soko mine is also directed into Moravica. This water is coming from mine bathroom, restaurant etc., but this water is going through purification system before entering the river.

5. POSSIBILITY OF DEWATERING FROM GROUND SURFACE

During the analysis of possibilities for dewatering in Soko mine, one of the ideas was to use drain well in order to capture water from limestone. The designed well has a capacity of 20 – 50 l/s.

Since we are dealing with ground water of high quality, it could be used for drinking water supply of villages downstream. It should be mentioned that it is not yet possible to apply this solution, because the ground where the well would be installed is influenced by underground mining works and it is in the process of subsidence and horizontal displacement.

After the end of mining works in that area, when the ground stabilizes, such solution would be possible. There are many possible benefits from such dewatering system. Dewatering costs for Soko mine would decrease significantly and at the same time high – quality drinking water would be produced. This water could be used for water supply of downstream villages, and even of town of Sokobanja.

5.1. Drain well depth. At this moment, based on available geological and hydrogeological data, estimated well depth is 420 m.

5.2. Lithological profile. According to available data and previous exploration works, estimated lithological profile by drain well axe is as follows:

- **0 – 310 m (+380 to +70 m) – sand clay, clay sandstone alternately;**
- **310 – 420 m (+70 to -40 m) – dolomite limestone with significant inflow of groundwater in the interval between K +39 m and K+12 m.**

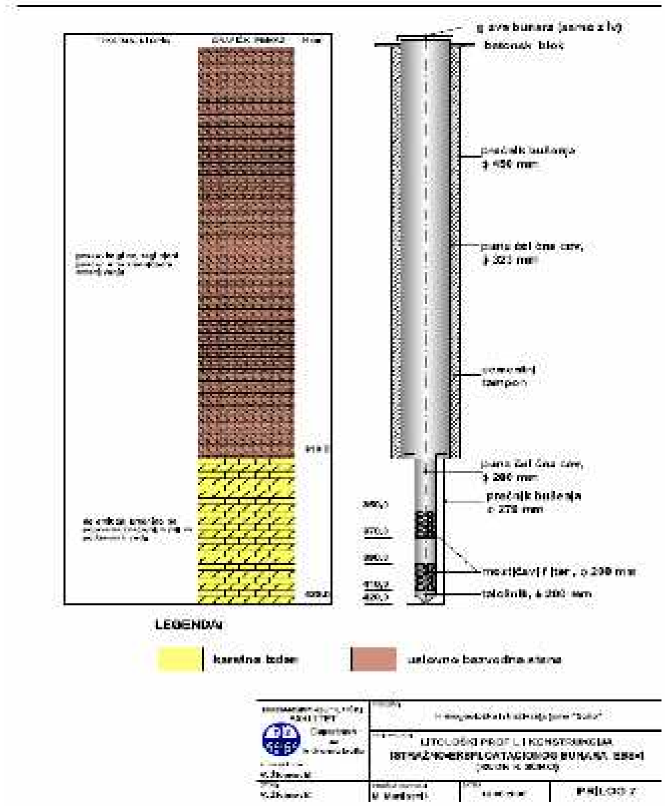

Figure 2 – Lithological profile and construction of drain well

5.3. Drain well construction:

0 – 310 m (+380 to +70 m) – rotation drilling, 450 mm drilling head diameter;
0 – 310 m (+380 to +70 m) – steel lining, 323 mm diameter, with cementing of interspace;
310 – 420 m (+70 to -40 m) – rotation drilling with 279 head diameter, rinsing with pure water;
322 – 420 m (+82 to -40 m) – installation of drain well construction, steel pipe with 200 mm diameter, with filters in the intervals 350 – 370 m (+30 to +10 m) and 390 – 410 m (-10 to –30 m).

Construction should include 12 m long folding and 10 m long precipitator. [2]

CONCLUSION

It can often be heard in Sokobanja that groundwater from Soko mine pollutes Moravica River. That is not correct. Quality and volume of water pumped into Moravica are very important and very beneficial for the river, because it helps in achieving of Bilogocal Minimum or Ecologically Acceptable Flow (EAF), as it was shown in chapter 4.

Drain well could solve several important problems in Soko mine, but it could also have a commercial value.

After the completion of mining works in sector OP-4, it is possible to start drilling a drain well. Drain well would solve the problem of dewatering in this sector of Soko mine; Pumped water could be directed right into Moravica River. Considering the quality of water, it could also be used as drinking water for surrounding villages and town of Sokobanja;
Considering the quality of water, it would be possible to bottle the water. Production of drinking water became one of the most profitable industries in Serbia, with 190 million EUR profit last year. Even producers admit that their business is very profitable. 650 million liters of water were sold in Serbia and 68 million liters was sold on foreign markets.

