[0008] The molecular weight distribution is one of the most important properties of a polymer. By changing this parameter, the crystalline structure and the crystallization rate of a polymer is dramatically influenced, which has impact on the convertability and usability of a certain polymer for a certain application. As an example, for extrusion applications like sheet, pipe, film, raffia, or thermoforming, a broader molecular weight distribution is advantageous, while for applications like fiber or injection molding a narrower molecular weight distribution would be advantageous. As used to processing polymers produced using phthalate based Ziegler-Natta catalysts, the converters insist in molecular weight distributions typically produced by such catalysts and expect that phthalate free Ziegler-Natta catalysts deliver a similar molecular weight distribution. Unfortunately, state of the art diether based catalysts deliver polymers where the molecular weight distribution is too narrow while succinate based catalysts deliver polymers where the molecular weight distribution is far too broad.

SUMMARY OF THE DISCLOSURE

[0008a] In an aspect, there is provided a supported Ziegler-Natta catalyst system comprising a diether internal electron donor as the only internal electron donor and having an activity and hydrogen response suitable for the production of propylene polymers having a molecular weight distribution (PI(GPC)) in the range from about 5.75 to about 9.

[0008b] In another aspect, there is provided a method for making a solid catalyst component for use in a Ziegler-Natta catalyst system, the method including:

(a) combining a porous particulate support in an inert solvent with a hydrocarbon soluble organomagnesium compound to form a slurry mixture;

(b) halogenating the organomagnesium compound;

(c) reacting the slurry mixture with a titanium compound, followed by reacting the slurry mixture with an internal donor ~~comprising~~ consisting essentially of at least one diether compound;

(d) extracting the solid intermediate with a mixture of a titanium compound and a hydrocarbon solvent to form the solid catalyst component; and

(e) recovering the solid catalyst component;

wherein the diether compound is selected such that the resulting solid catalyst component has an activity and hydrogen response suitable for the production of propylene polymers having a molecular weight distribution in the range from about 5.75 to about 9.

[0008c] In an aspect, there is provided a catalyst produced by the process as defined above.

[0008d] In an aspect, there is provided a process for the polymerization of olefins of formula $CH2=CHR^1$, in which R^1 is hydrogen or a hydrocarbon radical having 1-12 carbon atoms carried out in the presence of a catalyst as defined above.

[0008e] In another ~~aspect~~embodiment, there is provided a propylene polymer having a molecular weight distribution (PI(GPC)) in the range from about 5.75 to about 9 produced using a supported Ziegler-Natta catalyst system comprising a diether internal electron donor.

[0009] Embodiments disclosed herein provide a non-phthalate Ziegler-Natta catalyst system for the polymerization and copolymerization of olefins that overcome the above shortcomings in the prior art and provide a Ziegler-Natta catalyst system with a unique selection, combination, and treatment of the three essential components of a Ziegler-Natta catalyst, the support, the transition metal component and the internal donor, as described below. The resulting Ziegler-Natta catalyst has unusually high activity, excellent hydrogen response and stereoselectivity, while the molecular weight distribution is comparable to phthalate containing Ziegler-Natta catalysts.

[0010] ~~In one aspect, e~~Embodiments disclosed herein relate to a method for making a solid catalyst component for use in a Ziegler-Natta catalyst system. The method may include the steps of: (a) combining a porous particulate support in an inert solvent with a hydrocarbon soluble organomagnesium compound to form a slurry mixture; (b) halogenating the organomagnesium compound; (c) reacting the slurry mixture with a titanium compound, followed by reacting the slurry mixture with at least one diether compound (internal donor); (d) extracting the solid intermediate with a mixture of a

titanium compound and a hydrocarbon solvent to form the solid catalyst component; and (e) recovering the solid catalyst component. The solid catalyst component can be combined with an aluminum cocatalyst and an external donor to provide a Ziegler-Natta catalyst useful for the polymerization of olefins.

[0011] Other ~~aspects~~ embodiments and advantages will be apparent from the following description and the appended claims.

DETAILED DESCRIPTION

[0012] In one aspect, embodiments disclosed herein relate to Ziegler-Natta catalysts useful for the polymerization of olefins. The Ziegler-Natta catalyst system provided herein includes an aluminum compound, a solid catalyst component and preferably an external electron donor. The solid catalyst component includes a titanium compound, a magnesium component containing at least one halogen, a porous particulate support, and at least one diether compound. The magnesium component of the solid catalytic component is provided from a hydrocarbon soluble organomagnesium source.

