INTEGRATED ANAEROBIC - AEROBIC MBBR: A NOVEL APPROACH TO HIGH STRENGTH WASTEWATER TREATMENT

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Introduction

While anaerobic systems offer an attractive route of waste to energy and substantially reduce energy and sludge disposal costs, most commercially available anaerobic systems (e.g. USAB, EGSB etc.) require substantial capital investment and are prone to process upset and thus demand skilled operators. In addition, many anaerobic systems will involve an additional aerobic polishing system in order to meet the required discharge quality, which increase capital and land requirements and complexity of operation.

In order to overcome these challenges, a new integrated anaerobic - aerobic technology based on moving bed media was developed to provide a small, cost effective and simple solution for a wide variety of wastewaters. The innovative Dynamic Anaerobic Aerobic (DANA) system provides a solution for medium to high strength wastewater while generating biogas for energy recovery and achieving a high effluent quality. DANA offers an attractive alternative to granular based anaerobic treatment followed by conventional aerobic treatment in one unit instead of two consecutive units.

The anaerobic and aerobic systems are combined in one reactor, one on top of the other. In both treatment steps the active biomass grows on free-floating plastic media (biomass carriers) that has a protected surface area of $650 m^2/m^3$. In the anaerobic stage, wastewater enters the system at the top of the anaerobic stage and flows downwards through the media while the biogas is

accumulated in a biogas blanket above the liquid. Following the anaerobic stage wastewater is transported to the aerobic MBBR stage to remove the remaining organic load (Figure 1). The fixed biofilm (reduced risk for biomass washout) and the down-flow regime in the anaerobic stage eliminate the need for a complex 3-phase separation system between sludge, water and biogas and thus not only substantially reduce cost but allows for easy upgrades of existing plants. The DANA system was successfully tested in two large industrial pilot plants (capacity 200 – 500 l/h) for several months. One pilot plant was located in a potato starch processing plant in Germany and the other in a juice factory in Israel. Both plants reached a Volumetric Loading Rate (VLR) and Carrier Loading Rate (CLR) in the anaerobic stage of up to 21 kg COD/m^3/d and 40 kg COD/m^3 carrier/d, and an overall COD removal of above 90%. Both pilot plants demonstrate the simplicity and ease of operation of the new DANA system. The results of these two pilot plants will be discussed in this paper.

Material and Methods

Pilot plant configuration

The combined anaerobic and aerobic systems are constructed in one reactor as described in the introduction.

The pilot plants dimensions and operation data are summarized in table 1 below. Figure 2 shows the potato starch pilot plant in Germany.

Inoculation of the anaerobic tank in the Potato pilot plant was done by adding 10% inoculated biomass carrier from a bench scale operating reactor. Inoculation resulted in a shorter startup time in comparison to the juice pilot plant.

Analyses

Analyses of pH, Temp., VFA, total and soluble COD, NH_4-N and PO_4-P for both influent and effluent were performed according to Standard Methods.

Results and discussion

Within 4 months, the potato starch pilot plant reached a volumetric loading rate (VLR) of 21 kg/m^3/d (Figure 2) and a carrier loading rate of 40 kg/m^3 carrier/d. The juice factory pilot plant reached a VLR of 16 kg/m^3/d and a CLR of 32 kg/m^3 carrier/d. In both pilot plants there were fluctuations in both COD conversion rates VLR and CLR, possibly due to some toxic compounds in the wastewater and fluctuations in the volatile fatty acids (VFA) concentrations. In order to maintain a low VFA, both pilot plants were operated with a high recirculation rate of up to 100%.

References

1. APHA AWWA, Standard Methods for the examination of water and wastewater, 2005, 21st Ed.
2. Chernicharo.C.A.L., 2007, Anaerobic reactors, Biological Wastewater treatment series, volume 4, IWA.

Table 1: Summary of pilot plants dimensions and operation parameters

Parameter	Potato starch - Germany	Juice factory - Israel
Anaerobic volume [m^3]	2.35	6
Anaerobic carriers fill ratio [%]	43	50
Anaerobic dimensions [m]	3 m high, 1 m diameter	3 m high, 1.6 m diameter
Aerobic volume [m^3]	2.35	2.5
Aerobic carriers fill ratio [%]	43	50
Aerobic dimensions [m]	3 m high, 1 m diameter	1.25 m high, 1.6 m diameter
Raw wastewater COD [g/l]	5	2 – 16
Wastewater temp. [°C]	35 – 37	35 – 37
pH	6.8	6.8
Raw wastewater flow [l/h]	200	500
Downflow velocity with recirculation [m/h]	0.76	0.28
Dissolved oxygen in aerobic stage [mg/l]	2	2
Carriers density [kg/m^3]	970	970

