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LETTER TO THE EDITOR

Radiation-Induced Curing of Prepolymers of Some Condensation Systems

It is not yet well known that condensation reactions occur effectively under the action of irradiation.

This report is related to the radiation-induced condensation reaction in the presence of certain additives. The authors have found

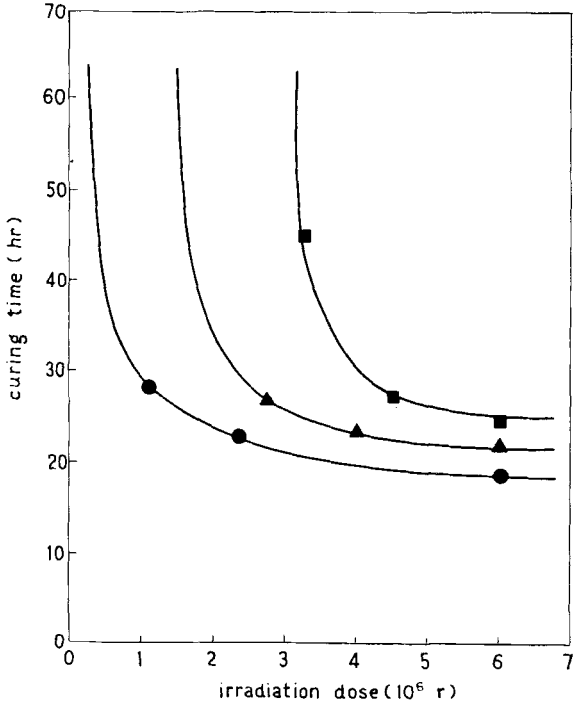

Fig. 1. Radiation-induced curing of urea · formaldehyde prepolymer-chloral hydrate solution system at room temperature in air. Concentration of chloral hydrate: ■, 2. 4 wt. %; ▲, 4. 8 wt. %; ●, 9. 0 wt. %.

that prepolymers of formaldehyde-urea, formaldehyde-melamine, and formaldehyde-phenol systems could be cured by the action of ionizing radiation in the presence of certain additives such as methylene dichloride, chloroform, carbon tetrachloride, trichloroethylene, aluminum trichloride, sodium chloride, potassium chloride, chloral hydrate, and poly(vinyl chloride), all of which contain chlorine atoms in their molecular structures (Figs. 1-3). The formaldehyde-urea prepolymer used in this experiment was obtained by the following method.

