Pathways for recovery and energy savings in wastewater treatment plants - examples of good Norwegian practices

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Valuable resources in wastewater

- **Organic matter** (energy)
- **Nutrients** (phosphorus and nitrogen)
- **Heat**
- **Water**

Create Value from Waste!

- Wastewater treatment plants are normally designed to **reduce the content of organic matter and nutrients** in order to protect the environment (receiving waters). Energy (and often chemicals) are used to achieve this, without much consideration of the sustainability of the treatment plant

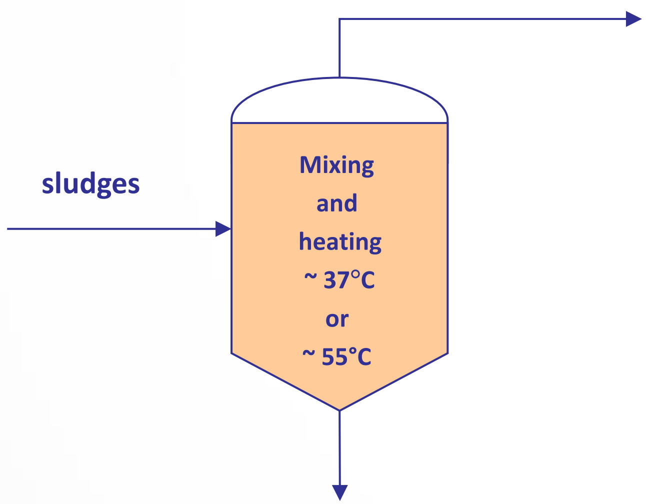
- In recent years the **interest of recovering resources** from wastewater has **increased dramatically**, and many wastewater treatment plants have plans to be **energy neutral** within few years («energy factories»)

Energy recovery

From wastewater

- Heat pumps producing **heat from treated wastewater**
- Microbial fuel cells **producing electricity (emerging technologies)**

From wastewater sludges



Biogas production in anaerobic digestors **(*60-70% methane*)**

- Central **heating systems**
- Combined **heat and power (co-generation)**
- Upgrading to **vehicle fuel**
- Upgrading for **supply to a natural gas grid**

Fuel for incineration, pyrolysis or gasification processes

Fuel for the cement industry

Example 1

Converting from mesophilic to thermophilic operation of anaerobic digesters to increase energy production

Zwiększenie energii dzięki przekształceniu pracy fermentacji beztlenowej z mezofilnej na termofilową

Definitions

Mesophilic anaerobic digestion (MAD): Operating at 35-40^{o} C in the digester

Thermophilic anaerobic digestion (TAD): Operating at ≥ 50^{o} C in the digester, and ≥ 55^{o} C if sludge hygienisation is an objective

Potential objectives

- Improved pathogen removal (hygienisation), depending on the pathogen control criteria in each country
- Increased degradation of organic matter in sludge, resulting in:
  - Increased biogas production
  - Reduced amount of sludge to be disposed of
- Increased capacity of existing digesters or reduced digester volume for new digesters.

Plant performance and operational experiences

- Data from U.S.A, Sweden,Denmark,Germany and Norway with a broad range of operating conditions. Most plants have been converted from mesophilic to thermophilic operation, and are not employing the draw-and-fill mode to improve pathogen removal and achieve controlled hygienisation.
- Thermophilic anaerobic digestion (TAD) can increase the reduction of organic matter (volatile solids) and thereby increasing the biogas production by ~20 % compared to mesophilic anaerobic digestion (MAD). The amount of total solids (TS) for final disposal can be reduced by 10-15 % compared to MAD operation
- Improved dewaterability and reduced foaming are experienced with most TAD plants. Process stability is no problem with close process control
- Strong odours from TAD sludge. Cooling of sludge necessary prior to subsequent treatment, use or diposal
- Increased water content in the biogas from TAD plants may require improved water removal, depending on gas utilization

