Supplementary information

Effect of ultrafiltration membrane material on fouling dynamics in a submerged anaerobic membrane bioreactor treating domestic wastewater

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Table S1 AnMBR operational conditions

Parameter	Value
Reactor effective volume	15 L
Hydraulic retention time (HRT)	12 h
Sludge retention time (SRT)	50 days
Mixed liquor suspended solids (MLSS)	8±3 gr/L
Temperature	25±0.3 °C
pH	7±0.2
Oxidation-reduction potential (ORP)	(−400) to (−500) mV
Total organic loading rate (OLR)	1.9 g COD/L day
Membrane flux	6 L/m^{2}h
Sparging rate	60 (L/m^2 min)
Filtration mode/backwash	10 min/60 s

Table S2 Contact angles and mean surface tensions\free energies (in mJ/m^2)

Mem-brane	SAD*	Contact angle (°)			γ^{LW}	γ^-	γ^+	γ^{AB}	ΔG^{LW}	ΔG^{AB}	ΔG_{SL}
		Water	Glycerol	Diiodomethane							
PAN	1.075	40.2±5.2	48.1±2.2	43.1±2.8	36.2	37.3	0.4	8.1	-3.6	18.6	**15.0±7.7**
PES	1.036	66.4±2.2	61.3±2.2	22.3±2.3	44.5	14.6	3E-5	0.04	-8.0	-24.8	**-32.8±5.0**
PVDF	1.062	80.3±1.8	69.4±6.1	56.2±2.3	29.5	6.5	0.6	4	-1.2	-42.7	**-43.9±3.2**

* Surface area difference (sometimes termed "surface area ratio") = $\frac{\text{Actual surface area}}{\text{Projected surface area}}$

Table S3* Multiple regression coefficients and p values of the effect of membrane properties on fouling

Membrane property	Coefficient	Std. error	p value
Roughness	1.5282	3.9846	0.71^{ns}
Surface free energy	**-5.5124**	**0.6742**	**1.86E-05**
ζ potential	2.5779	3.1916	0.44^{ns}
Pore size	-4.0888	3.9561	0.328^{ns}
Permeability	4.8366	18.9415	0.804^{ns}

ns - not significant

Table S4 One-way ANCOVA p values – the effect of surface free energy on the EPS fouling composition (absolute concentration and relative abundance of each component in the foulant)

EPS fouling parameter	Fouling type	Correlation direction	p value
Absolute concentration	Proteins	(-)	0.0278*
	Polysaccharides	(-)	0.0132*
	DOC	ns	*0.1812*[ns]
Relative abundance	Proteins	(-)	0.0470*
	Polysaccharides	(-)	0.0468*
	Other	(+)	0.0152*

ns - not significant; * $p < 0.05$; (+) / (-) - positive / negative correlation to surface free energy

