**Table S1.** Composition of synthetic wastewater feed in mg/L.

| Carbon source | | Nutrients and Iron | | Trace Metals | |
|---|---|---|---|---|---|
| Starch | 238.1 | Urea | 179.0 | $Cr(NO_3)_3{\cdot}9H_2O$ | 1.50 |
| Milk Power | 226.7 | $NH_4Cl$ | 24.88 | $CuCl_2{\cdot}2H_2O$ | 1.05 |
| Yeast | 101.9 | $MgHPO_4{\cdot}3H_2O$ | 56.62 | $MnSO_4{\cdot}H_2O$ | 0.21 |
| Peptone | 33.97 | $KH_2PO_4$ | 45.66 | $NiSO_4{\cdot}6H_2O$ | 0.66 |
| Na-acetate$\cdot 3H_2O$ | 256.9 | $FeSO_4{\cdot}7H_2O$ | 11.32 | $PbCl_2$ | 0.20 |
| | | | | $ZnCl_2$ | 0.41 |

**Table S2.** Characteristics of MF membranes used in AnMBR biofouling experiments.

| | **PVDF MF** | **PES MF** |
|---|---|---|
| Rejection size (µm) | 0.3 | 0.2 |
| Material (polymer) | Polyvinylidene fluoride | Polyethersulfone |
| Surface roughness value (rms) | | |
| - 3 x 3 µm Area | 94.5 | 38.1 |
| - 30 x 30 µm Area | 0.423 | 0.348 |
| Contact Angle | 77° | 32° |
| Zeta Potential (mV) | -18 | +19 |