Cost estimates compared to MAD

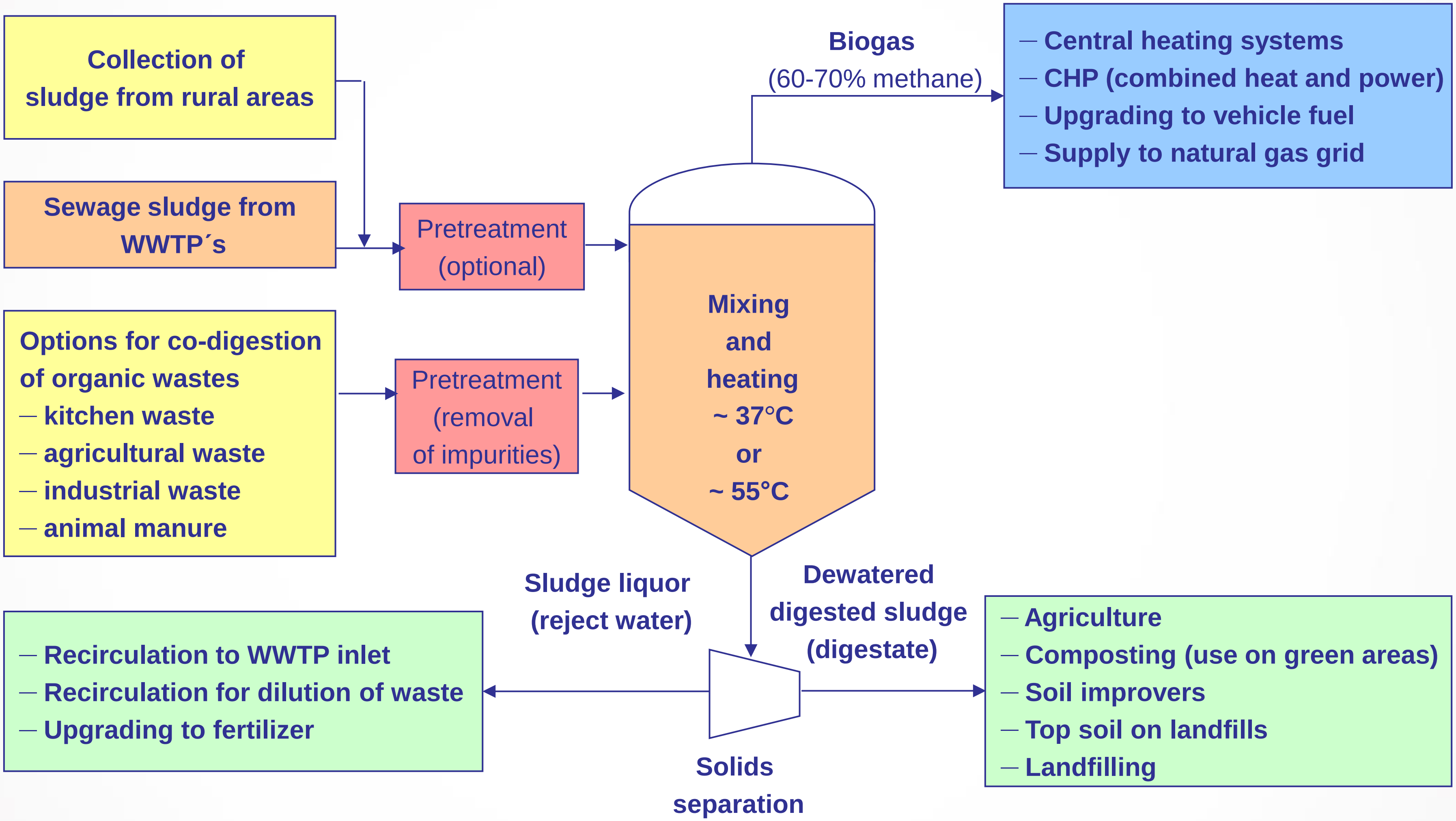
- Few data on investment costs of new TAD plants, but they should not differ much from the investment cost of similar MAD plants
- Converting from MAD to TAD normally involves fairly low investment costs (heat exchangers, sludge pumps, some piping and valves, etc.)
- Operation costs reduced. Increased energy consumption to raise and maintain temperatures above 50 °C is more than balanced by increased biogas production (provided utilization of all the gas produced) and reduced amounts of sludge to dewatering and final disposal

Example 2

Co-digestion of sewage sludge and organic wastes to increase energy production

Ko-fermentacja osadu ściekowego z odpadami organicznymi dla zwiększenia produkcji energii.

