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WEAK TRANSVERSE MAGNETIC FIELD EFFECT ON THE VISCOSITY OF $Ni(NO_3)_2$–H_2O SOLUTION

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ABSTRACT

Experiments performed at 25°C show that transversally applied magnetic field *H* of strength of 12 kG; at high concentrations decreases the viscosity of $Ni(NO_3)_2$–H_2O solution. At low concentrations, however, the applied magnetic field increases the viscosity of $Ni(NO_3)_2$–H_2O solution in such a way as the observed effect value approaches the already measured viscosity increase of the pure water at the same magnetic field and temperature conditions.

INTRODUCTION

This work describes the applied transverse magnetic field effect on the viscosity of $Ni(NO_3)_2$–H_2O solution at 25°C temperature (Table 1, Fig. 1). It was found that the applied magnetic field *H* of strength of 12 kG at high salt concentrations decreases the viscosity of $Ni(NO_3)_2 \cdot 6H_2O$–H_2O solution while at low salt concentrations the applied magnetic field increases the viscosity of this solution in such a way that in limit this increase approaches the already observed magnetic field effect on the viscosity of pure water[1, 2]. This therefore strongly supports the recent findings by Lielmezs et al.[1] and Lielmezs and Aleman[2] that an externally applied magnetic field weakly increases the viscosity of pure distilled water and that of the KCl–H_2O solution.

EXPERIMENTAL

The recent papers by Lielmezs et al.[1] and Lielmezs and Aleman[2] describe in detail the apparatus and methods used for the measurement and evaluation of the transverse applied magnetic field effect on the viscosity of pure distilled water. As previously described[1, 2] the measuring apparatus consists of two parts: the electromagnet system and the viscometer–temperature bath assembly. The same Cannon-Fenske opaque (calibrated; reverse flow, No. 50, V561) viscometer was retained for use in this work; and the same viscometer cleaning and measurement procedures as well as calculation methods were used in this work. As a consequence of this, the

TABLE I

SUMMARY OF RESULTS

Conc. *(mol* l^{-1}*)*	*Arithmetic mean fractional viscosity* $\nu^* = [(\nu^H - \nu^\circ)/\nu^\circ] \times 100$	*Statistical analysis*[a]	
		Standard deviation σ_H[b]	*Null hypothesis with* $\mu_H = \mu_0;\ \sigma_H \neq \sigma_0$
0.1000	+0.1177	2.7749×10^{-4}	Rejected at 99% confidence level
0.2000	+0.0139	3.2863×10^{-4}	Not rejected
0.3439	−0.1214	4.1674×10^{-4}	Rejected at 99% confidence level
0.5000	−0.2473	11.9374×10^{-4}	Rejected at 99% confidence level
1.0000	−0.5833	7.8167×10^{-4}	Rejected at 99% confidence level
1.5000	−0.8995	5.5740×10^{-4}	Rejected at 99% confidence level
3.0000	−1.6051	4.0866×10^{-4}	Rejected at 99% confidence level

[a] For detailed discussion regarding the use of statistical analysis methods please refer to any standard textbook.

[b] Standard deviation, σ_x, is defined as:

$$\sigma_x = \sqrt{\frac{\sum_{i}^{n} (X_i - \bar{X})^2}{n - 1}}$$

overall accuracy of this work is at the same accuracy level as found and in detail discussed in our previous work[1, 2].

RESULTS AND DISCUSSION

Following the calculation method of our previous work[1, 2]; the viscosity of $Ni(NO_3)_2 \cdot 6H_2O$–H_2O solution for both, the applied and the no applied (ambient earth magnetic field) magnetic field condition, was calculated from the simplified expression:

$$\nu = Ct \tag{1}$$

where ν = viscosity in stokes; C = constant (determined by calibration); t = efflux time in seconds.

The results of this study are given in Table I and Fig. 1. Table I presents for all concentrations of $Ni(NO_3)_2 \cdot 6H_2O$–H_2O solution, at 25°C temperature and the magnetic field strength H = 12 kG, the fractional viscosity coefficient, defined as

