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Microplastic in Gravity-driven Membrane Filtration for Cold Climate Decentralized Wastewater Treatment

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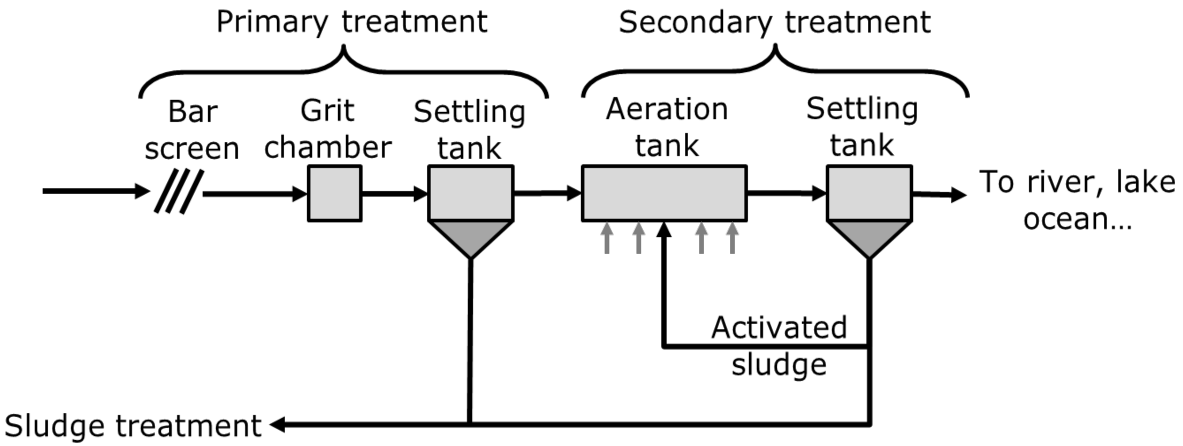
Microplastic in Conventional Biological Process

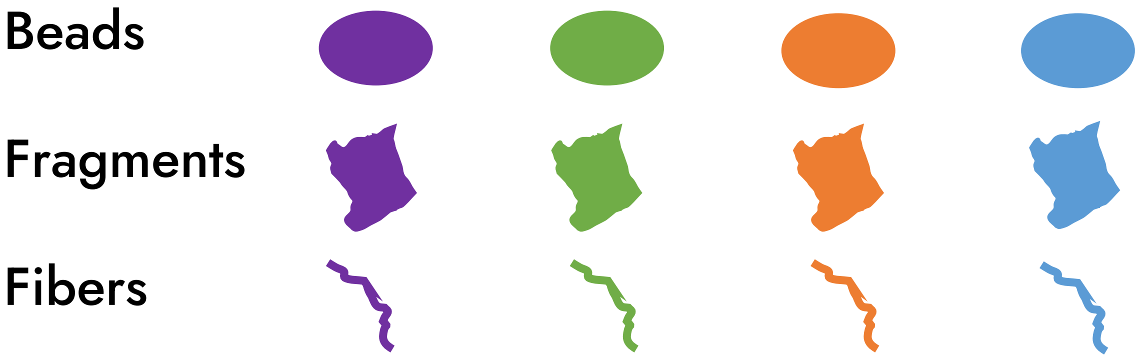


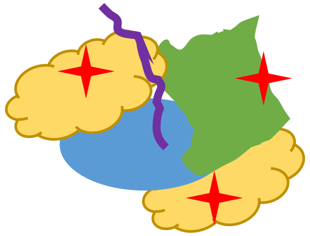
- Sedimentation/ floatation: 41-99% removal
- Activated sludge process: 17-98% removal