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MINING IN PRINCIPALITY OF SERBIA FROM 1835. UNTIL 1839.

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***Abstract:** In the work has been shown start of the renewal of Serbian mining for the time of governance of knyaz Milos. Receiving autonomy by Hatt-i humayun in 1830 and after resolving conditions within the principality of Serbia, knyaz Milos has dedicated himself to solving economy problems of the principality. One of the special branches was mining. Knyaz in 1834 has called baron Herder, mining expert from Saxony to come to Serbia and start mining production. Although baron Herder did not stay for a while in Serbia, his visit represents beginning of the mining in the principality of Serbia, after which future industrialization and economic growth start in the principality of Serbia.*

***Key words:** Knyaz Milos, mining, baron Herder, Principality of Serbia, mining production*

After receiving autonomy in 1830, knyaz Milos has done certain measures which applied in geopolitical areas of Serbian territory that had been listed in Hatt-i humayun in order for Serbian territories to arrange an administration, organize an army, bring to life economic and educational institutions and solve many necessary questions that requested immediate answers which were important for the survival and development of the principality.[4] After consolidating his authority and organizing conditions within the principality, knyaz has committed himself to solving economic problems which represented a challenge for the young principality. One of the special positions in Serbian economy took mining, which were according to plans of knyaz, should relieve the principality of importing necessary minerals: salt, lead, iron, silver, capper and others, and still, from mining fill up the principality's treasury.[5]

In 1834, knyaz Milos invited professor of mining academy in Freiburg Mr. Sigismund August Wolfgang, baron of Herder, in that time very reputable and acknowledged mining expert, to visit Serbia and explore its mining and geological potentials.[6] It remains unknown who brought knyaz with von Herder.

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[3] *nenad.anzel@live.com*

[4] П. Јовановић, *Рударство на тлу Србије*, књ. 1, Београд, 2007, 465.

[5] *Исто*, 466.

[6] V.Simić, *Istoriski razvoj našeg rudarstva*, Beograd 1951, 64.

It is considered that it could possible be a merchant from Vienna Dimitrije Rodovic, which traded and bought many necessities for Serbia in Saxony.[7] Following 1835, knyaz Milos had sent Rodovic to Saxony, to negotiate with baron Herder about mine exploring in Serbia, after which mines would be open, and would satisfy internal needs of the principality, and even make certain surplus for exporting.[8] Herder, same year over Dresden, Prague arrives to Vienna, where he met with Rodovic and handed him a letter dedicated to knyaz Milos. In the letter he listed elementary needs which are necessary for the beginning of mining production. In Serbia, Herder comes on the 6th of August in 1835, where knyaz's brother Jevrem awaits for him, since knyaz was on his way to Tsarigrad.[9]

Knowledge about mining activities on the territory of the principality of Serbia, before arrival of baron Herder, are badly done and incomplete. Except information which stayed from Austrian occupation in the 18th century (1718-1738) and individual experiences gained in the First Serbian Uprising, without them there would be hardly any data.[10] Many travelers that visited parts of Europe under Ottoman empire, all up to baron Herder (1835), have barely contributed to the knowing about mineral wealth of Serbian principality. Rare example represents A. Weingartner whom in his travelling notes, printed in 1820 under name *Uber Serbien*[11] (About Serbia) mentions mines such as Majdanpek, Rudnik and Novo Brdo.[12]

Even though at the beginning of the 19th century it was not known a lot about mineral wealth of Serbia, it was still considered that Serbia has a great amount of mineral wealth, and it was just a matter of waiting for a suitable moment for the beginning of exploring and opening the mines. Otto Pirch[13], in his report from Serbia records that "that mine opening and mine digging will start as soon as right people who are appropriate for the job are brought". All up to arrival of baron Herder in Serbia, Serbia was geologically unexplored and from a view of mining science, almost unidentified country. Even though the knowledge of the mineral wealth was unfamiliar and it lacked information, and despite of that it was immense. The importance that was given to the job, show huge preparations for the arrival of baron Herder to Serbia, also as care and interests of knyaz Milos for his work and reports. Preparations of knyaz Milos to invest thousand ducats in Herder's study about mineral wealth of Serbia, says about serious intentions of knyaz that mining activity totally arouse.[14]

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[7] В. Симић, *Из скорашње прошлости рударства у Србији*, Београд 1960, 17.

[8] Р. Љушић, *Кнежевина Србија 1830-1839*, Београд 2004, 100.

[9] В. Симић, *Из скорашње прошлости рударства у Србији*, 17.

[10] П. Јовановић, *Рударство на тлу Србије*, 466.

[11] A. Weingarther published the text in 1820. called *"Uber Serbien"(About Serbia)* in which he mentions some ore and mines in Serbia. His work was translated into serbian in 1822. and 1827.

