RHEOMETERS IN SCANNING MODE FOR THE CURE OF RUBBERS

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Rheometers, especially the moving die rheometer (MDR), are widely used under isothermal conditions for determining the parameters of the cure of rubbers with the following drawbacks. At least three experiments are necessary at different temperatures selected within a rather narrow temperature window for obtaining the temperature dependency of the rate of cure. Moreover, it takes some time for the sample to attain the selected temperature, and for a high temperature of the dies, the reaction takes place before thermal equilibrium has reached [1]. With this new way of using the rheometers proposed in this paper, the dies with the rubber samples in them are heated from the room temperature up to the selected final temperature with a constant rate [2]. Calculations have been done for evaluating the performances of this method. The kinetic parameters such as the activation energy and the pre-exponential factor, as well the order of the overall reaction, are obtained from only on experiment. The temperature in the sample is uniform and nearly the same as that of the heating dies. The profiles of temperature and of the sate of cure developed through the sample thickness are rather flat during all the process. The parameters of interest, with the value of the heating rate, should be between 2 and 10°C/min. In order to reduce the time of experiment, the rate of the linear temperature programming can be changed, with a high value at the beginning up to the reaction starts followed with a lower value. Finally, other better ways of heating can be used, the one being with the square-root of time-temperature programming[3]. The theoretical study is made either by a mathematical treatment or by a numerical method using the heat transfer by conduction and the heat evolved from the cure reaction. These methods are convenient especially when the enthalpy of cure is not so high, lower than 20-30 kJ/k.

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3- I.D.Rosca and J.M.Vergnaud, Polymer, 44, 4067-4074, 2003