Simplified Treatment of Municipal Solid Waste by Adjustment of Percolation *BIOLEACHATE° Process*

Peter Schalk

InnoWaste, Germany

Abstract

Mechanical and biological treatment has become established as a concept for handling municipal solid waste. The biological process aims to degrade the organic fraction of the waste to a stabilized product through fermentation and rotting processes. The organic fraction and water are the main sources of emissions on landfills. Therefore waste treatment is especially focused on the wet organic fraction. There is a direct relationship of organic waste and water content through biological degradation and dewatering of solid waste. Most of the MBT-systems have been developed and installed in countries with a sanitary management of municipal solid waste which is financed by public fees or waste charges. When applied in developing and emerging countries these technologies initially have to be adjusted technically for a different composition of solid waste firstly. Secondly the limited budget for treatment of municipal solid waste requires to a cost-effective facility process. As a result for this application the approved system of percolation is adjusted to the simplified treatment, BIOLEACHATE° process.

Inhaltsangabe

Die mechanische und biologische Abfallbehandlung hat sich als ein Konzept zur Aufbereitung von Siedlungsabfällen aus Haushalten und Gewerbe etabliert. Dabei steht die biologische Behandlung im Zentrum der Aufbereitung. Die biologische Umsetzung zielt auf den Abbau durch Vergärung und Rotte, um den biogenen Abfallanteil zu reduzieren und ein stabilisiertes Endprodukt zu erzeugen. Durch Abbau und Entwässerung entsteht ein vergleichsweise hoch belastetes Prozess- und Abwasser, das einer Reinigung zu unterziehen ist. Die meisten MBA-Systeme sind in Ländern mit relativ geordnetem Abfallmanagement entwickelt und installiert worden. Bei Anwendung der Technologien in den Schwellenländern müssen erstens diese technisch der andersartigen Abfallzusammensetzung angepasst werden. Zweitens sind kostenreduzierte Behandlungsmethoden gefragt. Das bewährte Perkolationssystem wurde deshalb zu dem vereinfachten Verfahren *BIOLEACHATE°* modifiziert.

Keywords

anaerobic digestion, biodegradation, biogas, dewatering, leaching, mechanical-biological treatment, percolation, process water treatment, reduction of pollutants, waste water treatment

1 Mechanical and Biological Treatment of Mixed Municipal Solid Waste

1.1 Introduction

Throughout the world the treatment and utilisation of municipal solid waste based on economic and ecological aspects is gaining increasing importance. With reference to the global problem of preserving natural resources and promoting environmental protection waste management is concerned with the following central ideas:

- **Conservation and management of natural resources**
- **Waste avoidance** (quantity and toxicity)
- **Waste reuse and recovery** (materials, energy)
- **Safe disposal** (landfilling, incineration).

In most countries, industrial and household solid waste are disposed at dumpsites. Landfill disposal, in particular of waste containing organic fractions, is producing significant emissions (outgasing of odours and methane, release of leachate). For this reason, there are specific requirements concerning the location and the operational management of landfill sites. European regulations require a pre-treatment and especially the reduction of organic fraction before disposal on a dumpsite (EC Landfill Directive 1999):

- **Waste recovery of recyclable fraction**
- **Biological treatment of biodegradable solid waste**:

  recovery of organic fraction (composting)

  production of biogas (anaerobic digestion)

  reduction of the mass of biological degradable solid waste

1.2 Development of Percolation

In 1997 WEHRLE-WERK AG, Emmendingen, a medium-sized company in Germany which is working in the field of energy and environmental technologies bought the licence for percolation of municipal solid waste. At this time I was responsible for research and development of this idea to technical scale. From 1997–1999 a pilot plant (BIOPERCOLAT®) was continuously been operated at ZAK Kahlenberg dumpsite, Germany. In 1999 as a result of its successful development Kahlenberg gave the order to build a plant designed for a throughput of 18,000 t/y mixed solid waste. The technical

plant operated from 2000 to 2003 during this period biological drying of residual waste and mechanical separation were added to ZAK process. This technical plant achieved proved and reliable results with respect to technology and economics. In 2004 ZAK Kahlenberg decided to build a plant designed for a throughput of 100,000 t/y. This plant was commissioned in March 2006 and the waste treatment is operating at a steady state for more than two years. The ZAK process is definitely one of the most innovative mechanical-biological waste treatment for municipal solid waste with an advantageous combination of aerobic processing and anaerobic digestion.

