

A STUDY OF THE EFFICIENCY OF PLASTICIZERS IN POLYVINYLCHLORIDE BY THE NUCLEAR MAGNETIC RESONANCE METHOD*

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(Received 24 February, 1964)

IT IS well known that the efficiency of plasticizers in polymers can be assessed by various methods, for example by the reduction in glass temperature, T_g , [1, 2], the change in physicomechanical characteristics [3] etc. On the example of phthalates and sebacates as plasticizers for polyvinylchloride (PVC) it has been shown that the efficiency of the plasticizers is dependent on their chemical structure [2, 4].

It seemed of interest to examine the possibility of determining the efficiency of plasticizers for this previously studied polymer, PVC, by the nuclear magnetic resonance (NMR) method, by measuring the spin-spin (T_2) and spin-lattice (T_1) relaxation times. This is the subject of the present communication.

EXPERIMENTAL

The test specimens were in the form of films, 0.25–0.30 mm thick, made by milling on rollers. The plasticizers examined were: a) phthalate esters—dimethyl phthalate (DMP), diethyl phthalate (DEP), dibutyl phthalate (DBP), dioctyl phthalate (DOP) and dinonyl phthalate (DNP); b) sebacate esters—dibutyl sebacate (DBS) and dioctyl sebacate (DOS); c) tricresyl phosphate (TCP). The plasticizer content of the specimens varied between 9 and 43% by weight. Most of the measurements were made on specimens containing 39% of plasticizer. The specimens were stabilized by the addition of small quantities of calcium stearate.

The relaxation times T_2 and T_1 were measured on hydrogen nuclei at a frequency of 16.6 Mc/s by the impulse NMR (spin echo) method in a production-line NMR relaxometer manufactured by the Kazan Mathematical Machine Plant. For measurement of T_2 times of the order of 10^{-5} – 10^{-2} sec the method of Hahn [2] was used with successive impulses at 90 and 180°. The length of the 90° impulse was 8 msec. The inhomogeneity of the magnetic field of the apparatus is such that self diffusion does not affect the measurement of T_2 up to 20 msec. For measurement of larger values of T_2 the method of Carr and Purcell [6] was used. Spin-spin relaxation times shorter than 10 msec were determined from the width of the NMR line recorded as the derivative of the absorption curve from an ordinary NMR spectrometer operating at 17 Mc/s, by means of the formula $T_2 \approx (2/\sqrt{3})(1/\gamma \cdot \delta H)$ where

* Vysokomol. soyed. **6**: No. 12, 2185–2188, 1964.