The generations of Ziegler-Natta catalysts for polymerization of α-olefins

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Abstract:
In this study, the recent advances in the area of olefin polymerization have been reviewed and the study is allocated to the six generations of Ziegler-Natta catalysts, which have been improved during five recent decades up to now. The focus is on the fifth generation area in which we have started a study for preparing of a new catalyst with diether donors. Beside this, some recent papers about preparing of diether catalysts have been reviewed and the space molecular structure of the diether is presented.

Keywords: Ziegler-Natta, polymerization, propylene, diether

Introduction:

Without any shadow of doubt, the discovery of Ziegler catalysts for polymerization of ethylene follow with the corrections done by Natta for polymerization of propylene and other α-olefins was a peak point for invention of a new method for polymerization of α-olefins. Although, Ziegler started polymerization with ethylene, but nowadays some of hydrocarbon monomers are polymerized by these catalysts within polymerization processes including solution, slurry and gas phase in open or closed systems.

These catalysts are able to produce linear polymers with high molecular weight and crystalinity. When ethylene, propylene or other α-olefins are polymerized, one can produce a linear product without branch but with high crystalinity and special space order by controlling of propagation step of reaction. In 1953, Ziegler et al performed the polymerization at ordinary pressure and temperature by using of aluminum alkyls and some halides of transition metals .The Ziegler-Natta method is the only process, which is used for producing of polypropylene and its copolymers like propylene-ethylene and terpolymers like propylene-ethylene-dien, because propylene cannot be produced by free radical polymerization.

The base of Ziegler-Natta catalysts contains two main components, a derive of transition metal like Titanium, Vanadium, Chrome or Zirconium. The transition metal components which are used in the structure of Ziegler-Natta catalysts are: $TiCl_3$, $Ti(OR)_4$, VCl_4, VCl_3, $VOCl_3$, $TiCl_4$, $CrCl_3$, and $ZrCl_4$. The second component, which is usually called co-catalyst, is an organometalic composition. The current organic co-catalysts are: $Al(C_2H_5)_3$, $Al(C_2H_5)_2Cl$, $Al(C_2H_5)Cl_2$, $Al(I\text{-}C_4H_9)_3$, $Al(n\text{-}C_3H_7)_3$ and $Zn(C_2H_5)_2$.

Ziegler-Natta catalysts can be classified into six categories in aspect of genesis time. As is shown on table 1,the activity and isotacticity index have been increased during the time.