Co-digestion of sewage sludge and organic wastes to increase energy production



Objectives of co-digestion with sewage sludge

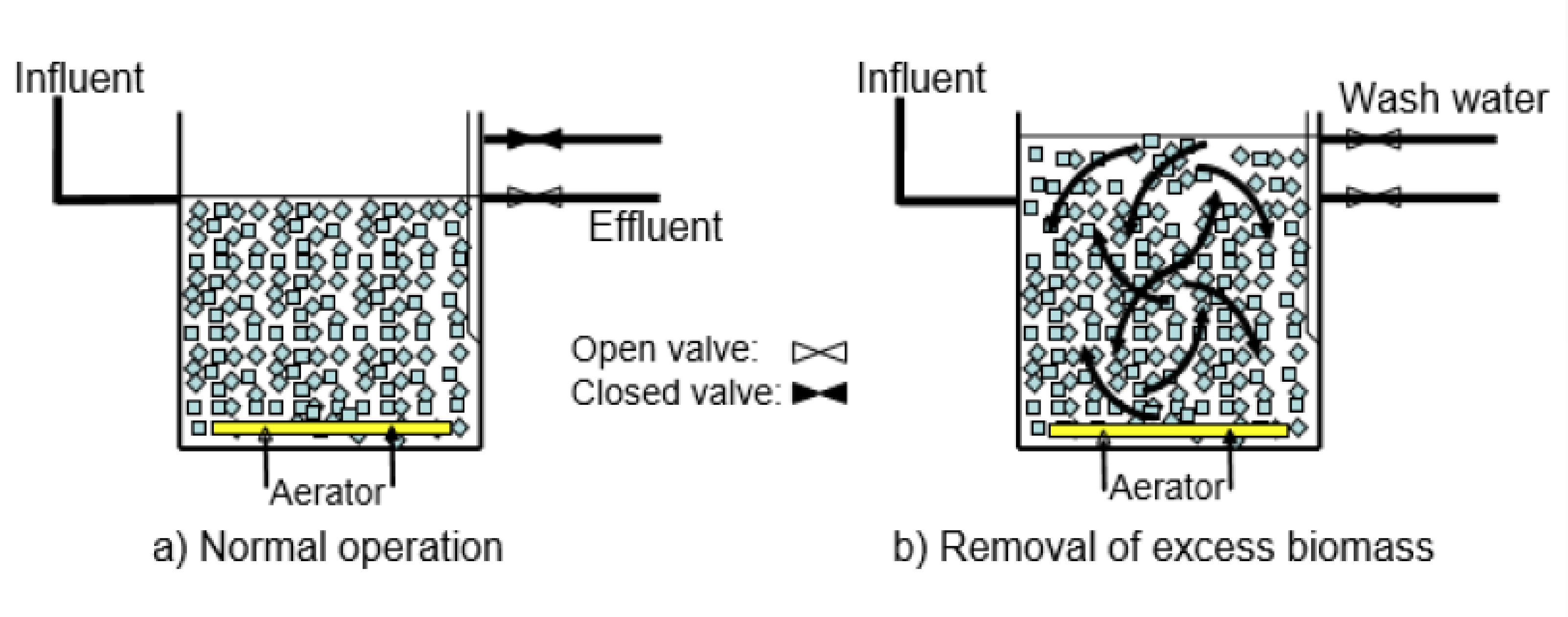
- Existing biogas plants for sewage sludge with spare capacity
  - ✓ Increase the biogas production within existing infrastructure
  - ✓ Increase the income from sales of renewable energy and gate fees
- New biogas plants
  - ✓ More substrates incur bigger plants with lower unit costs for construction and operation
  - ✓ Increases biogas production with increased income
  - ✓ Allows for establishing profitable biogas plants in municipalities with small amounts of sewage sludge

Example 3

Implementation of new technology for biological treatment of wastewater to reduce energy consumption

Wdrożenie nowej technologii dla biologicznego oczyszczania ścieków dla redukcji zużycia energii

