Impact Polypropylene Copolymers. Characterization as a Tool to Optimize their Synthesis.

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Polypropylene (PP) is a semicrystalline thermoplastic widely used due to its singular properties among polyolefin materials [1]. Polypropylene homopolymer provides stiffness and toughness but exhibits low impact strength at low temperatures, and therefore its applications are limited [2]. In the last decade, the efforts of scientists and manufacturers have been focused on the introduction of an elastomeric component intra- or intermolecularly connected to PP structure, in order to improve the high impact resistance at low temperatures [3]. In this sense, new PP grades, such as random copolymers and impact copolymers, have emerged.

Polypropylene copolymers contain one or more different types of monomers in the polymer chain, and are produced in a single reactor. Impact copolymers are composed by dispersed phase particles distributed over a polypropylene crystalline matrix. Industrially, the impact copolymers process requires a secondary reactor in which rubber phases are introduced in order to be uniformly distributed in the polypropylene matrix. In any case, properties of a polypropylene resin can be adjusted, depending on processing conditions and catalysts, by varying the level of comonomer distribution in the polymer.

In this work, the synthesis of different impact polypropylene copolymers has been carried out in a one-reactor working in sequential mode. The study is completed with an analysis of the influence of some experimental conditions on molecular properties. Thus, two kinds of catalytic systems, metallocene and Ziegler-Natta, have been used to obtain random and blocky comonomer distribution. High-activity Ziegler-Natta catalysts comprise $MgCl_2$, $TiCl_4$, and an “internal” electron donor and are typically used in combination with an aluminum alkyl co-catalyst such as $AlEt_3$ and an “external” electron donor, which is added in polymerization [4]. External donor addition amount is related with the polypropylene tacticity which has been determined by TREF and ^{13}C-NMR. On the other hand, a pre-polymerization step under mild conditions has been introduced previously to the main polymerization reaction, and the polymer particle size and morphology have been analyzed by SEM with or without pre-polymerization step. Also, the effect of hydrogen addition to the reaction has been studied to know the melting index variation of these copolymers, and therefore the molecular weight and molecular weight distribution.

It is important to emphasize that molecular characterization of impact polypropylene copolymers, studied by TREF, ^{13}C-NMR and GPC, play a significant role to properly tailored experimental conditions (reaction time, ethylene flow, catalyst and the experimental process), and hence to achieve a material with a specific monomer content and distribution.

References:

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