

LANDFILL GAS EXTRACTION SYSTEMS AND UTILISATION IN HUNGARY PUSZTAZAMOR LANDFILL SITE OF FKF ZRT. BUDAPEST

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SUMMARY: The Pusztazámor landfill is the largest Hungarian domestic waste landfill site which was built in 2000, employing state-of-the-art technology. The placement of domestic waste started in 2000 and will, in all probability, continue until 2005. In the first of three placement segments, a gas extraction system with a gas booster station and a flare system was started-up in autumn 2006 in one section to be able to design the final gas utilisation plant with regard to the gas quantity and quality. After a test operation (pumping trail) of only 6 months, it turned out that the gas quality is suitable for the utilisation in a gas engine, even in accordance with the strict TA air 2002 requirements. However, the usual West-European gas prognosis models cannot fully be applied to Hungary. The conservative designs and calculations regarding the amount of gas will probably be exceeded by a factor of "1.5 to 2". Reasons for this could be the mild climate and higher water introductions into the landfill body. The effect on the chronological course of the gas production remains to be seen.

1. INTRODUCTION

The author Wolfgang H. Stachowitz found the Pusztazámor landfill site in 2004/2005 while looking for landfills that could be financed as Kyoto-mechanism projects (Clean Development Mechanism projects). At the same time, the operator, FKF Zrt., was trying to find suitable gas engineers and consultants for the planning, designing and projecting which should be responsible for the gas extraction system with utilisation, and assist in the implementation of degasification, with longstanding experience in this field. At Easter 2005, the co-operation was started.

The Pusztazámor landfill site was first started up with a floor area of approx. 18 ha for the disposal of waste in 2000. The entire future landfill placement area is divided into three segments with four sections each (see Figures 1 to 3).