→ sludge sorption and secondary sedimentation

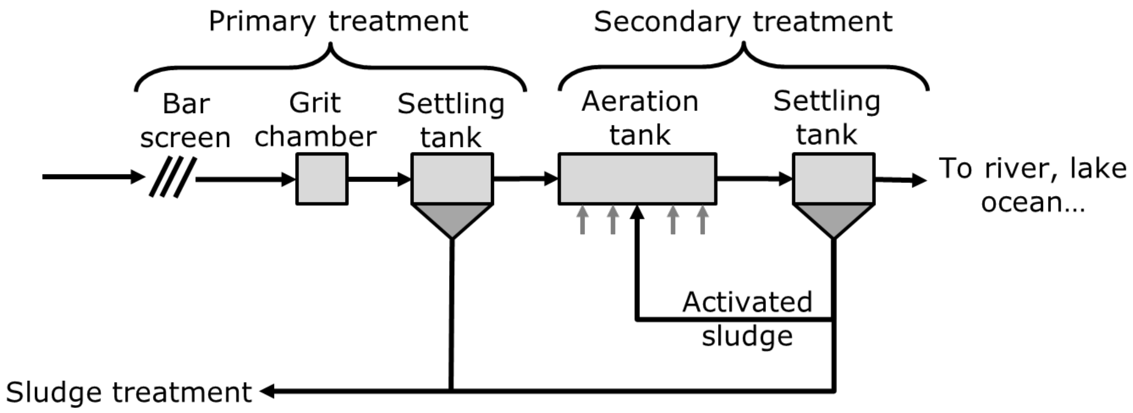
High removal fluctuations due to variable microplastic characteristics:

- Shape
- Material
- Agglomeration: organics, other wastewater components





Conventional Biological Process



- Preferably warmer temperatures and continuous flow
- Long start-up and adaption time with varying feed
- High energy consumption for aeration
- Sludge requires post-treatment

Decentralized wastewater treatment:
Modularity, stable performance, simple operation, adaptability

Decentralized Wastewater Treatment

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- Reported decentralized treatment systems

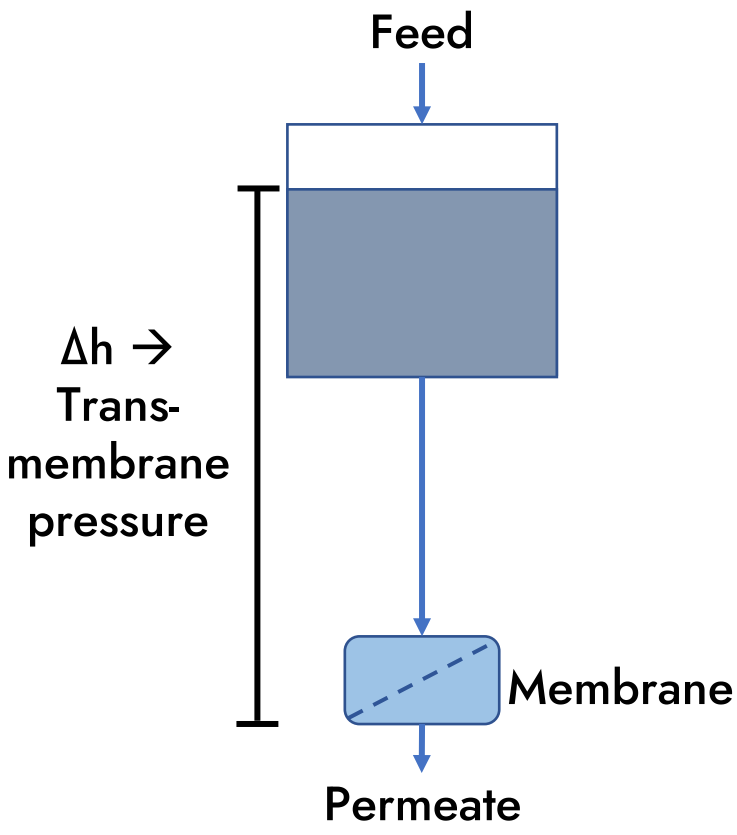
Septic tanks
Constructed wetlands
Biological systems
Membrane bioreactors
etc.

