BIOGAS

TECHNOLGY BRIEF

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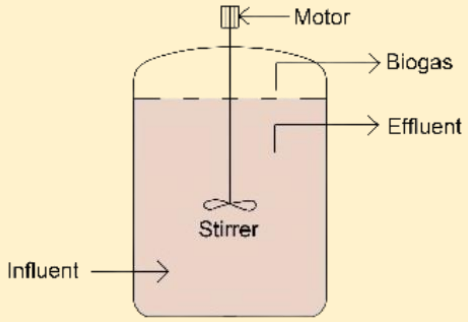
Continuous Stirred Tank Reactor (CSTR)

Introduction

CSTR is considered as the earliest high rate anaerobic digestion reactor. This first generation technology has demonstrated higher reliability. CSTRs are applied to treat wastewater having high-levels of suspended solids. This is widely used to treat high-strength liquid animal manure & solid substrates, & organic industrial wastes. This technology can be adopted to accommodate co-digestion, as well as to produce bio-hydrogen.

Operating Principle

CSTRs are designed for continuous flow. Influent solids & liquid biomass is constantly pumped into the reactor from its bottom. This is stirred by one or a few mechanical or hydraulic stirrers (mixers). Complete mixing makes microorganisms to get suspended inside digester. It makes a good influent - microorganism inoculum contact & interaction while allowing mass transfer between them. Speed of stirring is regulated to optimize operation to ensure homogenization of composition & temperature, so that concentration of substrate & microorganisms is uniform everywhere inside reactors. Mixing is done continuously or intermittently, which inhibits precipitation & prevents crust & sediment formation too. Digestate gets removed from reactor at the same rate as the inflow, ensuring that the microorganisms removed with effluent are replaced by growth of microorganisms inside the reactor. The reactor offer a self-discharging port for digested slurry, often with an automatic slurry level control Temperature inside reactor is regulated to optimize the process. A wall jacket (continually circulating heated or cooled water) surrounding the digester, internal tubes or external heat exchangers are used to regulate temperature, allowing independent heating or cooling. Liquids get separated at inverted cone at top of the reactor. Produced biogas comes out of reactor through its top. A flexible cover at the top of the digesters collects & stores biogas & biogas is then used for many purposes.



Operation of a single CSTR is simple, but less efficient in effluent quality. Therefore, 2-stage systems are also used.

Technical Details

- Circular (or rectangular) tanks are made of concrete, steel, etc., & can be in different dimensions; Height to Diameter (H:D) ratio ~ 3 - 5; Impeller's diameter is usually ~ 1/3 rd of the vessel diameter. The distance between two impellers is ~ 1.2 impeller diameter
- Simple in configuration & easy functioning
- Good maintenance of temperature & pH
- Operative at both thermophilic or mesophilic phases
- Have better buffering capacity for variations in pH
- HRT: 20 - 60 days
- Can operate with low to medium loading rates

Applications

Can manage dry matter of 5% - 10% solid content & high suspended solids (TSS) concentrations (25,000 mg// TSS). Wastewater & municipal sewage treatment plants; Food processing factories (beverage such as breweries, dairy such as milk, yogurt & cheese, & tanneries); Pulp & paper industries.

Suitable for high fats, oil and grease (FOG) concentrations, high protein (nitrogen) content wastes under mesophilic phase & low protein content wastes under thermophilic phase.

Challenges

- Microbial bacteria can get washed out with the effluent, at high organic loading rates resulting in lower hydraulic retention times. Structure & operation make it hard to retain high microorganism concentrations in the reactor.
- Rapid acidification due to mixing & continuous stirring
- Produced volatile fatty acids can lead to inhibit anaerobic digestion process
- Incapable to uphold greater quantity of fermenting microbes due to its hasty mixing operational pattern.
- Short-circuiting of influent inside the digester

References

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