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Influence of Different Aluminium Alkyls on the Ziegler-Natta Polymerization

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Extended Abstract

Ziegler-Natta (ZN) catalysts are among the most significant types of catalyst for the industrial production of plastics. The main components of ZN catalysts are $TiCl_4$ in combination with an organic aluminium component as a cocatalyst. In addition, there are a variety of chemicals that improve or alter the catalyst behaviour. Various carrier materials such as $MgCl_2$ or SiO_2 are used to influence catalyst activity and particle shape. In addition, there is a large group of electron donors for influencing the catalyst behaviour and the final polymer [1, 2].

Nevertheless, the aluminium compound as a so called "cocatalyst" is one of the most decisive factors in the polymerization with ZN catalyst systems [3]. Therefore, a systematic study was carried out to determine the influence of different aluminium alkyls on the homo-polymerization of ethylene with a ZN catalyst system. For the experiments triethylaluminium (TEA), triisobutylaluminium (TIBA) and tridodecylaluminium (TDDA) were used in different concentrations. The three components were selected for their different properties and industrial importance. TEA is the most commonly used aluminium alkyl with little to no steric hindrance. TIBA is a, more complex aluminium alkyl mainly used as scavenger agent, while TDDA is generally unknown. A 0.5 l multi-purpose reactor system with liquid propane as solvent and a commercially available ZN catalyst of the 4th generation were used to carry out the polymerizations. The data obtained was used to model the polymerization activity based on kind and amount of the aluminium alkyl used.

The polymerization activity was different for each aluminium alkyl. While the polymerization activity increased to a plateau for the more complex aluminium alkyls TIBA and TDDA, TEA behaved differently. With TEA as a cocatalyst, the polymerization activity increased to a peak value at a concentration of 3 mmol l^{-1} and decreased for higher concentrations. In general, the polymerization activity achieved, increased with the size of the aluminium alkyl molecule. TDDA exhibited the highest polymerization activity at 4.5 mmol l^{-1}, which was 25% above the activity level for TEA and 20%, respectively, over that of TIBA. In conclusion, the steric differences of the used aluminium compound have a great influence on the polymerization activity. Based on the experimental data, a model was created to simulate all cases for the concentration of the three different aluminium alkyls. For this, the model postulated by Alshaiban and Soares [4] was extended to additionally represent the influence of aluminium alkyl and its concentration.

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