BEST PRACTICE OF MINE WATER MANAGEMENT AND TREATMENT – AN INTERNATIONAL REVIEW

Christian Wolkersdorfer[1] and Robert Kleinmann[2]

Kurzfassung: Im Vortrag werden die derzeit aktuellen passiven und aktiven Reinigungssysteme für Grubenwasser dargestellt und deren Vorteile sowie Nachteile diskutiert. Der „extended abstract“ beschreibt in Kürze die häufigsten aktiven und passiven Systeme zur Reinigung von Grubenwasser und stellt die wesentlichsten Vor- und Nachteile zusammen.

Extended Abstract

Introduction

Mine water management is necessary during and after the active mining period. Both open pit and underground mines need a thorough water management plan to ensure that receiving surface water, groundwater, and marine waters are not adversely affected by polluted mine water. In addition, mine water management must ensure that the miners and the mining operations are not negatively affected by an excess of water entering the mine. In general, mine operators do what they can to prevent acid generation but the mine water that is contaminated must be treated.

Independent of the treatment method chosen, a thorough investigation of the mine water chemistry and the water make of the mine is essential. Besides the flow, oxygen saturation, and pH, the base capacity, acid capacity, and the key metal concentrations of the mine water are essential parameters that must be known to properly design a water treatment operation. Many treatment operations have failed because of insufficient knowledge of mine water chemistry and flow, and especially how one or both vary over time.

Active Mine Water Treatment Technologies

Active mine water treatment plants (Figure 1) aim at removing the pollutants in mine water by physical (involving filters or membranes) or chemical processes. Active treatment means that human action is required to keep the treatment process running, along with energy and/or chemicals. Consequently, the term active treatment is not normally used if, for example, mine water is pumped from a mine into a constructed wetland. In many cases, the principal focus of active treatment plants is pH adjustment to an alkaline pH, aeration, and the resultant removal of iron. Often, other positively charged ions co-precipitate with the hydrolysed iron. Ions reduced by co-precipitation include arsenic, cadmium, and, to some degree, uranium. At some sites, the presence of high concentrations of uranium, manganese, or other contaminants (including radium) require additional measures. In recent years, the removal of sulphate has become a focus of mine water treatment, especially in South Africa.

[1] Prof. Dr. Christian Wolkersdorfer; Cape Breton University; Industrial Research Chair in Mine Water Remediation & Management; 1250 Grand Lake Road; Sydney, Nova Scotia, B1P 6L2, Canada; Christian@wolkersdorfer.info

[2] Dr Robert L.P. Kleinmann; US Dept. of Energy; NETL; POB 10940; 15236-0940 Pittsburgh, USA; Robert.Kleinmann@netl.doe.gov

The most commonly used active treatment technologies are the LDS (low density sludge) and HDS (high density sludge) processes, including all the variations of this technology.

This technology requires oxidation of the mine water, adding alkaline material to the mine water, and removal of the sludge that is formed.

Other approaches include ion exchange, reverse osmosis, and various sulphate removal processes. Most active treatment processes produce iron or gypsum-rich sludge. Only a limited amount of sludge can be used for other purposes so far, e.g. as a colorant in the brick industry. Consequently, the sludge is generally a waste product and adds to the treatment cost. Compared to passive treatment systems, active treatment systems can usually be constructed within a relatively short time and, once constructed, can be used immediately after the plant has been commissioned. Yet, the costs for chemicals, sludge handling, and disposal, as well as maintenance staff are usually very high compared to passive treatment systems.

Fig. 1: Overview of the active treatment plant Schlema-Alberoda (Saxony, Germany) for the removal of uranium, radium, arsenic, iron, and manganese (2005-09-15, © Christian Wolkersdorfer).

Fig. 2: An aerial view of the Neville Street passive treatment system (Cape Breton Island, Nova Scotia, Canada) with an aeration cascade at the bottom, followed by a settling basin and an aerobic constructed wetland at the top of the image (2010-08-29, © Langille Photos, Nova Scotia, for PWGSC and ECBC).

Passive Mine Water Treatment Technologies

Passive treatment is a summary term for various treatment options that consume little or no chemicals. Since the first description of passive treatment systems in the mine water literature in 1982, several thousand passive treatment systems have successfully been implemented. They are often the choice for low flow or low pollution waters and for remote abandoned mine sites. Though the original definition of passive treatment included only systems that functioned without chemicals or electrical energy, the term has evolved and now includes enhanced passive treatment technologies where either chemicals or electrical energy is used to start passive treatment processes. The best known processes include aerobic and anaerobic constructed wetlands (figure 2), open limestone channels, and anoxic limestone drains. A combination of anoxic limestone drains and aerobic wetlands together constitute vertical flow reactors (also called RAPS, or SAPS). Passive treatment technologies require little maintenance compared to active treatment plants, but no maintenance can, and has, caused passive systems to fail.

Advantages of passive treatment are the low maintenance costs and that they can fit nicely into the surrounding landscape. Disadvantages include the large areal requirement, the high investment cost for purchasing the appropriate property, in some cases seasonal changes in treatment efficiency and the fact that passive treatment options are not applicable for all types of mine water.

Hybrid approaches exist; these are referred to as semi-passive techniques. A common example adds mechanical aeration to increase the effectiveness of passive treatment technology.

Appropriate System Evaluation

Software (AMDTreat) can be downloaded for free from the U.S. Office of Surface Mining Reclamation and Enforcement (OSM) website to help a user identify the most appropriate mine water treatment technology.