

Iesaistītās organizācijas LLP nosacījumu izstrādē:

- DEPA - Dānijas Vides aizsardzības aģentūra;
- DAAC - Dānijas Lauksaimniecības konsultāciju dienests;
- JTI - Zviedrijas Lauksaimniecības mehanizācijas institūts;
- ZM - Latvijas Zemkopības ministrija;
- VARAM - Latvijas Vides aizsardzības un reģionālās attīstības ministrija;
- LVAF - Latvijas vides aizsardzības fonds;
- LLU - Latvijas Lauksaimniecības universitāte;
- LZF - Latvijas Zemnieku federācija;
- LLKC - Latvijas Lauksaimniecības konsultāciju centrs.

PROBLEMS WITH RECLAMATION OF ACID LAKES IN THE AREA OF MUŻAKOW LAKES

TADEUSZ CHRZAN

Prof., Dr. hab.

Technical University of Zielona Góra
str. Podgorna 65 – 246, Poland

Phone: (068) 3254831, Fax: 4868 3245597

***ABSTRACT.** In the paper is described actual state of environment after brown-coal exploitation with open-pit and deep-boring methods. The results of recultivation-investigations are shown, which shown the problems of the strong acid lakes-recultivation. In the paper are also shown the geological and hydrogeological characteristics of the coal deposit area.*

1. Introduction

In the Mużakow-Curve area the open-pit and deep-boring brown coal mining is leaded from the 100 years. As the result of this exploitation is occurred landscape's change – instead the pine-forests we have not covered with plants dump areas, excavations and acid lakes. After the mining activities the anthropogenic Lakeland origins with 100 lakes and 1000ha of non-recultivated area.

2. Geological characteristic of the Mużakow-Curve

2.1. Geographical localization

The described areas are located in the neighborhood of polish-germane border in the middle of the Odra-river length. The Mużakow-Curve is a morphological upland in the form of semicircle open to the north. The south-polish glacier, running with the Lausitzian-Nysa ice-marginal valley formed it. The eminencies of the Curve are the end moraine, piled up and elevated to the 153m a.s.l. Thrusting glacier caused the folding of the Tertiary sediments. As the result of this process the brown-coal deposits located deep under the ground level were putting up, what is good from the exploitation point of view. Actually the Mużakow-Curve is divided in the middle of length with Lausitzian-

Nysa river valley. The first part of described area is located in Poland, the second one (at the other side of the river) in Germany. The lignite beds in the polish part of the Mużakow-Curve are forming in the Łęknica-city locality the "Babina"-deposit. The beds are folded and under exploitation were the top-parts of the deposit's folds on the area a dozen or so km length. The folds are till 140m deep.

2.2. Geological structure [1]

The oldest sediments are clays, mudstones and limestones of upper Cretaceous period. On this layer are lying Tertiary sediments depths about 115m. In these sediments are occurred 4 lignite beds:

- 1) on the 50m depth – bed "Lausitzian Henryk", with seam thickness about 7,0m,
- 2) on the 65m depth – bed "Lausitzian II", with seam thickness about 13,5m,
- 3) on the 95m depth – bed "Ścinawski – Lausitzian III", with seam thickness about 6,0m,
- 4) on the 110m depth – bed "Głogów – Lausitzian IV", with seam thickness about 4,0m.

These beds, especially not deeply lying (and from this case under exploitation), are surrounded by the sand-mudstone sediments with a large amount of micas.

Until the 20m deep from the ground surface occur also alternately sandbanks and gravelbanks with clays-interbeddings.

Between 20 and 50m occur a thick clay and sludge-layer, which are exploited for the refractories production.

From the geological structure results, that both: surface grounds and after-exploitation grounds (clays and sludges) are not suitable for recultivation process in the forest and grassland directions.

2.3. Hydrogeological conditions

The ground waters occur locally in the Quaternary sand-gravel formations over the clay-formations. The deepness of these waters enriched 15m. The Tertiary ground waters are building a few aquifers with depth till 20m. They are separated through clay, sludges and lignite layers. The water occurs in the sand layers, with parts diameters from coarse-grained sand to the silty sand. They are the waters under pressure about 550 kPa (55m of the water column) propagated to the long distances.