[0013] In the preparation of the catalytic systems according to embodiments herein, a particulate porous support is used. The support may be any type of support commonly used in Ziegler-Natta type catalysts which is compatible with the polymerization of alk-1-enes. The support must have the ability to chemically, physically or mechanically bind the halogenated magnesium compound.

[0014] It is preferred to use porous supports having a specific surface area in the range from about 10 to about 1000 m^2 /g, preferably of from about 50 to about 700 m^2 /g, and more preferably from about 100 m^2 /g to about 600 m^2 /g, wherein the specific surface area is determined in accordance with DIN 66131. The catalyst support has a mean particle diameter in the range of from about 5 to about 200 μm, preferably from about 10 to about 100 μm, and more preferably from about 15 to about 70 μm. Mean particle diameter herein refers to the volume average mean (median value) of the particle size distribution as determined by Malvern Mastersizer Analysis in accordance with ASTM Standard D 4464-00.

CLAIMS

What is claimed:

1. A supported Ziegler-Natta catalyst system comprising a diether internal electron donor as the only internal electron donor and having an activity and hydrogen response suitable for the production of propylene polymers having a molecular weight distribution (PI(GPC)) in the range from about 5.75 to about 9.

2. A method for making a solid catalyst component for use in a Ziegler-Natta catalyst system, the method including:

   (a) combining a porous particulate support in an inert solvent with a hydrocarbon soluble organomagnesium compound to form a slurry mixture;

   (b) halogenating the organomagnesium compound;

   (c) reacting the slurry mixture with a titanium compound, followed by reacting the slurry mixture with an internal donor ~~comprising~~ consisting essentially of at least one diether compound;

   (d) extracting the solid intermediate with a mixture of a titanium compound and a hydrocarbon solvent to form the solid catalyst component; and

   (e) recovering the solid catalyst component;

   wherein the diether compound is selected such that the resulting solid catalyst component has an activity and hydrogen response suitable for the production of propylene polymers having a molecular weight distribution in the range from about 5.75 to about 9.

3. The process of claim 2, wherein the diether compound has the general structure (I):

$$R^1O - (C\,R^5R^6)_n - CR^3R^4 - (C\,R^7R^8)_m - OR^2 \quad \textbf{(I)}$$

where

R^1 and R^2 are the same or different and are selected from the group consisting of a saturated or unsaturated aliphatic group of from 1 to about 20 carbon atoms or an aryl group of from 6 to about 20 carbon atoms,

$n + m = 2$ to 4,

R^3, R^4, R^5, R^6, R^7 and R^8 are identical or different and are each a hydrogen atom, a linear, cyclic or branched hydrocarbon group, for example an alkyl group of from 1 to about 20 carbon atoms, an alkenyl group of from 2 to about 20 carbon atoms, an aryl group of from 6 to about 20 carbon atoms, an arylalkyl group of from 7 to about 40 carbon atoms, an alkylaryl group of from 7 to about 40 carbon atoms or an arylalkenyl

dimethoxypropane; 2-ethyl-2-tert-butyl-1,3-dimethoxypropane or the corresponding 1,3-diethoxypropane analogues or 9,9-bis(methoxymethyl)fluorene or 9,9-bis(ethoxymethyl)fluorene.

9. The process of claim 2, wherein the diether donor compound is used in an amount of from about 0.01 to about 2 mole for each mole of the magnesium halide compound

10. A catalyst produced by the process of any one of claims 2-9.

11. The catalyst of claim 10, wherein the catalyst has an activity and hydrogen response resulting in the production of propylene polymers having a molecular weight distribution (PI(GPC)) in the range from about 5.75 to about 9.

12. A process for the polymerization of olefins of formula $CH2=CHR^1$, in which R^1 is hydrogen or a hydrocarbon radical having 1-12 carbon atoms carried out in the presence of a catalyst according to any one of claims 1 and 10-11.

~~13. A propylene polymer having a molecular weight distribution (PI(GPC)) in the range from about 5.75 to about 9 produced using a supported Ziegler-Natta catalyst system comprising a diether internal electron donor.~~