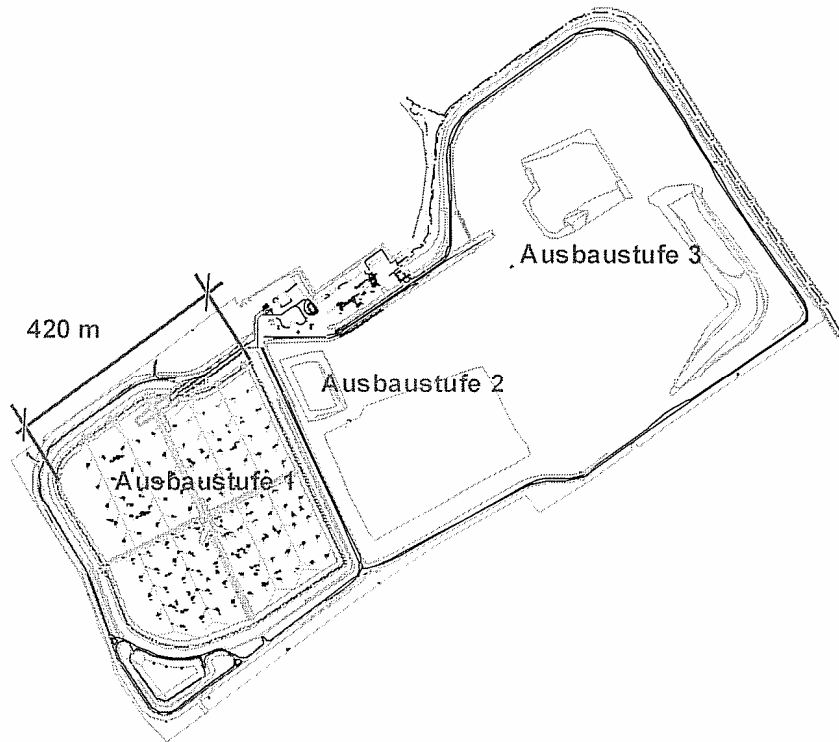


Figure 1. Expansion stages / placement segments

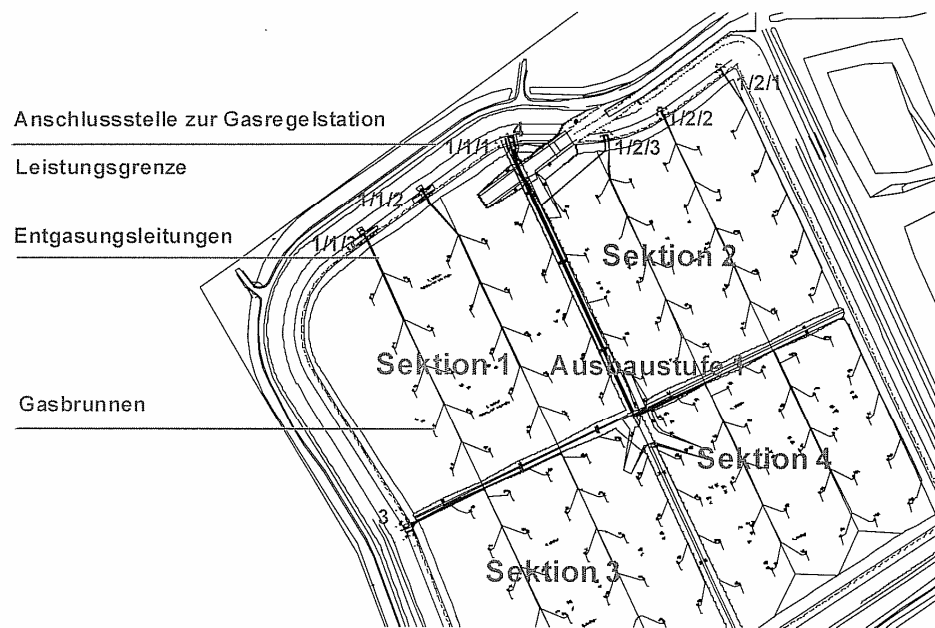


Figure 2. 4 Sections in segment 1 - Shows the connection point for the gas manifold station / Limit of performance & supply, pipes and gas wells



Figure 3: Aerial photo, taken during the construction of the landfill in 2000

The landfill is operated by the Budapest Sanitation Department (FKF Zrt.); approx. 350,000 t of residual waste are deposited per annum, mainly deriving from Budapest city.

With a combination sealing as the landfill base sealing, the landfill corresponds to state-of-the-art as far as the geological and hydrogeological construction is concerned.

In the course of the landfill base sealing construction, landfill gas wells and ducts were installed to allow landfill gas extraction from below.



Figure 4: Aerial photo taken during the first placement of waste in 2000 with the gas wells. The gas wells variant implemented in 2000 with a continuous gas extraction from below, taking a short-term effect, turned out to be very susceptible to the condensate level in the landfill body on the occasion of gas extraction tests in 2006.



Figure 5: Gas wells for horizontal base extraction in 2001

Table 1. Design parameters of the Pusztazámor landfill

		Expansio n stage 1	Expansio n stage 2	Expansio n stage 3	Total
Base area	Ha	18.4	14.2	21.7	54,3
Dumping volume (without surface sealing)	mill. m ³	4.6	4.5	6.2	15.3
Amount of residual waste	mill. t	2.9	2.8	3.9	9.6
Filling height	m	65	65	71	
Start-up		2000	2010	2017	

2. IMPLEMENTATION OF THE EXTRACTION TEST FOR THE EXAMINATION OF THE GAS PROGNOSIS MODELS AND OF THE GAS EXTRACTION VIA THE LANDFILL BASE

From Easter 2005, the regulations for the contractual arrangements between the operator and owner of the landfill of the Fővárosi Közterület-fenntartó (FKF Zrt.), the Hungarian consulter involved, and DAS – IB GmbH were developed. In June 2005, the first contracts between FKF and DAS-IB were signed, aiming to buy, on the basis of the available gas prognosis models and of the base gas extraction, a machine-technical plant for section 4, consisting of:

- a gas manifold station with 16 gas well connections
 - a condensate shaft
- and to hire
- a 500 m³/h gas booster station (firing capacity of approx. 2.5 MW_{th}) with a high-temperature flare.

DAS – IB GmbH was responsible for the machine-technical plants and the Hungarian MÉLYÉPTERV KOMPLEX MÉRNÖKI Rt. company took over the works regarding the civil work and connections with the existing gas well ducts, the electric supply, and the outdoor installations to be built at the planned site in section 4.



Figure 6: Projected installation place of the machine-technical plant for section 4

The invitations to tender were issued in autumn 2005, and evaluated at the turn of the year 2005/2006. Bidders could then be heard in February 2006. Subsequent to an intensive examination and selection, ERBE ENERGETIKA Kft. was chosen as the general contractor in March 2006. The essential subcontractors are Pro2 – Anlagentechnik GmbH for the gas booster station and the high-temperature flare, and HEERS & BROCKSTEDT UMWELTTECHNIK GmbH for the gas manifold station and the condensate shaft.