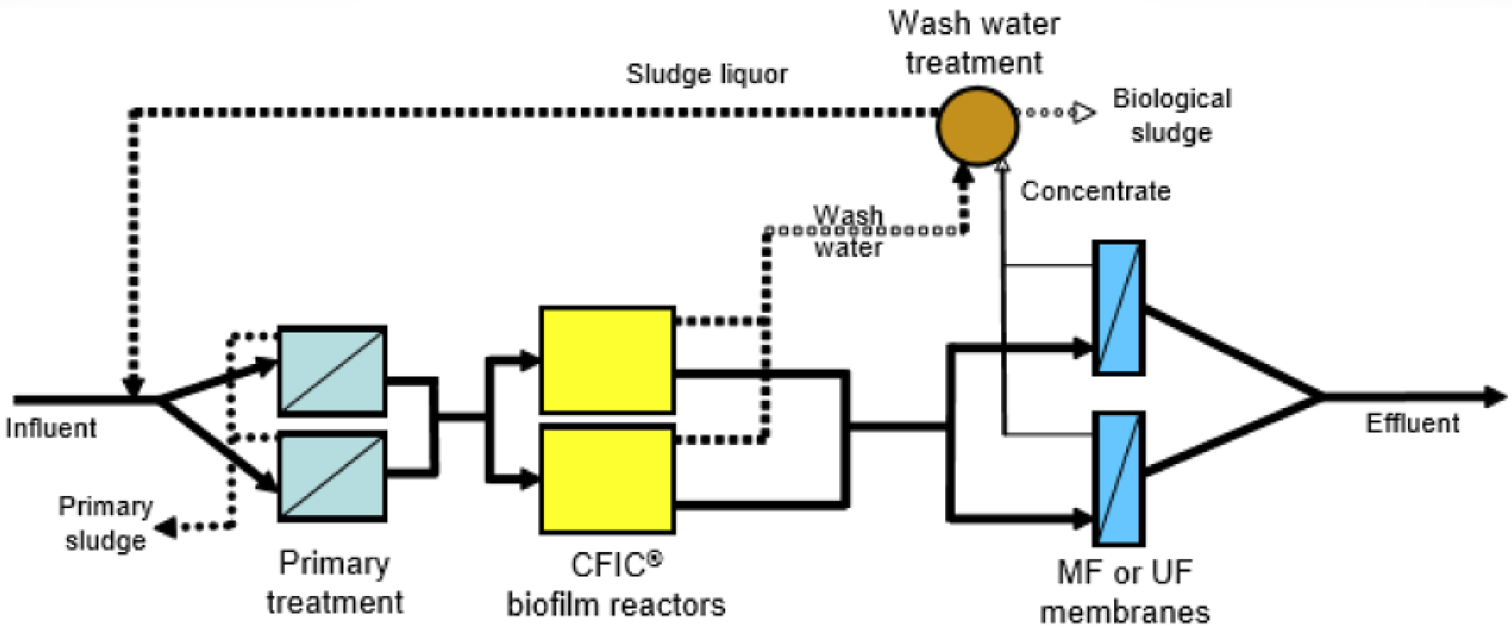
Implementation of new technology for biological treatment of wastewater to reduce energy consumption



HOW CFIC® WORKS

- During normal operation, highly packed carriers can serve as a “filter” to reduce solids concentrations in the treated water and thus allow the CFIC® to be combined with membrane for wastewater reuse without employing an intermediate solids separation unit.
- The CFIC® process has continuous inflow to the bioreactor and intermittent cleaning, using influent wastewater, which removes excess biomass (sludge) from the biofilm carriers.

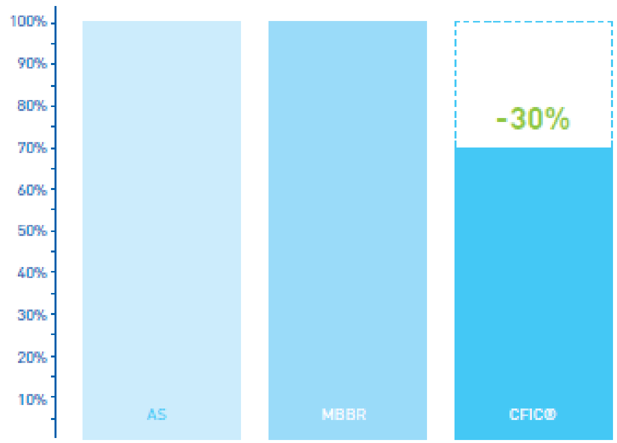
Implementation of new technology for biological treatment of wastewater to reduce energy consumption



