On the Mechanism of Action of Epoxy Stabilizers in Poly(vinyl Chloride) Compositions

Epoxy compounds are generally used as thermal stabilizers of PVC. On the other hand, these compounds are used as plasticizers of polymer. The stabilizing action of epoxy compounds consists in the formation of chlorohydroxy derivatives with liberated hydrogen chloride.[1-4]

Fig. 1. Change in conductivity of solution after addition of each portion of zinc stearate.

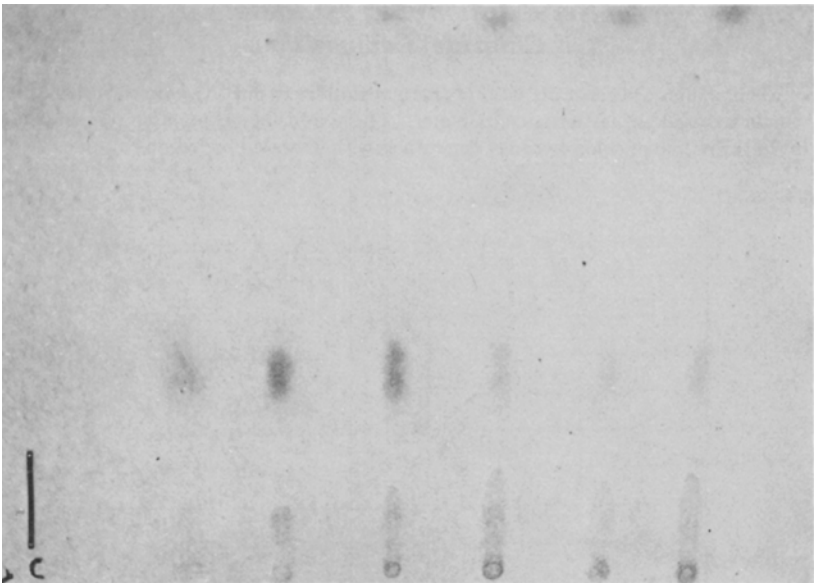


Fig. 2. Thin-layer chromtogram: (1) sample before addition of first portion of zinc stearate; (2) after addition of 20%; (3) after addition of 40%; (4) after addition of 60%; (5) after addition of 80%; (6) after addition of 100% zinc stearate; (7) octyl epoxystearate solution in pure ethanol.

The problem of reversible reaction between epoxy compounds and HCl has not yet been explained.[2,4,5] The consequence of using epoxy compounds in stabilizing compositions has, therefore, not yet been pinpointed.

EXPERIMENTAL

Kinetic measurements of conductivity of alcoholic solutions of HCl containing octyl epoxystearate were made.

To 0.02*N* HCl in ethanol containing 1% octyl epoxystearate, zinc stearate in stoichiometric amount in relation to HCl was added in five equal portions. The change in solution conductivity caused by addition individual portion of zinc stearate was measured (Fig. 1).

After the conductivity was stable (after addition of each portion), a 10-μl sample was taken for thin-layer chromatography analysis.

The chromatogram of Figure 2 was taken according to the methods for lipids derivatives[6] on silica gel G layer 0.75 mm thick and heated initially to 120°C. The solvent mixture benzene: ethyl acetate (98:2) was used for separation of individual components.

Chromatograms were developed with 50% H_2SO_4 at 120° in 30 min. Identification of spots were made using the R_f of each component.[6]

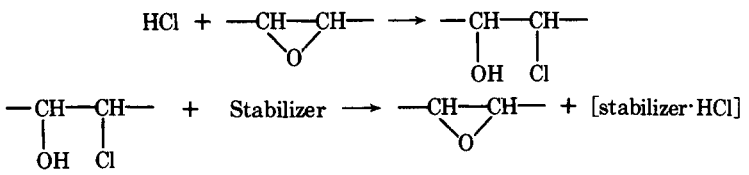
DISCUSSION

The chromatogram showed three lines of spots. Near the starting line, there are the products of reaction of zinc stearate and some contaminates as well. In the middle line, there are spots of the mixture of octyl stearate chlorohydroxy and dihydroxy derivatives; and near the frontal line, there are situated spots of octyl epoxystearate.

After addition of 20% and 40% of a stoichiometric quantity of zinc stearate, the amount of octyl chlorohydroxystearate is for practical purposes unchanged. Simultaneously, on the basis of high conductivity measurements, the presence of free HCl in the solution may be detected.

The addition of the next portion (60% of stoichiometric quantity) causes the consumption of free HCl in solution, and the next conversion leads to migration of HCl from octyl chloroxydroxystearate to zinc stearate, since that movement increases the intensivity of spots near the front of the solvent, which involves octyl epoxystearate.

The below-mentioned mechanism of action of epoxy compounds seems to be adequate:



On the basis of experimental data, one can come to the conclusion that the reaction of epoxy compounds with HCl in the presence of thermal PVC stabilizers is reversible. This may be the reason why epoxy compounds are highly reactive agents transporting HCl from the source of formation to the acceptor until the thermal stabilizer is consumed.

References

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