} Often fluctuating effluent quality, complicated systems

- Emerging pollutants in decentralized systems well studied

  → except microplastics

Gravity-driven Membrane Filtration (GDM)

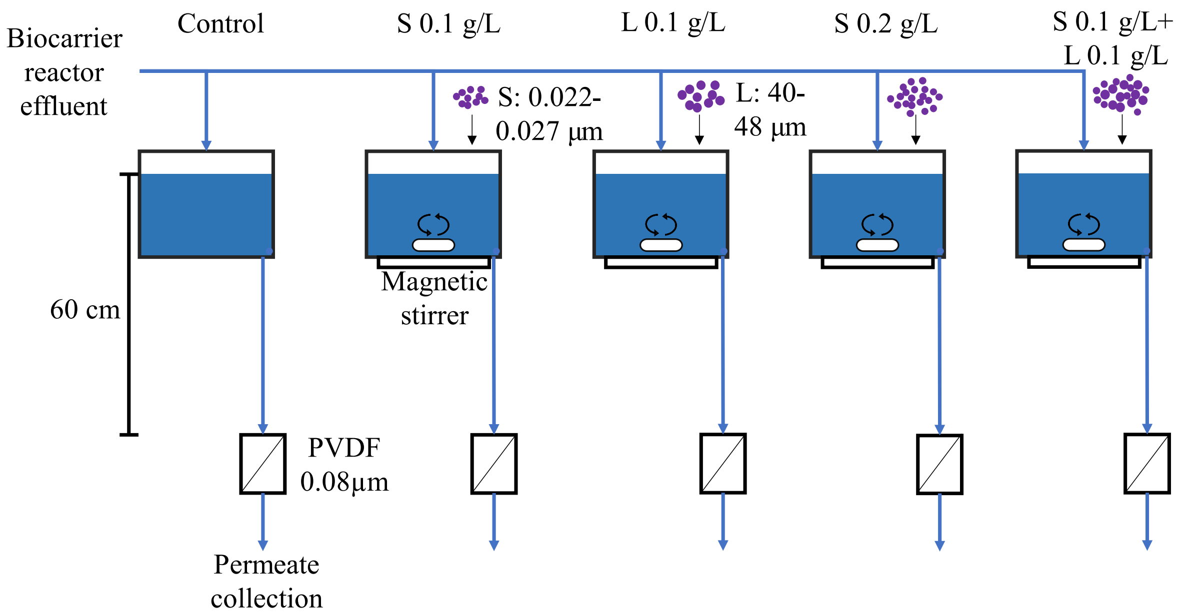


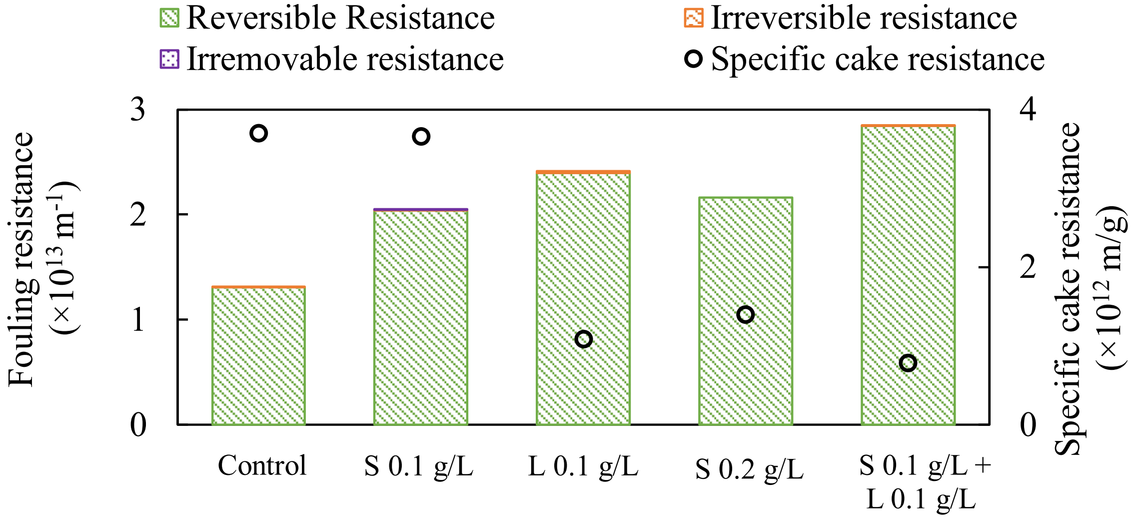
Why GDM?