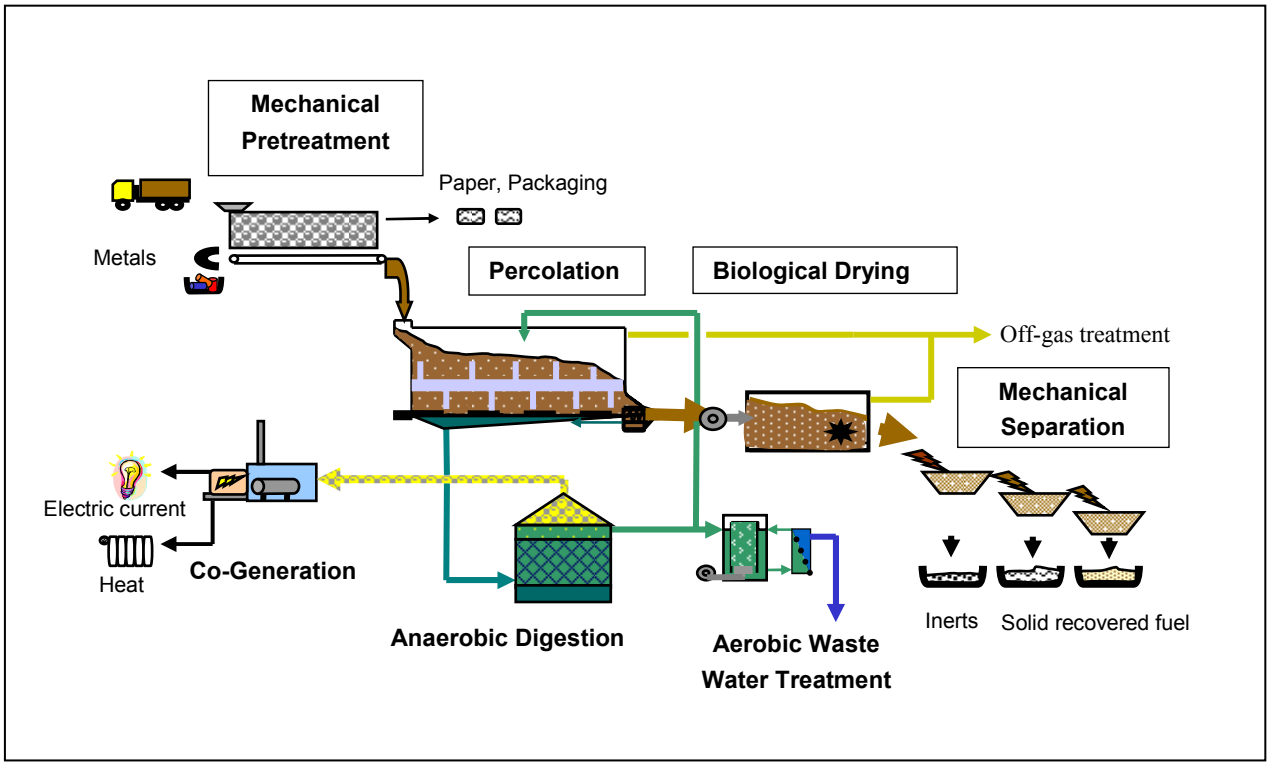

Fig. 1: MBT concept ZAK Kahlenberg

Mechanical-biological treatment is carried out with mixed municipal solid waste including the biowaste (30-50% mass). In this case the solid waste treatment is mainly focused on weight reduction and stabilisation of the municipal solid waste. The organic proportion of the waste is converted to biogas. The dewatered and dried residual waste allows material and energy utilisation (waste-for-recovery and waste-for-energy). The concept Kahlenberg has following process stages.

Mechanical and Biological Treatment

Mechanical pre-treatment (screening, separation of metals and bulky refuse)

Biological treatment (percolation, degradation, biogas production)

Biological Drying

Increasing calorific value of solid recovered fuel

Preparing for mechanical separation

Mechanical separation

Separation of inert fractions and solid recovered fuel

This process combination is one of the first of its kind to combine anaerobic digestion with subsequent production of solid recovered fuels from mixed residual waste. Contrary to the conventional mechanical-biological treatment the residual waste is not landfilled but is in fact reused as a source of energy.

