Gas Extraction System on the Sudokwon Landfill Site Seoul / Korea

Jürgen Martens,
HAASE Energietechnik AG, Neumünster / Germany

With a planned total surface of twenty million square metres, the Sudokwon landfill in Seoul, South Korea, will be one of the largest landfill sites in the world, if not the largest organized and managed site worldwide. In two phases of construction so far, HAASE Energietechnik has implemented a gas utilization plant with cogeneration facilities and booster units fuelled on landfill gas. At the end of 2002, the first phase of construction was taken into operation. All in all, a total of 9 containerized HAASE standard CHP modules are now operating and produce a total of about 10 megawatt electric. (Fig. 1)

The aim of this article is to describe the gas extraction system and to give an outlook over future plans to design a new gas collection system with special respect to the use of standardized units for gas utilization. This article also provides some information about the gas utilization facility.

Fig. 1: Cogeneration plant with 9 containerized CHP modules on the Sudokwon landfill site (Korea)

The Sudokwon landfill site

Since 1992, waste from about 15 million inhabitants of the Seoul conurbation is deposited on the Sudokwon landfill site. The first section of the landfill (Area 1) was closed down in September 2000 with a total of 58 million cubic metres of waste. The second section (Area 2) was opened in October 2000 and is scheduled to be in operation until the year 2008/2009. It has a capacity of 67 million cubic metres and is currently being filled up with approximately 20,000 tons of waste per day. A third section (Area 3) will be opened in 2008/2009.

45,000 cubic metres of gas per hour are currently being extracted from Area 1. In the past, this gas simply used to be flared. (in comparison: The Schwanebeck landfill near Berlin, one of the largest landfill sites in Germany, produces about 3,000 cubic metres of gas per hour). Today, the Sudokwon cogeneration plant generates electrical energy from about 7,500 cubic metres of landfill gas. The power generated by the CHP plant is directly supplied to the installations on site. Excess electricity is exported to the public network.

The gas extraction system

The gas extraction system of Area 1 does not meet the current German standards for such installations. In order to collect the enormous amounts of gas produced in the landfill body, horizontal gas wells were installed while the waste was being deposited in this landfill section. The gas wells are quite large in diameter and cause many problems, due to movements in the landfill body (settling phenomenon).

The gas extracted from the landfill body is delivered to three circular pipelines (Fig. 2) that direct the gas towards a central gas booster unit. The circular pipelines are installed above ground. They are a constant source of trouble, because they are exposed to substantial variations in the outdoor temperature, in a way that the material suffers from wear and tear by extension and contraction. Further problems are caused by condensate accumulating in the pipework.

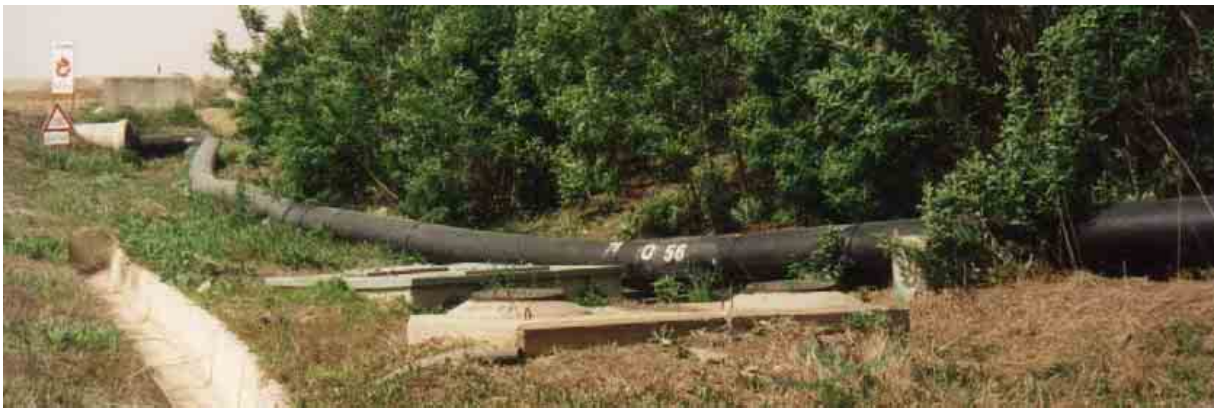

Fig. 2: Old circular pipeline, Area 1

The central booster unit sucks the gas out of the landfill body. Before the CHP plant was installed, all the gas extracted from the landfill used to be flared (Fig. 3).

