Environmental Stress Relaxation Studies of Polymers: Effect of Temperature on Polyethylene-Benzene System

Synopsis

The method of stress relaxation has been used to study the effect of temperature on the stress decay behavior in the system of polyethylene–benzene. The behavior of stress decay in the polyethylene under benzene at various temperatures was observed and the activation energy of polyethylene–benzene system was obtained.

INTRODUCTION

Stress failure of polymers such as polyethylene under solvent such as benzene series hydrocarbons poses a problem of considerable interest.[1] It was, therefore, decided to investigate the effect of temperature on the stress decay behavior in the polymer under solvent.

Stress failure of polyethylene caused by benzene was selected as stress failure of polymer under solvent, since it was described in a previous paper.[1] The determination can be followed by measuring the stress decay of the polymer as a function of temperature.

EXPERIMENTAL

Materials

Polyethylene and benzene used in this work were the same as those described in a previous paper.[1]

Apparatus and Procedure

The apparatus used in this work was the same as those described in a previous paper.[1]

Polyethylene films were set in the clamps in the inner vessel containing benzene as solvent at various temperatures, preheated in the unstrained state for 15 min, then extended. The determination was followed by measuring with a balance the residual stress as a function of time in these film samples held at constant extension in a thermostated vessel containing benzene as solvent at various temperatures.

RESULTS AND DISCUSSION

The changes, with time, in stress of polyethylene films under benzene at various temperatures were studied with a 50% elongation.

Figure 1 shows the relationship of the logarithm of stress versus linear time and its dependence on temperature. From this result it is clear that the increase in the slope of log stress plotted against time with increasing temperature indicates an accelerating effect of stress decay. When the relaxation time of stress decay shown in Figure 1 are considered as the reciprocal of a rate constant for solvent cracking and the rate constants are plotted against the temperature, the relationship shown in Figure 2 is obtained

From this relationship an activation energy for solvent cracking was obtained; E = 24 kcal/mole.

From these it is clear that the effect of temperature on the stress decay is apparently related to its acceleration of the solvation reaction of polymer.

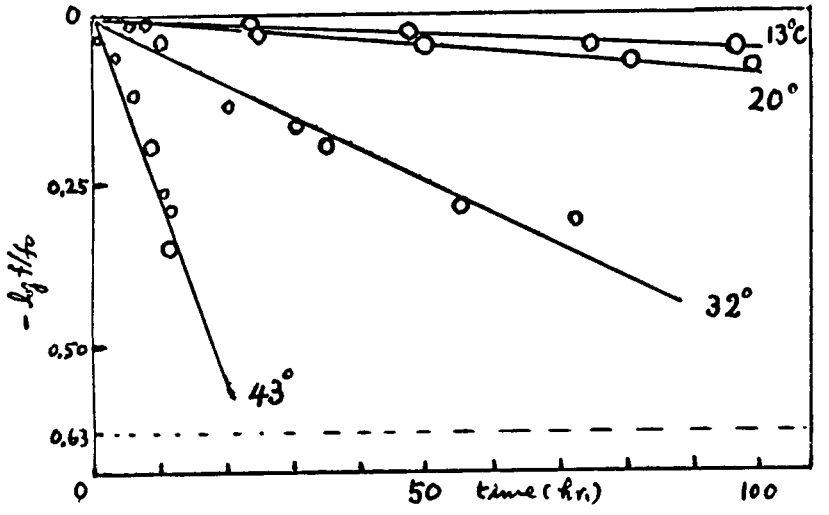

Fig. 1. Stress relaxation of polyethylene–benzene system.

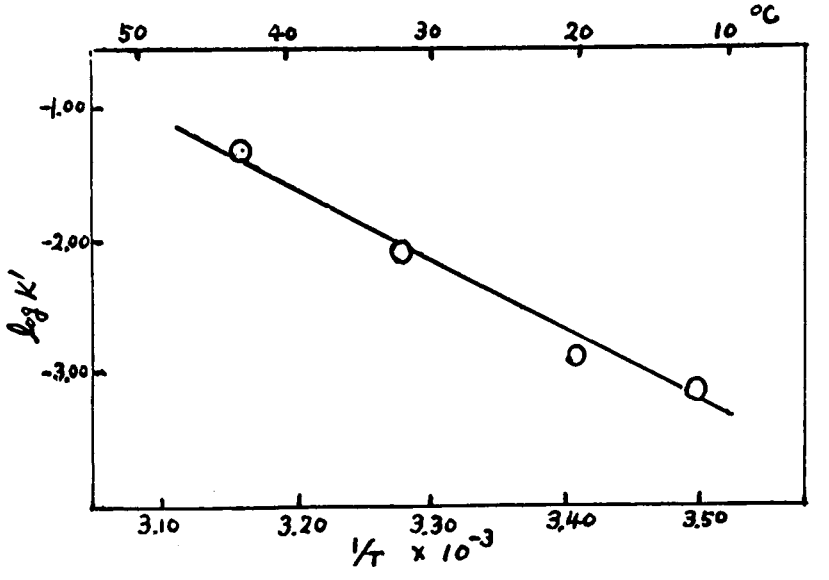

Fig. 2. Temperature dependence of rate constant.

Reference

1. M. Nisizawa, *J. Appl. Polym. Sci.*, **13,** No. 8 (1969).

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