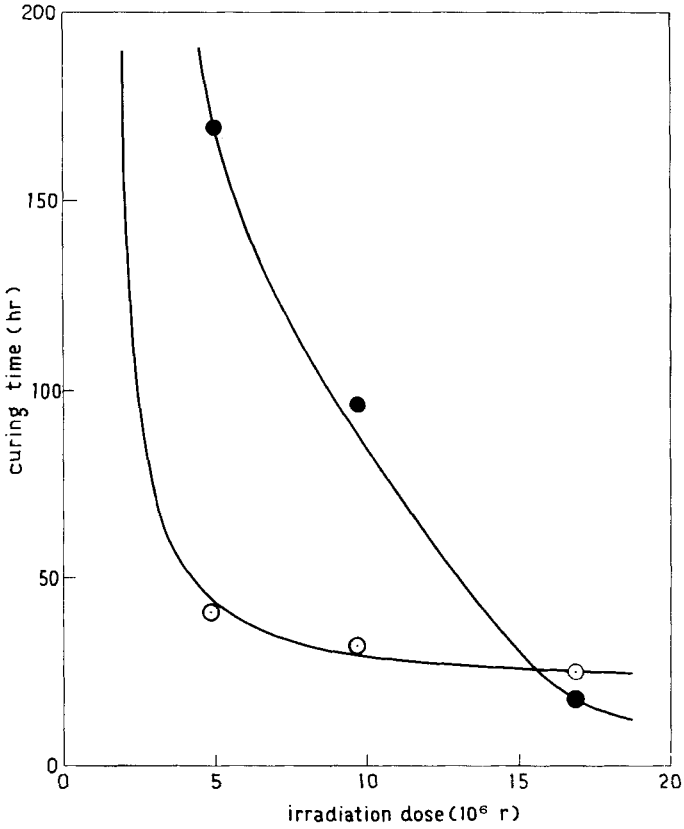

Fig. 2. Radiation-induced curing of urea · formaldehyde prepolymer-aluminum trichloride and urea · formaldehyde prepolymer-poly(vinyl chloride) dispersion systems at room temperature in air. ⊙, Urea · formaldehyde prepolymer-$AlCl_3$ (17 wt.%); ●, urea · formaldehyde prepolymer-poly(vinyl chloride) (17 wt.%).

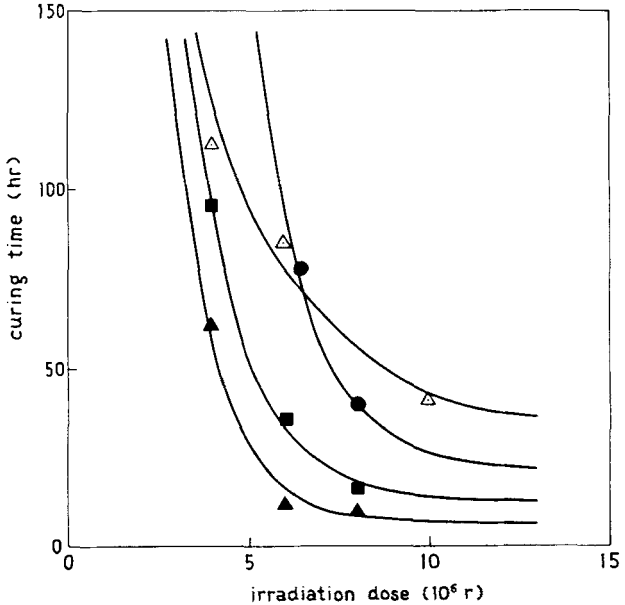

Fig. 3. Radiation-induced curing of urea formaldehyde prepolymer-chlorine-containing solvents dispersion systems at room temperature in air. ▲, Urea · formaldehyde prepolymer-carbon tetrachloride (17 wt. %); △, urea · formaldehyde prepolymer-carbon tetrachloride (9 wt. %); ■, urea · formaldehyde prepolymer-chloroform (17 wt. %); ●, urea · formaldehyde prepolymer-methylene dichloride (17 wt.%).

One hundred parts of formaldehyde and 30 parts of urea were mixed at pH 7-8 and heated at 90°C for 1 hr to give a methylol urea compound; then small amounts of formic acid were added to keep the pH at 4. 8-4. 9 to give a methylene product. After heating at 90°C for 3 hr, prepolymers were obtained and sodium hydroxide was added to neutralize the product.

Curing time was determined by the looseness of the fluidity of the system, and the systems changed into hard brittle resin after gelation. Curing of prepolymers were found also to be possible by photoirradiation in the presence of chlorine gas. But photoreaction is not as convenient from the viewpoint of the homogenity of the formed polymers.

The necessary curing time is very variable, depending on the reaction conditions, and could be controlled by the suitable selection of such factors as the nature and amount of additives and the intensity and total dose of irradiation.

It is unlikely that these condensation reactions occur by the primary active species formed directly by irradiation. These reactions may be indirect reactions caused by the catalytic intermediates formed by the radiolysis of the additives. The direct radiation-induced polymerization in binary or multicomponent systems has already been investigated in previous papers [1].

Binary systems have two advantages in radiation-induced polymerization. One advantage is the physical effects such as the phase changes with which our previous reports [1, 2] have been mainly concerned. The other effect is a chemical one caused by the active species or products of the irradiation of the partner components. It is possible to utilize some of these products as a catalyzer of some chemical reactions.

This might be called radiation-induced indirect reaction through the radiolysis of the second components. The mechanism and practical application of these reactions will be published elsewhere.

ACKNOWLEDGMENT

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