



*VIROWFLOW™ TECHNOLOGY:
LANDFILL ENVIRONMENTAL MANAGEMENT*

TECHNICAL PAPER



Woodlawn Bio-reactor, NSW

TECHNICAL PAPER

INTRODUCTION

The management of municipal and industrial solid waste has become an acute problem due to the increasing expansion of industrial activities and rapid urbanisation. According to the OECD Environmental Indicators, municipal waste collection and treatment represent more than one third of the public sector's financial efforts to abate and control pollution.

BACKGROUND

Landfill leachate is generally highly polluted wastewater, which has percolated through a deposit of solid waste. Generally, leachate has a high biochemical oxygen demand (BOD) and high concentrations of organic carbon, nitrogen, iron, manganese, chloride, and phenols. Many other chemicals may be present, including solvents, pesticides, and heavy metals.

According to the Environmental Protection Agency, in 2005 U.S. residents, businesses, and institutions produced more than 245 million tons of Municipal Solid Waste (MSW), which represents approximately 2.0 kg of waste per person per day. In many countries it is now a requirement to collect and treat landfill leachate meeting strict discharge guidelines as well as avoiding contamination of surface and groundwater bodies.

The main concerns of leachate relate to the potential impact from inappropriate waste management on human health and the environment (soil and water contamination, air quality, land use and landscape). It is important that leachate is treated before discharge into the surrounding land or receiving waters.

ViroFlow™ Technology can be applied to wastewater and solids treatment. It incorporates the use of ElectroBind™ reagent, an environmentally safe reagent, whose properties include high acid neutralising capacity, fast settling rate characteristics and high metal binding efficiency.

This Technical Paper covers the main applications of ViroFlow™ Technology, which are:

- > Stabilizing waste prior to landfill disposal (e.g. Thiess Services Landfill - Queensland);
- > Treatment of leachate (e.g. Nudgee landfill - QLD; Wauchope transfer station - New South Wales, and;
- > Revegetation of treated landfill (e.g. Woodlawn bio-reactor - NSW).

VIROFLOW™ TECHNOLOGY APPLICATION

ViroFlow™ Technology using ElectroBind™ reagent works by forming strong ionic bonds with metal ions in the leachate and soil. ElectroBind™ reagent effectively immobilizes metals into insoluble, non-reactive sediment.

ElectroBind™ reagent has many applications in landfill including leachate treatment, solid waste treatment and revegetation of disturbed areas. The reagent is effective at binding up metals in both leachate and soil.

The high charge-to-mass ratio of ElectroBind™ reagent increases its ability to strip metal ions from solution and soil.

The heterogeneous mineral surfaces in ElectroBind™ reagent catalyse metal precipitation from solution at a pH lower than that achievable with conventional alkaline treatments such as lime and sodium hydroxide. This is achieved by providing nucleating surfaces and acting as substrates for precipitation.

The primary mechanism of acid neutralization and metal uptake in ElectroBind™ reagent is the dissolution of readily soluble alkaline minerals which supply hydroxides, carbonate ions for the precipitation of insoluble metal hydroxides, carbonates and hydroxy carbonate compounds on the product's surfaces. The ability of ElectroBind™ reagent to strip trace metals increases with time. The majority of metals bound by ElectroBind™ reagent is held as structural components of the mineral and therefore cannot be easily removed.

Most trace metals are initially trapped by adsorption. ElectroBind™ reagent is dominated by particles with a high surface area-to-volume ratio and high change-to-mass ratio. During aging, elements are redistributed to become structural components of new minerals during recrystallisation.

Many landfills are located on historic mine sites, as such there may be a problem with acid rock drainage (ARD). This process occurs when pyrite is exposed to oxygen and water, causing it to oxidize, producing both ferrous and then ferric ions, resulting in sulphuric acid. One tonne of pyrite alone can produce 1.5 tonnes of acid. The complexity of this reaction has considerably inhibited the design of effective treatment options. Extreme acidity lowers soil and water pH and limits availability of soil nutrients to plants. ViroFlow™ Technology, using ElectroBind™ reagent, has been used to successfully neutralize ARD from landfills.

ElectroBind™ reagent used in ViroFlow™ Technology neutralizes acid in soil, inhibits future acid generation, and actively promotes revegetation in contaminated or pyritic soils. It also prevents the leaching of heavy metals, by binding them as part of the formation of new, chemically and physically stable mineral phases with very low solubility. These new mineral phases remain stable, even if there are large changes in acidity, temperature and pressure over time.

Plants can uptake the required nutrients in a bio-available form, without absorbing potentially harmful contaminants. ElectroBind™ reagent is not therefore harmful to wildlife that may eat these plants.

Treating contaminated soil with ElectroBind™ reagent efficiently binds up metals and neutralizes activity, this in turn allows successful revegetation of the soil, decreasing erosion of the soil, and any runoff from rainfall will not be contaminated, protecting the surrounding areas from degradation. ViroFlow™ Technology is a cost-effective, environmentally friendly total solution that can be implemented *in-situ* at any landfill site.

