A COMPARTMENTAL MODEL OF AN ANAEROBIC DIGESTER FOR IMPROVED DESCRIPTION OF THE PROCESS PERFORMANCE

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Objective

- Linking the CFD hydrodynamics and kinetics model of anaerobic digestion (AD) using a compartmental model (CM) approach.

Methodology

- ✓ CFD model of AD mixing for sludge using Herschel Bulkley rheology model
  - to understand velocity distribution and calculate the flux exchange.

CFD model: Hydrodynamics, no biochemical reaction and non-ideal mixing → Flux exchange →

Kinetics model: ideally mixed biochemical reaction and no hydrodynamics → Kinetics (ADM1) →

CM: CFD-bio-kinetics model

- ✓ Compartmentalization of AD from CFD velocity distribution.
- ✓ implementing the CM with ADM1.

Compartmentalization of AD from CFD model

❑ The digester was compartmentalized in to 8 compartments based on velocity magnitude.

- High velocity zone $\geq 0.6\vec{v}_{max}$: C3
- Medium velocity zone: $0.25\vec{v}_{max} \leq \vec{v} < 0.6\vec{v}_{max}$: C1 and C5
- Low velocity zone: $0.05\vec{v}_{max} \leq \vec{v} < 0.25\vec{v}_{max}$: C2, C4 and C6
- Stagnant zone: $< 0.05\vec{v}_{max}$: C7 and C8

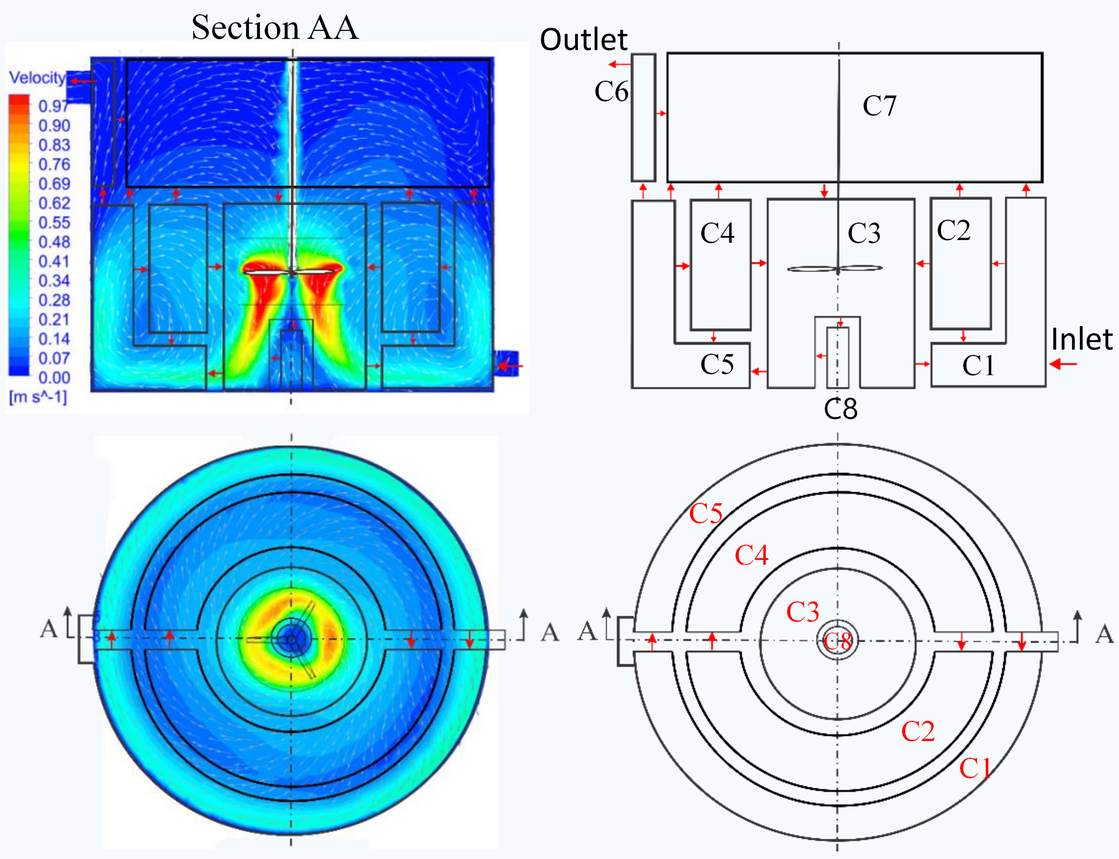

Fig. 1. Compartmentalization of AD from CFD model velocity contour and velocity vector