2.4. Lignite exploitation

The beginning of the lignite mining in the Mużakow-Curve locality is connected with Raszyn-mine opening in 1863. The little mines were conglomerated in the mine-energetic complexes, as Tschöpelner Mine Company with 12 MW power rating and annual coal-output 330 thousand-Mg. The bigger open-pit mine was Tuplice Mine, working for the glass-works, with annual coal-output 42 thousand Mg. In the year of 1898 was opened deep-boring mine "Wiktor" in the Trzebiel-village, working for the glass-work, with annual coal-output 110 thousand Mg.

In the 1945 were started the mines: "Babiba" (near Łęknica-city) and "Henryk", next "Smogóry", "Słone", "Maria" and "Sieniawa". In the 1971 the total coal-output was 700 thousands Mg. In the following years (till the 1976) the lignite-mines were progressively closed, left the region with many strongly transformed, non-recultivated areas. The amount of transformed areas is shown in table 1.

Table 1

The areas transformed by the mining activity [4]

Mine	Locality	Area in ha
Tuplice, Wiktor	Tuplice, Trzebiel	460
Smogóry	Smogóry	40
Sieniawa	Sieniawa	83
Maria, Emma, Matylda	Lasocin, Nieciecz, Królikowice	60
Tschöpelner M.Comp.	Nowe Czaple, Łęknica, Bronowice	432
Total area		1190

After deep-boring exploitation the breaking down of the chambers and headings were occurred.

The above lying materials are sands, therefore on the ground surface were formed long and narrow sink-troughs, which next were filled with rain or ground waters. Open-pit excavations also were filled with rain and ground waters. This way between the Tuplice and Łęknica-cities, on the length of 20km, was formed artificial anthropogenic Lakeland, with about 100 lakes 20 to 100 years old.

The 3 basins groups were specified:

- Tuplice-locality – 30 sink-basins and 11 ponds,
- Trzebiel and Kamienica-locality – 33 sink-basins,
- Chwaliszowice and Łęknica-locality – 40 sink-excavation- and excavation-basins.

The basins from the Tuplice locality are the oldest, with predomination of elongated shape and NE-SW direction, lying in the forest, with mild banks.

The steep and high banks characterize the second and third groups.

The most often the water basins have elongated shape length 95 to 896m, bright 20 to 468m and asymmetric elongated profile. The one slope of the typical water basin is steep and the second one on the other side of basin is gently sloping. The basins are deep (3 to 24m) in compare with small water area (2500 to 202000m²).

The slopes of the basins, formed by the dumps-slopes are not so steep, strong eroded and naked and therefore less stable. The plants are farther from bank-line.

In the basins formed after lignite exploitation waters are weekly transparent, with rust-brown-color and very low pH value between 2,2 and 3,4. The characteristic feature of these basins is presence of the ferrous sulfate (FeSO₄). This compound in the presence of oxygen formed in water the sulfuric acid. The alkalinity of the water is so small to neutralize formed sulfuric acid therefore the waters in such basins are strong acid.

3. The actual state of the after-mining area

The lignite exploitation in the Mużakow-Curve locality caused the changes in the hitherto existing landscape. On the big areas were damaged:

- pine-forests with the soil-layer,
- primarily plane terrain's surface.

Instead of this were formed dumps builds from cover material and the water basins.

The significant changes referred to the surface water run-off, and water aquifers layout (they were combined from primarily divided layers).

Instead of the pine-forest formation was originated the landscape typical for Lakeland, which consists from the depressions filled with water and non-covered with plants slopes of the dumps. The some lakes are temporarily drying-out, other have enough water for the local strings feeding.

Cover material dumps are formed in predomination amount from silts and silty sands. From the mineralogical point of view the cover material consists of quartz, micas, lignite-dust, and muscovite with a small admixture of illite and caolinite. Also the ferrous sulfides (pyrite) are occurred in amount till 1%. The dump-areas are till 25m above primarily surface level high. They are cones-complexes with inclination till 45° . The top parts of these cones are not leveled and recultivated. Until the 1976 exist in Poland any law regulations imperative to the after-mining-areas recultivation.

