

ICCHES 2023

(PREVIOUSLY KNOWN AS ICBioE)

International Conference on Chemical Engineering & Sustainability 2023

INVESTIGATING THE EFFICIENCY OF INTEGRATING MICROBIAL ELECTROLYSIS CELL TO ANAEROBIC DIGESTER FOR BIOMETHANE PRODUCTION

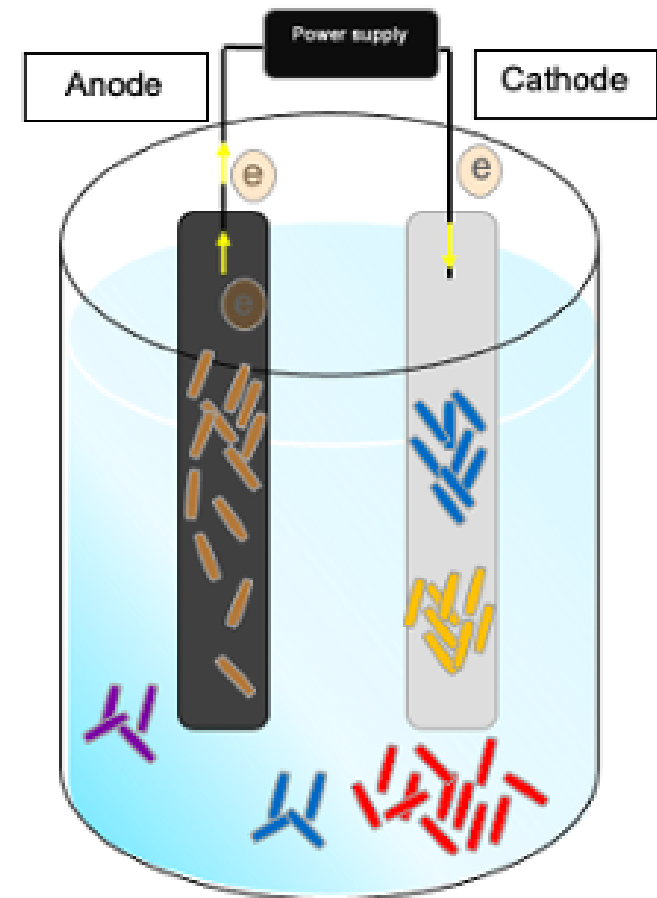
- Author: Aseel Al-Da'as, Prof.Md Zahangir Alam, Assc.Prof. Azlin Suhaida
- Guide author: Aseel Al-Da'as.

Background of Study

Anaerobic digestion is a process for biomethane production
Biomethane only accounts for 50-60% only

Microbial electrolysis cell : Is to produce hydrogen

MEC-AD: for the CO_2 H_2 upgrade within the system



Problem statement

Hydrolysis: Is a rate-limiting process in the fermentation process

Pre-treatment of substrate

MEC-AD Hybrid system

Acidogenesis Pathways: Acidogenesis pathway plays a huge role in the CO₂ upgrade to biomethane

