Chapter

CONTROLLED ORGANIC TREATMENT SYSTEM FOR ACID MINE DRAINAGE (AMD) AND MUNICIPAL WASTE WATER

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ABSTRACT

Most landscapes in South Africa are affected by the process of mining. The environmental results are large amounts of heavy metals and a low pH in the soil, caused by acid mine drainage (AMD) and in most of the irrigation water. Additionally, the quantity and quality of water is – like in most African and developing countries – limited and mostly too scarce for economical processing to drinking water quality. Mining processes and the weather conditions affect the whole agricultural sector in terms of water quantity and water and soil quality.

For this reason, an organic medium was tested to prove of its function purifying water resulting from mining processes. All results showed an increase in pH from pH 3.0 of the AMD to more than pH 5.5 and a reduction in heavy metals of about 80%. Acid mine drainage normally has to be treated with chemicals in order to get an acceptable quality to release the water into wetlands. The organic treated AMD has the quality of irrigation water and could be used for irrigation in agriculture without any negative site effects on the existing soil or water over the long term. The same organic medium was used to optimize the efficacy of municipal waste water treatment as a pre-treatment. More than 30% of the full treatment was done by the organic medium with the effect of decreasing heavy metals and minimizing cytotoxicity and endocrine disruptors. In

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controlled samples the cytotoxicity, caused by specific endocrine disruptors could be significantly reduced by the treatment with the organic treatment system.

Keywords: Acid mine drainage (AMD), Municipal waste water, Heavy metals, Biological rehabilitation, *Casuarina equisetifolia*, Endocrine disruptors.

1. INTRODUCTION

The aim of the presented research project was to propose a controlled wetland system which is easy to maintain and to manage, resistant against external influences and sustainable over long periods of time.

With this in mind a controlled wetland system composed of organic material compacted in bags was applied for different applications. The first application was highly contaminated acid mine drainage (AMD), an effluent from the mining industry, with low pH and high content of heavy metals. The second application was raw municipal waste water with a high load of suspended solids (about 30%) and soluble or part-soluble substances (about 70%) which require biological treatment.

The acid mine drainage is usually treated by chemicals such as the expensive and toxic caustic soda (sodium hydroxide, NaOH) to increase the pH, in order to reduce corrosion in pipes and pumps (Maree, 2004). The use of lime (calcium carbonate, $CaCO_3$), is to increase the pH for the precipitation of metals and some accumulated residues in the cleaned water (Maree, 2004). This use of chemicals can be reduced by an adapted and optimized controlled wetland system.

The standard method for treating municipal and industrial sewage water is a two step treatment – mechanical and biological, where all suspended contaminants are filtered, metabolised by micro-organisms and used as nutrition for their reproduction. Some of the contaminants are too complex for the normal micro-organisms to reduce as their enzymes cannot break down the long chain complex compounds found in some pollutants (Cheung, 1998).

For both applications the controlled wetland system was suitable and resulted in heavy metal reduction and pH stabilisation. Additionally a reduction and elimination of cytotoxicity and some of endocrine disrupting chemicals (EDCs) like estradiol, which are major problems in normal waste water treatment techniques, could be achieved.

2. MATERIALS AND METHODS

2.1. Organic Medium

The organic medium is a 50% mixture by volume of the pine-bark from *Eliote* sp. and leaves from the beech species *Casuarina equisetifolia* with various populations of bacteria (e.g. *Bacillus licheniformis*, *Bacillus cereus*, *Serratia marcescens*, *Bacillus pumilus*), fungi (e.g. *Acremonium* sp., *Aspergillus* sp., *Geotrichum* sp., *Phoma* sp., *Penicillium* sp.), yeast and micro organisms from the semi-decomposed leaves and bark. *Casuarina equisetifolia* is also