

Kanamaru measured the fluidities and yield-points of polyvinylbutyral which was plasticized with dibutyl phthalate. When $\ln \eta$ are plotted against $\ln f$, however, they form a line which has a different slope from ours. The reason for this difference may be due to the different ranges of viscosity for the two cases, that is, for the rubber 10^6 - 10^{11} poises and for the latter 10^{10} - 10^{13} poises. We are going to investigate the relation by either elevating or lowering the viscosity by the addition of fillers and plasticizers respectively.

24. Theoretical Considerations on the Elasticity of Plasticized Polyvinyl Chloride (PVC).

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The author regards the elasticity G of plasticized PVC as the visco-elasticity. Kuhn gives a formula for the viscoelasticity of polymer, which consists of k units as follows,

$$G = G_1 e^{-t/\lambda_1} + G_2 e^{-t/\lambda_2} + \dots + G_k e^{-t/\lambda_k}$$

where $G_1, \dots, G_k, \lambda_1, \dots, \lambda_k$ are elasticities and relaxation times of units respectively and t is time of observation. The author proposes thereof a simplified average formula as follows.

$$G = G_L e^{-t/\bar{\lambda}}$$

$\bar{\lambda}$ is an average relaxation time and is indicated as follows.

$$\bar{\lambda} = \bar{A} e^{\bar{E}/RT}$$

where \bar{E} and \bar{A} are the average value of activation energy and entropy of segments respectively. From this formula, the following empirical formula after Dienes will be derived.

$$\frac{\ln G_L - \ln G_H}{\ln G - \ln G_H} = \left(\frac{R}{E} \right)^n T^n = BT^n$$

where G_L and G_H are the elasticity at the temperature low and high respectively, while B and n are both constants.

Plasticizer added to the polymer lowers the viscosity and the elasticity of the system. Plasticizer of smaller λ shows the higher softening effect and gives greater temperature coefficient of elasticity.

According to the author's theory the plasticizer of smaller E/λ and also smaller λ shows the superior plasticity.

Thus, from the conclusion in consideration of the weight average of λ between plasticizer (1) and polymer (2), was obtained the following equation which indicates that $\log G$ decreases linearly in accordance with plasticizer content W_1 .

$$\ln G \approx \ln G_L [\ln \lambda_2 - W_1 (\ln \lambda_2 - \ln \lambda_1)] + C$$

Finally, provided that the equation, $\ln \lambda = A \ln M + B$, is given, where M is molecular weight of polymer and A, B are constants, the following linear relation between $\ln G$ and M is obtained.

$$\ln G \approx \ln G_L [A \ln M - \ln t] + C$$