# Workshop « Soft Material Models »

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## Rheological characterization of aqueous polymer solution: PVA

H. ZOUBEIR[1*], N. LAHLOU[1], M. LAMINE[1], M. TOUHAMI OUAZZANI[1], S. ANISS[1]

[1] mechanical laboratory, Physics department, Faculty of Sciences, Hassan II University, B.P 5366, Casablanca, Morocco

[*]hind.zoubeir@capgemini.com

## Abstract

The aim of this work is to study the effect of polyvinyl alcohol concentration on the rheological behavior of the aqueous solution. This enables us to determine the behavioral law when the most appropriate operating mode is chosen, and the most aqueous solution is reached. This work has enabled us to characterize the viscoelastic properties of these solutions with different polymer concentrations, and to identify the critical frequencies for which the behavior is modified.

## Methodology

The operating procedures used are the quasi-stationary mode and the oscillatory mode. The first one, consists in fixing the velocity and plotting the rheogram $\boldsymbol{\tau}$ as a function of the deformation rate, $\dot{\gamma}$, ranging from 0 to 100 $s^{-1}$. For the second mode, the sinusoidal signal is imposed on the rheometer, and the stress $\tau$ from 0 to 1Pa is given to obtain the deformations. Such mode is characterized by the complex shear module, $G^*$, which allows the access to the modulus of storage G' and loss modulus G" and the complex complacency J =1/G*,

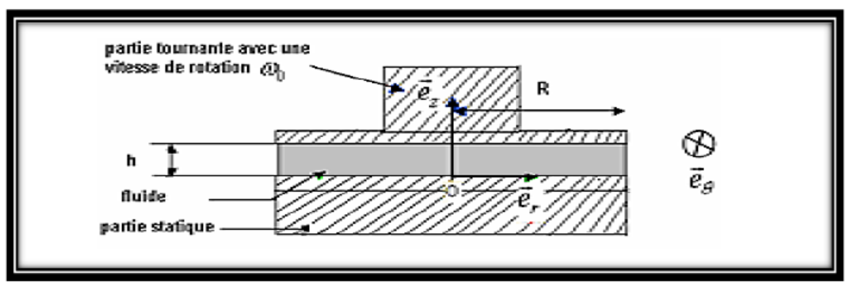



Figure (1): Plan plan geometry

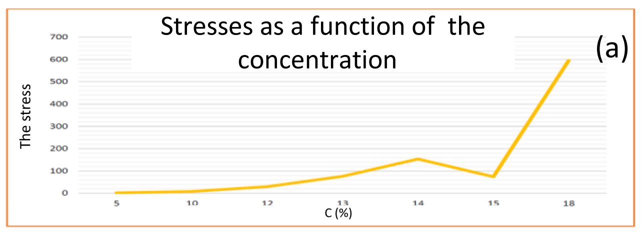
## Context

Polymers play a very important role in the industry in general, such as the aeronautical automotive and other industries, That's why we chose PVA, a polymer widely used throughout the world [1].

The characteristics of this material, such as its **density**, **glass transition temperature** and above all its **solubility and melting temperature**, make it very useful [2]. In terms of applications:

- Paper coating for ships.
- Packaging of dissolving compressed detergents.
- Lubricants in drops for eyes and rigid contact lenses.
- Reinforcing fibers in concrete [3].

## Results



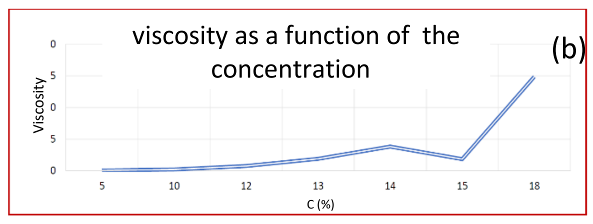
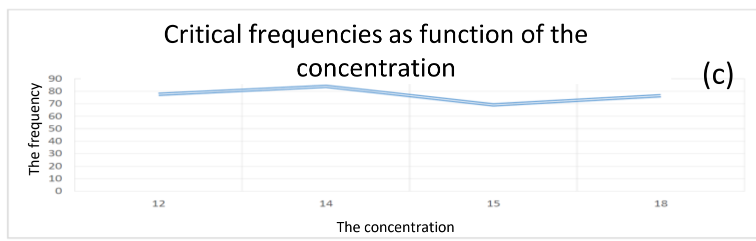