1.3 Operating Results of Percolation and ZAK

The percolation process produces easily convertable organics and accelerates the anaerobic digestion. The main benefits of percolation are dewatering and mass reduction of residual waste. The biological process of the percolation supports an effective drying within 7 - 9 d of retention time. The solid recovered fuel with a residual moisture content of 15 % contains a calorific value of 11,000 to 22,000 kJ/kg. The municipal solid waste is reduced to about 35 % solid recovered fuel which is used for energy recovery as industrial combustion (Fig. 2).

Another 11% is removed by biological degradation. When converted it results in a specific biogas production of about 70 m³/t (70 % by volume CH_4) of treated solid waste. The plant operation is self-sufficient in energy and more than one third of electricity is for sale. Warming up the anaerobic digestion (mesophile) needs approx. 50 kWh/t and heat for sale is up to 200 kWh/t.

Degradation and dewatering result in excess water (30 %) which is treated by an aerobic waste water treatment (membrane bio-reactor system). About 10 % of inert substances are discharged from the original municipal solid waste.

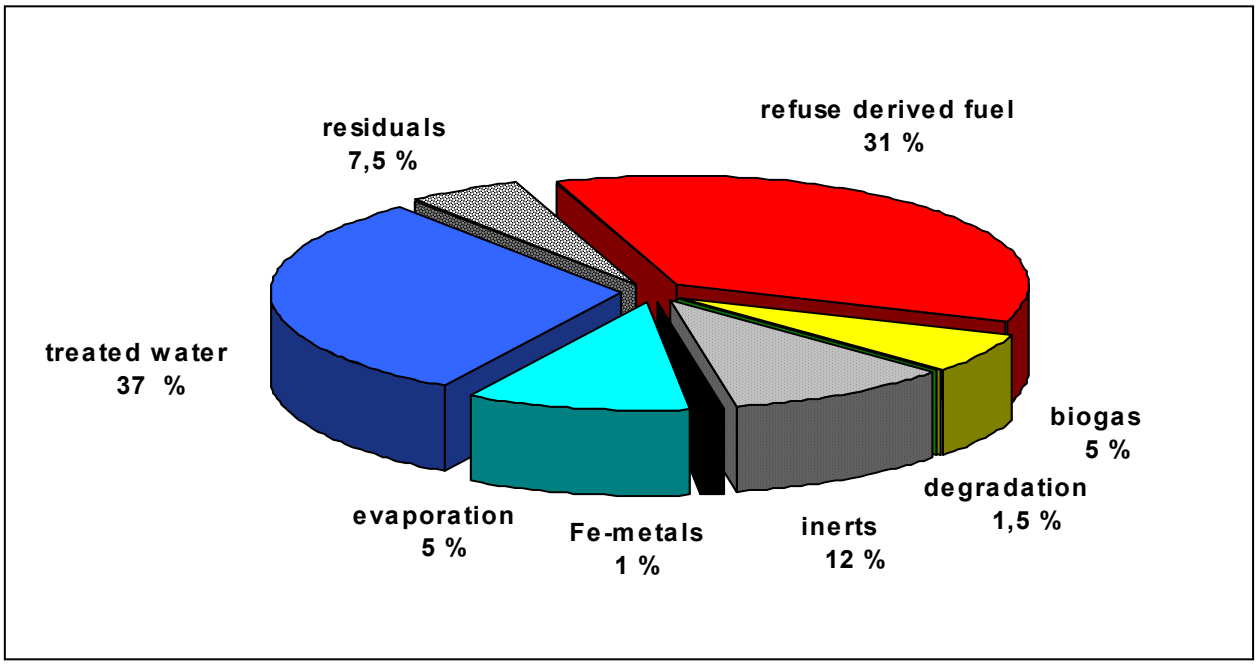

Fig. 2 Mass balance of the Kahlenberg concept (PERSON, SCHREIBER, GIBIS 2008)

2 Adjustment of Percolation to *BIOLEACHATE° Process*

2.1 Reasons for Adjustment of Percolation

The percolation process was developed for mixed municipal solid waste and has been operating reliable for more than 6 years in technical plants in Germany. When applied to developing and emerging countries percolation must initially be adjusted technically for a different composition of mixed solid waste and also for a limited budget for waste treatment. In comparison with German solid waste the organic fraction and water content are often much higher in these countries. The wet organic fraction starts biological processes even in the bins and the treatment plants receive a mixed waste with a high bioactivity. Additionally overcrowded areas are generating multiple waste exceeding the capacity of most of MBT processes that operate up to 2,000 t/d throughput. The retention time of biological treatment requires large plants and great efforts in operating management.

