Estimation of Extraction Pressure EP – 2 December 2020

The main determinants of EP are[1] area A supplied by the capillary, oxygen consumption M and permeability $\wp$ of that area, capillary radius r_c , blood hematocrit Hct , oxygen diffusion coefficient D and red blood cell velocity v_{RBC} . These can be combined in two groups, outside and inside the capillary, and the latter in a standard form, the so-called Peclet number:

(1) $$Pe = \frac{\Delta z\; v_{RBC}}{2\,D}$$

where Δz is the distance between the erythrocytes, directly related to the hematocrit which is defined as the volume fraction of erythrocytes in the capillary:

(2) $$V_{RBC} = Hct(V_{RBC} + \pi r_c^2 \Delta z)$$

where V_{RBC} is the volume of a single erythrocyte – the corresponding plasma volume is $\pi r_c^2 \Delta z$.

In terms of this Peclet number, a first estimate of EP is:

(3) $$EP = \frac{M\,A}{8\pi\wp}\left\{ 1 + \left(\frac{1}{Hct} - 1\right)\frac{c_1}{(c_2 + Pe^2)(c_3 + Hct)} \right\}$$

where $c_1 = 85$, $c_2 = 130$ and $c_3 = 0.1$ for rat heart.

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[1] Bos C: Mathematical Modeling of Oxygen Transport from Capillaries to Tissue. Dissertation Thesis, University
 of Nijmegen.