[12] П. Јовановић, *Рударство на тлу Србије*, 466- 467.

[13] Otto Dubislav fon Pirch, prussian officier, had traveled trough Serbia in 1829. and his notes were published in the book called *"Travels trough Serbia"*. He brought first results of mineral researching of thr mine on the mountain Rudnik.

[14] Б. Миљковић Катић, *Рударство као државни пројекат убрзаног развоја кнежевине Србије у време кнеза Милоша и Уставобранитеља*, у: Zbornik radova Istorija rudarstva Srednje Evrope, Fruška Gora 2009, 105.

Before arrival of baron Herder, and much later, in Serbia only existed unorganized and primitive mining which was usually done by residents of nearby villages that lived in surroundings of old mines. From mines it was exploited: lead in Podrinje, gold from streambed of Pek, Mlava and Timok, iron in Kursumlija, Vlasina and Kopaonik.[15] This was the situation that awaited baron Herder in 1835 when he arrived in Serbia. First travel of baron Herder around principality started on the 24th of August from Kragujevac and lasted until 3rd of September. In total, baron had visited in eight occasions principality of Serbia, where he researched mineral wealth of the principality. The ast, eighth trip, had ended on 2nd of November in 1835.[16]

On his eighth trip through Serbia Herder recorded, that he almost on "*every step*" encountered ruins of abandoned and ruined mining work, on the ruins of melting furnaces, remains of slag and slag dumps, which had given an impression that Serbia has plentiful of mineral wealth. Unfortunately, numerous of this works were more legacy of one small mining, and not systematically, greater and well organized work. That were remains of smaller mining activities, that individuals were digging and in primitive melting furnaces melted. After exhaustion of a mine like that, a miner would have gone to some other location.[17] Besides mining, baron Herder was interested in other mineral resources, especially salt. Even though he sought to find a salt mine, which was one of his primal tasks of his invitation to Serbia, sadly, Herder had often concluded that "*there is no trace of salt*".[18]

Herder's trip from a professional stand of view, according to Vasilije Simic, pioneer of modern Serbian geology, hasn't revealed anything new, videlicet that hasn't been known at the time. Herder had just visited mines and places of some former smelters which were already known in Serbia. On those sites, Herder didn't stay for a long time and he didn't question their geological structure of the places he had visited. Places that visited, he described as well as other normal travelers.[19]

Baron Herder didn't manage to finish his report about mineral wealth of Serbia since he died in 1838. He had left only notes, which were printed in Serbian language, in a shorter edition, in 1845, under the name "*Herder's mining trip through Serbia*". Original text was printed in German and was printed in 1844.[20] In spite that baron Herder hasn't finished his job and hasn't truly fulfilled the expectations, his visit represented turnover in the history of modern Serbian mining. Advantage of his return from Serbia is reflected in a fact that interest of domestic and foreign capital for researching and investing in mining has began rapidly to grow. Arrival of baron Herder to the principality of Serbia could be considered as a first chapter in rebuilding Serbian mining.

[15] П. Јовановић, *Рударство на тлу Србије*, 468-469.

[16] В. Симић, *Из скорашње прошлости рударства у Србији*, 18-21.

[17] П. Јовановић, *Рударство на тлу Србије*, 469-470.

[18] Љ. Ристић, *О рудном благу и околностима развоја рударства у Србији XIX века*, у: Zbornik radova III, Međunarodna konferencija Istorija rudarstva Srednje Evrope IRSE '11, knj.2, Zlatibor 2011, 20.

[19] В. Симић, *Из скорашње прошлости рударства у Србији*, 26.

[20] П. Јовановић, *Рударство на тлу Србије*, 470.

Despite of, from a time perspective, this chapter lasted very short, from the beginning of his preparation for his arrival (1834) up to his death (1838) and a change of authority in the principality of Serbia, it left indelible trace in Serbian mining.[21] After baron Herder, Serbia has been visited by more mining and geological experts, who established that Serbia has plentiful of ore and minerals.

In terms of giving concessions for exploring and exploiting mineral wealth, knyaz and the *Sovjet* (Serbian government) were thinking that mineral wealth are public, so only government can use it for its wellbeing. There are no files which say that foreigners before 1835 asked for concession on exploitation of Serbian mines, but there are after that period.[22] First British consul in Serbia Lloyd Hodges (1837-1839) which was close to knyaz Milos, was interested for the possibility of investing of British concessioners in Serbian mining. First offer of British concessioners for tenancy of Serbian mine occurred in 1841. Intermediary in that business concession to Franz Bideau was denied, however it was allowed in 1842, with leaser from England Kyle Pickersgill , they travelled through Serbia together to conduct mine exploring.[23]