Figure 2: Effect of the concentration on: (a) Stress, (b) Viscosity, (c) critical frequency




Figures **2 (a)-(c) :** First figures **(a), (b)** show that the variation of the stress and viscosity increases when the concentration increases. At concentration equal to 15% the aqueous solution changes its behaviour**.** Figure (c) corresponds to the concentrations : 5%, 10%, 12%, 14%,15% and 18% and the Frequency range is 70Hz and 80Hz.

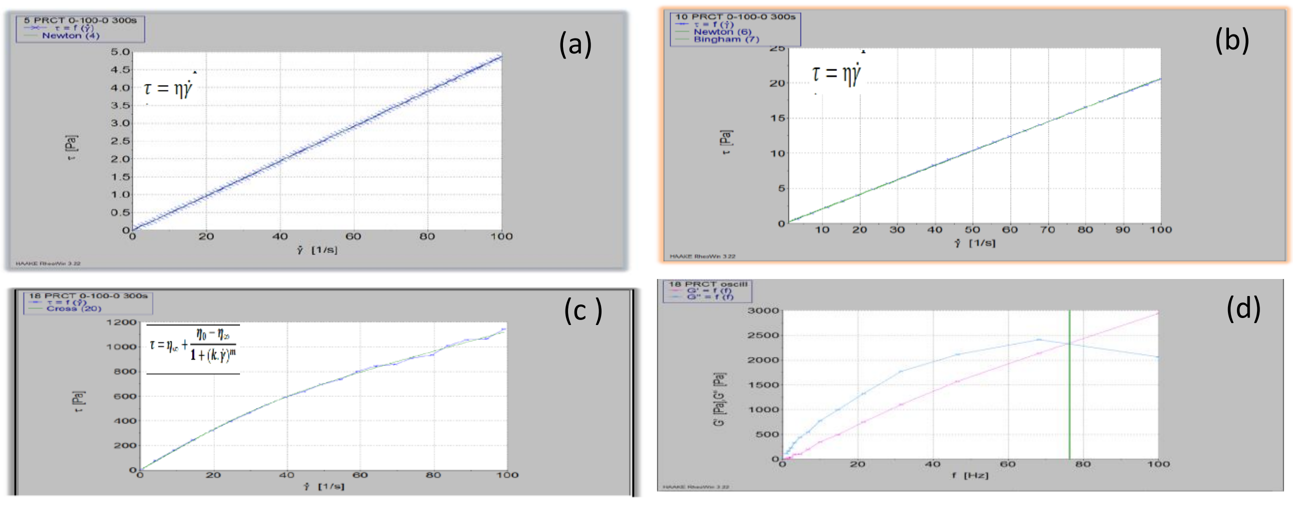



Figure 3: Stress versus the rate deformation for concentrations: (a) 5%, (b) 10%, (c ) 18%
(d): G' and G'' versus the frequency.

From figures 3 (a)-(c), one can see that for the concentration equals to 5% and 10%, we have a Newtonien behaviour, whereas for 18% a Cross behaviour is observed.
Figure 3(d) shows that the intersection of G' and G'' provides a viscoelastic behaviour at 76.34 Hz,

## Conclusion

At the end of this work, we were able to determine the behavior of polyvinyl alcohol at different concentrations. We have provided some of the viscoelastic properties that characterize this polymer and have been able to show that at a frequency of 15%, there is a change in behavior, and that above 18%, polyvinyl alcohol becomes a glue, resulting in viscoelastic behavior.

## References

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