Wetland Treatment of Acid Mine Drainage

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ABSTRACT

Acid mine drainage (AMD) is a large problem in many watersheds where coal is mined. It is formed when sulfide minerals are exposed to oxygen and water during mining and other natural events. AMD is known for having high sulfate concentrations, high levels of dissolved metals and a pH less than 4.5. Aerobic and anaerobic wetlands are one way of treating AMD. Aerobic wetlands depend on the AMD having alkalinity so that metals can precipitate out. Anaerobic wetlands are used for AMD that does not have alkalinity. These wetlands produce alkalinity through microbial sulfate reduction and limestone dissolution in anaerobic sediments.

KEYWORDS

Wetlands, acid mine drainage (AMD), wetland treatment, constructed wetland.

INTRODUCTION

Acid Mine Drainage (AMD) is a very large problem in areas that have a history of coal or precious metals mining. AMD is caused by the oxidation of sulfide minerals by chemical and microbial processes. This produces sulfuric acid and heavy metal ions which get into surface and ground waters. The Environmental Protection Agency (EPA) and individual states have taken action to clean up existing problem areas and to prevent further environmental degradation from mining projects. This brings up the question of how do we treat AMD? This paper will look at wetland treatment of AMD.

ACID MINE DRAINAGE

As stated above acid mine drainage is caused by the physical and chemical weathering of common minerals. One of the main sources of this is the weathering of iron pyrite (iron II sulfide). The chemistry behind this process is as follows (Horan, 1999):

$$4\ FeS_2 + 15\ O_2 + 14\ H_2O \rightarrow 4\ Fe(OH)_3 \downarrow + 8\ H_2SO_4$$

Pyrite + Oxygen + Water → "Yellowboy" + Sulfuric Acid

The first part of this reaction is the oxidation of pyrite by oxygen. Sulfur is oxidized to sulfate and ferrous iron is released. This reaction generates two moles of acidity for each mole of pyrite oxidized.

$$2\ FeS_2 + 7\ O_2 + 2\ H_2O \rightarrow 2\ Fe^{2+} + 4\ SO_4^{2-} + 4\ H^+$$

Pyrite + Oxygen + Water → Ferrous Iron + Sulfate + Acidity

The second reaction involves the conversion of ferrous iron to ferric iron. The conversion of ferrous iron to ferric iron consumes one mole of acidity. Certain bacteria increase the rate of oxidation from ferrous to ferric iron.

$$4\ Fe^{2+} + O_2 + 4\ H^+ \rightarrow 4\ Fe^{3+} + 2\ H_2O$$

Ferrous Iron + Oxygen + Acidity → Ferric Iron + Water