Dirk Wijnbeek
Environmental Entrepreneur
dwijnbeek@mweb.co.za

Energy opportunity at sewage treatment works

AN OPPORTUNITY PRESENTS ITSELF

In an article titled, *Sewerage the next ESKOM* (29 April 2010, SAPA), a Green Drop report from the Department of Water Affairs was quoted which stated that more than 75% of South Africa's sewage plants are not up to standard. In *Business Day* of 28 April 2010 it was reported that only 7% of wastewater treatment systems comply with international standards.

Opportunity? Indeed!

Taking the current crucial national drivers – green energy, job creation and skills development – into account, the sewerage scenario certainly offers a highly 'opportune opportunity'.

Landfill sites are increasingly being used to tap methane gas, particularly for use to generate electricity. Sewage and animal manure also emit methane gas. Although there are several initiatives under way locally using animal dung to generate electricity, there are no big-scale initiatives of this nature in South Africa exploiting the energy potential of human waste.

A promising programme has, however, now been developed and patented with the Department of Energy. A pilot plant, which will use sewage to generate electricity and purify water, in cooperation with an international partner, has been proposed.

WORKING PRINCIPLES OF A BIOGAS PLANT

The conversion of organic materials happens through the biochemical decomposition (hydrolysis) of high-molecular organic compounds into low-molecular compounds (organic acids, salts and alcohols): organic compounds + H_2O → $C_5H_7NO_2$ + HCO_3 + other organic waste.

Further conversion of the obtained dissolved compounds (organic acids and alcohols, i.e. $C_5H_7NO_2$ and HCO_3) would then yield the gasses methane, carbon dioxide and ammonia (CH_4, CO_2 and NH_3).

The biological process of consecutive (phasic) conversion of organic compounds can take place in an anaerobic environment, i.e. in an oxygen-free tank (also known as a biological reactor). At the first stage of fermentation the substrate hydrolysis takes place under acidogenic bacterial influence. At the second stage the elementary organic compounds come through the hydrolysis oxidation by means of heteroacidogenic bacteria, resulting in the production of acetate, carbon dioxide and free hydrogen. The other part of the organic compounds, which include acetate, forms C_1 compounds (elementary organic acids). These produced substances serve as the feedstock for methanogenic bacteria of the third type. This process flows into two processes of which the character depends on the different bacteria types. The two different bacteria types then convert the compound obtained during the first two stages into methane (CH_4), water (H_2O) and carbon dioxide (CO_2).

Both CH_4 and CO_2 are classified as greenhouse gasses.

The envisaged pilot project proposes to use 60 t of municipal sewage per day. The biogas would be extracted and then fed via pipeline to a compressor where the pressure would be raised to 80–100 mbar to satisfy the requirements of the co-generator. The co-generator would supply both electricity and heat energy. The electricity would be supplied to the national grid and the heat energy would be utilised in the plant to keep the digesters warm, thereby enhancing gas production.

The end of the line would produce solid and liquid bio-fertiliser, rich in nitrate.

PROMISING PROSPECTS

The biogas produced in the manner described above would translate into:

- Electricity production of 9 000 000 kW per year
- Carbon reduction estimated at 72 000 t per year

The electricity would convert to about 160 households per day from one such plant. The suggestion is to place several of these proposed plants at the 821 sewage plants in South Africa. The National Blue Drop report, released in 2009 in Cape Town, stated that these 821 plants treat a total flow of about 5,258 billion litres of wastewater a day, almost half of it in Gauteng.

The report states further: "Analysis of the operational flows indicates that Gauteng manages the bulk of the national load (49%), followed by the Western Cape (17%) and KwaZulu-Natal (14%). The balance of the provinces receives and treats the remaining 20% of wastewater generated in South Africa."

The report says that, of the 821 plants, a total of 40 – those awarded Green Drop status – were in an "excellent situation", 78 were "good", and 243 delivered an "average performance". However, 143 plants were rated as in a state of "very poor performance" and 317 as in a "critical state".

These numbers strongly support the case for implementing sewage-based power generation as a matter of urgency. It would amount to a significant reduction in carbon emissions, while stimulating job creation and supplementing electricity supply to a sizeable number of households.

Ultimately this project should form part of the greater green strategy of any municipality. Potential further enhancements include the purification of methane and the subsequent compression of the gas to liquid. This could be used as the well-known LP gas and/or fuel for vehicles. □

Source:
http://www.saice.org.za/downloads/monthly_publications/2011/2011-Civil-Engineering-october/#/0