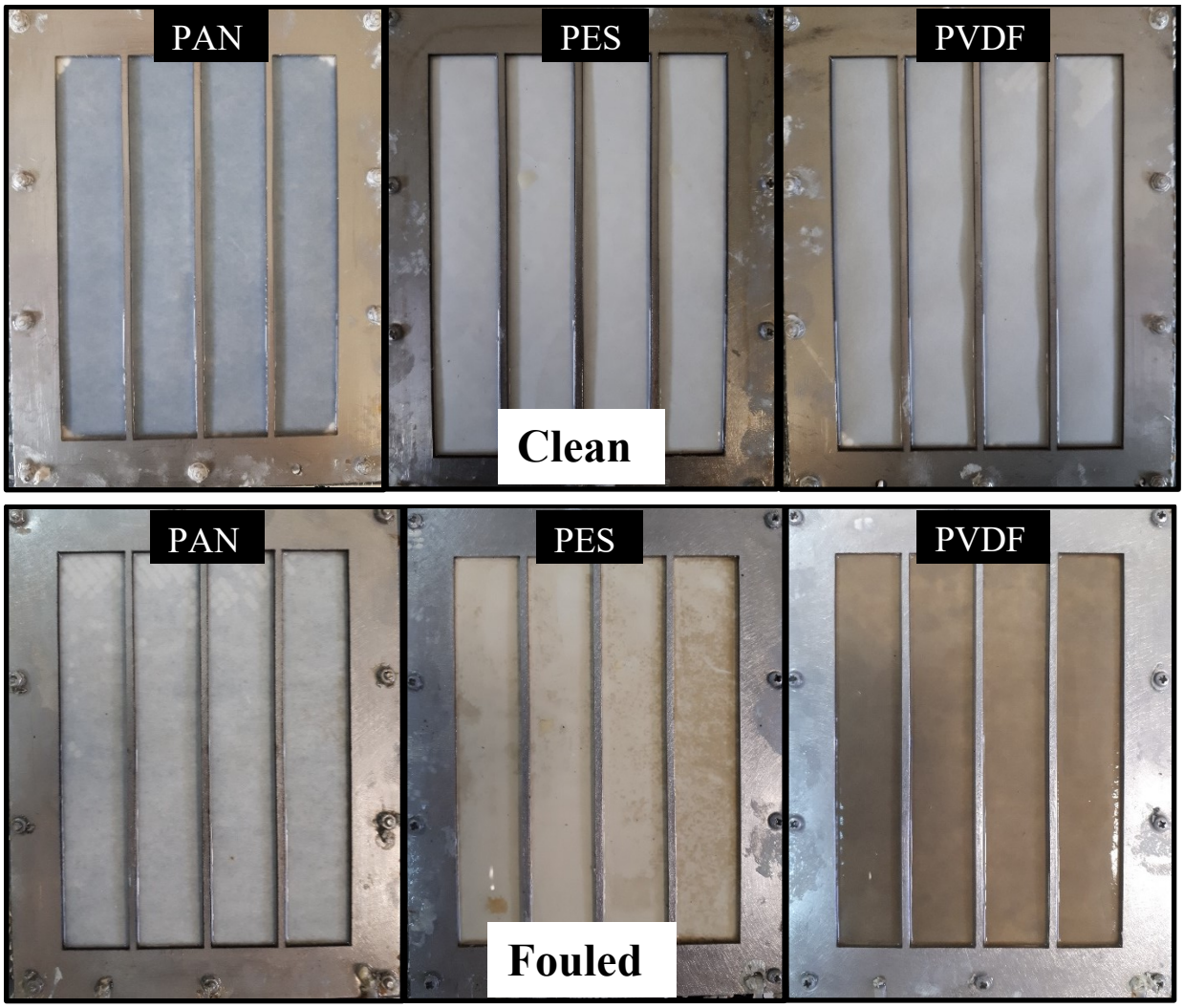

Image S1 Images of clean (top) and of the fouled membranes (bottom) removed from the AnMBR after 8 days of operation.

