

Appendix : Computation of the viscosity

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This article describes how to calculate the viscosity without using the method presented in the article [1]. The results can be analyzed to obtain graphs to analyze the dependence of viscosity on composition and temperature.

Computation of the viscosity

Using the model proposed in the source [1] the viscosity will be computed. Using the weight concentration of glycerol C_m that is computed as follow :

$$C_m = \frac{\rho_g V_g}{\rho_g V_g + \rho_w V_w} \quad (1)$$

using $\rho_w = 1000(1 - (\frac{|T-4|}{622})^{1.7})$ and $\rho_g = 1277 - 0.654T$ and where V and the temperature T , the viscosity of the water and the glycerol can be computed :

$$\mu_w = 1.79e^{\frac{(-1230-T)T}{36100+360T}} \quad (2)$$

Then glycerol :

$$\mu_g = 12100e^{\frac{(-1230-T)T}{9900+70T}}; \quad (3)$$

Then the coefficient α is computed, using coefficients $a = 0.705 - 0.0017T$ and $b = (4.9 + 0.036T)a^{2.5}$:

$$\alpha = 1 - C_m + \frac{abC_m(1 - C_m)}{aC_m + b(1 - C_m)} \quad (4)$$

Using the coefficient α and the viscosity above, the dynamic viscosity can be computed :

$$\mu = \mu_w^\alpha \mu_g^{1-\alpha} \quad (5)$$

Then, as the viscosity of interest is the kinematic one, it is needed to compute the density of the mixture:

$$\rho = \rho_g C_m + \rho_w (1 - C_m); \quad (6)$$

To finally obtain the desired kinematic viscosity :

$$\eta = \frac{\mu}{\rho} \quad (7)$$

As an example, a concentration of 82.8% and a temperature of 23.7 C. Using those equations with the parameters above, the following graphes can be obtained.

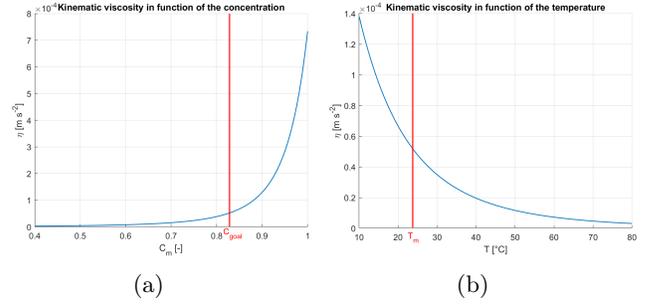


Figure 1: (a) Kinematic Viscosity in function of the weight concentration $C_m = \frac{M_g}{M_w + M_g}$ at $T = 23.7$ C; (b) Kinematic Viscosity in function of the measured Temperature T_m at $C_m = 0.828$

Those graphs can then be used to do a quantitative analyse on how the errors in the composition and in the measurement of the temperature can influence the measured viscosity. For the example case, it can be seen that an error in the temperature will lead to a more important difference in the viscosity than an imprecision in the composition.

[1] C. Nian-Sheng, *Formula for the Viscosity of a Glycerol-Water Mixture* (Zhejiang University, 2008)