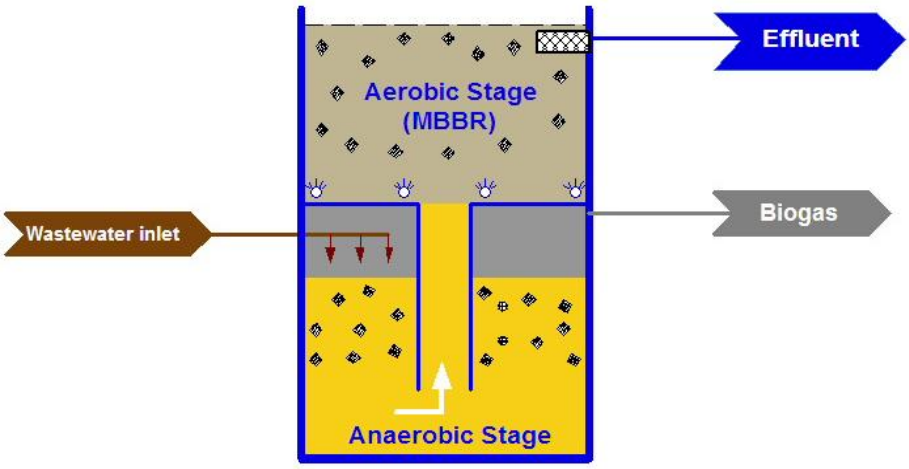

Figure 1. Process flow diagram of the DANA system

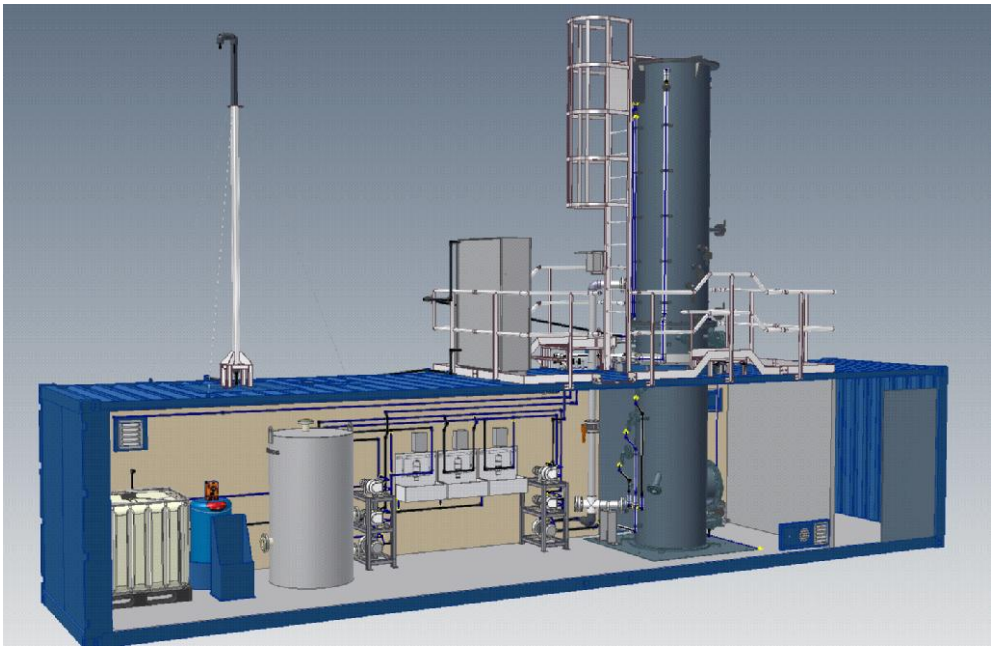

Figure 2. The Potato starch DANA pilot plant unit

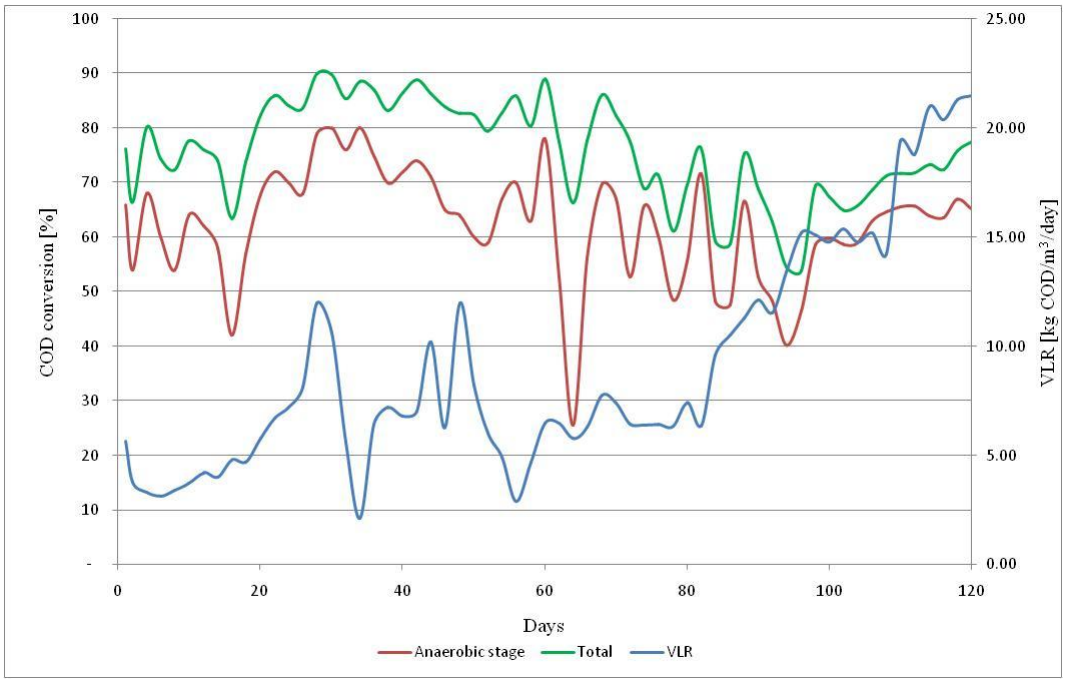

Figure 3. Potato starch pilot plant – VLR and COD conversions

Figure 4. Anaerobic biofilm at different piloting period