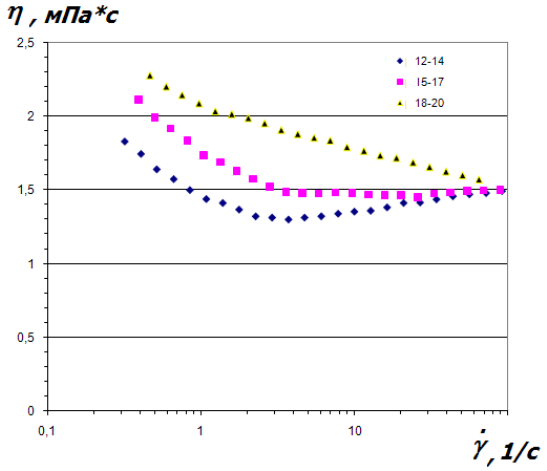
BLOOD PLASMA VISCOSITY WITH APPARENT WALL SLIP UNDER COUETTE FLOW

V.A. Mansurov, A.M. Kapitonov

The Belorussian State Medical University, Medical & Biology Physics Sub-faculty, Minsk, Belarus

mansurov@tut.by

Plasma viscosity is an important factor for the pressure-flow relationship in small blood vessels and especially in capillaries. Also changes in the concentration of one or more plasma protein fractions will result in a change in plasma viscosity. Plasma viscosity can therefore be used both as a diagnostic tool for the presence of diseases known to alter the proteins, and as a measure of the extent of the condition. For this reason, accurate measurements of rheological properties of blood plasma are very important [1]. The observational accuracy depends on several measuring factors. In particular, the wall slip contributes significantly measuring errors.
The main aim of this work is evaluation of wall slip velocity for the blood plasma taken form 20 healthy volunteers under Couette flow.



The apparent viscosity of blood plasma for three working units

We have measured the non-linear rheology of whole blood plasma for smooth shearing surfaces. The rheometer is a shear rate controlled apparatus with coaxial cylinder geometries. The dimensions measuring units were 12/14 mm, 15/17 mm, 18/20 mm (r/R - first number is internal diameters, second – external, gap – 1mm), the height was 18 mm . The shear rate range was 0.2 – 60 1/s. The working unit temperature was 25 ± 0.25 °C.

According to Mooney's hypothesis [2 - 4] the angular velocity Ω of turned part of working unit is $\Omega = \Omega_s + \Omega_f = \bar{u}_s(R) + \int_{\tau_1}^{\tau_2} \dot{\gamma}(2\tau)\, d\tau$, here, Ω_f - the angular velocity of fluid, Ω_s - the angular velocity of wall layer and $\Omega_s = \omega' \cdot \tau^m$, where ω' and m are empirical constants, $\bar{u}_s(\dot{\gamma}) = \omega' \cdot \tau^m (R + r)2$ - mean wall slip velocity. The mean wall slip velocity was calculated with Krieger's method [5].
Results: it was obtained that ω' = 0,48 ± 0,04 и m = 0,87 ± 0,03 (p < 0,05). The mean wall slip velocity for shear stress $\tau = 5$ mPa amounts about 0,04 mm/sec, at $\Omega_f \cdot R$ = 3,5 mm/sec.

Conclusion: it is shown, that the apparent wall slip into a rotation viscometric unit contributes significantly to measuring errors. A normal index of the angular slip velocity that is inherent in healthy donors has been established. A wall layer thickness generated by plasma dispersed phase has been estimated.

References

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