



*A COMMERCIAL APPLICATION OF
VIROMINE™ TECHNOLOGY*

**CASE STUDY
COAL MINE WASTEWATER,
LARGE COAL MINE, QUEENSLAND**

*ViroMine™ Technology was effective in treating coal mine
dam wastewater at this large coal mine in Queensland*

A large coal mine in central Queensland commissioned Virotec to deploy its ViroMine™ Technology in both a direct addition and permeable reactive barrier (PRB) configuration to treat on-site acidic mine wastewater.

The direct addition of Acid B Extra™ resulted in the following treatment outcomes presented in Table I, which show that the addition of Acid B Extra™ resulted in a significant increase in pH and a significant reduction in all target heavy metals to within regulatory discharge limits.

TABLE 1: RESULTS FOR THE TREATMENT OF COAL MINE DAM WASTEWATER USING DIRECT ADDITION

Parameter	Dam Before Treatment	After Treatment with ViroMine™ Technology	Regulatory Discharge Limits
pH	6.0	6.0	6.0-8.0
Iron (mg/L)	44	0.5	5.0

Table I: Before and after results for the direct addition treatment of acidic coal mine wastewater at a large coal mine in Queensland.

The option of using PRBs to treat AMD at coal mine sites has the potential advantage that well-designed barriers can be constructed and left unattended, but there are challenges with designing barriers that work effectively over the long term. Designing PRBs that do not develop preferential flow pathways (piping or tunnelling) is testing, with the main challenge lying with the selection of suitable reactive materials for use in the construction of the PRB. For extremely acidic water (pH <2.5), olivine-rich rocks can be used to form cheap PRBs, but they cannot raise pH or reduce the metal content of wastewater sufficiently, and thus they can really only be used as a first-stage treatment option.

Limestone (or similar materials, such as magnesium carbonate) has been widely used to form PRBs, but there are many problems with its use (Evangelou and Zhang, 1995; Powell and Blowes, 1998; Evangelou, 1998), including: 1) reaction between lime and sulphate forms gypsum that blocks pore spaces and progressively reduces the hydraulic conductivity of the barrier; 2) aluminium- and iron-oxyhydroxides, that precipitate as the lime neutralises acid, coat lime particles and prevent them from continuing to neutralise water; 3) lime is slightly soluble and can be leached out in high rainfall areas before all acid has been neutralised; and 4) lime barriers seldom reduce metal concentrations to acceptably low values.

Anoxic limestone drains (Titchenell and Skousen, 1996; Skousen and Sextstone, 1999) were developed in an attempt to solve the problems caused by iron-oxyhydroxide precipitation, but they cannot prevent aluminium hydroxide precipitation and they do not overcome the other problems associated with the use of lime; it is also very difficult to ensure that anoxia is maintained in the drains. Many anoxic limestone drains fail within a few months of construction, and very few continue to operate effectively for more than two or three years.

Acid B Extra™ can be used to form PRBs that will neutralise acid and strip trace metals from contaminated water without impeding water flow. These types of PRBs can be constructed using porous pellets or blocks prepared or by mixing Acid B Extra™ with sand, soil or crushed rock which might be available on site. The design and dimensions

of each PRB need to be carefully determined to provide a balance between hydraulic retention time (i.e., reaction time in the barrier or filter) and the barrier permeability required to handle flow rate and volume of the water to be treated.

PRBs designed for use in ViroMine™ Technology have several advantages over PRBs constructed using limestone, including: 1) they can be used with fully oxygenated water; 2) iron and aluminium are largely removed by crystal growth on iron-oxides and aluminium-hydroxides present in Acid B Extra™ rather than by precipitation of oxyhydroxide coatings on particles that need to remain in contact with the water; 3) the formation of gypsum does not adversely affect permeability; 4) minerals in Acid B Extra™ have a low solubility and are not lost during high rainfall; 5) metal concentrations in water passing through the PRB are acceptably low; and 6) PRBs constructed using ViroMine™ Technology support healthy plant growth and can be revegetated while still in use.

PRBs constructed for use in ViroMine™ Technology have demonstrated that their permeability remains roughly constant from the time the first water is passed through them until the limit of their water-treating capacity is reached. As with all PRBs, there is a limit to their capacity to effectively treat water at which point they need to be replaced. However, unlike PRBs formed using limestone or other materials, metals bound to the minerals in Virotec's PRBs remain tightly held, and if the barrier needs to be removed or replaced, the spent media can be spread on land elsewhere on the site and revegetated. Alternatively, the exhausted material in the PRB may simply be left where it is and revegetated, with a new PRB being placed beside it.

Virotec designed and utilised a PRB to treat the wastewater from the large coal mine in Queensland in order to test its effectiveness in treating contaminated coal mine wastewater and the results of treatment are presented in Table 2. From these data it can be seen that the PRB was effective in raising pH and reducing aluminium concentrations in the wastewater.

TABLE 2: RESULTS FOR THE TREATMENT OF COAL MINE DAM WASTEWATER USING A PERMEABLE REACTIVE BARRIER FILTRATION SYSTEM

Parameter	Dam Water Before Treatment	Dam Water After Treatment with ViroMine™ Technology	Discharge Limits
pH	2.9	7.3	5.0-9.0
Aluminium (mg/L)	34.3	<0.05	5.0

CONCLUSION

From these data it is evident that ViroMine™ Technology was effective in treating coal mine dam wastewater at this large coal mine in Queensland using both direct addition and filtration methods. The direct addition of Acid B Extra™ resulted in the reduction of all target metals to within regulatory limits and pH was adjusted to allow for dam wastewater to be discharged. Aluminium was reduced by 99.9%, manganese was reduced by 94%, nickel by >95%, and zinc by >99%. The use of Acid B Extra™ media also resulted in the successful treatment of acidity and aluminium, with aluminium being reduced by 99.9%.

REFERENCES

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