Secondly the limited budget for treatment of municipal solid waste requires a cost-effective processing facility. The starting point of developing and emerging countries for treatment of municipal solid waste is much lower than German waste management. Lower cost technologies are required. As a result for this application the approved system of percolation is adjusted to the simplified treatment, BIOLEACHATE° process.

2.2 Leaching and Dewatering

The wet organic fraction keeps water in the centre of the treatment of municipal solid waste. Water is the main fraction of solid waste. It has a key role in biological processes as hydrolysis and aerobic treatment (see Fig. 3).

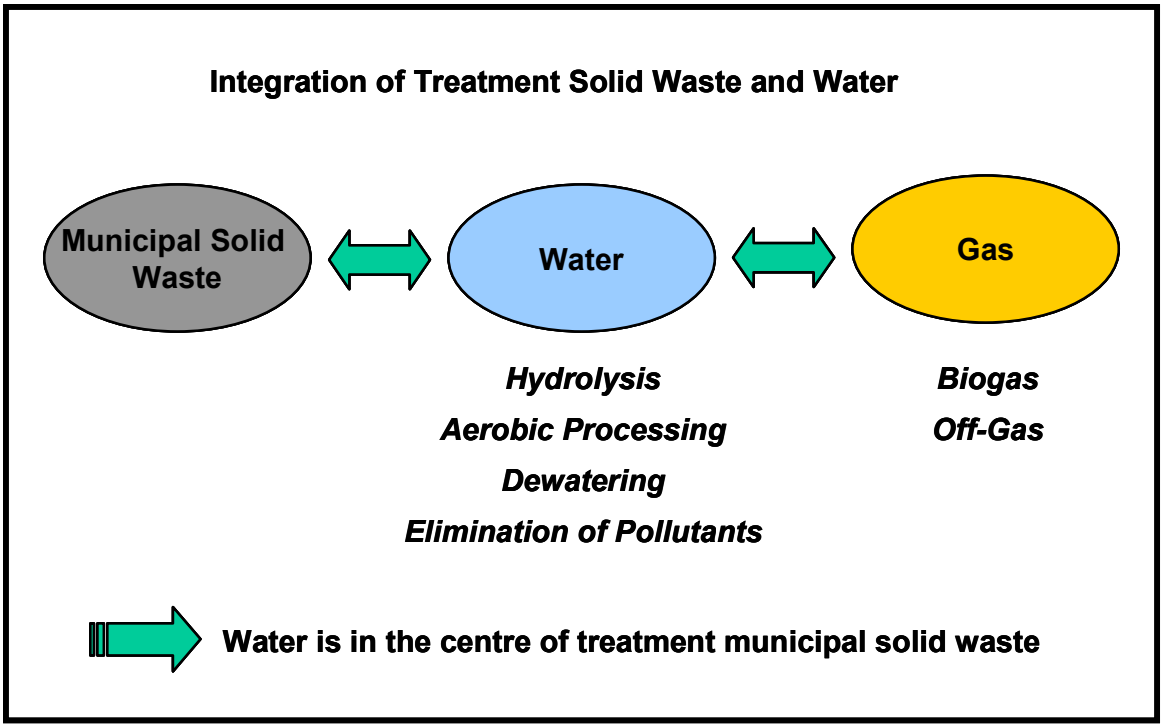

Fig. 3 Water in the centre of treatment of MSW

Technically leaching is the washing out of soluble organic fractions for anaerobic digestion. After less than 18 hours of treatment more than 80% of soluble COD is leached into process water (see Fig. 4). Shortly after beginning leaching the formation of organic acids increases (beginning of hydrolysis). Soluble pollutants (i.e. ammonia and odours) are also eliminated from residual waste.