Results

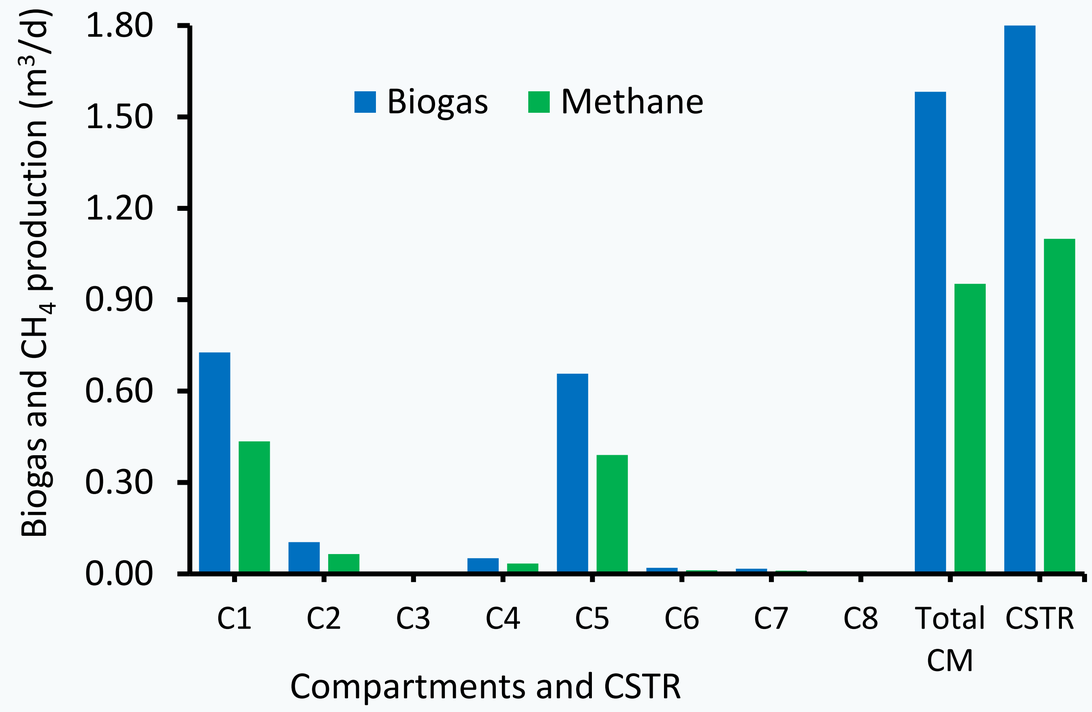

Fig. 2. Biogas production: a comparison of compartmental and CSTR models

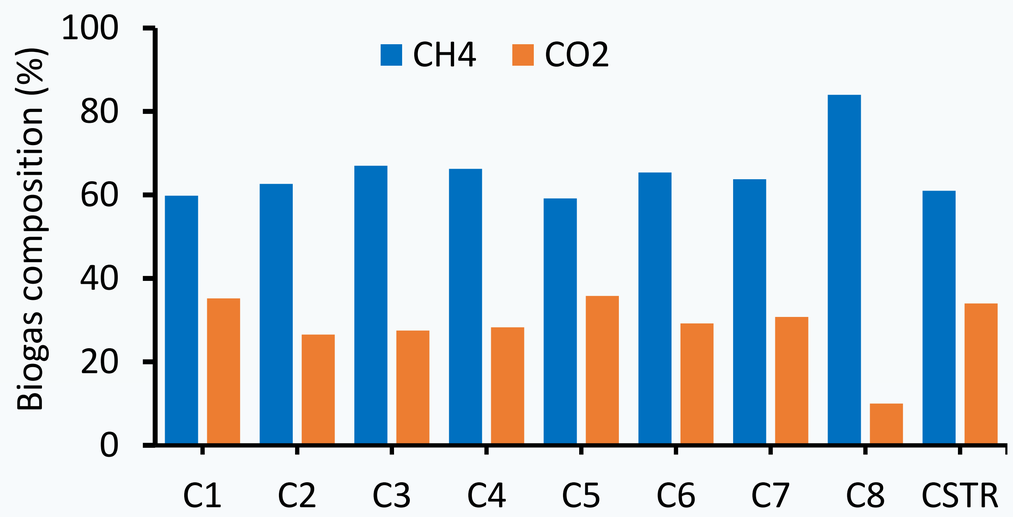

Fig. 3. Biogas composition: a comparison of compartmental and CSTR models

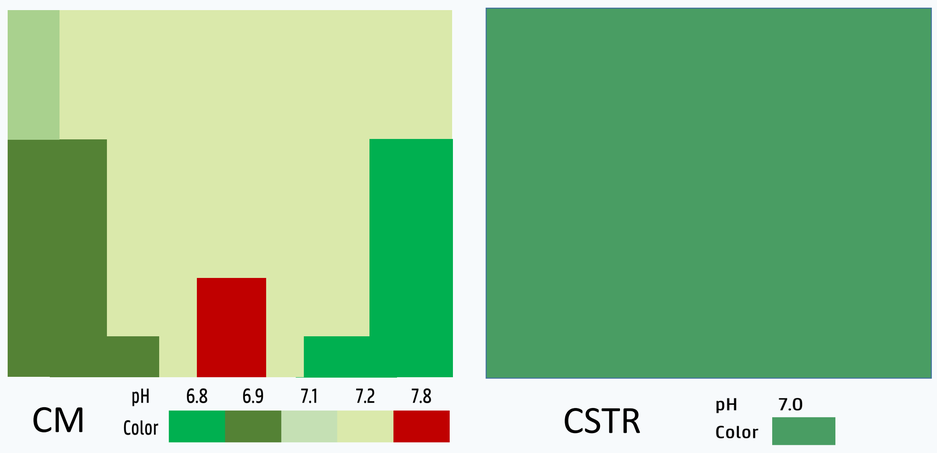

Fig. 4. The pH distribution in CM varies while it is constant across the digester volume in CSTR model

Conclusion

- ❖ The AD performance in CM deviates from the CSTR AD model.
- ❖ With CM the variation of biochemical reaction, substrates and biomass concentration distribution and pH can be studied locally unlike the CSTR AD model.
- ❖ CM reduces the computational cost, time and resources required by the CFD to model AD kinetics.

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SUPER

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