Efficient technology for the combined treatment of waste water and solid waste - the DUPLEX-Technology

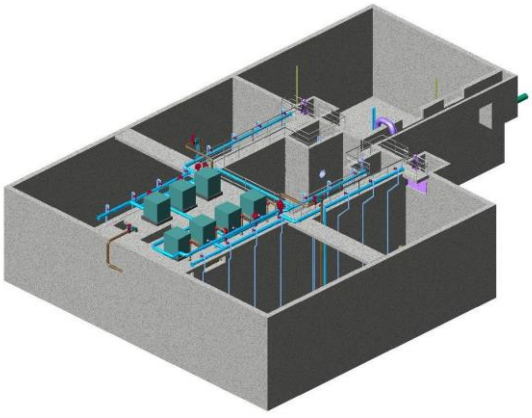
Prof. Dr.-Ing. Peter Hartwig, aqua consult Ingenieur GmbH, Hannover/ Germany

1. Wastewater treatment without external energy

For the reuse of wastewater, usually an advanced wastewater treatment (C, N, P-removal and disinfection) is required. With a demand of electricity of around 35 to 60 kWh per person and year the energy costs are the main part of the operation costs of such wastewater treatment plants (WWTP). Electric energy can be generated from the Biogas gained from the digestion of the wastewater sludge. But this technology up to now was limited to bigger WWTPs, e.g. > 50,000 PE, as a result of the required specifically high investment for the digester, the gas treatment and the gas usage facilities. New developments focus on the increase of the economy of the digesters by adding energy rich co-substrates like the organic fraction from the solid waste treatment or industrial organic residues (co-fermentation). A goal is an energetic autarky plant operation independent from the public network. By the method of co-fermentation the size of the economical feasible application of digestion can go down to 10,000 PE.

2. Compact wastewater treatment technology

Under compact wastewater treatment here it is understood a technology, which minimized the space demand, the mechanical and electrical installations and the energy demand. The *H-Batch* (realized for example in northern India) technology is a concentrate of approved technologies and includes advanced biological carbon, nitrogen and phosphorous remal and the co-fermentation of the sludge with further organic substrates to get an energetic autarc operation.



Picture 1: Scheme of a *H-Batch* reactor with an integrated anaerobic stage and additional storm water storage tank

Picture 2: H-Batch system for a capacity of 5,400 m³/d (40,000 PE) in Srinagar/India

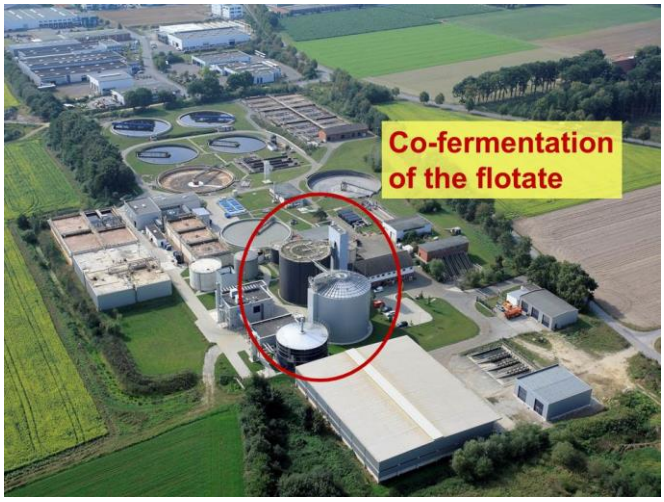
3. Biogas production and Co-Fermentation

To cover the electricity demand for the wastewater treatment, from the biogas electric energy can be produced by combined heat power plants (CHP). Around half of the energy which is contented in the biogas will be available as heat, which can be used for the process itself (heating of the digester to 38 °C) and for heating or cooling of buildings.

For an economical realization especially for small plants very compact solutions are required. Such a compact system, where the anaerobic digester can be integrated in the biological treatment plant, has been developed by aqua consult (*H-Batch* system) and is applied in two projects (hydraulic capacities 15,000 m^3/day and 5,400 m^3/day). The main advantages of this system are the short ways for the sludge, the integrated sludge thickening and the compact construction. The digester is designed in a way that conditioned external substrates can be fed, e.g. the organic fraction of the solid waste. For the conditioning the solid waste has to be sorted and the organic fraction has to be pre-treated.

The specific efficiency of the biogas system is strongly dependent from the feeded substrates. With feeding the surplus sludge from wastewater treatment plants to a digester, around 0,5 up to 1,0 m_N^3 biogas per m^3 digester volume can be expected, while by the dosage of co-substrates like the organic fraction of solid waste an increase up to 2,5 m_N^3 biogas per m^3 of digester volume is possible to reach. By this the operation costs of the wastewater treatment plant can be decreased significantly.

As one example of an efficient Co-fermentation the combined treatment of the sewage sludge from the city of Rheda-Wiedenbrück (85,000 PE) and as co-ferment the residues from a slaughterhouse with a capacity of 30,000 pigs per day can be given. The electric demand of the complete treatment station is around 1.2 MW and the energy production is around 3.9 MW. The benefit from the selling of the electricity contributes significantly to the high economy of that plant.



Picture 3: Co-Fermentation on the WWTP Rheda-Wiedenbrück, Germany

4. The organic fraction of the solid waste

The organic content of the solid waste is responsible for the main environmental problems: smell emissions, CH_4-emissions, leachate pollutes the groundwater, fires on deposits.

