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OXYGEN MASS TRANSFER IN OXYGEN/MEMBRANE/WATER FLOW SYSTEMS

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Summary: This work addresses the quantification of oxygen mass transfer in an oxygen/membrane/water flow experimental set up as a design tool of extracorporeal membrane blood oxygenators, in terms of fluid dynamics and membrane surface area arrangement.

The set up consists of an oxygen chamber at constant pressure and a slit for water circulation (2X×2B×Z where 2B≪Z,2X) as a surrogate of the blood chamber, separated by integral asymmetric poly(ester urethane urea) PEUU membrane. The bi-soft segment membranes designated by PEUU 100, PEUU 95, PEUU 90 and PEUU 85 have 0, 5, 10 and 15% of polycaprolactone respectively [1]. They display increasing degrees of hemocompatibility and decreasing oxygen permeation flow rates. The oxygen concentration, C(O2), was measured as a function of time, t, by a sensor at oxygen pressures of 22.5 and 45 cmHg and water flow rates of 2.0, 2.5 and 3.0 L/min. A global mass transfer coefficient, K(O2), was determined by K(O2)=(dC(O2))/dt)x(V/(A•C*(O2)), where V is the reservoir volume, A is the membrane permeation area, C*(O2) is the equilibrium oxygen concentration at the liquid/membrane interface and (dC(O2))/dt is the slope of the straight line of C(O2) vs t, for the short times range.

The resistances to oxygen transfer in the liquid stream and in the membrane were predicted respectively by convection/diffusion and solution/diffusion models. Neglecting the resistance in the oxygen chamber, a three resistances in series model was used to predict a global mass transfer coefficient. The good agreement of predictions with experimental values was observed mainly for PEUU 90 and PEUU 95 membranes, with approximate values of 4 to 4.5E m/s. The partial mass transfer of oxygen in the liquid phase was correlated to geometrical and flow parameters [2].

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References

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