Contribution ID: **394** Type: **Oral presentation**

Biofouling in membrane bioreactors decreases the retention of free plasmid DNA carrying antibiotic resistance genes

Wednesday, October 7, 2026 9:45 AM (15 minutes)

Membrane bioreactors (MBRs) effectively remove bacteria during wastewater treatment. Less is known about removal of extracellular DNA, including ARG-carrying plasmids, which are far smaller. If released into the environment, such plasmids can persist for months and be taken up by bacteria via transformation. During MBR operation, biofilm forms on membranes and may act as an additional barrier to free DNA. We hypothesized that thicker biofouling layers increase free-DNA retention.
To test this, we quantified retention of three ARG-carrying plasmids of different sizes using model MBRs at different biofouling stages. Biofilm thickness was continuously monitored by optical coherence tomography. At defined growth stages, free plasmid DNA was spiked into the feed and retention quantified by ddPCR.
Without biofouling, retention ranged from 95.4% to 99.9%, depending on the plasmid. Contrary to our hypothesis, plasmid passage increased up to 6.3-fold in MBRs with early biofilm formation. Retention declined further at later stages.
These findings suggest biofilm growth promotes preferential flow paths that facilitate plasmid migration through the membrane barrier by increasing local flux and reducing contact time. EPS may further reduce adsorption or electrostatic repulsion by occupying binding sites. Plasmid degradation and uptake did not play a significant role. This highlights that MBR anti-biofouling strategies, while increasing performance, also aid in retaining free AMR-plasmids.

Keywords

Antimicrobial resistance, plasmids, membrane bioreactors, biofouling, transformation

Registration ID

OHS26-93

Professional Status of the Speaker

PhD Student

Junior Scientist Status

Yes, I am a Junior Scientist.

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Session Classification: Session 10: AMR I

Track Classification: AMR