عنوان مقاله:

Numerical simulation of extracorporeal membrane oxygenators to investigate important parameters and membrane thickness in oxygen exchange rate

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خلاصه مقاله:

In this article, an extracorporeal membrane oxygenator (ECMO) is simulated in ۲D geometry using computational fluid dynamics (CFD). Momentum and mass transport equations were solved for the laminar flow regime (۳۰ < Re < ۱۳۰ for the blood channel) using the finite element method. In this study, the software COMSOL was used as the solver. To this end, the main problem of ECMO devices is the pressure drop and the risk of thrombus formation due to blood stagnation, so to solve this problem, the oxygen transfer rate to the blood should be increased. Therefore, in the present study, to optimize the oxygen transfer rate of the blood, three basic parameters were examined: blood flow velocity, oxygen velocity, and membrane thickness. Blood flow was considered at five different velocities (۰.۲, ۰.۴, ۰.۵, ۰.۶, and ۰.۸ mm/s). Results showed that increased blood flow velocity adversely affected oxygen permeability, increasing oxygen permeability from about ۶۰% at ۰.۲ mm/s to about ۲۴% at ۰.۹ mm/s. In addition, five different membrane thicknesses (۰.۰۴, ۰.۰۶, ۰.۰۸, ۰.۲, and ۰.۳ mm) were investigated, and, as expected, better oxygen exchange occurred as the membrane thickness decreased. We also found that the diffusion rate is about ۴۰% for the ۰.۴ mm/s thin films and about ۲۵% for the same inlet velocity and larger film thickness. Furthermore, the oxygen diffusivity increases from ۲۸% to ۳۸% as the oxygen gas velocity increases. However, oxygen velocities above ۰.۸ mm/s should not be used, as the range of oxygen diffusivity variation decreases with higher oxygen gas velocities.

کلمات کلیدی:

Microfluidic blood oxygenator (MBO), Extracorporeal membrane oxygenation (ECMO), Computational Fluid Dynamics (CFD), Porous media, polydimethylsiloxane (PDMS) membrane