A reactive extrusion process for the imidization of poly(styrene-co-maleic anhydride)

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ABSTRACT: Imidization of (styrene-co-maleic anhydride) (SMA) with amines may improve some of its end-use properties. The objective of this paper was to study its kinetics and to evaluate the potential of carrying out this reaction by reactive extrusion. The kinetics was investigated in tetrahydrofuran solution at 15-55 ^{o}C and in ethylbenzene solution at 85-130 ^{o}C, respectively. A clam-shell co-rotating twin screw extruder with a diameter of 20 mm and a length-to-diameter ratio of 48 was used for the reactive extrusion process in the bulk at 230-260 ^{o}C to produce a copolymer of styrene and N-phenylmaleimide (SMI). The extent of reaction was determined by FTIR and a new and yet simple method, electric conductance titration. It was found that the imidization involved two-steps: ring-opening to produce an acido-amide group and ring-closing to form the corresponding imide group. The imidization rate was greatly influenced by the reaction temperature and the amine/anhydride molar ratio. This was particularly so for the ring-opening reaction which was limited by the diffusion and steric hindrance effect of the amine. The ring-closing reaction was controlled by the devolatilization rate of the resulting water molecule and the activation energy. A model for the imidization kinetics was developed based on the reversible ring-opening reaction and irreversible ring-closing reaction.

KEYWORDS: Reactive extrusion, SMA, imidization, kinetics, modeling.