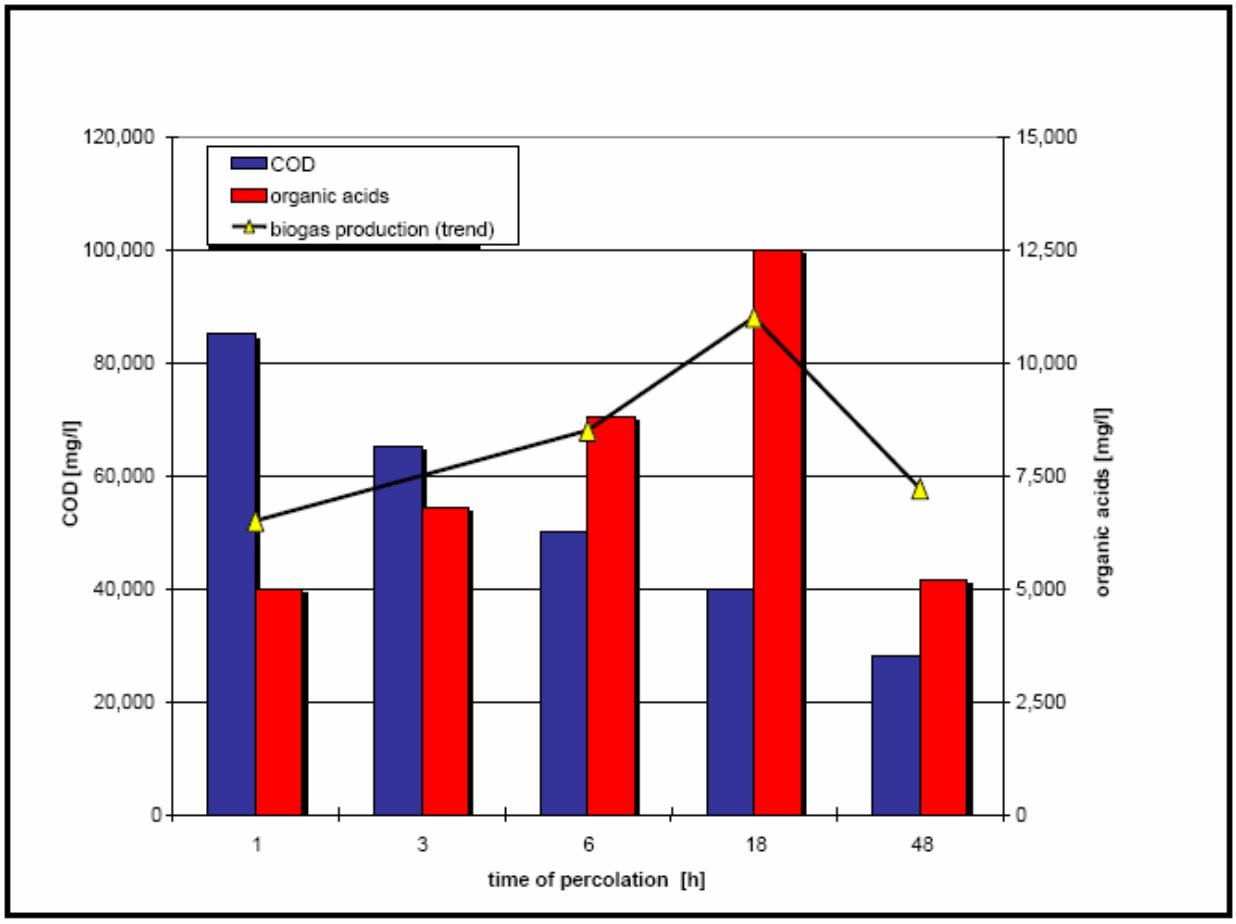

Fig. 4 COD and organic acids from leaching and biogas production

2.3 BIOLEACHATE° process

The BIOLEACHATE° process is derived from the percolation process and has its main elements in process water treatment. Mechanical pre-treatment is done by sieving and removal of metals, plastic foils and cardboard (see Fig. 5)

The screen underflow which contains the bio-organic fraction goes to the leaching process. Easily soluble and odoriferous substances are washed out or are dewatered from solid waste by the mechanical press. After separation of sand and inert fractions process water is degraded aerobically within the hydrolysis reactor. The process water is converted anaerobically into biogas. The generated biogas is used for energy production in a combined heat and power generator.