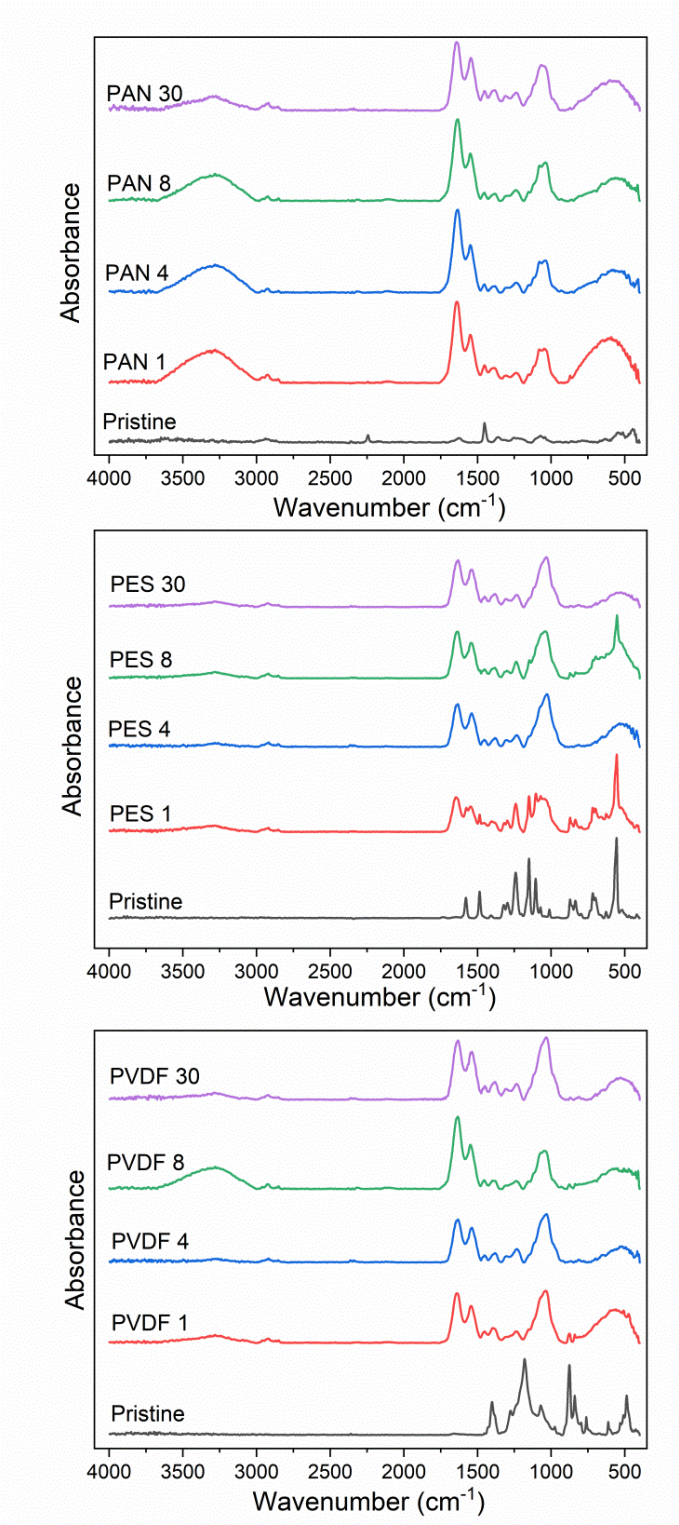

Figure S1 ATR-FTIR spectra of pristine and fouled PAN, PES, and PVDF membranes after 1-, 4-, 8-, and 30-day runs.

