



A COMMERCIAL APPLICATION OF VIROMINE™ TECHNOLOGY

CASE STUDY: HIGHWAY CONSTRUCTION WASTEWATER TREATMENT, CHEONGJU CITY, SOUTH KOREA

ViroMine™ Technology was effective in treating both the acidity and the metal contamination in the leachate emanating from the highway construction project at Cheongju City.



*Drainage System (above)
Filtration system utilizing
ViroMine™ Technology (left)*

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“The ViroMine™ Technology filtration system containing Acid B™ pellets continues to provide effective long-term treatment of acidic metal-contaminated water being generated from the Cheongju City highway construction site.”

BACKGROUND

Cheongju City is the provincial capital of Chungcheongbuk-do province, South Korea. The city is home to the Sangdang Mountain Fortress, which dates to a 1716 restoration of the site on the slopes of Mt. Uam; Cheongju National Museum, which houses exhibits of cultural artifacts; Heungdeok Temple, where the Jikji, the oldest extant book printed using movable metal type, was created; and the site of the Yongdusaji Cheoldanggan or “Iron Flagpole of the Yongdu Temple”, a designated Korean National Treasure used to honour the Buddha.



Figure 1: Highway construction at Cheongju City (left) and sample of the pyritic rock responsible for generating sulphuric acid and metal contaminated leachate (right).

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Korean Highway Construction constructed a new highway bypass near the city. Much of the highway was built in an area where the rocks contained abundant iron pyrite that could easily react to produce acidic metal-contaminated leachate once it was exposed to water and air as a result of highway excavation (Figure 1). The pyrite oxidises by the same processes that produce highly hazardous acid rock drainage water at many mine sites.



Figure 2: Photograph showing yellow-brown iron oxyhydroxides precipitated on rocks, soil and plants; this precipitation is one of the common indicators of the presence of acid rock drainage water.

When the pyritic rocks were exposed during highway construction and flushed by rainwater and groundwater, the resulting leachate water had a low pH and high concentrations of many metals, particularly, aluminium (Al), copper (Cu), iron (Fe), manganese (Mn) and zinc (Zn).



Figure 3: Photograph showing the water treatment ponds with leachate fed by gravity from the acid-generating rock (upper left).

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The original acid rock drainage management plan for the highway construction involved treating the contaminated leachate through a largely natural pond system. However, this system did not adequately lower the concentrations of metals in the leachate. To overcome this problem, Geoenvirontec was contracted to design, construct and implement an effective treatment system that would both neutralise the acidity and remove the dissolved metals from the water. As a result of its partnership with Virotec, Geoenvirontec turned to ViroMine™ Technology to solve the problem.

TREATMENT STRATEGY

Geoenvirontec conducted a series of laboratory tests to determine the optimum strategy for treating the leachate. Several filter columns were manufactured and tested at different contaminated water flow rates, hydraulic retention times (HRTs) and reagent-to-waste ratios in Geoenvirontec's laboratory in Pusan. As a result of this work, Geoenvirontec developed an "over-under" baffle filter system that could effectively neutralise the acidity and remove the metals from the leachate.



Figure 4: Filter columns being tested at Geoenvirontec's laboratory.



Figure 5: Photograph showing the source of the leachate from the highway (top centre) and the diversion channel (centre) used to divert leachate to the ViroMine™ Technology filter system (bottom left).

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The filter system could then be constructed down the hill from the source of the leachate from the highway site (Figure 5) so that flow could be maintained by gravity without the need for pumps. The ViroMine™ Technology filter system deployed by Geoenvironetec to treat the leachate from the Cheongju City highway construction site consists of a series of concrete tanks and baffles, with each filter bed containing about two metres of Virotec's Acid B™ porous pellets (Figure 6). Leachate is fed by gravity to the system, and the head pressure of the system “drives” the leachate to the bottom of the filter beds via the baffles, and through the Acid B™ pellets for treatment. The hydraulic retention time in the filter system is about six hours.



Figure 6: The ViroMine™ Technology filter system; Acid B™ pellets have been placed in the bottom of this filter (and another filter to the left) with a series of over-under baffles between the two filter beds.

RESULTS

The effect of passing the leachate through the filter system can be seen in Table 1. From this data it can be seen that pH increased from 2.8 to 8.0 as a result of the treatment. The concentrations of all metals, including the primary target metals, were lowered substantially as a result of the treatment; metal removal efficiencies were: Al = 99.9%; As = 90%; Cd = 91%; Cu = 99%, Fe = 98%; Pb = 92%; Mn = 90%; and Zn = 93%. The concentrations of all metals in the discharge water were below the target limits.

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TABLE 1: EFFECT OF TREATMENT IN THE FILTER SYSTEM USING VIROMINE™ TECHNOLOGY

Before and After Leachate Treatment Results		
Parameter	Influent Leachate	Leachate After Treatment with ViroMine™ Technology
<i>pH</i>	2.8	8.0
<i>Aluminium (mg/L)</i>	250	1.0
<i>Arsenic (mg/L)</i>	0.2	≤0.02
<i>Cadmium (mg/L)</i>	0.12	≤0.01
<i>Chromium (mg/L)</i>	0.25	≤0.02
<i>Copper (mg/L)</i>	10	≤0.01
<i>Iron (mg/L)</i>	450	10
<i>Lead (mg/L)</i>	0.40	≤0.03
<i>Manganese (mg/L)</i>	9.0	1.0
<i>Zinc (mg/L)</i>	40	3.0

CONCLUSION

ViroMine™ Technology was effective in treating both the acidity and the metal contamination in the leachate emanating from the highway construction project at Cheongju City. The filtration system using the Acid B™ pellets in an over-under baffle system was easy to design and construct, and it can be operated for a significant length of time without the need for maintenance.

TESTIMONIAL

“The ViroMine™ Technology filtration system containing Acid B™ pellets continues to successfully treat the long-term acid and heavy metals being generated from the Cheongju City highway construction site. We developed the system along with the main contractors for the project, Dyne Architects & Engineering, and all parties are satisfied with the results. The system was easy to install and has proven remarkably robust over time. After more than a year, the ViroMine™ Technology filtration system continues to produce good results for the client.

This is the second successful ViroMine™ Technology project we have implemented in Korea. We would recommend the Technology to anyone with mining or road construction waste problems, as it can provide a wide range of flexible solutions and is extremely cost-effective.”

— Dr Jeongyul Suh, Chief Executive Officer, Geoenvironetec Co. Ltd.