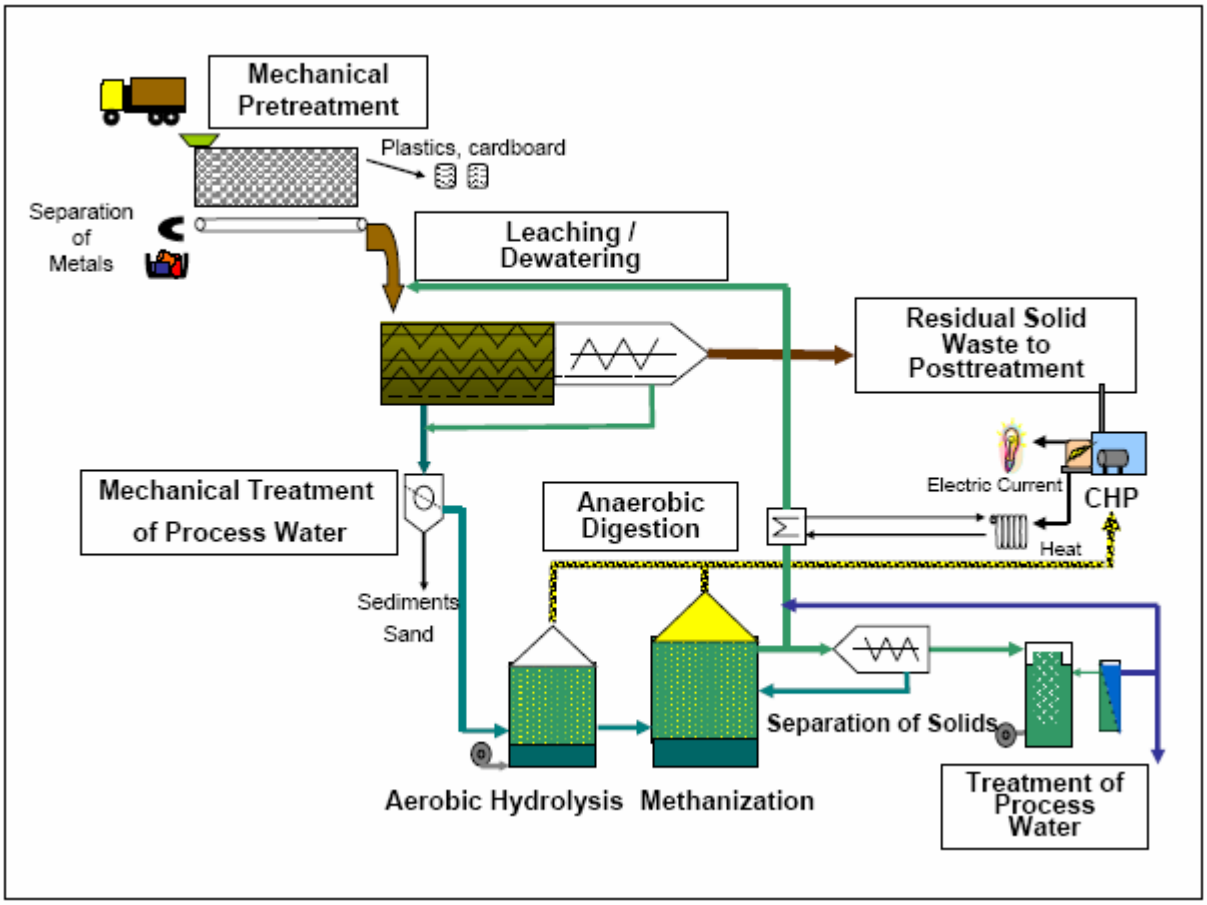

Fig. 5: BIOLEACHATE° process

The effluent of the anaerobic digester is reused as process water for leaching. Part of the circuit water and the excess waste water are treated in an aerobic process water plant. The organic fractions and nitrogen compounds are removed by denitrification and nitrification in a membrane bioreactor system.

The solid output of *BIOLEACHATE°* is treated by subsequent rotting to break down biological activity before landfilling. Another option is to reduce moisture by aerobic drying to produce solid recovered fuel (waste-to-energy). The leaching process prepares excellently residual waste for final rotting or biological drying. Soluble organics are converted to biogas and ammonia is washed out by leaching thereby supporting aerobic processes. There is also no biological break between anaerobic digestion and rotting as known in other systems. After the leaching process there are still enough organics which are easily degradable providing biological energy for aerobic processes.

3 Conclusions

The biological processing remains the centre of the mechanical-biological treatment of municipal solid waste. The biological degradation and dewatering of the *BIOLEACHATE°* process are leaching out most of pollutants into process water. In-

noWaste has a broad and long experience in the percolation of municipal solid waste and the treatment of process water. The adjustment of percolation to the *BIOLEACHATE°* process is applicable to emerging countries with huge waste problems and limited budget for financing the treatment of solid waste.

4 Literature

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Dr. Peter Schalk
InnoWaste
Bergstr. 3
DE 79331 Teningen
Phone +49 7641 95 86 36
Fax +49 7641 95 86 37
Email info@innowaste.de
Website: www.innowaste.de