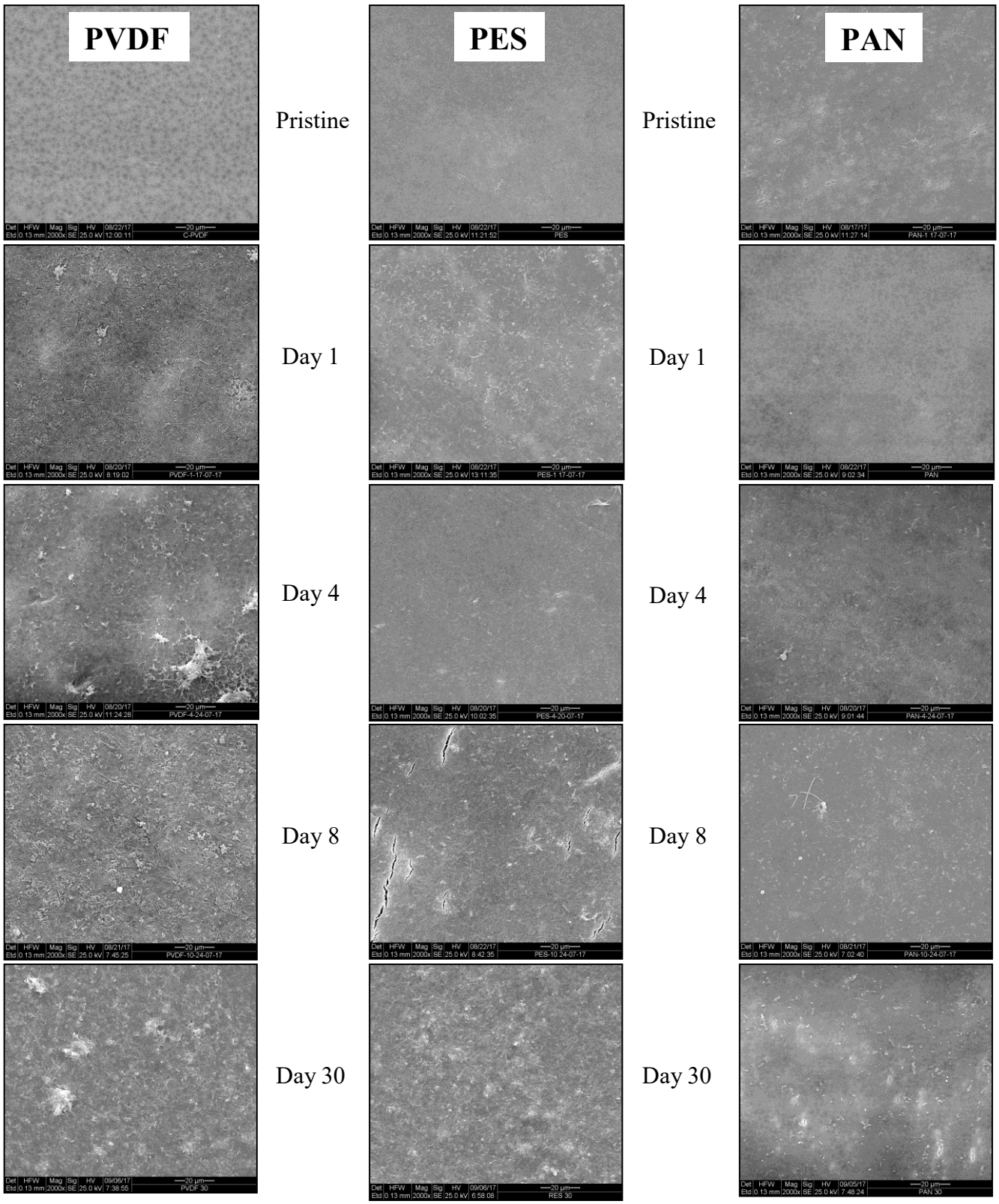

Figure S2 SEM images of the three membranes, pristine and following a 1-day, 4-day, 8-day and 30-day run.

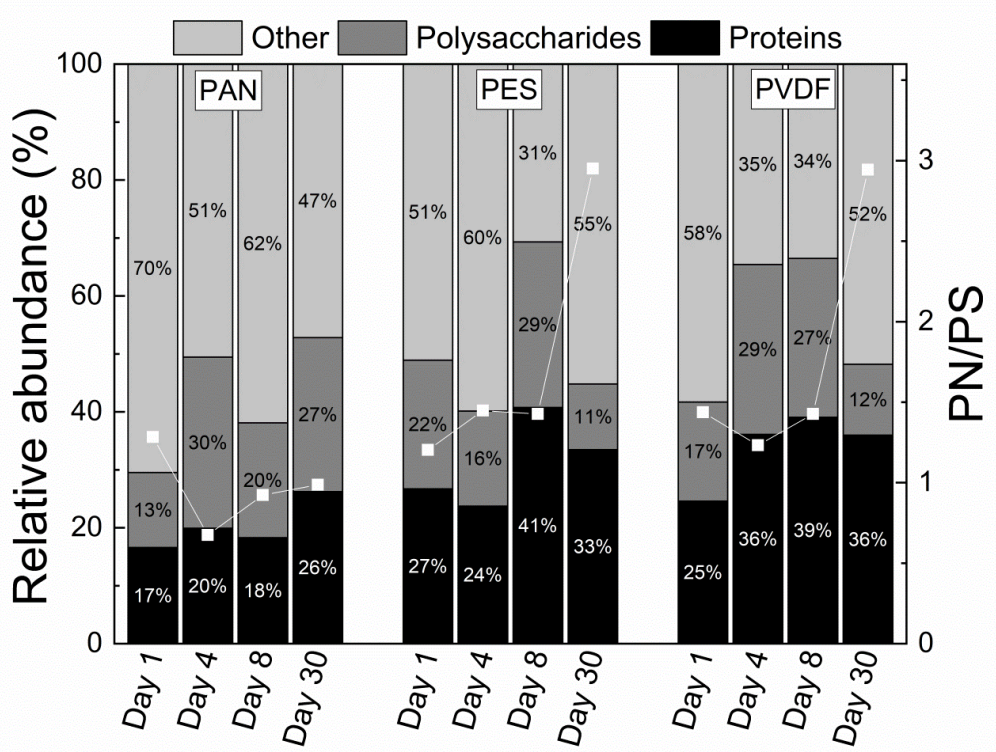

Figure S3 Relative abundance of proteins, polysaccharides, and 'other' substances (which generally refers to biopolymers) on the each of the three membranes after four runs. The white line represents the PN/PS ratio. The protein and polysaccharide concentrations were normalized to the carbon concentrations (0.53 and 0.44 gr C/gr, respectively), and are presented as the fraction of the total carbon concentration in the EPS.