Energy-Efficency by Renewable Energy

Wastewater contains a remarkable amount of chemical and thermal energy. Since wastewater is reliably produced every day, this energy is renewable.

The following renewable energy sources are available at WWTPs:

- **Wastewater heat**: thermal energy can be extracted by heat pumps from raw sewage or plant effluent; in theory 10 % of all buildings could be heated with this energy.
- **Hydropower**: where wastewater flows downward, its energy can be used; where the drop is sufficiently steep, turbines, Archimedean screws or water wheels can be installed for power generation.
- **Digester gas energy**: by power and heat co-generation from digester gas the entire heat demand and a great portion of the power demand of a WWTP can be covered.
- **Solar energy**: large footprint plants lend themselves for installation of photovoltaic cells. Solar energy can also be directly used for sludge drying (See HUBER Solar Active Dryer SRT).
- **Wind energy**: some plants are located in flat and windy locations where installation of wind turbines for power generation is economical.

Digester Gas Utilization

DIGESTER GAS PRODUCTION

- Gas production depends on:
- Wastewater and sludge composition
- Process of wastewater treatment
- Digester design, equipment and operation (e.g. mean solids retention time, number of stages, mixing quality, even temperature)
- At plants with nitrogen removal 20 – 25 Nl/(PT•d) and at plants without nitrogen removal about 30 Nl/(PT•d) digester gas is generated,.
- Gas production can be increased by addition of other organic waste, e.g. fat from grease traps.
- It can be increased by homogenization or disintegration of secondary sludge

DIGESTER GAS UTILIZATION

- Power has per kWh at least 3 times the value of heat.
- All gas should be used for power and heat co-generation. Gas flares are necessary, but should never be used.
- Gas-fired boilers serve for redundancy.
- Turbo-charged gas engines with high λ operation are mostly used, transferring ≈ 35 % of the energy into power and ≈ 55 % into heat (≈ 90 °C hot water).
- Fuel cells can transfer over 40 % into power, but need very clean gas; experience is still limited.
- Micro-turbines are compact, but transfer < 30 % of energy into power.
- Co-generation systems also serve for emergency power generation.
- Heat generation is usually sufficient to cover the entire plant's heat demand. Coolers are needed during summer.
- Where heat demand, e.g. for sludge drying, exceeds generation, power and heat co-generation should be increased by addition of natural gas.
- Gas engine sizing depends on load and supply management. They could be operated around the clock, or during high-tariff periods, or for capping peak demands.
- Gas holders should store 0.5 – 2 d of gas production, depending on gas engine operation schedule.
- Heat storage, if required, should only be sized for building heating. Digesters store much heat.
- Heat exchangers for digester heating should be sized to match scheduled co-generation time.

Wastewater Heat

Sewage has a temperature of 10 – 14 °C even during winter. Its latent heat is always available. A heat pump, cooling 1 m^3 wastewater by 1 °C, supplies over 2.1 kWh heat and consumes ca. 0.5 kWh power.

Our ThermWin® Solution recovers heat from various sources:

- **Grey water**: This relatively warm wastewater can be treated and reused as service water, e.g. for toilet flushing or for irrigation (See our HUBER GreyUse® Solution). In addition, ist heat can be recovered and used for water heating.
- **Raw sewage**: Heat extracted from sewers is used for heating of large nearby buildings, e.g. schools, gyms, swimming pools, nursing homes or office buildings. This method is economical from a sewage flow of 10 l/s and a heat consumption of 60 kW.
- **Plant effluent**: Recovered heat is used at the plant, e.g. for sludge drying (See our HUBER Solar Active Dryer SRT), or for heating o adjacent buildings.
- **Sludge water**: Filtrate or centrate from dewatering of digested sludge is still warm. We use the extracted heat for raw sludge warming.

ENVIRONMENTAL EFFECTS

- If 100 kW heat are used year round, CO_2 emission from natural gas heating is reduced by over 200 t/a.
- The 25 kW power consumption of the heat pump leads to 115 t/a CO_2 emission with the current German energy mix for power generation. Net reduction is thus 85 t/a.
- If the heat pump is operated with power co-generated from natural gas, 40 kW heat is additionally generated. 280 t/a CO_2 emission from a boiler is replaced by 125 t/a CO_2 emission from the co-generation system. Net CO_2 reduction is now 155 t/a.
- Raw sewage temperature reduction by 1 °C has little impact on its treatment. Nitrification is somewhat slower.
- Effluent temperature reduction is good for the receiving waters, particularly during summer.

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