EXTENDED ABSTRACTS OF PAPERS PRESENTED IN THE POSTER SECTION AT THE 7TH INTERNATIONAL CONFERENCE ON TOURISM AND SUSTAINABLE DEVELOPMENT HELD IN TIMISOARA ON 19TH APRIL 2018
ACID MINE DRAINAGES – OCCURRENCE, PROPERTIES AND IMPACT ON THE ENVIRONMENT

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Abstract: Intensive exploitation and copper ores processing are associated with the formation of large quantities of solid waste such as mine dumps and flotation tailings. The predominant sulfide mineral which occurs in these wastes is pyrite. Under natural conditions, the availability of oxygen and atmospheric water on waste dumps brings about the initial spontaneous dissolution of pyrite and generation of sulphuric acid, which enables leaching of other less abundant sulphide minerals and oxide minerals contained in the ore.

The presence of certain indigenous species of bacteria has a favourable effect on these processes, which eventually leads to the generation of mine waters. As a result of weathering, the products of oxidation are dissolved and leached in the form of acid mine drainages (AMDs), whose influence on the environment is extremely harmful due to a high content of heavy metal ions (Cu, Zn, Pb, As, Cd, Ni, Mn etc.) and sulphuric acid (Eigbor et al., 2007; Stanković et al., 2009; Brough et al., 2013; Kefeni et al., 2017). A large number of published papers have investigated the chemistry and mechanism of dissolution of pyrite and the associated non-ferrous minerals, the occurrence of AMDs, their movement and impact on the environment as well as the ways to minimize such impact (Trumić et al., 2010; Bogdanović et al., 2013; Simate and Ndlovu, 2014; Bogdanović et al., 2016). Due to the huge quantities of mining waste, mining waters occur for decades after mine closure.

There is a constant trend in the development of new technologies in the world to minimize this type of pollution, both in active and abandoned mines. Treatment processes for contaminated waste streams include chemical precipitation, ion exchange, adsorption and ultra-filtration; the choice of method is based jointly on the concentration of heavy metals and the cost of treatment (Moodley et al., 2017; Rodriguez - Narvaez et al., 2017).

In Copper Mines Bor, Serbia, there are a few AMDs containing heavy metal ions such as: copper, iron, zinc, nickel as well as sulphuric acid. These are so-called „blue waters“, from underground mine, from AMDs collected at the bottom of the open pits in Bor, Veliki Krivelj and Cerovo as well as seepages from flotation tailing dumps in Bor and Veliki Krivelj. The main toxic constituents of these waters are copper ions, the concentration of which varies mainly from 5 to 500 ppm, but in some cases > 1000 ppm and sulphuric acid (pH = 3.5 to 4). These amounts come into the Krivelj River and via the Timok River to the Danube, damaging them heavily and permanently. Figure 1 shows locations the sites of mine water springs along the Krivelj River valley.

In some sources of waste water copper ion concentrations are such that a serious consideration should be given to its extraction and recovery not only
for the purpose of reducing a threat to the streams and the river in their proximity but also for the purpose of achieving economic benefits of its commercialization. In this paper was to examine the possibility of mine waste leaching by using acid mine waters as a leaching agent. If a leaching field was formed on a waste dump and mine waters were captured, collected and used for preparation of the leach solution, an increased copper content could be expected after leaching as well as a total copper recovery increase. The leach solution obtained in this way would be a relevant source of copper extraction in a useful form. This approach to the solution of problems associated with mine waters and waste dumps, which involves copper recovery from them, is of great importance for two reasons:
- the first one being economic since production costs for this process of copper recovery would be lower than for pyrometallurgical processes;
- the second reason stems from the fact that leaching of low-grade ores or waste rocks would result in a decreased pollution of the environment with copper and other metal ions as well as with sulphuric acid generated as a result of the natural leaching processes having in mind both protection of surface watercourses and the economic benefits.