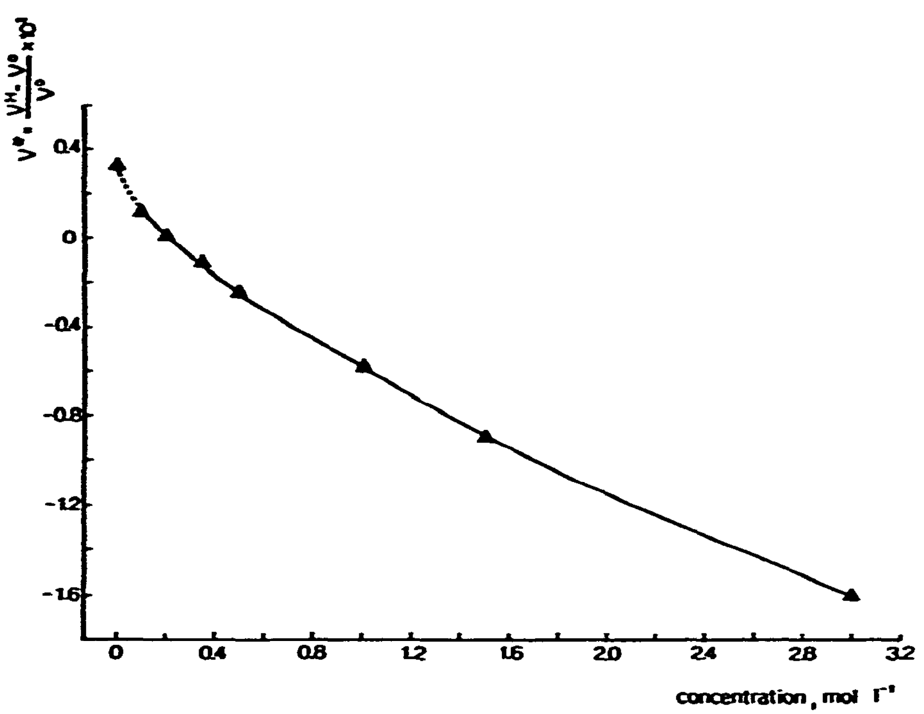

Fig. 1. Relation between the fractional mean average viscosity $\nu^* = [(\nu^H - \nu^\circ)/\nu^\circ] \times 100$ and the concentration of Ni $(NO_3)_2 \cdot 6H_2O$ in water. Dashed line (-----) indicates the extrapolation to the experimentally observed magnetic field effect of the pure water viscosity (refs. 1, 2).

$\nu^* = [(\nu^H - \nu^\circ)/\nu^\circ] \times 100$. The ν° however is the arithmetic mean average viscosity at the ambient earth magnetic field (or no-field condition) while ν^H is the corresponding viscosity value at the given applied magnetic field strength H.

Table 1 also presents statistical analysis data; standard deviation, σ_H, calculated at the applied magnetic field strength H; and the t-distribution null-hypothesis results assuming that the means are equal ($\mu_H = \mu_0$) while the variances for the applied field and no-field conditions are not equal, i.e. $\sigma_H \neq \sigma_0$.

The obtained results (Table 1, Fig. 1) show slightly above the concentration of 0.2 mol l^{-1} of $Ni(NO_3)_2 \cdot 6H_2O)$-H_2O solution, the viscosity of this solution at constant magnetic field (H = 12 kG) and fixed temperature (T = 25°C) decreases as the salt concentration of this solution is being increased. At salt concentrations of 0.2 mol l^{-1} and less, the solution viscosity under the influence of an applied magnetic field (H = 12 kG) however tends to increase in such a way as to at infinite dilution finally approach the already observed magnetic field effect on the viscosity of pure distilled water at the same magnetic field and temperature conditions[1]. This limiting behaviour of the very dilute $Ni(NO_3)_2 \cdot 6H_2O$-H_2O solution viscosity under the influence of an applied magnetic field supports strongly our previously reported finding that an applied external magnetic field increases the viscosity of pure water[1].

On the other hand, Table 1 and Fig. 1 reveal that at the vicinity of 0.2 mol l^{-1} concentration of $Ni(NO_3)_2 \cdot 6H_2O$ in water; the external magnetic field does not affect the viscosity of solution at all. That is, we have reached for the given applied magnetic field strength and temperature a limiting or critical concentration at which the solution viscosity apparently becomes independent of the magnetic state.

The exact mechanism for the observed viscosity changes in the applied magnetic field cannot be understood with any certainty at this time. However, it might be of interest to study the reported magnetic field effect on the solution viscosity in view of the microstructural behaviour of transitional metal ion complex formation in water recalling that any changes observed in shear viscosity are essentially determined by the rates of the involved molecular reorientational and translational motions[1, 2]. Then, of course, the possible connection between the observed water viscosity anomalies and the experimentally caused solution interfacial effects[1, 2] would become of secondary importance.

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