Microbial enrichment

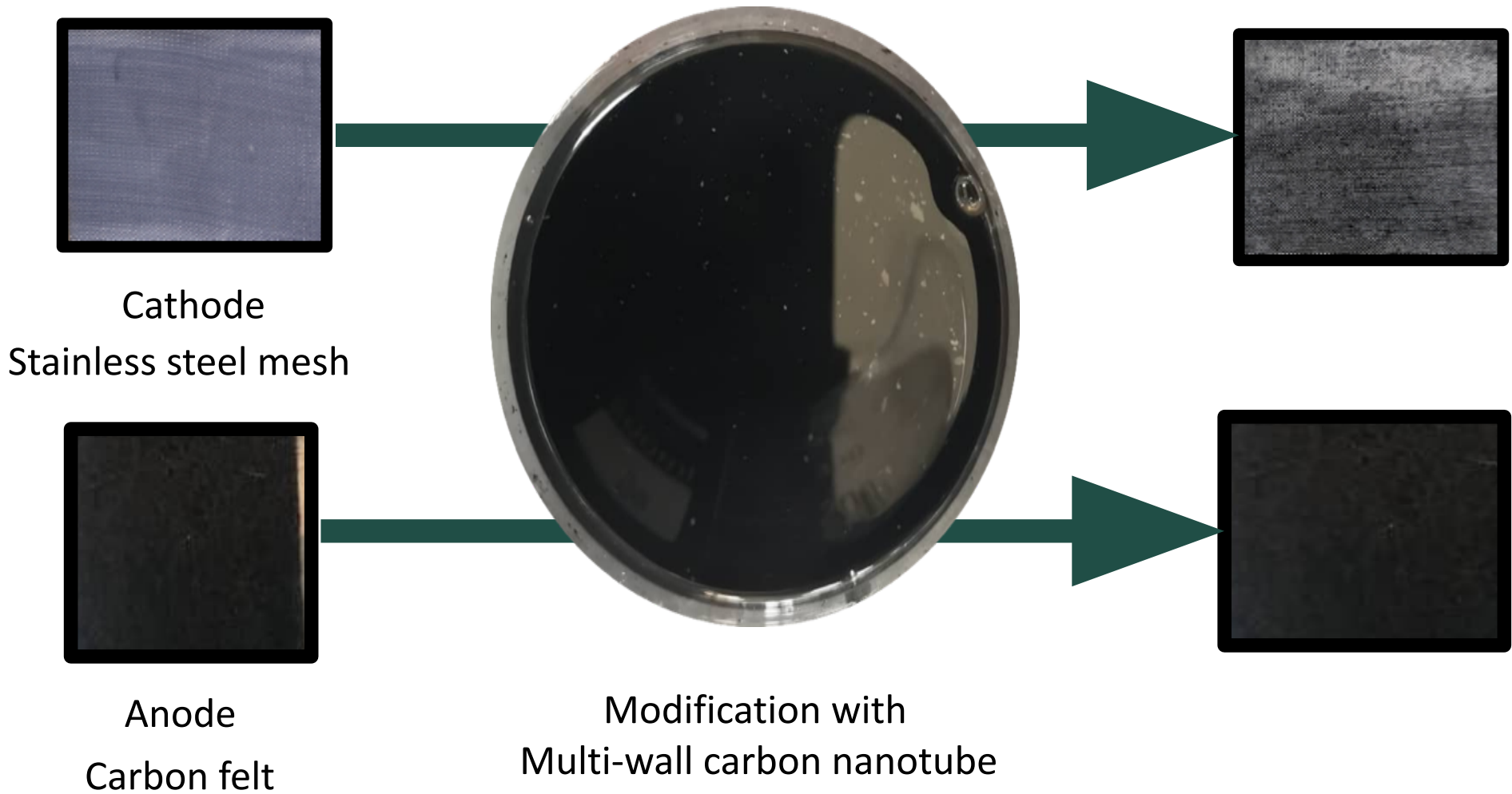
MEC-AD Hybrid system

Inoculum is the key factor to produce biomethane

Mixing inoculum

MEC-AD Hybrid system

ELECTRODE'S MODIFICATION



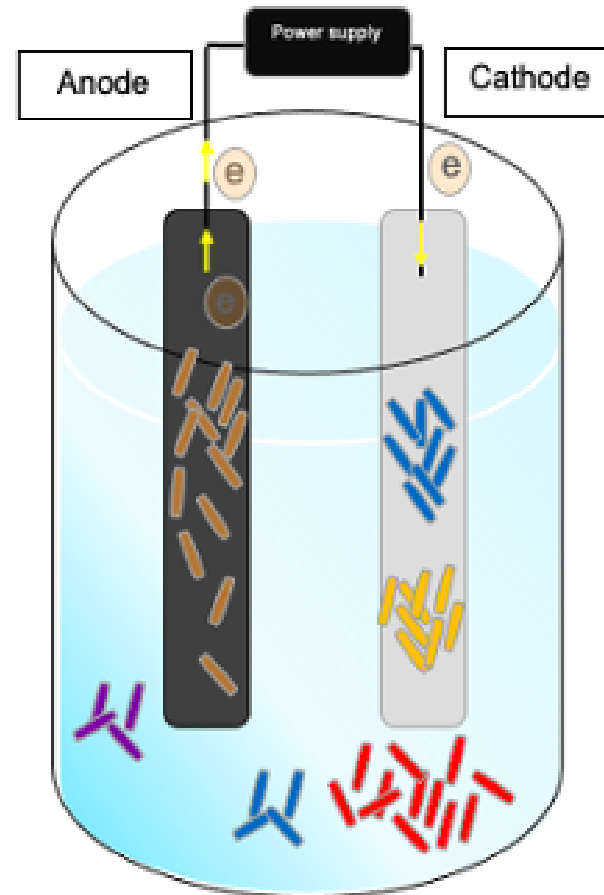
SYSTEM SET-UP

OPERATING CONDITIONS AND SUBSTRATE

SUBSTRATE: FOOD-WASTE

APPLIED POTENTIAL: 0.9V

TEMPERATURE: 37°C



MEC-AD Hybrid system set-up

ANALYSIS

Hydrolysis efficiency:
Monitor COD over 48h

