succinate based catalysts deliver polymers where the molecular weight distribution is far too broad.

SUMMARY OF THE DISCLOSURE

[0011a] In one aspect, there is provided a $MgCl_2$-based catalyst system comprising: titanium, a support, and 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; wherein the support comprises a $MgCl_2$-xROH support, wherein x is in the range of from about 1.5 to about 6.0 and ROH is an alcohol or a mixture of alcohols where R is a linear, cyclic, or branched hydrocarbon unit with 1-10 carbon atoms.

[0011b] In another aspect, there is provided a $MgCl_2$-based catalyst system comprising: titanium, a support, and 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; wherein the support comprises a $MgCl_2$-xROH support, wherein x is in the range of from about 1.5 to about 6.0 and ROH is an alcohol or a mixture of alcohols where R is a linear, cyclic, or branched hydrocarbon unit with 1-10 carbon atoms; wherein the $MgCl_2$-xROH support does not comprise silica material.

[0011c] In another aspect, there is provided a $MgCl_2$-based catalyst system comprising: titanium, a support, and 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; wherein the support comprises a $MgCl_2$-xROH support, wherein x is in the range of from about 1.5 to about 6.0 and ROH is an alcohol or a mixture of alcohols where R is a linear, cyclic, or branched hydrocarbon unit with 1-10 carbon atoms; wherein the $MgCl_2$-xROH support does not comprise silica material with an average particle size of less than 10 microns.

[0011d] In another aspect, there is provided a process for the polymerization of olefins of formula CH_2=CHR1, in which R1 is hydrogen or a hydrocarbon radical having 1-12 carbon atoms carried out in the presence of a catalyst described herein.

[0012] Embodiments disclosed herein provide non-phthalate Ziegler-Natta catalyst systems for the polymerization and copolymerization of olefins that overcome the above shortcomings in the prior art and provide Ziegler-Natta catalyst systems with a unique method of selecting and combining 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.

[0013] Improved Ziegler-Natta catalyst may be formed according to embodiments herein using a spherical $MgCl_2$-xROH support, where R is a linear, cyclic or branched hydrocarbon unit with 1-10 carbon atoms and where ROH is an alcohol or a mixture of at least two different alcohols, preferably where the ROH is ethanol or a mixture of ethanol and a higher alcohol with R being a linear, cyclic or branched hydrocarbon unit with 3-10 carbon atoms, preferably 4-10 carbon atoms; and where x has a range of about 1.5 to 6.0, preferably about 2.0 to 4.0, more preferably about 2.5 to 3.5 and even more preferably 2.95 to 3.35.

[0014] The catalyst includes a Group 4-8 transition metal, such as Ti, and a diether compound as internal donor. The catalysts described herein have an improved activity performance in olefin polymerization reactions as well as good stereoregularity and hydrogen sensitivity while the molecular weight distribution is comparable to phthalate containing Ziegler-Natta catalysts.

[0015] Embodiments herein are also directed to methods of making the improved Ziegler-Natta catalyst. Generally, spherical $MgCl_2$-xROH (x = 3.0 - 3.3) is treated with a transition metal halide, such as $TiCl_4$, at a low temperature (-10°C to +10°C). The reaction product is heated to approximately 80°C and contacted with the diether

CLAIMS

What is claimed:

1. A $MgCl_2$-based catalyst system comprising: titanium, a support, and 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; wherein the support comprises a $MgCl_2$-xROH support, wherein x is in the range of from about 1.5 to about 6.0 and ROH is an alcohol or a mixture of alcohols where R is a linear, cyclic, or branched hydrocarbon unit with 1-10 carbon atoms.

2. A $MgCl_2$-based catalyst system comprising: titanium, a support, and 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; wherein the support comprises a $MgCl_2$-xROH support, wherein x is in the range of from about 1.5 to about 6.0 and ROH is an alcohol or a mixture of alcohols where R is a linear, cyclic, or branched hydrocarbon unit with 1-10 carbon atoms;
wherein the $MgCl_2$-xROH support does not comprise silica material.

3. A $MgCl_2$-based catalyst system comprising: titanium, a support, and 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; wherein the support comprises a $MgCl_2$-xROH support, wherein x is in the range of from about 1.5 to about 6.0 and ROH is an alcohol or a mixture of alcohols where R is a linear, cyclic, or branched hydrocarbon unit with 1-10 carbon atoms;
wherein the $MgCl_2$-xROH support does not comprise silica material with an average particle size of less than 10 microns.

4. A process for the polymerization of olefins of formula CH_2=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 1-3.