

Solving time-dependent and parametric problems using COMSOL Multiphysics

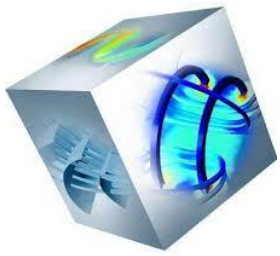
Giorgio MATTEI

giorgio.mattei@centropiaggio.unipi.it



Course: Fenomeni di trasporto biologico

Date: 24 Nov 2015



Problem description: sphere

- Model steady-state O_2 diffusion and consumption within a cell laden construct

$$\begin{aligned} \nabla \cdot (-D \nabla c_{O_2}) &= R - \mathbf{u} \cdot \nabla c_{O_2} && \text{Generic advection and} \\ R_{O_2} &= V_{O_2} \cdot \delta(c_{O_2} > c_{O_2,cr}) && \text{diffusion equation} \end{aligned}$$

- Boundary oxygen concentration: $c_{O_2} = p_{O_2} \cdot K_{H,O_2} = 0.21 \text{ mM}$
- Oxygen consumption rate: $V_{O_2} = [1 \cdot 10^{-3}, 5 \cdot 10^{-4}, 1 \cdot 10^{-4}] \text{ mol}/(\text{m}^3 \cdot \text{s})$
- Oxygen diffusion in the construct: $D_{O_2} = 1 \cdot 10^{-9} \text{ m}^2/\text{s}$
- $\delta(c_{O_2} > c_{O_2,cr}) = \text{flc1hs}(c_{O_2} - c_{O_2,cr}, c_{O_2,cr}/2) \rightarrow$ COMSOL smoothed Heaviside function with continuous first derivative and without overshoot
- Critical oxygen concentration to account for cell necrosis: $c_{O_2,cr} = 2.64 \text{ }\mu\text{M}$
- Cell construct volume: 27 mm^3



How long does it take to reach the stationary state?