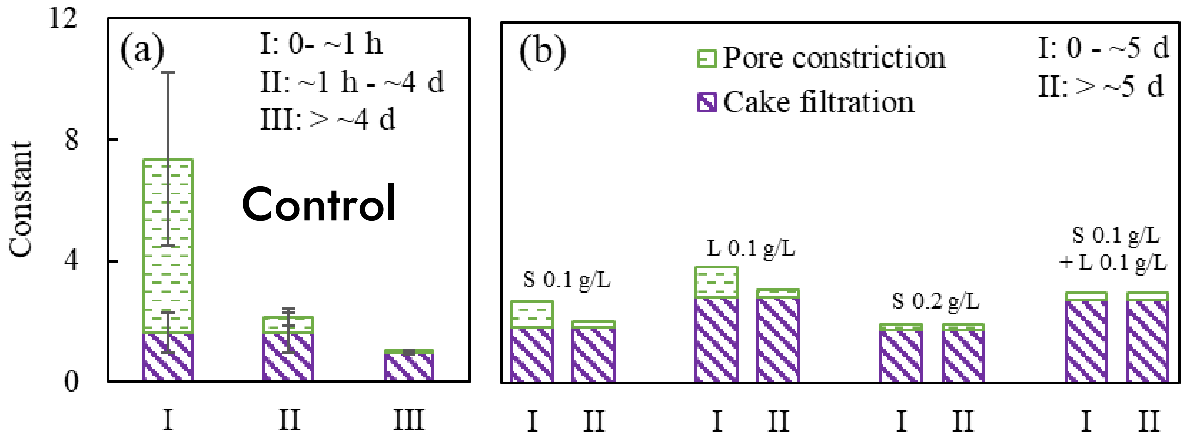
- Simple in design and maintenance, high modularity
- Able to handle fluctuating inflow and low temperature
- Suitable for decentralized application

➡ Microplastic accumulation?