In July / August 2006, the installations and the start-up were carried out, and the operating staff trained with regard to the operation of the gas collection and the gas disposal system on the Pusztazámor landfill.



Figure 7: Signing the contracts on March 29th, 2006



Figure 8: Construction phase in July and August 2006

In parallel to the start-up, the personnel was trained, the required optimisations of the gas collection system carried out, and the first FID measurements of the landfill body and the boundaries implemented by DAS-IB. The target of this one-week training course was to enable the operating personnel to carry out operation and the necessary measurements on the gas plant independently. Besides the FID measurement, importance was attached to the determination of the raw gas values: CH₄, CO₂ and oxygen, as well as to gas temperature and gas extraction pressure. FKF did not only attach importance to an intensive training, but also purchased all measuring devices required for the implementation of these works, including the necessary personal protection. Since September 2006, FKF carries out these measurements with its own personnel. Monitoring and evaluation is carried out in parallel by DAS-IB as a control entity. For comparison reasons and for important discussions of the data and information, as well as for the exchange of experience, monthly meetings take place at the landfill with all parties involved: from the operator and the main contractor to the consulting engineers. These meetings also serve to discuss the next steps regarding a further extension of landfill gas extraction system and degasification and its necessary implementation. Furthermore, two raw gas analyses for the gas-accompanying substances F, Cl, Σ Si and S were carried out by an independent laboratory during the first six months of operation, to be able to make a statement with regard to a low-maintenance landfill gas motor-operation. It is envisaged to optimise the gas collection system by the end of 2007 by new gas well bores and to expand the plant size by 1000 m³/h for the booster station and the high-temperature flare.



Figure 9: Measurements and optimisations during the test phase of degasification

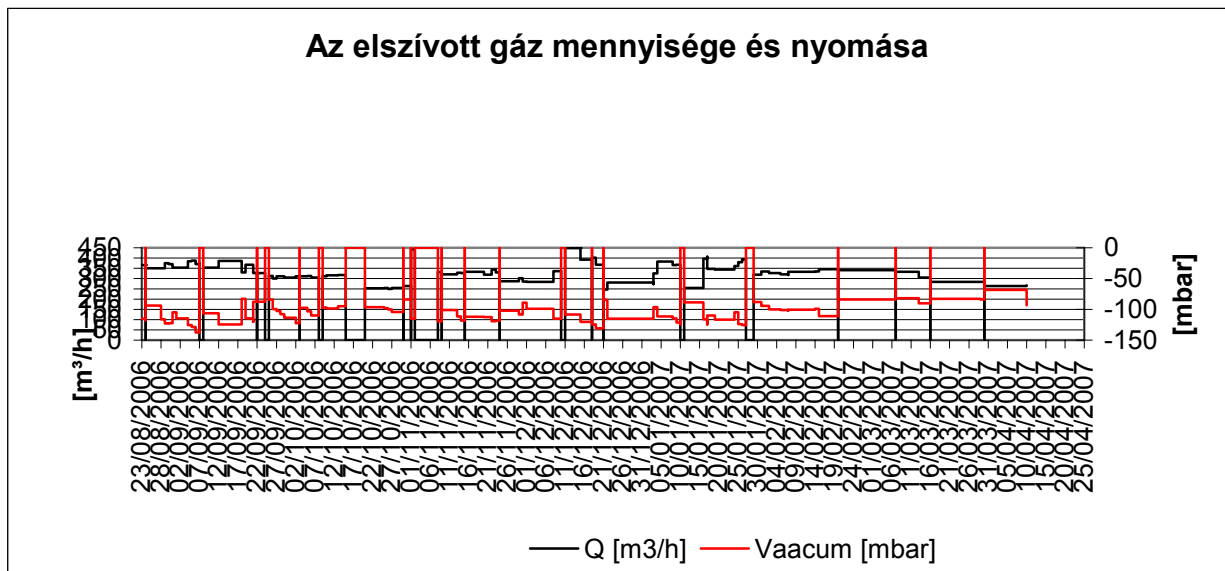


Diagram 1: Accompanying test evaluations, here: amount of gas and gas suction pressure