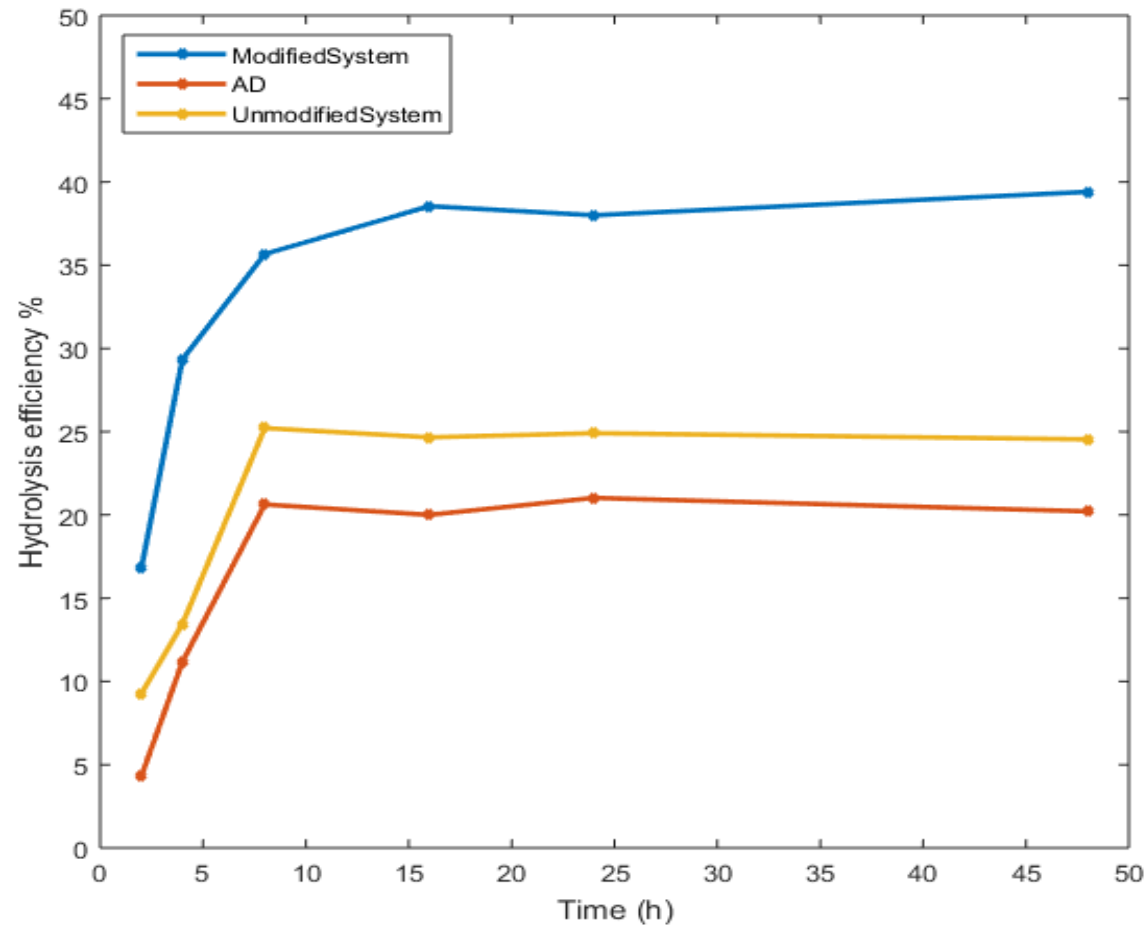
Acidogenesis pathway:
HPLC of VFA

BIOMETHANE PRODUCTION KINETIC: GOMPERTZ MODIFIED MODEL

$$M(t) = fd \cdot \exp\left\{-\exp\left[\frac{Rm \cdot e}{fd} (\lambda - t) + 1\right] t > 0\right\}$$

where $M(t)$ - the accumulative CH_4 yield at the time of t (mL/g COD); fd - the maximum CH_4 potential (mL); λ - the lag-phase (d); Rm - the maximum CH_4 production rate t - the digestion time (d); and e - the exponential e (2.71828).