That visit of baron Herder was beneficial, showed preparations and opening of certain mines. Videlicet, Herder did not succeed to finish his report, but he, over representative in Vienna, Dimitrije Rodovic sent letter to knyaz where he presented his opinion which mines in first phase should be opened: 1) Lead mines: at the mountain Rudnik, on location Majden in a place called Bezdan. 2) Iron mines: in eastern Serbia in Majdanpek, as also Kopaonik. 3) Coal mines: Herder in his research did not find coal, just brown coal in the place Miliva next to Despotovac and also Smederevo.[24]

Additionally, Herder has suggested to knyaz that for the possibility of mining, he should sent few young Serbs to Freiburg to learn mining science, and which after they would come back to Serbia and open new mines. Decision that Serbian descendants shall be sent to Freiburg has been brought two years after (1839). Mainly because of material reasons, descendants have been sent to Chemnitz not to Freiburg, since education was cheaper there. There were sent four descendants (Ivan Matic, Dorde Brankovic, Vasilije Bozic and Stevan Pavlovic). After finishing studies in 1845 they came back to Serbia.[25] Since in that time, there were no mines or mining activity in the principality of Serbia they have been rearranged to Ministry of Finance, where they have done civil service type of job.[26]

In order to fully bring to life mining in Serbia, Herder in a letter sent on the 10th of May 1837 has proposed to knyaz Milos to accept bigger migration of Saxonians to Serbia.[27] As experienced miners they would enhance development of mining and bring new things, as modern techniques of digging and processing ore.

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[21] *Исто*, 471.

[22] Д. Милић, *Страни капитал у рударству Србије*, Београд 1970, 38.

[23] Љ. Ристић, *Британски капитал у рударству Србије (XIX век),* у: Zbornik radova Istorija Rudarstva Srednje Evrope, 81.

[24] В. Симић, *Из скорашње прошлости рударства у Србији*, 27-31; П. Јовановић, *Рударство на тлу Србије,* 475.

[25] П. Јовановић, *Школовање рударских инжењера у Србији (1837-2010),* Београд 2010, 54.

[26] П. Јовановић, *Рударство на тлу Србије*, 479.

[27] В. Симић, *Из скорашње прошлости рударства у Србији*, 28.

Dismissal of knyaz Milos in 1839 has prevented this idea, because *Sovjet* has rejected requests of 50 Saxon families to migrate to Serbia.

First practical result of the research of baron Herder was opening of the first Serbian coal mine – Miliva at Despotovac in 1837. In a lack of professional staff, knyaz has ordered to Sovjet that work on the mine opening, shall be given to Franz Janko.[28] Sovjet had given Janko appropriate *"Instruction"*[29] and that fist instruction about beginning of the work on the mine opening and renovation of mining in Serbia. Sovjet in the 6th of February in 1837, on a position of a supervisor of a mine had set Milosav Zdravkovic – a man from Resava, one of the most known and the richest men in Pomoravlje and Resava.[30] Work of the first mine in Serbia, was not going according to the plans. Lack of infrastructure, many difficulties with the transport, which were done with the oxcart. As also bad quality of lignite which was not suitable as a fuel for boilers on the steamers which were on Danube, has brought to closing the mine after only four months of work. Sovjet, by the order of Knyaz Milos, in the letter from the 14th of July 1837. dictates to the new manager Anta Stepanovic to suspend further digging of the coal.[31]

After death of baron Herder in 1838, knyaz Milos has left without his faithful and loyal advisor and his removal from controlling Serbia, in 1839 postponed the beginning or reviving mining and industrialization in Serbia for the whole decade.

At the time of his first governance of Serbia, knyaz Milos Obrenovic with the help of his persistance, personal capabilities and interests, has set a base for a modern serbian mining and enabled necessary support from the Principality and initial enthusiasm, which in the later period enabled faster development. 1837, was a turnover, because in that year it was determined which mines will be open. In that time first legal basis of mining mere made, the decision of sending youth staff on mining engineering education abroad, wich represents a solid base for the beginning of renovation and start of the work in the area of mining.

Young serbian mining in its beginnings was confronted by many obstacles. Persistence and will of knyaz Milos at first had not brough up to expected results, beacause serbian principality had to do more on the internal plan. Lack of qualified staff and experts, bad infrastructure and unorganized economic interests were hindering prosperity. Still, bases that were set during the governance of knyaz Milos, have enabled that in the following decades mining of Serbia will become one of the backbones in modernization and industrialization of the Principality.

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[28] В. Симић, *Развој угљенокопа и угљарске привреде у Србији*, Београд 1958, 7-8.

[29] Текст Инструкције у целини видети у: В. Симић, Развој угљенокопа и угљарске привреде у Србији, 7.

[30] П. Јовановић, *Рударство на тлу Србије*, 481.

[31] П. Јовановић, *Рударство на тлу Србије*, 482.