Picture 4: New deposit in the Republic of Moldova – to be rehabilitated soon

The value of the organic fraction is the high energy content and the content of nutrients (nitrogen, phosphorus). With suitable technologies like the anaerobic digestion of the organic fraction, these values can be used in an economical and environmental friendly way. Usually the digestion is operated separately. The operation is stable but has to be controlled in a good way, because of the high concentration of Ammonium in those reactors (up to 5,000 mg NH_4-N/l). In the case of pH-changes into values pH = 8, there is a risk of NH_3-N inhibition of the anaerobic process. In the combination with sewage sludge, the operation is easier because of the dilution effect by the relatively thin sewage sludge.

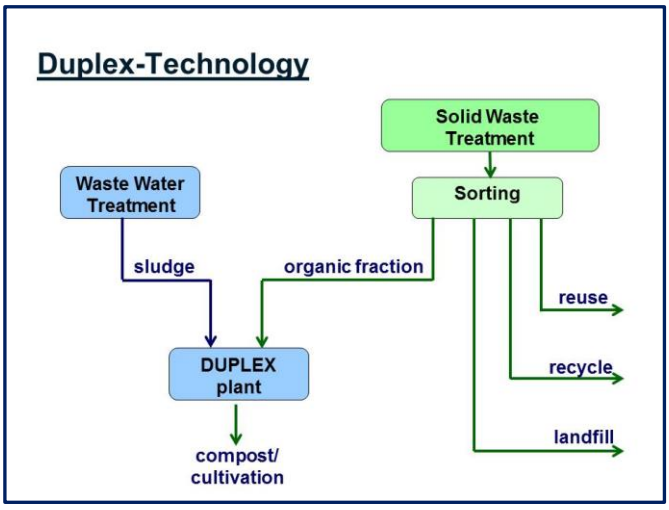
Picture 5: Mono-digestion of the organic solid waste fraction, after sorting

5. *DUPLEX*-Technology

Under *DUPLEX*-technology it is understood that the organic fraction of the solid waste is co-fermented together with the surplus sludge of the wastewater treatment. This combination result in synergies regarding the specific usage of the volume, the water contents of the different streams and contributes by this to a effective and economic municipal infrastructure.

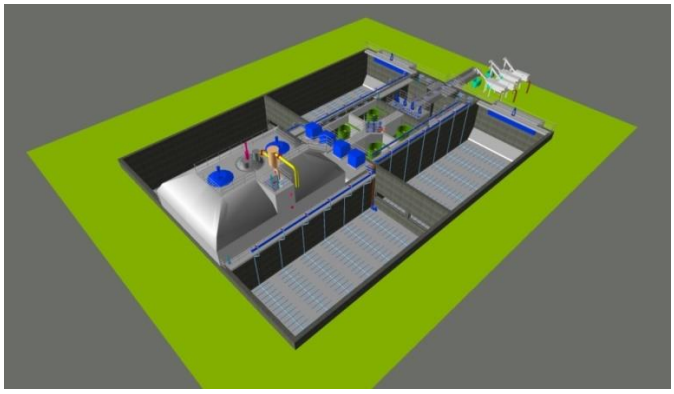
The solid waste has to be treated (sorting, conditioning) before the organic fraction can be fed to the digester, which is integrated in the compact wastewater treatment plant. The suitable type of sorting technology is dependent to the collection modus of the solid waste and has to be adapted to the local conditions. The conditioning of the organic fraction of the solid waste has the components removal of the mineral compounds (small particles from glas, stones, metals) and the swimming compounds (plastics, others) in a pulper and a mixing with anaerobic sludge in the pre-heating facilities.

The produced gas has to be treated (particle removal, drying, sulphate removal, silicate removal) before the usage in CHP-units. The electricity can be used to cover the electric energy demand of the treatment process and be fed into the public network. The heat can be used for the process, to heat the buildings and for further heating or cooling tasks. The remaining sludge can be composted together with greenery residues from the municipality.

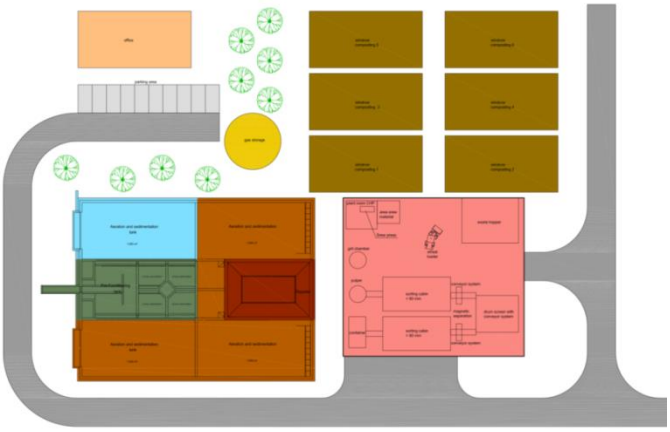


Picture 6: The scheme of a DUPLEX-plant

The wastewater can be reused for irrigation, as industrial water, for groundwater recharge or for further applications.



Picture 7: DUPLEX-technology for energetic autarky treatment of wastewater and solid waste



Picture 8: Layout scheme for a DUPLEX application

As further significant advantage of this combined treatment of wastewater sludge and solid waste organic fraction (Duplex-technology), a solution for the otherwise cost intensive solid waste organic fraction treatment is achieved. By using the co-fermentation and the technological concept of the DUPLEX-system as described, the waste water and solid waste treatment can be executed on a most economic and efficient level.

Prof. Dr.-Ing. Peter Hatwig
aqua consult Ingenieur GmbH
Mengendamm 16
D – 30177 Hannover/ Germany
hartwig@aqua-consult.de