The dump areas like these were heaped not far from excavations till the 40m deep. After the lignite exploitation ending these excavations were filled with water, what gives the landscape of water-basin surrounded by the high dump-hills build from fine-grained and silt-materials.

The lakes created after the mining of lignite has ended have a very low pH level averaging from 2.8 to 3.5 (acid). And their potential, Rh, is higher than 600mV. The concentration of sulphates was 101 to 1488 SO_4/dm^3 and concentration of ferrum was up to 182 $\text{mg, Fe}/\text{dm}^3$ (Table 2).

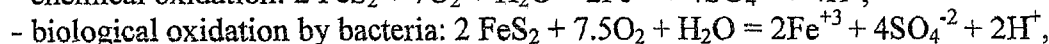
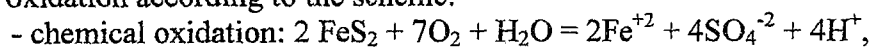
Table 2

Results of the examination of water in open pits of former lignite mines in the area of Muzakow lakes [4].

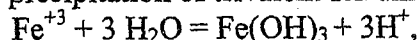
The place of water sampling	pH	SO_4 mg/dm^3	Cl mg/dm^3	Fe mg/dm^3	Ca mg/dm^3	Mg mg/dm^3	Mineral acidity Mval/dm^3	Fe^{+2} mg/dm^3
A lake of the area of 15.07 ha	2.5	1488	28	33.3	153	138	5.5	3.0
A lake of the area of 3.52 ha	2.2	632	17	29.7	74	77	2.7	2.8
A lake of the area of 6,86 ha	3.4	321	49	7.2	63	41	0.6	1.2
A lake of the area of 2.80 ha	3.0	557	40	24.2	95	69	1.4	2.8
A lake of the area of 3.34 ha	2.9	693	19	27.3	93	79	2.6	3.0

The chemical content of water is influenced by complex processes of pyrite decomposition which lead to the creation of sulphur acid and ferrum sulphate. A FeS_2 pyrite located on the bottom of a lake can be subjected to:

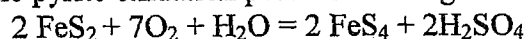
a) oxidation according to the scheme:



b) precipitation of trivalent ferrum compounds:



The pyrite oxidation process can be generally as follows:



The pyrite oxidation by *Thiobacillus ferrooxidans* bacteria is 5 to 10 times faster than chemical oxidation.

4. Theoretical aspects of neutralisation of acid waters

The neutralisation of acid waters can be achieved using basic compounds or via biochemical reduction of sulphates to hydrogen sulphide using organic compounds. The

neutralisation of acid waters can also be achieved via natural oxidation and reduction processes and exchange of chemical components between water, bottoms and atmosphere. The neutralisation of acid water can be achieved using chemical methods by mixing it with strongly basic solutions or its filtration through a layer of basic materials (bed). To neutralise acid water one can use the following:

NaOH solution of 20% to 30% concentration,
 Ca(OH)₂, a milk of lime of 5% to 15% concentration,
 Na₂CO₃ solution or MgO granulate.

The calculated [3] amount of NaOH in the waters of antropogenic lakes is from 130 to 320 NaOH/dm³ and of lime is from 100 to mg, CaO/dm³. In the waters that lack oxygen the bacteria, *Desulfovibrio desulfuricans* reduce sulphates contained in waters with low Rh potential to sulphides, which in turn react with ferric ions causing the precipitation of FeS or FeS₂.

As the result of laboratory studies [3] of waters from reservoirs No. 38 and 54 and municipal sewage and sewage from milk processing plants (mixed in proportion of 1:1) it was determined that such a mixture cause the growth of bacteria which produce sulphates, so after 24 days there was a significant reduction of sulphates and Rh potential and growth of pH to 5 - 6 (Table 3).

5. Conclusions

Both theory and laboratory studies show that there is a possibility of changing acid waters from antropogenic lakes to waters chemically neutral. It can be done using chemical or biological methods of sulphates reduction. It is proposed to use, as the source of carbon for bacteria which reduce sulphates, the following: wood dust, sawdust, sewage, paper industry wastes and wastes from milk processing plants which can be obtained at almost no cost. The biochemical method is much cheaper than the chemical one.