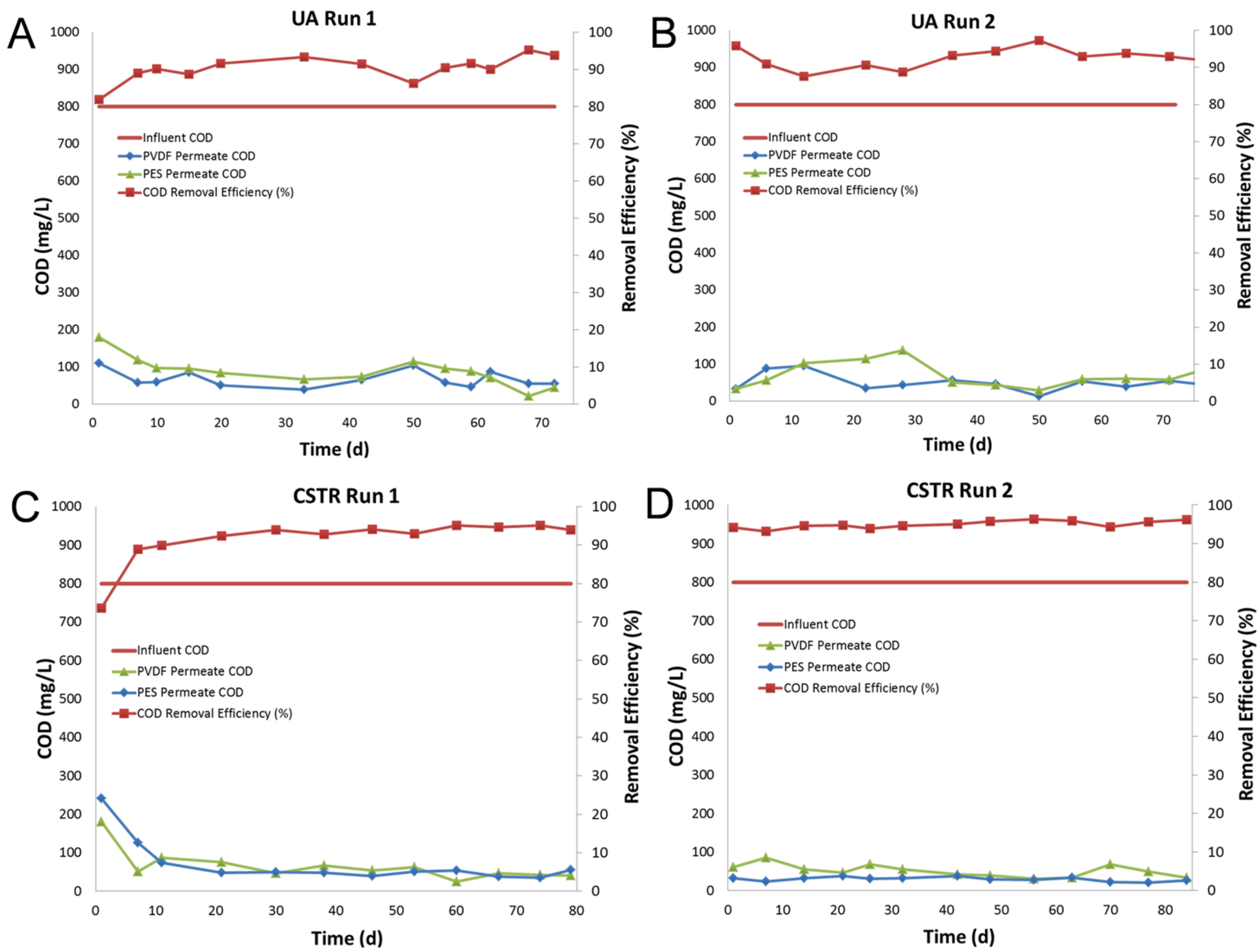


Figure S1. COD concentrations in AnMBR influent and effluents and removal efficiencies for (A) UA Run 1, (B) UA Run 2, (C) CSTR Run 1, and (D) CSTR Run 2.

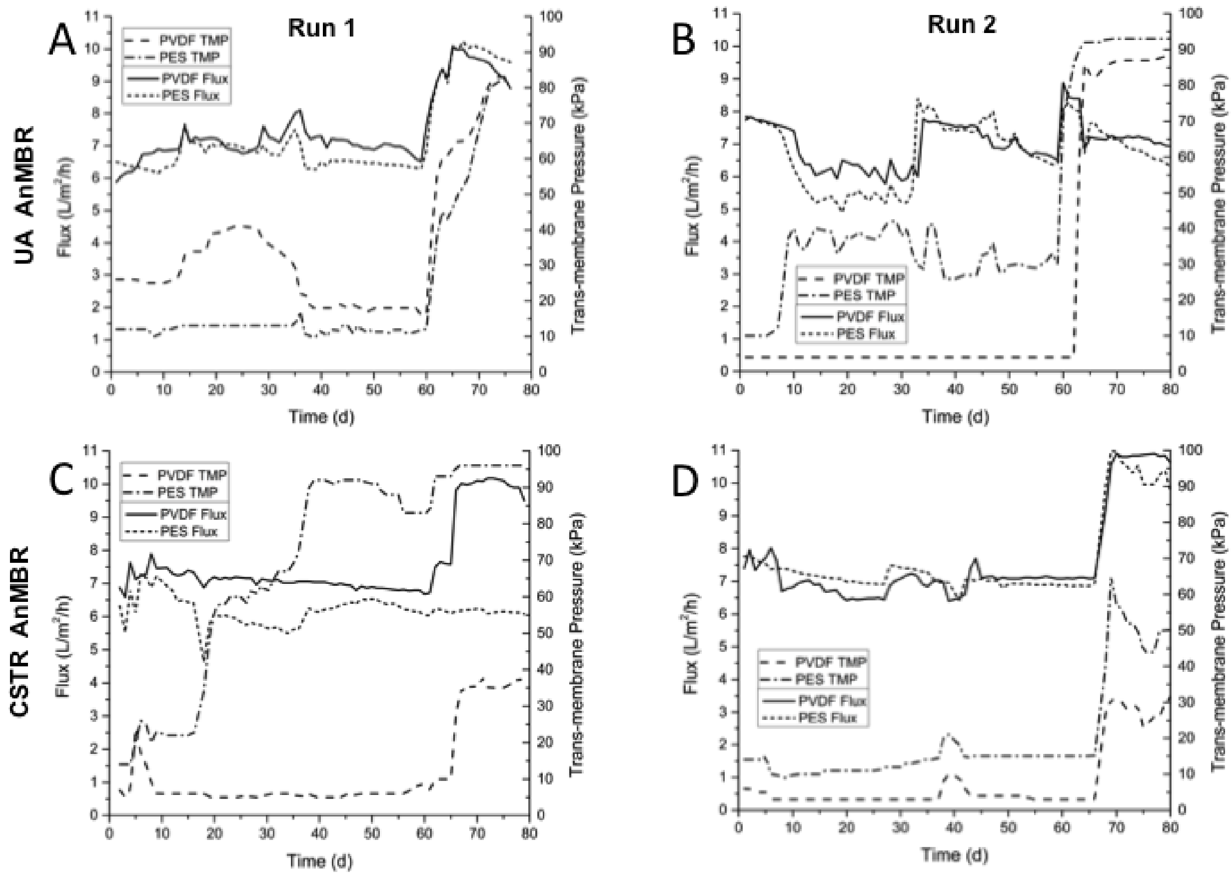


Figure S2. Transmembrane Flux and Transmembrane Pressure (TMP) across AnMBR PVDF and PES MF membranes for (A) UA Run 1, (B) UA Run 2, (C) CSTR Run 1, and (D) CSTR Run 2.

