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Monitoring of bacterial biofilm formation in sands using complex electrical conductivity

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Geophysical monitoring of bacterial activities in subsurface has drawn significant interest in various civil engineering, hydrocarbon recovery, soil remediation practices. This study explored the feasibility of use of complex electrical responses to monitor bacterial biofilm formation in soils. Two runs of column experiments were conducted, in which the model bacteria Shewanella oneidensis MR-1 were cultured in a sand-pack and stimulated to form biofilms. During the bacterial growth and biofilm formation, the variations in complex electrical conductivity were monitored at a frequency range of 0.01–1000 Hz. As a result of the bacterial growth and biofilm formation, it was observed that the imaginary conductivity significantly increased by more than 500% and the real conductivity was reduced by more than 13% in the both runs. However, we observed the spatial variations in the complex conductivity values, showing the greatest variations near the nutrient injection port occurred and the least variations near the outlet fluid port. It appeared that the imaginary conductivity effectively captured bacterial growth and biofilm formation in porous media, while the real conductivity was heavily affected by porosity reduction as well as pore fluid conductivity. The obtained results suggest that complex conductivity can be effectively used to capture the bacterial growth and biofilm formation in soils.

References

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