Setup

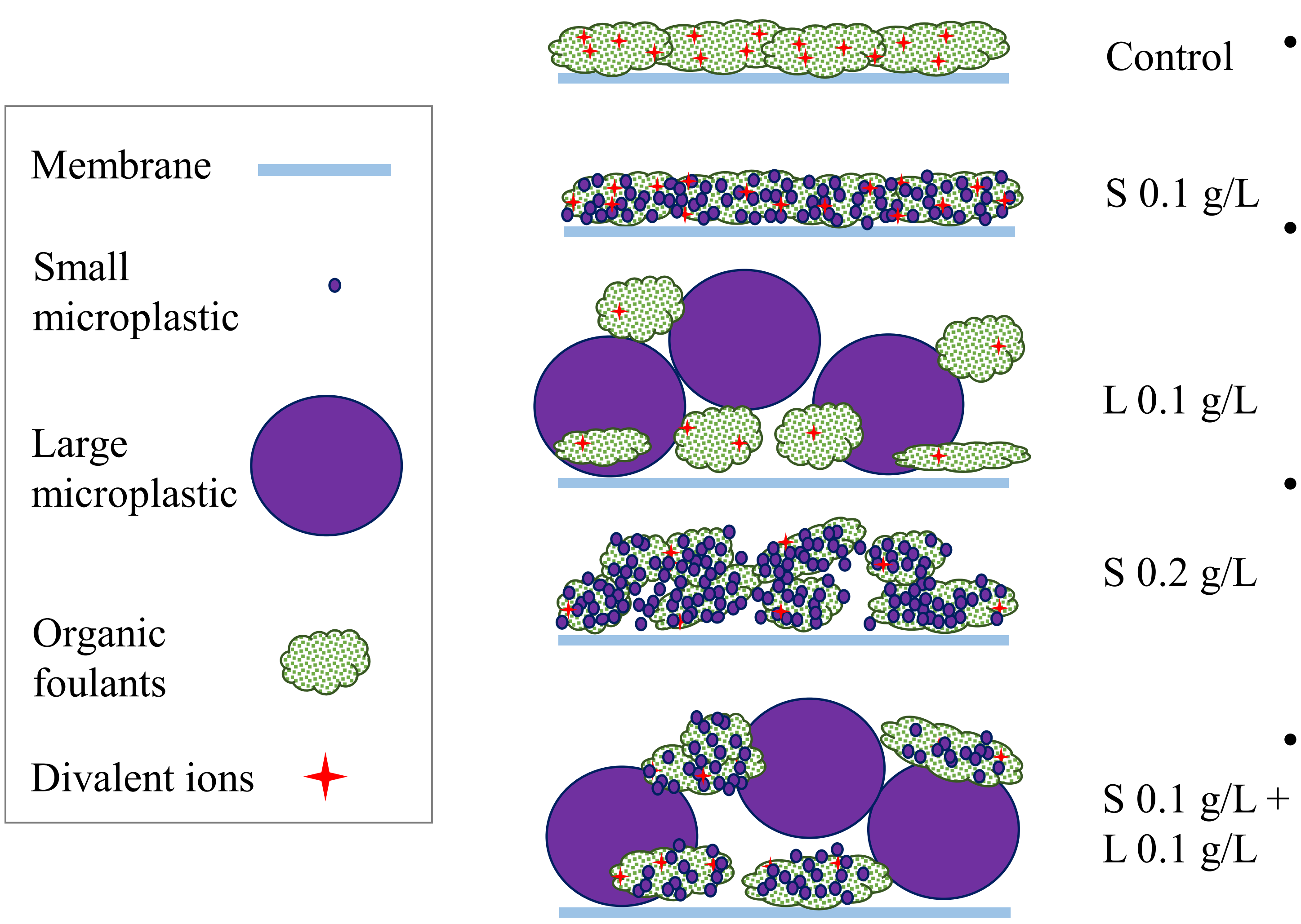






- Cake layer fouling dominant
- With MPs: 56 to 117% increase in cake fouling
- MP size increase → resistance increase
- MP amount increase → resistance unchanged

Results: Cake Layer



- With small MP (0.1 g/L): cake density comparable to control
- With large MP: lower cake density, but more mass, low divalent ions
  → Large spaces between MP create pores
- With small MP (0.2 g/L): higher porosity, higher mass, lower divalent ion density
  → Weaker bridging between organics
- Large & small MP: porous cake layer with low divalent ion concentration

Results: Metal Accumulation

- With MP: higher metal accumulation
- Metal content similar to foulant mass
  → Increased MP offered more retention opportunities
- No clear trend regarding MP sizes
  → competition with divalent ions?

	Foulants (µg/m^2)				
	Control	S 0.1 g/L	L 0.1 g/L	S 0.2 g/L	S 0.1 g/L + L 0.1 g/L
Ti	374.42	1212.18	1549.54	1248.73	2259.01
V	405.57	275.20	483.72	541.94	789.81
Cr	92.63	100.28	234.94	193.10	280.67
Mn	4978.04	2442.94	6281.94	5951.71	13056.44
Co	315.98	112.13	546.99	281.60	854.09
Ni	177.34	149.25	307.55	378.48	615.67
As	24.85	17.25	23.83	47.76	58.91
Rb	13.23	11.67	18.97	27.47	34.82
Sr	1666.35	1128.70	1297.87	2756.01	2756.34
Mo	74.57	82.22	46.68	112.09	79.52
Cd	4.82	10.41	13.95	25.63	25.26
Sn	10.68	12.83	17.25	24.16	44.41
Sb	8.67	15.21	13.28	19.59	19.36
Ba	938.19	721.97	1016.79	1485.20	2627.00
W	5.81	8.93	21.09	16.18	43.52
Hg	0.64	0.80	1.14	1.57	2.14
Pb	110.63	5173.98	5068.77	15900.31	15198.31

Conclusion & Acknowledgments

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- Varying characteristics of MPs make their removal challenging
- MP in decentralized systems little studied
- MP increases resistance in GDM
- MP leads to metal accumulation in cake layer

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VEITUR

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Grants and Funds

Thank you!

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