RESULTS AND DISCUSSION: HYDROLYSIS



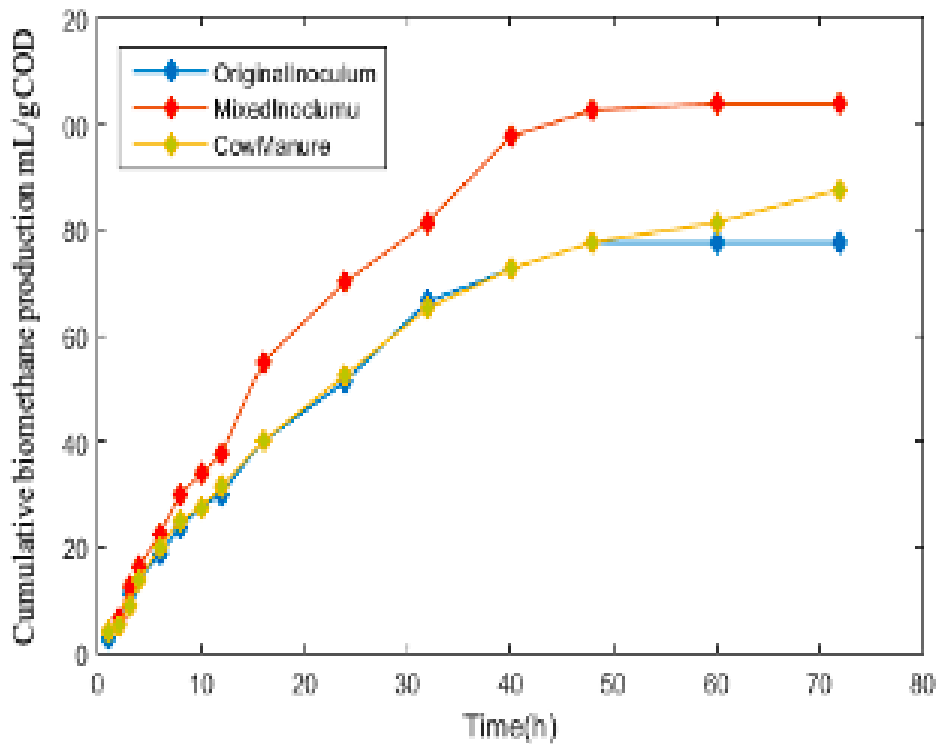
Hydrolysis efficiency of conventional digester, modified electrode system, and unmodified electrode system

RESULTS AND DISCUSSION: ACIDOGENESIS

Different analytical data on acidogenesis performance

System	VFA Initial concentration (mM)	VFA final concentration (mM)	Acetic acid COD (g/L)	pH	Final COD (g/L)	Biomethane (mL/g COD)
AD	14.5	45	2.8809	4.3	7	8.5
U-MEC	22.9	85.5	5.4417	4.5	7.4	13.8
M-MEC	90	106	6.8288	4.8	8.25	26.4

RESULTS AND DISCUSSION: MIXING INOCULUM



Dynamically fitted parameters according to Modified Gompertz model

Inoculum	Fd ml/g COD	Rm(m L/h)	λ (h)	R squared
Original	29.1	0.875	11.42	0.992
Cow-manure	31.24	0.825	12.61	0.991
Mixed inoculum	38.68	1.2	11.95	0.992

Fd: Maximum CH₄ potential
 Rm: Maximum CH₄ rate
 Λ : lag-time

Conclusion:

modified electrodes outperformed unmodified systems and conventional digesters regarding hydrolysis efficiency. Both hybrid systems were dominated by the acetic acid pathway, which is favourable for the upgrade of carbon dioxide to biomethane in the final digestion stage. Lastly, fitting the biomethane data from three different inoculations to the modified Gompertz model has shown that mixing the inoculum showed the best biomethane production rate and potential.

ICCHES 2023

(PREVIOUSLY KNOWN AS **ICBioE**)

International Conference on Chemical Engineering & Sustainability 2023

Thank you

