Nomathamsanqa N.S. Sibisi

Development of an anaerobic digestion strategy for the OFMSW treatment and its co-digestion with sewage sludge

Abstract of the doctoral thesis

Supervisor: **prof. Marco Ragazzi**

The doctoral research project was initiated to contribute to the options available for improving and applying the anaerobic treatment process of the organic fraction of municipal solid waste (OFMSW). The project proposes a strategy different to those reported in the literature and currently available on the market today. The basic process of the proposed option is to separate the rapidly biodegradable chemical oxygen demand (RBCOD) and the slowly biodegradable chemical oxygen demand (SBCOD) fractions of the waste at low temperature and at atmospheric pressure. The former COD fraction is used as an anaerobic substrate while the latter is aerobically composted.

There are a number of advantages associated with this option and the main ones are the lowered effects of the hydrolyzation step, less energy input and a possibility for the use of one treatment facility for different municipal waste streams.

The research was divided into different sections which gave insight into the advantages, disadvantages and moreover the feasibility of this strategy at both lab and real scale. Firstly, a study was conducted to look at the physical separation options for the COD fractions and was further integrated with thermochemical treatments at 40 and 80°C with different NaOH, Al_2SO_4 and $FeCl_3$ concentrations. From this it was concluded that OFMSW pre-treatment with 500 mg $NaOH/kg_{OFMSW}$ at 40°C for 30 minutes yielded higher COD concentration in the liquid fraction.

The pre-treatment results obtained for the anaerobic substrate were used to conduct a co-digestion study. In this part, sewage sludge and the liquid fraction were treated together in an anaerobic reactor. From, this study it was observed that from the co-digestion experiments it was observed that using the available reactors for both the sewage sludge and the liquid fraction of OFMSW greatly improved the biogas production to about ten times.

A model was also developed for the obtained substrate and the developed model involved the description of the biogas production rate using the Gonzalez-Gil et al., (2002) equation given below

$$dP/dt = f_{sp}(1-Y)(dS/dt)$$

Where dP/dt is the GPR (Nl $l^{-1}d^{-1}$) and f_{sp} is the biogas production from the substrate (Nl/gCOD). In this experimentation the dS/dt factor was made as a sum of the monod and 1^{st} order equations.
In conclusion, an environmental effect of the proposed strategy was undertaken using the life cycle assessment (LCA) method. The inventory was limited mainly to energy flow and emissions while impact assessment was limited to greenhouse effect and energy consumption.
The results from this study show an environmentally friendly effect of the proposed strategy mainly due to the small reactor needed and thus less land affected by its construction and low energy consumption. The co-digestion on the other hand showed resource sharing to be useful cause no extra land needs to be affected.