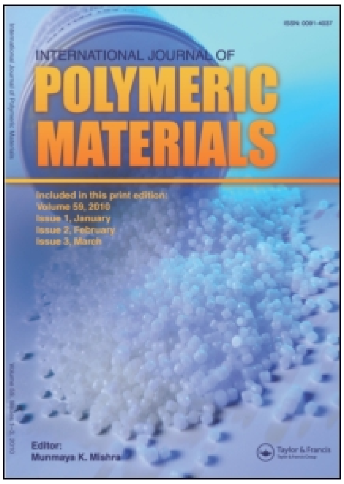

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Method for Studying the Effects of Electric Current on Parameters of Thermooxidizing Degradation of Electroconductive Polymeric Materials

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For the first time a method is proposed for studying the kinetics of oxygen absorption by a polymer matrix of electroconductive polymer composition (EPC) under the action of electric current. Maximum oxygen absorption rates, the inductive period and effective activation energy for the polymer matrix under electric current are determined.

KEY WORDS Electroconductive polymers, thermooxidation.

Most prospective spheres for the practical application of polymer materials are those concerning molecular electronics and electric techniques. In an overwhelming majority, polymers are subjected to the influence of electric fields or electric current. There exists a large number of facts showing the effects of an electric field on chemical processes in a polymer.[1,2] To study these phenomena a convenient tool is the electroconductive polymer composition (EPC) where chemical processes in a polymer matrix occur in direct contact with electroconductive chain microstructures.[3] To predict the efficiency of such polymer products and to find the optimum polymer composition, it is necessary to study the polymer oxidizing processes under the influence of electric current.

Thermoelectrooxidizing destruction (TEOD) is the destruction of a polymer under the simultaneous influence of three aging factors: heat, oxygen and electric current. Thermooxidizing destruction (TOD) is well studied for isotactic polypropylene (IPP).[4–6] In view of this fact it is expedient to study the electric current effects on this process for IPP.

To study the effect of electric current on the TOD process a special cuvette is designed, produced and tested (Figure 1). It consists of a glass vessel (1), a ground-in stopper (2), with two soldered tungsten electrodes (3). The electrode ends are threaded to screw in a specimen (4) by clamps (5). The cuvette is oriented horizontally and samples of 3.5–5 * 10** −5 m thickness and of 0.03 × 0.015 sq. m size are placed on perforated quartz glass (6) of the same size as the sample (0.03

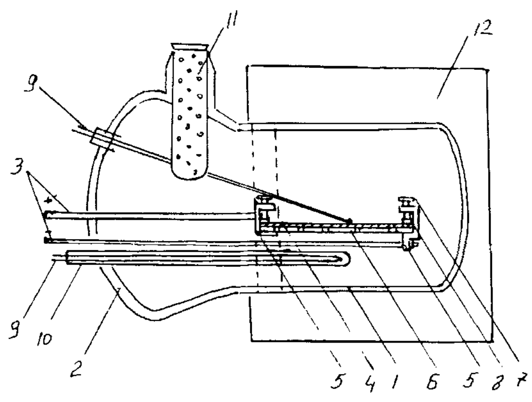

FIGURE 1 The cuvette used to study thermoelectrooxidizing destruction. (1) cuvette glass vessel; (2) stopper; (3) electrodes; (4) sample under investigation; (5) screw-clamps; (6) perforated quartz glass; (7) tightening screws; (8) superposed electrodes; (9) Chr-Alu thermocouple; (10) glass pocket; (11) vessels with KOH; (12) thermostate.

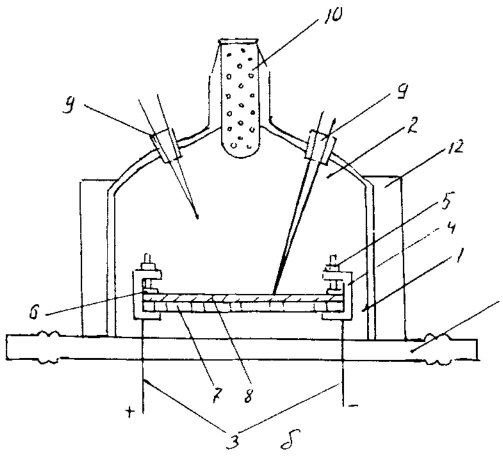

FIGURE 2 The cuvette used to study thermoelectrooxidizing destruction at constant temperature. (1) cuvette glass vessel; (2) stopper; (3) electrodes; (4) screw-clamps; (5) tightening screws; (6) superposed electrodes; (7) perforated quartz glass; (8) sample; (9) inputs with thermocouples; (10) perforated vessel for KOH; (11) double bottom for cooling agent to pass; (12) thermostate.

× 0.015) sq. m. Each sample is fixed to screw-clamps with screws (7). To ensure better electric contact, copper or brass superposed electrodes (8) of 0.015 × 0.015 × 0.01 cub. m size are clasped to sample ends. The ground-in stopper also has a grounded outlet (14) for connection to the static vacuum (10) where Chromel-Alumel thermocouple (9) ends are soldered in for measuring the cuvette temperature. The thermocouple ends are insulated with ceramics in cuvette inner space and with polychlorovinyl at the outlet. The cuvette outlet is fitted with two vessels with fused KOH (11). The reaction cuvette is placed inside the thermostate (12). All the thermocouples are connected to the recorder KOH-4. The temperature of above-mentioned parts is controlled in the course of the experiment. Deviations are determined by means of a recorder chart and pen movement rates. Duration

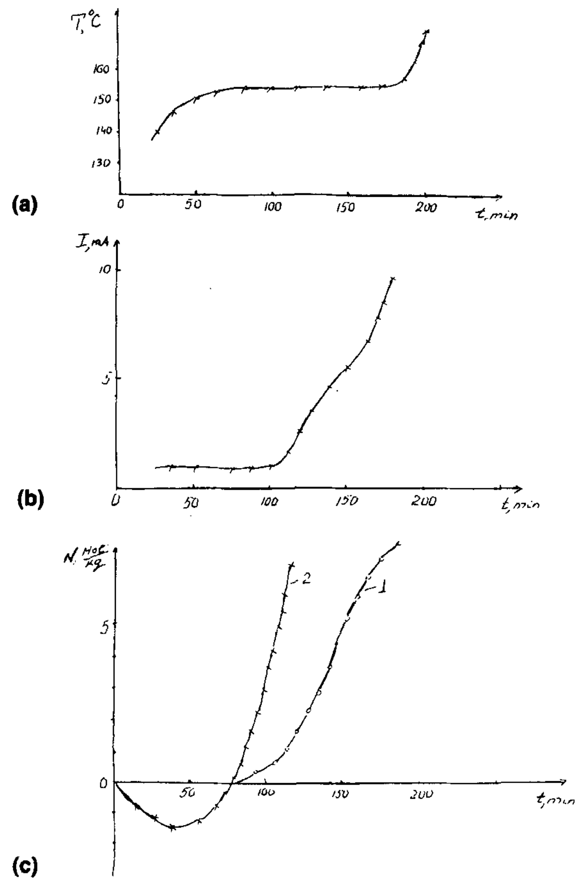

FIGURE 3 TEOD data for electroconductive IPP under unisothermal conditions. (a) Kinetic curves for oxygen absorption (1) without and (2) with electric current action; (b) Kinetic curve for current alteration; (c) Kinetic curve for temperature alteration.

of the experiment enables us to compare any temperature deviations with kinetic oxidizing process.

The experiment is carried out as follows: the sample on perforated quartz glass is fixed with screw-clamps, then vessels with KOH and thermocouples are fitted to the stopper, and the stopper is ground down to the cuvette glass vessel, then the assembly is connected to the static vacuum setup. The thermostate is heated to 3–5°C below the nominal value. The cuvette is tested for air tightness and then blown twice with oxygen. Then the necessary oxygen pressure is created, and the cuvette is placed inside the thermostate that is heated to the nominal temperature. The necessary voltage is applied to the sample and the timer is started. After heating for 3–5 min, the static vacuum setup is cut off using the differential manometer faucet and the observations are taken. Every two minutes we visually record the pressure changes by the manometer and the electric current through the sample due to the voltage applied, which is constant during the experiment. Then the kinetic curves of the process are calculated.

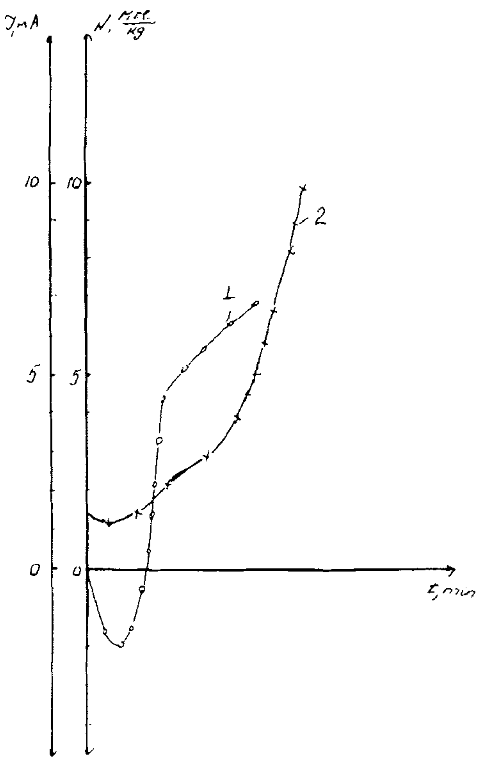

FIGURE 4 Kinetic curves for (1) oxygen consumption and (2) current alteration for electroconductive IPP when TEOD proceeds under isothermal conditions.

The TEOD of EPC on IPP is found to be exothermal.[7] So we designed a reaction cuvette (Figure 2) which has a cooling jacket with automatic temperature control. The latter consists of fan connected to a monitor potentiometer whose thermocouple is placed inside the cuvette. As soon as the temperature rises above the nominal, the fan begins to operate. Thus the temperature is maintained within an accuracy of 1–1.5°C. The experiment is carried out in the same succession as before. Figures 3 and 4 present the data obtained for TEOD of EPC on IPP under the action of electric current with use of the cuvette constructions mentioned above. For comparison, Figure 3a presents the TOD-curve of EPC without the action of the electric current.

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