Typical CFIC ® process arrangement

CFIC® vs Activated Sludge vs MBBR

CFIC® ENERGY CONSUMPTION

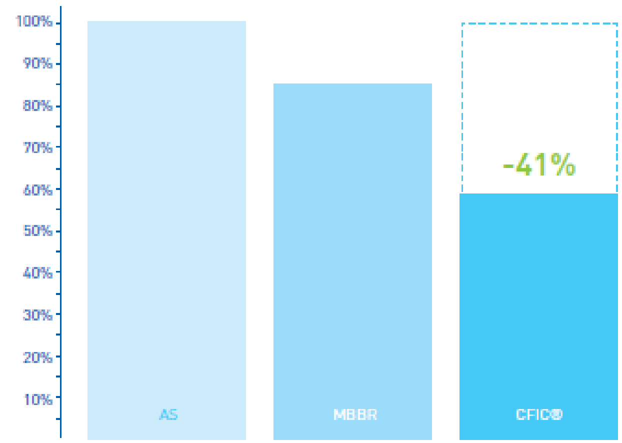


A higher oxygen transfer rate, due to a longer lifetime of the air bubbles, leads to lower energy consumption. The biological treatment stage of a WTTP accounts for 2/3 of its total power consumption.

CFIC® - The Energy Saver

- 20-30% higher surface area loading rates (SALR) than a MBBR - more treatment capacity in the same tanks
- Reduction in Energy consumption 20-30%

CAPEX



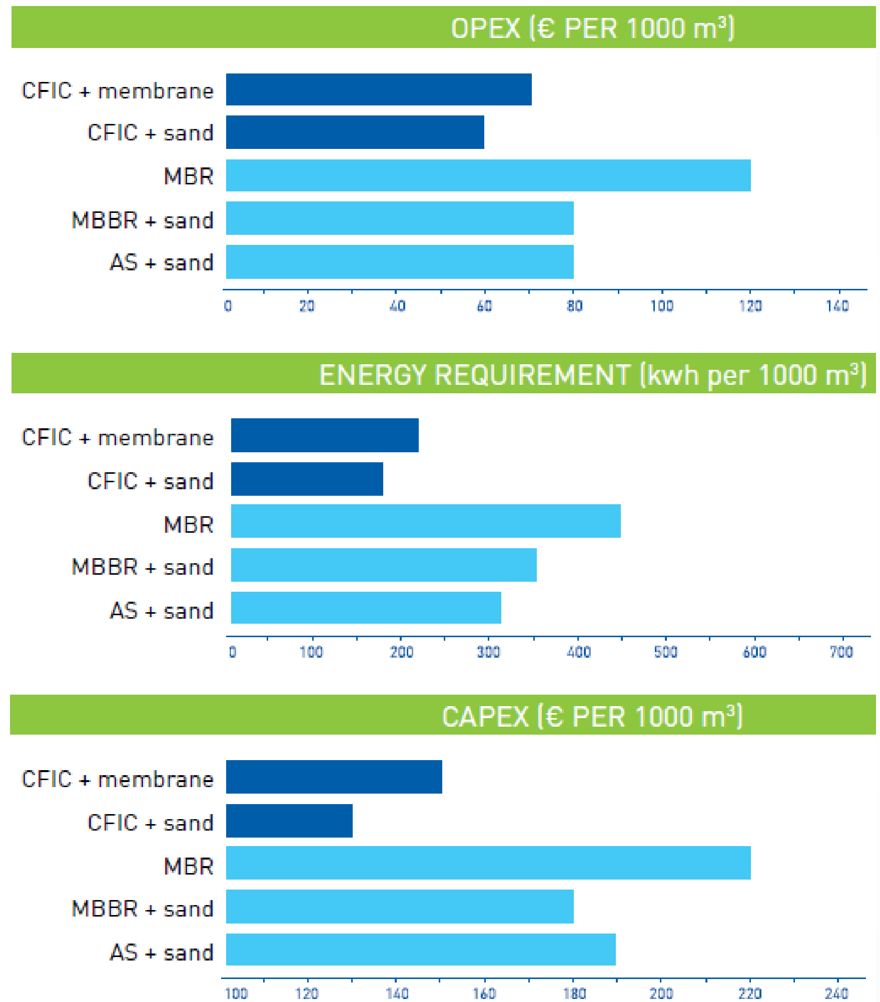
CFIC® can be integrated into existing WWTP, utilizing the existing infrastructure.

CFIC® - The CAPEX reducer

- When used with membrane, efficiency increases up to 5 times
- 20-30% less space required
- Significantly reduced need for secondary clarifier

Implementation of new technology for biological treatment of wastewater to reduce energy consumption

CFIC® benefits and savings



Numbers based on 80k PE municipal wastewater treatment plant. Results shown are reuse applications.

Thank you for your attention