CASE STUDY 1: WASTE STABILISATION OF VARIOUS INDUSTRIAL WASTES AT THIESS SERVICES LANDFILL, SWANBANK, QLD

Virotec regularly conducts waste stabilization using ViroFlow™ Technology on various industrial wastes that are brought into Thies's landfill site in Swanbank, Queensland. These industrial wastes are high in leachable metals, so they are treated with ElectroBind™ reagent which binds metals into a stable form that dramatically lowers leachable metals, meets leachate discharge limits and allows the waste to be disposed of in a safe manner. Test results are shown below.

| Parameter | Arsenic | | Chromium | | Cooper | |
|-----------|--|---|--|---|--|---|
| | Sample date: 16.12.05 | Sample date 09.01.06 | Sample date: 16.12.05 | Sample date: 09.01.06 | Sample date: 16.12.05 | Sample date: 09.01.06 |
| | TCLP Before Application of ViroFlow™ Technology (mg/L) | TCLP After Application of ViroFlow™ Technology (mg/L) | TCLP Before Application of ViroFlow™ Technology (mg/L) | TCLP After Application of ViroFlow™ Technology (mg/L) | TCLP Before Application of ViroFlow™ Technology (mg/L) | TCLP After Application of ViroFlow™ Technology (mg/L) |
| | TCLP 1 | 0.18 | < 0.001 | 1.2 | 0.014 | 16 |
| TCLP 2 | 2.8 | < 0.001 | 6 | 0.007 | 19 | 0.005 |
| TCLP 3 | 0.4 | < 0.001 | 0.11 | 0.009 | 1.4 | 0.008 |
| TCLP 4 | 0.44 | < 0.001 | 0.13 | 0.035 | 1.4 | 0.024 |
| TCLP 5 | 0.34 | < 0.001 | 0.24 | 0.008 | 4.8 | 0.009 |

NB. Metal levels have reduced significantly after treatment.

The following types of wastes have been immobilized by ViroFlow™ Technology prior to landfill disposal:

- > CCA contaminated soil and sludge;
- > Tannery waste;
- > Electroplating and metal finishing solid waste, and;
- > Hydrocarbon contaminated waste.

TABLE 1: RESULTS OF TREATING LEACHATE USING ELECTROBIND™ REAGENT (mg/L)

| Parameter | Raw Leachate | Treated Lechate |
|------------------------------|--------------|-----------------|
| pH | 7.5 | 8.8 |
| Arsenic | 0.14 | 0.09 |
| Iron | 1.5 | 0.12 |
| Lead | 0.01 | <0.005 |
| Manganese | 0.21 | <0.005 |
| Zinc | 0.20 | 0.07 |
| Total Suspended Solids (TSS) | 67 | 30 |

CASE STUDY 2: TREATMENT OF LEACHATE FROM A MUNICIPAL LANDFILL AT NUDGE, QLD

ViroFlow™ Technology using ElectroBind™ reagent was used successfully in the treatment of leachate from a municipal landfill site located in Nudgee, Queensland. The leachate was characterised as having a neutral pH along with mixed heavy metals and suspended solids (SS). The treatment was successful at reducing both the heavy metals and SS in the leachate (Table 1), resulting in much cleaner water. The technology was also successful in reducing odour in the leachate.

CASE STUDY 3: TREATMENT OF LEACHATE FROM WAUCHOPE TRANSFER STATION, PORT MACQUARIE, NEW SOUTH WALES

ViroFlow™ Technology was successful in treating contaminated leachate from the Wauchope transfer station, located south-west of Port Macquarie, NSW. The treatment involved filtering the contaminated leachate through ViroFilter™ system using a series of ElectroBind™ pellets which bound up the metals and contaminants in the leachate.

ViroFilter™ System was effective in removing the following from the leachate:

- > Heavy Metals;
- > Suspended Solids;
- > Phosphate;
- > BOD (Biochemical oxygen demand), and;
- > Odour.

CASE STUDY 4: AMELIORATION OF CONTAMINATED SOIL AT WOODLAWN BIO-REACTOR, NEW SOUTH WALES AND SUBSEQUENT REVEGETATION OF THE SITE

The Woodlawn bio-reactor, located in New South Wales, accepts municipal waste and subsequently generates electricity from the production of methane gas. Virotec has applied its ViroFlow™ Technology to the bio-reactor (a former mine site) because the overburden used to cap the reactor was contaminated with heavy metals. The capped bioreactor was unable to sustain plant growth and was characterised by having high metal concentrations and a low pH. Using ElectroBind™ reagent, Virotec lowered the metal leachable concentrations in the soil and raised the pH to an optimal range for plant growth. The site is being revegetated using native grasses and trees.



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