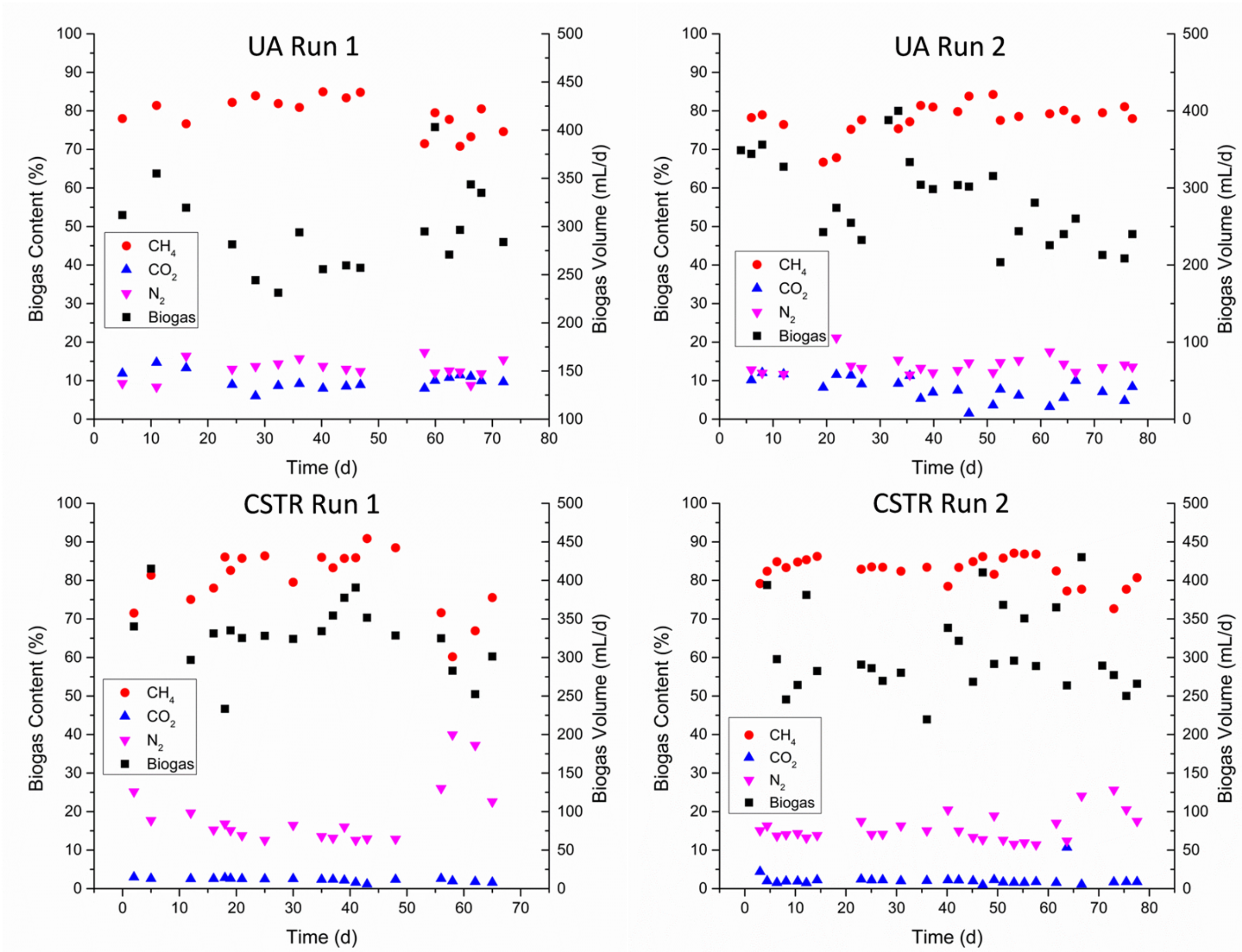


Figure S3. Biogas volume and composition in AnMBRs for (A) UA Run 1, (B) UA Run 2, (C) CSTR Run 1, and (D) CSTR Run 2.