Fig. 3: Old flare unit installed on the Sudokwon landfill site, Seoul (Korea)

Today, a gas pipeline delivers landfill gas from the central booster unit to the cogeneration plant over a distance of 1,500 metres.

Fig. 4: Old manifold for circular pipelines

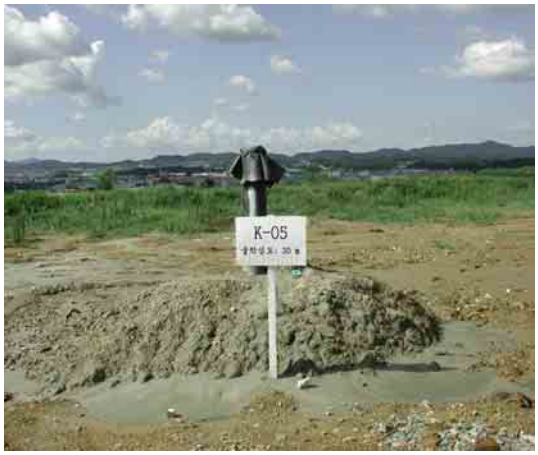

Fig. 5: New vertical gas well

The gas extraction system is currently being modernized and equipped with vertical wells (Fig. 5). Figure 6 shows a key plan designed by HAASE Energietechnik. From the vertical wells, gas conduits are directed towards the edge of the landfill body where they are connected to the central circular pipeline. This arrangement allows to monitor the quality and quantity of gas delivered from every single well and to make adjustments as desired.

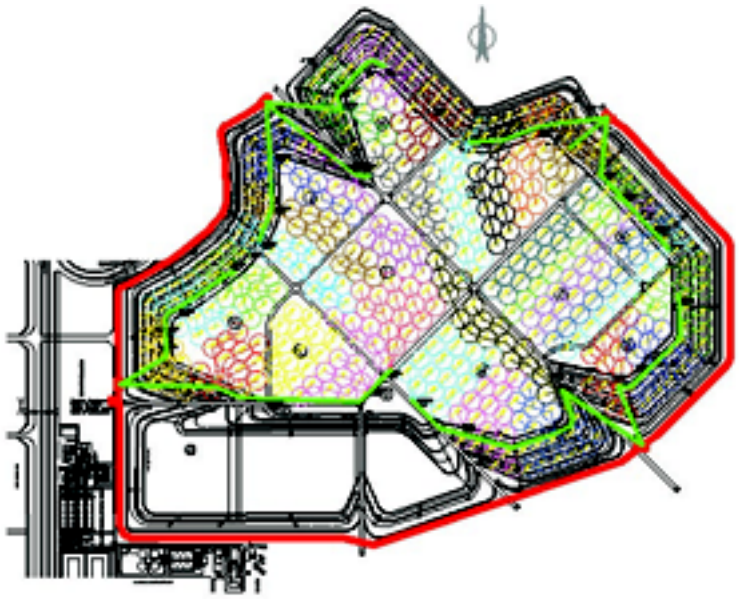

Fig. 6: Key plan for the modernization of the gas extraction system with vertical wells in Area 1

The current state of the gas extraction system is quite different. Figure 7 shows a horizontal well connected to a circular pipeline. Figure 8 shows the manifold joining the circular pipelines from Area 1 and 2. From here, the gas is delivered to the cogeneration plant.

Fig. 7: Horizontal gas well connected to the circular pipeline; old gas extraction system.

Fig. 8: Gas manifold joining circular pipelines from Area 1 and 2

Our proposal for the modernization of the gas extraction system in Area 1 includes the installation of four standardized booster units, their overall capacity being designed for the estimated maximum production of gas. The installation of four decentralized booster modules instead of one central gas extraction facility seems to be a luxury and more costly at first sight, but it indeed offers substantial benefits:

As the modules work independently from one another in a suction and force mode, the circular pipelines may be much smaller in diameter. Moreover, with the gas being cooled down at the booster

modules, the condensate will be collected and drained at this point. It will not cause any trouble in the circular pipelines.

The gas utilization facility

The gas delivered from the landfill body to the reception point has a temperature of up to 30°C. In order to eliminate the condensate, the gas is cooled down to a temperature of 5°C. Six booster modules, each equipped with side channel blowers, generate the operating pressure required for cogeneration. The boosters are designed with a bypass line that allows to keep the pressure constant, independent of varying CH_4 concentrations and independent of the current gas requirement of the CHP modules.