Keywords: sludge, waste, pulp and paper mill, environment protection
Figure 1. Locations of AMDs springs (UNEP, 2002; Bogdanović et al., 2013)

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PULP AND PAPER MILL SLUDGE UTILIZATION POSSIBILITIES IN TERMS OF ENVIRONMENTAL PROTECTION

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Abstract: Environmental protection and sustainability, in terms of reducing forest harvesting and saving the water resource is forcing the paper industry to look for alternative fiber resources. The solution can be sought in the recycling process of old used paper, but recycling process, in addition to cleaned fibers, generates waste sludge which must be treated further. Generally, it can be said that pulp and paper mill sludges originate mainly from primary and secondary water treatment in pulping and paper making process and from deinking process. In the primary sludge (after primary clarifier) the fiber concentration is high and the sludge consisting of coarse particles can be easily dewatered. In the secondary bio sludge (after secondary clarifier), less fibers are present and dewatering process is difficult resulting in low solid concentrations in paste-like form. The sludge from deinking process, where the recycled fibers are separated from additives and inks, besides fibers have high concentrations of inorganic minerals (kaolin, clay, calcium carbonate, titanium dioxide) and can be dewatered easily. In mill the sludge can be mixed before dewatering and often the origin of the sludge constituents are examines after dewatering faze (Latva-Somppi, 1998; Bajpai, 2015). Primary and secondary sludge production in pulp and paper mills has increased lately because the mills are struggling to close their water circuits entirely, so the improvement in water treatment represent the main reason of higher sludge production. The production of deinking sludge also recorded an increase because of paper recycling rate which has rapidly expanded during recent years. It is recorded that 72.5 % of all paper consumed in Europe was recycled in 2016 (CEPI, 2017). The generating sludge amount in paper industry varies within different regions from 100 kg (Bajpai, 2015), to 600 kg (Nosek et al. 2017), for each 1 ton of recycled paper. The reason can be found in the region development, different recycling rate and also in the fact that some mills have internally wastes treatment which reduce the solid waste generation (Bajpai, 2015). The total paper production in Europe in 2016. was 91 million tones and the recycled paper production at the same period was 47.8 million tones. If 14.3 million tons of deinking sludge which was generating at that period were being deposit without treatment, the negative influent to the environment is inevitable (CEPI, 2017). Otherwise with adequate treatment, the sludge can represent a potential useful secondary raw material. The potential sludge utilization it was examined through properties of pulp and paper mill sludge and have been presented in various publications (Scott and Abubakr 1995; Latva-Somppi, 1998; Geng et al. 2007; Deviatkin et al. 2015). The sludge is a mixture of fillers and pigments, fibers, fiber fines, printing inks and adhesive components. Its dry matter content is within the range of 38 - 62% and the ash content of sludge varies from 36 to 67 wt. %. For example, the typical composition of dry substances in deinking sludge from tissue paper
production is as follows: 40% fines, insoluble printing ink and adhesives, 26% clay and other fillers, 20% calcium carbonate, 11% fibers, 3% resins, fats, resin acids, soluble printing ink, deinking chemicals (Kujala 2012; Deviatkin et al. 2015). But the composition of deinked sludge from the production of wood containing graphic papers is not quite the same: 29% fines, printing ink and adhesives, 37% clay and other fillers, 19% calcium carbonate, 7% fibers, 8% materials extractable with methylene chloride (Holik, 2006). It can be seen that deinking sludge properties and composition are highly dependent on the waste paper composition which is used for paper production, as well as the properties of the paper being manufactured.

Generally, utilization of the possibilities of deinking sludge must be considered based on the characteristics of sludge. The higher fibers amount in sludge is required for production of corrugated material and hard board, while if there is a large percentage of long fibers in the sludge, than it is better to use it for construction materials production. The application of sludge in the production of bricks and cement is possible if the sludge is rich in calcium, aluminum, iron oxides - ash (Kujala 2012; Cusido et al. 2015; Deviatkin et al. 2015). The another possibility for sludge utilization is to use sludge to recovery energy and based on CEPI report approximately one third of sludge generated at paper mills located in CEPI member countries (Austria, Belgium, Czech Republic, Finland, France, Germany, Hungary, Italy, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, United Kindom) was treated with energy recovery in 2010. However, this treatment of sludge generated the large volumes of ash left after the combustion in any furnace type and to reduce the negative effect on the environment (air, water and soil pollution) and decrease the risk to human health, deinking sludge ash recovery must be implemented (Likon and Trebše, 2012).

It must be emphasized that there are many possibilities for sludge utilization but the final effects of the sludge utilization dependent strongly on the properties. Processes that have been successfully used in the sludge utilization in terms of environmental protection is represented in Fig. 1.

Keywords: sludge, waste, pulp and paper mill, environment protection
Fig 1. Processes that have been successfully used in the sludge utilization (Deviatkin et al. 2015)

REFERENCES: