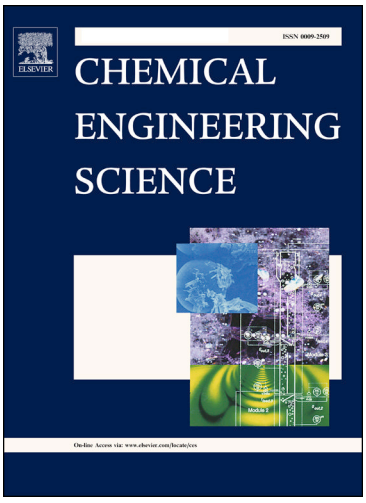

Optimization of oxygen transport within a tissue engineered vascular graft model using embedded micro-channels inspired by vasa vasorum

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PII: S0009-2509(18)30106-4
DOI: https://doi.org/10.1016/j.ces.2018.02.044
Reference: CES 14068

To appear in: *Chemical Engineering Science*

Received Date: 11 October 2017
Revised Date: 26 January 2018
Accepted Date: 25 February 2018

Please cite this article as: M. Soltani, M.A. Maleki, A.H. Kaboodrangi, B. Mosadegh, Optimization of oxygen transport within a tissue engineered vascular graft model using embedded micro-channels inspired by vasa vasorum, *Chemical Engineering Science* (2018), doi: https://doi.org/10.1016/j.ces.2018.02.044

Optimization of oxygen transport within a tissue engineered vascular graft model using embedded micro-channels inspired by vasa vasorum

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Abstract

Tissue Engineered Vascular Graft (TEVG) is a promising treatment for cardiovascular diseases because of its potential for repair and long-term patency. However, the quality and preparation time to achieve a mature TEVG has limited its use in clinical settings. Both of these factors can be improved by effectively growing TEVGs with a uniform and high cell density, which is currently limited due to the diffusion limit of oxygen and nutrients. In this paper we propose a novel optimized microchannel geometry in TEVG wall model that facilitates uniform oxygen transport within a simulated TEVG with high cell density. In order to model the oxygen mass transport incompressible Navier-Stokes, convection, and diffusion equations were solved numerically. Furthermore, to model oxygen consumption in the graft domain, Michaelis-Menten kinetics were coupled with the oxygen diffusion equation. Finally, an optimized model was yielded such that nearly four times the cell density can be sustained by using the proposed microchannels design compared to a simulated TEVGs with a solid wall. In addition, to minimize the oxygen gradient along the graft, multiple segments are added to microchannels and their locations along