Before the gas enters the CHP unit it passes through a filter system with activated carbon. This will avoid damage to the engine caused by trace elements such as chlorine, fluorine, etc. Downstream the gas purifier a measuring device allows to monitor the concentrations of CH_4, O_2, and CO_2.

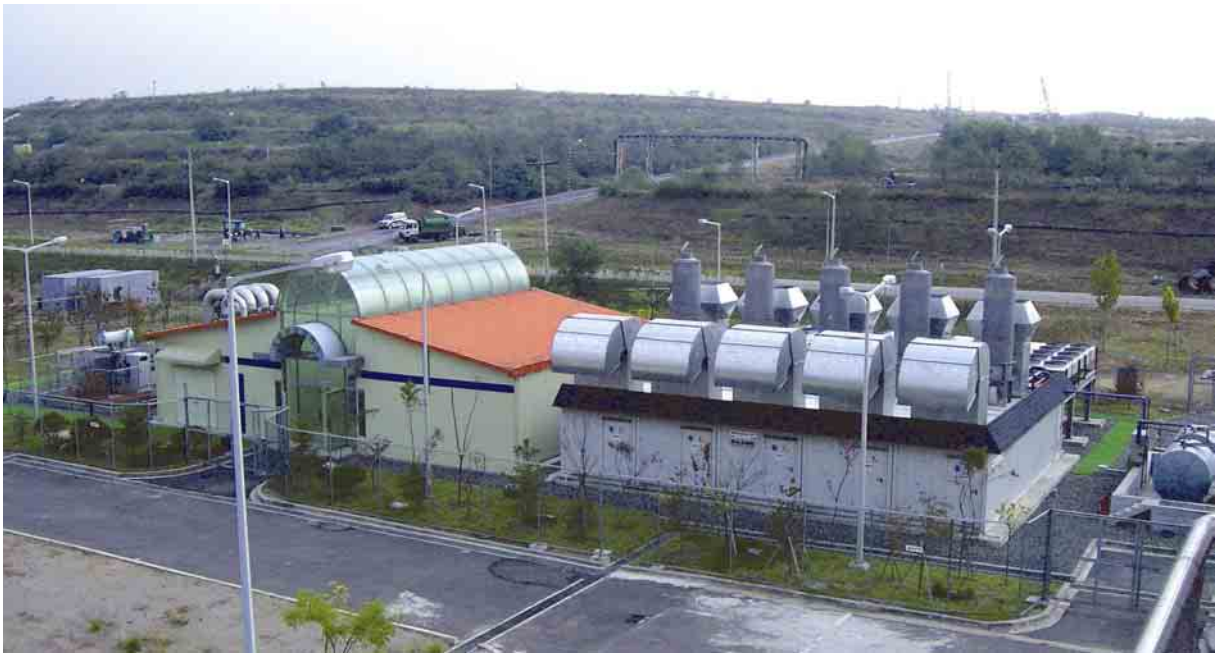

Fig. 9: First stage of construction with 5 CHP modules. Operation building on the left hand side.

The first stage of construction (Fig. 9) included the installation of five CHP modules of identical design. DEUTZ gas engines each generate 1.3 megawatt electric of medium high voltage (6.6 kV).

For the second stage of construction three modules of identical design were installed, each with an output of 1.1 megawatt low voltage (400V), plus one smaller module with an output of 370 kW

electric. Prior to shipment and delivery to Korea, HAASE Energietechnik assembled and tested all modules at the Neumünster factory. This way, the units were ready for immediate connection and operation on the Sudokwon site. Figure 10 shows three modules ready for shipment, assembled for the second stage of construction and tested on HAASE premises in Neumünster.

Summary and outlook over future plans

The CHP plant installed on the Sudokwon landfill site is a perfect example of a modern gas utilization facility in modular design, equipped with standardized components. Especially in view of the enormous gas quantity produced at this site, this plant configuration has essential benefits:

- High availability and operational reliability.
- Transferable experience, related to operation and maintenance.
- Perfect conditions for efficient logistics with respect to the availability of spare parts.
- Increased flexibility: In the event of variations in the quantity or quality of the gas, the system may be adjusted to new conditions by simply adding or removing some modules.

At present, the Sudokwon management undertakes to modernize the old gas extraction system according to German standards. HAASE Energietechnik acts in an advisory capacity.