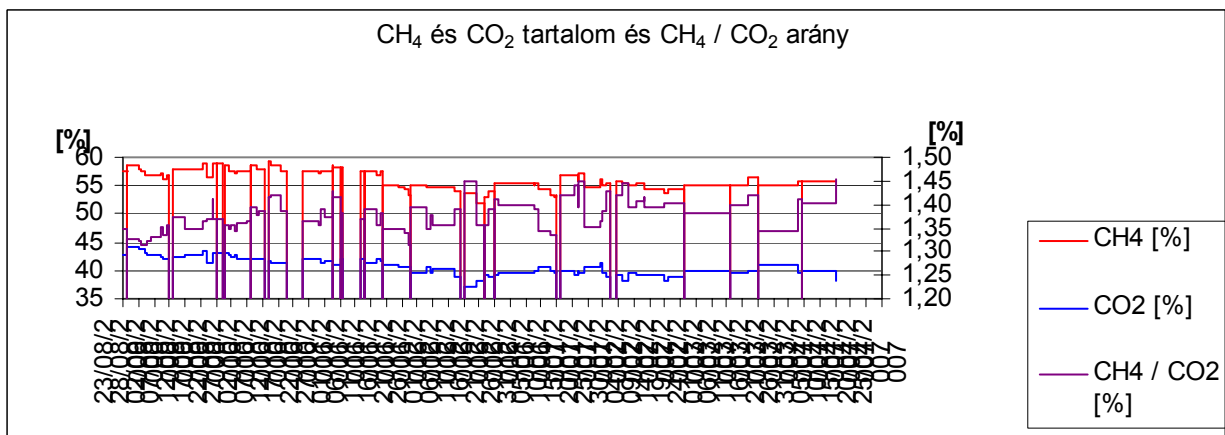


Diagram 2: Accompanying test evaluations, here: CH₄ and CO₂ – content in the row gas

3. EVALUATIONS / FINDINGS AND FURTHER STEPS

The following statements could be made after approx. six months of the pumping trail / test operation:

- The installed machine-technical plant is too small as regards the amount of gas, the heat input, and the design for the necessary extraction suction pressures, although the size of the sucked base area only amounted to approx. 4.5 ha and the deposited residual waste quantity to approx. 500,000 t during the past six years.
- The used gas prognosis models take climatic conditions at the site, or the consequences of the climatic effect (warm winter, excessive rain), only insufficiently into account.
- Gas extraction from below is not efficient enough – water lenses of up to 8 m could be ascertained in the landfill body after a waste placement operation of only approx. 6 years.
- The row gas temperature of the gas wells is lower than 20°C
- The landfill gas condensate in the condensate shaft foams and reaches the extraction system where it produces shutdowns.
- Warmer climatic conditions need to be taken into account for the final construction of the gas extraction system and later on for the CHP units.



Figure 10: booster & flare, condensate shaft and manifold station in spring time 2007

Table 4. Raw gas analyses by pollutants for utilisation in gas engines DIN 51872-5, VDI 3865, Ionenchromatographie

Parameter, row gas	concentration	
	September 2006	March 2007
Sauerstoff O ₂	Vol % 0,7	0,9
Stickstoff N ₂	Vol % 3,6	4
Stickstoff, luftfrei	Vol % 1	
Methan CH ₄	Vol % 54,4	54
Methan, Luftfrei	Vol % 56,3	
Kohlendioxid CO ₂	Vol % 41	40,2
Kohlendioxid, luftfrei	Vol % 42	
Gesamtchlor \sum Cl	mg/m ³ 11,5	19
Gesamtflour \sum F	mg/m ³ 15	11
Gesamtschwefel \sum S	mg/m ³ 110	25
Hexamethyldisiloxan	mg/m ³ 0,21	1,27
Hexamethylcyclotrisiloxan	mg/m ³ <0,19	< 0,57
Octamethyltrisiloxan	mg/m ³ <0,06	< 0,18

Octamethylcyclotrisiloxan	mg/m ³	0,42	< 3,31
Decamethyltetrasiloxan	mg/m ³	<0,08	< 0,18
Decamethylcyclopentasiloxan	mg/m ³	0,11	0,99

On the basis of the findings of the raw gas analyses in the pumping trail, it can be stated that, currently, the landfill gas of the Pusztázámor landfill is suitable for the utilisation in gas engines.

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