



Activation energy in particle suspensions

F.J. Rubio-Hernández¹, S. Murillo-González¹,
A.I. Gómez-Merino¹, N.M. Páez-Flor²

¹Departamento de Física Aplicada II, Universidad de Málaga, Málaga (Spain)

²DECEM, Universidad de las Fuerzas Armadas, Sangolquí (Ecuador)

Assuming that the molar activation energy in a fluid is interpreted as a measure of the potential energy barrier required for the molecular movement [1], the viscosity of a fluid depends on the actual size of the molecules, and the presence of solid particles in a suspension increases the dissipation of energy when the system flows, therefore it is expected that the viscosity of the suspension is higher than that of the pure solvent at a given temperature. The dependence of the viscosity of some silica/glycol suspensions with the temperature can be fitted using an empirical function analogous to the Arrhenius equation, $\ln \eta = \frac{E}{RT} - \ln C$, where η is the viscosity, C is a system-dependent constant, E is the molar activation energy for the viscous flow, T is the absolute temperature and R is the gas universal constant. When the temperature of the suspension decreases two effects are observed. First, larger aggregates of particles are formed due to the reduction of the thermal agitation and, second, the number of links among the molecules of the liquid phase increases. These two effects give place to a higher increase in the viscosity with the temperature compared to the pure solvent. Assuming that a higher viscosity value is due to a smaller free volume available for the molecular movement, and taking into account that the free suspension volume is limited only to the liquid fraction [2], it should be expected that the viscosity of the suspension is less sensitive to temperature than that of the pure solvent.

In this work the dependence on the temperature of the viscosity values of the silica/glycol suspensions is compared to that of the liquid media. The results have shown a lower activation energy when the solid volume fraction increases, which has been explained with a scheme that assumes that the particle links are less sensitive to thermal energy absorption than the joining bonds among the solvent molecules. Our conclusion is that, for a given mechanical energy applied to the system, the thermal energy absorbed by the system is mainly used in the rupture of bonds between the solvent molecules. This study can be useful to understand the mechanisms that govern the differences in the activation energy values found between samples of foods, in which many factors are connected with sample composition [3].

- [1] Briscoe B, Luckham P, Zhu S. *Rheological properties of poly (ethylene oxide) aqueous solutions*. J Appl Polym Sci **70** (1998) 419-429.
- [2] Shenoy AV. *Rheology of filled polymer systems*. Kluwer Acad Pub, 1999, The Netherlands.
- [3] Alvarez MD, Canet W. *Time-independent and time-dependent rheological characterization of vegetable-based infant purees*. J Food Eng **114** (2013) 449-464.