PHARMACEUTICAL

Blood Viscosity Analysis

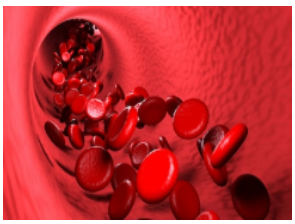
- dependence on temperature and hematocrit -

KEY BENEFITS

- FAST TEMPERATURE SCREENING
- LOW VOLUME
- QUICK & SIMPLE

Introduction

Characterization of blood viscosity in physiologically relevant conditions is fundamental to understand hemodynamics. Proper tissue perfusion occurs when blood viscosity falls within certain levels. Many parameters can influence whole blood viscosity but most notably its value is due to properties of its constituents (plasma and cells) and external paramaters like temperature. As blood flows within a wide range of vessel nature/shapes, wide shear range analysis is necessary to be representative of these conditions.



In this application note blood is tested over a wide shear range typical of circulatory system conditions. Temperature and hematocrit effect are also studied. As Fluidicam^{RHEO} uses confined microfluidic technology, blood analysis is safely conducted with no air contact and using low sample volume.

References:

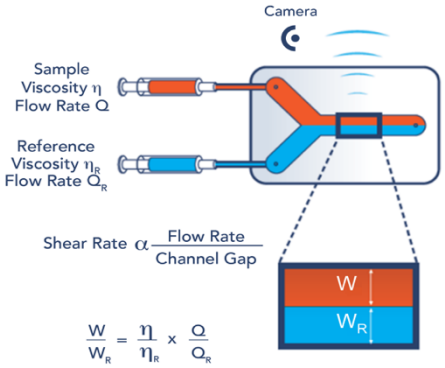
1- *Galdi, Giovanni P., Rolf Rannacher, Anne M. Robertson, and Stefan Turek. Hemodynamical Flows: Modeling, Analysis and Simulation. Oberwolfach Seminars, v. 37. Basel : [London: Birkhäuser ; Springer, distributor], 2008.*

2- *Rand, Peter W., Eleanor Lacombe, Hamilton E. Hunt, and William H. Austin. 'Viscosity of Normal Human Blood under Normothermic and Hypothermic Conditions'. Journal of Applied Physiology 19, no. 1 (January 1964): 117–22.*

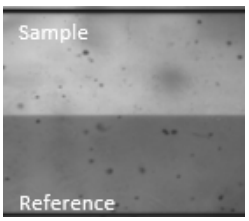
3- *Snyder, Gk. 'Influence of Temperature and Hematocrit on Blood Viscosity'. American Journal of Physiology-Legacy Content 220, no. 6 (June 1971): 1667–72.*

Reminder of the technique

Fluidicam^{RHEO} uses a co-flow microfluidic principle to measure viscosity. The sample and a reference solution are simultaneously introduced into the microfluidic channel (typically 2.2mm X 150µm) with controlled flow rates. This results in a laminar flow where the interface position between sample and reference relates the viscosity ratio and flow rates.



Images acquired during the measurement allow the software to calculate the position of the interface and directly plot an interactive flow curve.



Method

Whole defibrinated sheep blood with hematocrit (Ht=38%) and its four dilutions with Ht =34%, 25%, 18% and 8% have been used for this study. Hematocrit concentrations were obtained by diluting blood sample in sheep serum.

Using Fluidicam^{RHEO} microfluidic rheometer, samples were analyzed at four temperatures: 39°C (sheep corporal temperature)[1], 35°C, 30°C and 25°C. 150µm deep microfluidic chip allowed to measure viscosity at shear rate range from 300 to 10 000 s^{-1}.An aqueous reference solution (Formulaction, 5 mPa.s at 25°C) was used for these tests.

Typical shear rates can be expressed knowing blood flow velocity and vessel inner diameter. Table 1 below gives the estimated results for human vessel conditions [2] :

Vessel type	Mean wall shear rates [s^{-1}]
Veins	150 – 240
Femoral artery	300
Cappilaries	400 – 1600
Arteriols	8000

Table 1: Shear rates in blood vessels.