On the laboratory scale the problem has been resolved.

Table 3

Examples of biochemical reduction of sulphates in the waters from the reservoir No. 38 [3]

Time of measurements	pH reaction	Redox potential mV	Sulphates mg/dm ³	Ferrum III mg/dm ³	Ferrum II mg/dm ³
A. Sewage from milk processing plants					
After stirring	3.1	633	367	35.8	4.1
After 4 days	3.3	631	342	20.9	4.2
After 8 days	3.4	628	342	16.3	4.2
After 17 days	3.4	621	318	12.2	4.6
After 24 days	4.2	-51	256	6.2	5.1
After 29 days	5.0	-182	112	1.2	5.3
B. Municipal sewage					
After stirring	3.0	627	340.1	36.7	2.4
After 4 days	3.0	626	340.1	22.3	3.5
After 8 days	3.2	619	316.1	18.1	4.3
After 17 days	3.25	518	316.1	11.2	4.3
After 24 days	3.9	-86	286.2	7.2	5.3
After 29 days.	5.2	-170	156	1.8	5.7

REFERENCES

- Chrzan T. *Badanie środowiska naturalnego na terenach pogórnicznych Środkowego Nadodrza*. Zielona Góra Polytechnic, 1998.
- Jędrzak A., Solski A. *Skład chemiczny wód zbiorników pojezierza antropogenicznego w rejonie Tuplice - Łęknica*. Zeszyty Naukowe No. 84, Higher School of Engineering, Zielona Góra, 1988.
- Jędrzak A., Solski A. *Teoretyczne podstawy możliwości odnowy wód kwaśnych*. Zeszyty Naukowe No. 114, Zielona Góra Polytechnic, 1997.
- Wróbel A. *Zmieniające się krajobrazy*. Zeszyty Naukowe No. 114, Zielona Góra Polytechnic, 1997.

TROKSNIS UN VIBRĀCIJA VIDĒ – VIDES KVALITĀTES KRITĒRIJI

JĀNIS DUNDURS

Ķīmijas zinātņu doktors

Rīgas Stradiņa universitāte, Darba un vides veselības institūts,

Aroda un vides medicīnas katedra,

Dzirčiema ielā 16, Rīga, Latvia, LV – 1007

T.: 409127

MIERVALDIS LĀCIS

SIA Akustika,

Kurzemes prosp. 3, Rīga, Latvija, LV – 1067

F.: 2417212

Ievads

Vibrācija un troksnis ir vieni no visizplatītākajiem vides fizikālajiem piesārņotājiem, kas rada diskomfortu, īslaicīgus, pārejošus veselības traucējumus, kā arī var izraisīt vai veicināt dažāda veida saslimšanas, kuras atsevišķos gadījumos noved pie invaliditātes (vājdzirdība, kurlums, vibrācijas slimības IV stadija u.c.). Tiek pat uzskatīts, ka troksnis ir viena no vislielākajām mūsu gadsimta nelaimēm un viens no galvenajiem stresa izraisītājiem.

Ar trokšņa un vibrācijas problēmām ir jāstopas gan sadzīvē, gan arī darba vidē. Transporta kustība pilsētās un kokapstrādes rūpniecība, diskotēkas un tekstilrūpniecība, lidostas un ģimeniskas ķildas, dzērāju klaigāšana, skaļa mūzika daudzdzīvokļu namos – tas viss ir paaugstināta trokšņa un vibrāciju cēlonis. Ir zināms, ka apmēram 15% no visā pasaulē nodarbinātajiem ir pakļauti trokšņa kaitīgajai ietekmei. Latvijā no ik gadus pirmreizēji reģistrētajām arodslimībām aptuveni 15 līdz 30% ir dzirdes orgāna saslimšanas un apmēram tikpat daudz tiek diagnosticētas kā vibrācijas slimība. Patiesībā šo saslimšanu skaits ir lielāks, jo jāņem vērā, ka mūsu valstī vēl nav sakārtots arodekspertīzes reģistra darbs.