**Biogas Composition Calculations**

Assuming:
Peptone = 100% Protein
Starch = 100% Carbohydrate
Milk Powder = 41.7% Carbohydrate, 29.7% Lipids, 28.6% Protein
Yeast Extract = 46.1% Carbohydrate, 9.0% Lipids, 44.9% Protein

Considering typical chemical formulas (Rittmann and McCarty, 2012)

| | | |
|---|---|---|
| Carbohydrates: $C_6H_{10}O_5$ | $f_s = 0.28$ | $f_e$=0.72 |
| Proteins: $C_{16}H_{24}O_5$ | $f_s = 0.08$ | $f_e$=0.92 |
| Lipids: $C_{16}H_{32}O_2$ | $f_s = 0.06$ | $f_e$=0.94 |
| Acetate: $C_2H_4O_2$ | $f_s = 0.11$ | $f_e$=0.89 |

and using:

$$C_wH_xO_yN_z + aO_2 \rightarrow bCO_2 + cH_2O$$

The overall synthetic wastewater composition (800 mg/L as COD) is calculated:

50% Carbohydrate, 19% Protein, 10% Lipids, and 21% Acetate

Based on the generalized stoichiometric equation and assuming $f_s + f_e = 1$ (Rittmann and McCarty, 2012, eqn. 13.5):

$$C_wH_xO_yN_z + aH_2O \rightarrow bCH_4 + cCO_2 + dC_5H_7O_2N + eNH_4 + gHCO_3^-$$

For each M compound:

| | M $CH_4$ | M $CO_2$ |
|---|---|---|
| Carbohydrates: | 2.16 | 2.50 |
| Proteins: | 7.60 | 3.35 |
| Lipids: | 9.20 | 1.52 |
| Acetate: | 0.89 | 0.93 |

Therefore 0.815 M of CO2 will be produced for each 1 M of $CH_4$ for this synthetic wastewater.

Average biogas production from reactors (measured):

| | UA (mL/d) | CSTR (mL/d) |
|---|---|---|
| Captured $CH_4$ | 224 | 257 |
| Effluent $CH_4$ | 59 (0.325 mL / 10 mL) | 56 (0.311 mL / 10 mL) |
| Captured $CO_2$ | 25 | 7 |
| Effluent $CO_2$ | 207 (1.15 mL / 10 mL) | 202 (1.12 mL / 10 mL) |

Based on the ideal gas law, total produced $CH_4$ and $CO_2$ could be determined:

| | UA | CSTR |
|---|---|---|
| $CH_4$ | 12.6 mM/d | 14.0 mM/d |
| $CO_2$ | 10.3 mM/d | 9.5 mM/d |
| $CO_2/CH_4$ | 0.817 | 0.679 |
| $CH_4$ | 0.202 g / d | 0.224 g / d |

**Theoretical methane production**

Maximum theoretical methane production was calculated based on:

$CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$
(16g) + (64g) $\rightarrow$ (44g) + (36g)

0.25 g $CH_4$ = 1 g COD
Therefore ideally at STP, 1 g COD = 350 mL $CH_4$.

**COD Converted to biomass**

Biomass wasted = 0.0235 g total per day (4 g/L average and SRT of 325-355 d)

Average microorganism decay rate $b_a$ = 0.03 (Rittmann and McCarty, 2012)

COD conv. to biomass = 1.42 g COD / g MLSS (Rittmann and McCarty, 2012)

Generated biomass = 0.0235 g + 0.03 x 4 g/L x 2 L (reactor volume) = 0.264 g / d

COD converted to biomass = $COD_{biomass}$ = 0.375 g COD / d

**Total COD Mass Balance**

$COD_{influent} = COD_{effluent} + COD_{biomass} + COD_{methane}$

$COD_{influent}$ = 1.44 g COD / d

UA $COD_{effluent}$ = 0.115 g COD / d (92% average removal)
CSTR $COD_{effluent}$ = 0.086 g COD / d (94% average removal)

UA $COD_{methane}$ = 1.44 - 0.115 - 0.375 = 0.950 g COD / d (theoretical)

CSTR $COD_{methane}$ = 1.44 - 0.086 - 0.375 = 0.979 g COD / d (theoretical)

UA $COD_{methane}$ = 0.806 g COD (measured)
CSTR $COD_{methane}$ = 0.896 g COD / d (measured)