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Biocell

By: Heather Kent

The City of Calgary's biocell landfill project

Improved landfill disposal methods have evolved along with growing environmental concerns, but for regulators and municipal administrators, municipal solid waste management has often been "at the bottom of the totem pole," according to Patrick Hettiaratchi, Ph.D., Professor of Environmental Engineering at the University of Calgary's Center for Environmental Engineering, Education and Research. Hettiaratchi's landmark pilot biocell project aims to turn that attitude around.

An innovative closed-loop recycling system that eventually recovers the landfill footprint, the biocell concept is a paradigm shift wherein, as Hettiaratchi puts it, "waste is considered a valuable resource rather than a nuisance to be dealt with."

In the 1970s, open dumping was accepted practice until concerns regarding their environmental and human health impact led to the development of sanitary landfills. A piecemeal approach developed as regulators realized that groundwater contamination control measures were needed. When the bioreactor landfill approach was proposed in the 1980s, "there was no real interest," says Hettiaratchi. "Although the bioreactor generated more interest by the 1990s, regulators were still focused on groundwater contamination.

Only the recent focus on climate change has resulted in landfill regulators placing more emphasis on landfill emissions, according to Hettiaratchi.

Jasna Hundal, P. Eng., Manager of Disposal and Treatment for the City of Calgary agrees.

"The benefits of immediate and longer term recycling through electricity generation and re-use of the landfill footprint in seven to ten years time make the project very appealing," she says.

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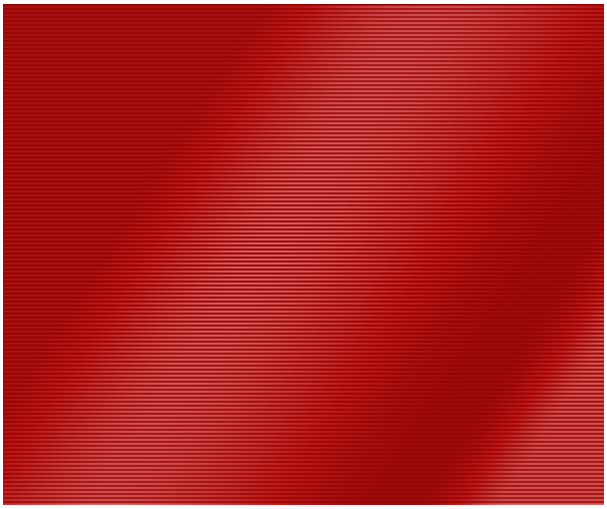

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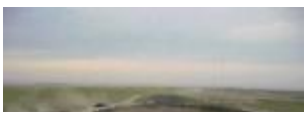

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The biocell project

The biocell shell was constructed on one hectare of land at the City of Calgary's 240-hectare Shepard landfill site in 2004. It began receiving waste in April, 2005.

The biocell project directly addresses the primary problems inherent in conventional dry-tomb landfills: operational aesthetics; ground- and surface-water contamination; gas emissions, and the substantial land requirements. It does this with a three-step system that uses methane gas to generate power.

In the first stage of the operation, the biocell acts as an anaerobic bioreactor, re-circulating leachate produced by organic waste in order to capture the energy content. During construction of the shell, a high-density polyethylene (HDPE) liner was used and a plastic pipe system installed for the collection and re-circulation of leachate, and to inject air to accelerate waste degradation during the second phase of aerobic operation. A gas collection system was also installed for emission capture and control. In addition, a variety of sensors were placed in the landfill to collect real-time data on temperature, moisture migration, settlement behaviour and loads. For example, 30 moisture sensors, collecting real-time data to determine the amounts of leachate in the waste, were placed in different locations in the shell.

"Maintaining about 50 per cent moisture content in the waste is ideal," says Hettiaratchi.

The biocell is shaped like a pyramidal square frustum, with the base measuring 50 m by 50 m, extending 10 m below the ground, and with a waste footprint of 85 m x 85 m. Approximately 65,000 tonnes of waste was placed in the shell over a 16-month period and the site was capped in October, 2006. A unique feature is the use of thin biocaps for the intermediate cover layers as well as for the final cover layer. Consisting of loose granular material (to facilitate the growth of Methanotrophs -- a bacterium capable of converting methane to carbon dioxide) and placed at 5 m intervals, the thin biocaps allow the leachate to pass through and convert the more potent greenhouse gas methane to carbon dioxide.

Organic material is best for the biocell, but as Calgary does not have a source-separated recycling program, about 70 per cent of the waste used was organic with the remainder metals, glass and plastics. Currently, Calgary recycles only about 20 per cent of its waste with the rest going to conventional landfills, says Hettiaratchi.

The current anaerobic phase of the biocell is expected to last for three to four years and the subsequent aerobic phase will last for one or two more years. After then, the site will be excavated, returning land to the City of Calgary. The city's landfills currently have a lifespan of about 30 to 40 years. The application of the biocell technology could expand this to 100 years or more, while generating electricity from methane gas emissions and significantly reducing the environmental impact of the landfill.

The biocell's methane gas production began generating power in September, 2006 in combination with methane from the remainder of the Shepard landfill.

Hundal says that over the next three to five years the city will evaluate the biocell's performance in terms of the amount of gas produced, how long it takes to stabilize the waste, and the impact of Calgary's winter weather. The performance of the monitoring equipment, which has not been used before in this kind of project, will also be assessed.

So far, Jasna Hundal is encouraged by the biocell. "We really have good gas production," she says. "I am quite hopeful and really interested to see how it works."

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