Contribution ID: **608** Type: **Oral 20 Minutes**

Oxygen Profile Characterization in Packed Bed Biofilm Using 19F Nuclear Magnetic Resonance Oximetry

Wednesday, 16 May 2018 15:40 (15 minutes)

19F magnetic resonance has become a popular method in the medical field for quantifying oxygenation in blood, tissues, and tumors. The technique, called 19F NMR oximetry, exploits the strong affinity of molecular oxygen for liquid fluorocarbon phases, and the resulting strong linear dependence of 19F spin-lattice relaxation rate R1 on local oxygen concentration. The success of 19F NMR oximetry in clinical contexts naturally introduces the possibility of repurposing this method to measure oxygen in different systems. Bacterial biofilms, aggregates of bacteria encased in a self-secreted matrix of metabolic products, are ubiquitous in environmental, industrial, clinical settings and, in all cases, oxygen gradients represent a critical parameter in biofilm behavior. However, measurement of oxygen distribution in biofilms is often cumbersome and in some cases intractable due to limitations of traditional methods (e.g. microelectrode). In the present work we demonstrate the ability of 19F NMR oximetry to accurately track oxygen profile development in dynamic systems experiencing rapid changes in oxygen concentration over time and space. We then use the technique to probe the oxygen environment of biofilms grown in a packed bed column, a system where spatially-resolved oxygen quantification is notoriously difficult. Construction of a calibration curve detailing the response of 19F R1 to oxygen concentration is accomplished by bubbling gases of variable oxygen concentration through pure-phase fluorocarbon and calculating R1 using the inversion recovery pulse sequence, and spatial R1 mapping is achieved using inversion recovery in combination with a spin-echo imaging sequence. Introduction of the fluorocarbon into the packed bed column is performed by emulsifying perfluorooctylbromide (PFOB) in an aqueous solution containing sodium alginate, and then dripping the solution into a calcium chloride solution to encapsulate the oxygen-sensing emulsion into spherical alginate gel beads. The gel beads are then used as the packed bed solid matrix such that oxygen measurement can be achieved without influencing flow. Over the course of microbial growth we monitor flow dynamic using 1H velocity mapping and oxygen profile using 19F R1 mapping, and synthesize the two datasets to generate novel insights into the interplay between fluid dynamics and resulting oxygen transport phenomena in these complex systems. For instance, this technique is used to identify rate-limiting growth substrates (oxygen versus nutrient) and to generate spatial maps of oxygen consumption rate constants. Two bacterial species are compared (Escherichia coli and Staphylococcus epidermidis), and different growth conditions and bed geometries are investigated.

References

Acceptance of Terms and Conditions

Click here to agree

Primary authors: SIMKINS, Jeffrey W. (Montana State University); Dr STEWART, Philip S. (Montana State

University); SEYMOUR, Joseph D. (Montana State University)

Presenter: SIMKINS, Jeffrey W. (Montana State University)

Session Classification: Parallel 8-D

Track Classification: MS 3.01: Application of NMR Methods to Porous Media: