UPON THE INDURATION OF THE UNSATURATED POLYESTER RESIN OF THE TYPE VINALKIDE 550-P. FIRST ANNOUNCEMENT: TESTING OF OPTIMAL CONDITIONS FOR INDURATION OF THE RESIN

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Key-words: unsaturated resin — vinalkide 550-p — induration — optimization — polymerization

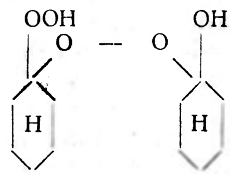
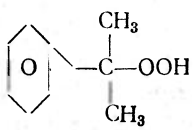
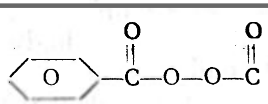
In the recent 10—15 years the newest successes of the science for polymers were disposed to the practical medicine. The application of the polymer products includes numerous medical branches and disciplines: artificial organs, apparatuses for assisted blood flow, artificial denture (prosthesis), etc. (1). There is a possibility to use those materials in the production of prosthesis-orthopaedical subproducts too (2). The present variety of plastics with their specific features determines the application in medical practice, for example compositions defending open wounds (3). Some compositions, based on unsaturated polyesters, have a slight smell and low toxicity only (4). Polymer compositions are the bandages (5) in the practice of orthopaedicists and their chemical base is the unsaturated polyester of malleic and phthaleic anhydrate as well as propylenglycol. The resin is mixed with styrol and is indurated under ultraviolet radiation. Such resins are very close chemically to the resins produced in our country; at the moment they have a wide and multiple application in the production of various materials, most often from glassfibroplastics. The technology for such production is based on the easy induration of the unsaturated polyester resins under the influence of redoxic systems. The Bulgarian resins Vinalkide 550-P, Vinalkide 6410-PD and Vinalkide 785-PE are used for many reasons and aims and the conditions for induration are resulting from a certain physical and mechanical sign. Relations between an initiator and accelerator are also selected; the idea is to reach maximum activity of the studied parameter. For example, some authors report optimal conditions of induration according to the compressive strength or blow strength (6). They improve certain physicomechanical features by modifying of polyester resins with methylmetacrylate or castor-oil; Another group of authors determine the relation between the concentration of catalyst and time of gelling of the unsaturated polyester resin (7, 8). A compromise decision between the physical and mechanical features is found, specially statical compressive strength, as well as fire-resistance of the resin by adding of optimal content of fire-stable substances (9). Y. Gopbatkina et al. report also the relation between the induration process and mechanical characteristics of the resin — its mode and module of elasticity (10).

The selection of one only criterion from the features to be the optimal standard for conditions of induration can neglect the rest ones. As the induration of polyester resins is a polymerizing reaction which leads to a formation of a space molecular set, it is naturally to study the induration itself as a polymerizing process and the selection of optimal conditions for this to be done according to the final stage — a space molecular set possessing the necessary complex of physico-mechanical features.

Material and methods

The polyester resin Vinalkide-550-P (produced in Chemical Plants "G. Genov", Rousse) was under study. This resin is a by-polyester between propyleneglycol, malleic and phthaleic acid in the following mol-relations: 25.08:21.20:18.73. To this resin was added 34.98 mol % styrol. Vinalkide 550-P is N. 14 742-79 according to Bulgarian Standards. The initiators in our study were cyclohexanon-peroxide, benzoil-peroxide and cumolhydroperoxide. They were taken in the experiments for their wide application in polymerizing processes. Table 1 represents the characteristics of the used peroxides:

Table 1

Peroxide	Structure	mol. mass	melt. point	activ. oxygen in 1 g peroxide
CYCLOHEXANON-peroxide		246	—	0.1032
CUMOLHYDRO-peroxide		152.2	—	0.1635
BENZOIL-peroxide		242.2	103—108	0.1327

The most oftenly used cobalt naphthenate was applied to form the redoxide-system; it is known that the cobalt ion is the most active metal component of the redoxide — systems (11).

The polymerizing process for induration of the resin was performed under nonisothermic conditions and the temperature of the reactional mass was increased proportionally corresponding to the reactional temperature.

Results and discussion

When there is a temperature isolation of the reactional mass the polymerizing process develops under nonisothermic conditions and the reactional temperature increases the temperature of the reactional mass. If the reactional vessel is isolated it is obvious that by the changes of the temperature we can determine the velocity of the chemical process, because according to the Hess law the quantity of liberated wormth corresponds to the reacted part of the resin. In our experiment was applied a reactional vessel with capacity of 200 cm^3 isolated from the outer microenvironment by penopolyurethane. Under such conditions the temperature changes along the process in time corresponds to the ve-

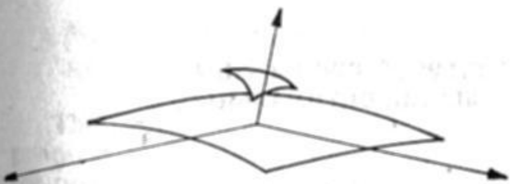


Fig. 1.

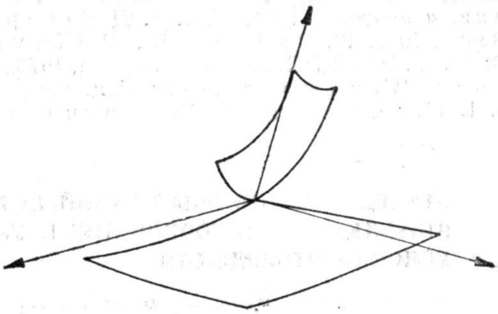


Fig. 2.

locity of the process itself, because a dynamic equilibrium between the liberated wormth and its distribution around is established. This relation between temperature and time is a characteristic one with an expressed maximum which according to our data is approximately equal to 70% performance of the double-bonds (units). As an example, fig. 1 shows the temperature changes in time for polyester resin with. 4.02% cyclohexanon—peroxide and 0.015% cobalt naphthenate. The time of maximum temperature as a function of the complex redoxide-system can be registered by different concentrations of peroxide and reductor; as well can be read some data about the relative velocity of the polymerizing process. Fig. 2 shows the times for reaching corresponding maximums as a function of the complex of initiator and accelerator. As it can be seen the velocity of the polymerizing process is changed in relatively wide ranges. All that allows the controlling of the velocity of induration with certain technology processes in definite ranges, i. g. the induration can be performed for an established period of time. Most often, however, we tend to fulfill a programme of maximum velocity of induration of the resin, because this reflects in the maximum production of certain objects, very often medical ones. As it can be seen from this figure best results are registered with a content of 7.55% cyclohexanon-peroxide and 0.060% cobalt naphthenate. As a rule, better characteristics will have those objects, produced by minimum quantity of initiator, i. g. minimum redoxide-system. Only when the additional component which is naturally mixed with the polyester resin, is characterized by a well developed surface and possesses satisfactory absorption qualities, the remnants (by-products) of the initiator could be without any significance for the characteristics of the products.

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ОТВЕРДЕНИЕ НЕНАСЫЩЕННОЙ ПОЛИЭСТЕРНОЙ СМОЛЫ ТИПА ВИНАЛКИД 550-П СООБЩЕНИЕ I. УЛУЧШЕНИЕ ОПТИМАЛЬНЫХ УСЛОВИЙ ОТВЕРДЕНИЯ

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В работе проведен литературный обзор по вопросам применения полимеров в медицине. Исследовано влияние некоторых редокси-систем на ненасыщенную полиэстерную смолу. Установлено, что пропиленгликоловый эстер малеиновой и фталовой кислот в соотношении 18:15:13 типа Виналкид 550-П, содержащий дополнительное количество 34,98 молн % стирола, твердеет с образование молекул различной структуры в зависимости от различных количеств инициатора (циклогексанoперекиси) и ускорителя (нафтената кобальта). Последние играют роль редокси-систем. Количество тепла, выделяемого при отвердении, приводит к повышению температуры реакционной смеси.

Установлена ярко выраженная зависимость между временем достижения максимальной температуны при отвердении и концентрацией редокси-систем. Представленная авторами пространственная диаграмма указывает на возможность улучшения условий, при которых твердеет оптимальное количество продуктов медицинского обихода.