LEACHATE TREATMENT OF SANITARY LANDFILLS USING LOW COST EVAPORATION TECHNOLOGY

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Landfilling is still the most common waste treatment technology in the world. Although the number of operating landfills is reduced environmental impacts of thousands of closed sites exist. Requirements on leachate treatment are tightening (Doedens & Theilen 1992). Many studies on leachate treatment have been made using for example municipal sewage treatment plants, filtering, short-rotation plantations, biological treatment, reverse osmosis, activated carbon and combination of methods mentioned above. However, all the methods have had serious economical or technical problems.

Conventional evaporation technology has been applied for leachate treatment but corrosion and high costs have been the key disadvantages (Seyfried & Thielen 1991). Those problems have been avoided with a new evaporation technology in a full scale treatment plant at a sanitary landfill in Finland.

New technology for leachate treatment

The evaporator concept is based on the mechanical vapor recompression process and applies the falling film principle (Fig. 1). The key innovation of the technology is a new heat transfer surface concept, where water evaporates on a thin plastic film.

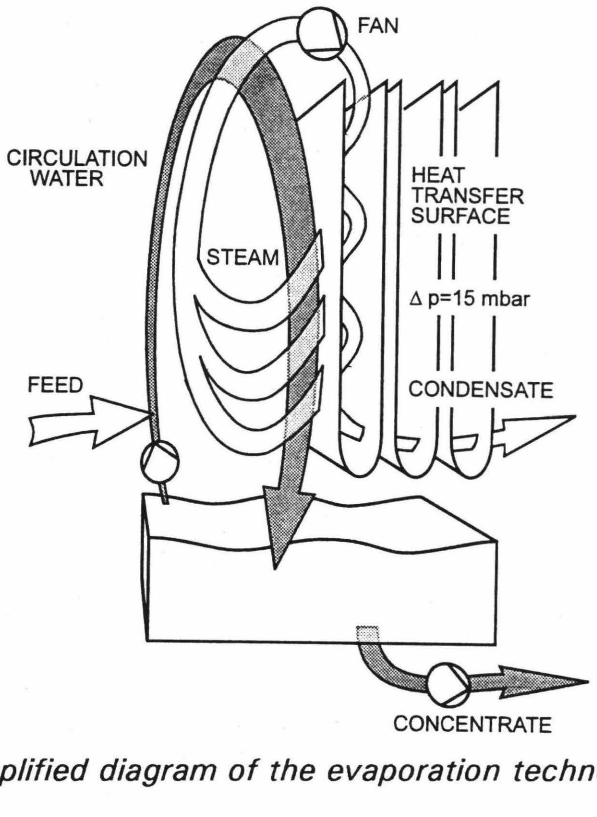

Figure 1. Simplified diagram of the evaporation technology.

As pretreatment the plant is equipped with sand filter. In addition pH adjustment below 4 is used to achieve good ammonium reduction. CO_2 is released in a tower before evaporation. Operating pressure (0,12-0,2 bar) and temperature (50-60 °C) are low, which allows the use of plastic film as heat transfer surface. Small temperature difference (2,3 °C) over the fan is used in order to keep energy consumption low (see equation 1).

$$P_k = c * m * \Delta T \qquad \text{(1), in which}$$

P = Power consumption of the recompression fan
c = constant
m = Vapor mass flow, that is evaporation capacity
Δ = Temperature difference over the fan

Plastic with low heat transfer coefficient has to have small (for example 0,02 mm) wall thickness in order to keep evaporation capacity high. Low effective temperature difference would mean low evaporation capacity, which is compensated with large heat transfer surface area (see equation 2).

$$\Phi = k * A * \Delta T_{eff} \qquad \text{(2), in which}$$

Φ = Evaporation capacity
k = Heat transfer coefficient
A = Heat transfer surface area
ΔT_{eff} = Effective temperature difference

Operating results of the full scale leachate treatment plant

Full scale plant with 130 m^3/d capacity was built in June 1996 at the sanitary landfill in Lahti in Finland. The plant is equipped with 1.500 m^2 plastic heat transfer surface. Sulphuric acid is used for pH adjustment below 4. In addition small amounts of lime is used to get pH of the condensate back over 7 before discharging treated leachate to the recipient.

According to five days continious controlling and sampling very good purification rate was achieved. COD_{Cr} of the effluent was below the detection limit. BOD_7 was analysed once before that period and it gave the result 6 mgO_2/l. Conductivity of the effluent even after adding lime was lower than median values (6 mS/m) of Finnish groundwater from springs.

Energy consumption during that control period in the middle of the winter was 13 kWh/m^3 leachate which is only a minor part of that energy demand of reverse osmosis for example. There are further plans to utilize energy from landfill gas to leachate treatment. Capacity of 5,2 m^3/h condensate was achieved. Because of high calcium concentration in the leachate cypsum precipitation limited the evaporation rate. Volume of the concentrate was 18 % of the influent. That is why hydrochlorid acid is recommended when high evaporation rate is desired.

Table 1. Influent and effluent quality of the Lahti leachate treatment plant using new evaporation techology in January 27-31, 1997 (n= number of samples).

Parameter	*Unit*	*Influent (n=3)*	*Effluent (n=5)*
Conductivity	*mS/m*	*402*	*2,8*
pH	-	*7,3*	*7,6*
COD_{Cr}	*mgO_2/l*	*227*	*<30*
Ammonium	*mgN/l*	*120*	*0,1*
Dissolved solids	*mg/l*	*2.200*	-
Suspended solids	*mg/l*	*47*	-

Purification rate aimed has been achieved in the full scale evaporation plant at the Lahti landfill. Energy consumption has been a little bit higher than expected. Investment and operating costs have been about 5 $\$/m^3$ leachate which is low compared to those of other efficient technologies; 25-35 $\$/m^3$ (Doedens & Theilen 1992). Some technical problems have also met with the first full scale evaporation plant. However, for example difficulties with electrical power network, pumping acid or measuring water level have very little deal with the key innovation.

Conclusions

New evaporation technology can be applied for leachate treatment at sanitary landfills. Purification rate at the full scale plant at the Lahti landfill has been very good and effluent quality meets all the requirements set. Total costs of the technology is only a minor part of the other efficient lechate treatment methods.

References

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