[0004] Figure 1 illustrates a schematic of an example of a gas-phase reactor system suitable for controlling reactor split and a product parameter based on a hydrogen leading indicator in accordance with embodiments described herein.

[0005] Figure 2 illustrates a graph of an example of a relationship between a hydrogen leading indicator, a trim catalyst/catalyst feed ratio, and a product parameter in accordance with embodiments described herein.

[0006] Figure 3 illustrates a diagram of an example of a non-transitory computer readable medium and processor in accordance with embodiments described herein.

Summary

[0007] A method including a) polymerizing at least one monomer in a gas phase reactor in the presence of a supported multimodal catalyst system comprising at least two different catalyst compounds to form a multimodal polyethylene product having a reactor split equal to respective weight fractions of resin components in the polyethylene product; b) applying a predetermined formula for a product parameter of the multimodal polyethylene product; c) obtaining incorporation data and production rate data from the reaction based upon the predetermined formula; d) determining an actual hydrogen leading indicator; e) comparing the actual hydrogen leading indicator to a target value for a hydrogen leading indicator to determine a deviation of the actual hydrogen leading indicator from the target value for the hydrogen leading indicator; and f) adjusting an amount of a catalyst precursor for forming at least one of the two different catalyst compounds and being fed to the gas phase reactor to control reactor split equal to respective weight fractions of resin components in the polyethylene product and the product parameter of the polyethylene product, where the catalyst precursor is activated and forms at least one of the catalyst compounds of the supported catalysts in the gas phase reactor and wherein the adjusted amount of catalyst precursor is based upon data obtained in c) and the deviation determined in e).

[0007a] In one aspect, the present disclosure refers to a method to control reactor split and a product parameter of a polyethylene product in a multimodal polymerization reaction comprising:

a) polymerizing at least one monomer in a gas phase reactor in the presence of a supported multimodal catalyst system comprising at least two different catalyst compounds to form a multimodal polyethylene product having a reactor split equal to respective weight fractions of resin components in the polyethylene product;

b) applying a predetermined formula for a product parameter of the multimodal polyethylene product, wherein the product parameter is flow index and the predetermined formula is Flow Index = $e^{\{A+C[H2_{mol}:C2_{mol}]+D[C6_{mol}:C2_{mol}]+E(ICA_{pp})\}} * (HMW_{mol}: LMW_{mol})^{B}$

wherein A is an intercept determined from a best fit line, and B, C, D, and E are slope terms determined from the best fit line, $H2_{mol}$:$C2_{mol}$ is the molar ratio of hydrogen to ethylene, $C6_{mol}$:$C2_{mol}$ is the molar ratio of hexene to ethylene, ICApp is the induced condensing agent partial pressure, and HMW_{mol}: LMW_{mol} is the molar ratio of the high molecular weight fraction to the low molecular weight fraction;

c) obtaining incorporation data and production rate data from the reaction based upon the predetermined formula;

d) determining an actual hydrogen leading indicator, wherein the hydrogen leading indicator is a H2/C2 flow ratio;

e) comparing the actual hydrogen leading indicator to a target value for a hydrogen leading indicator to determine a deviation of the actual hydrogen leading indicator from the target value for the hydrogen leading indicator; and

f) adjusting an amount of a catalyst precursor for forming at least one of the two different catalyst compounds and being fed to the gas phase reactor to control reactor split equal to respective weight fractions of resin components in the polyethylene product and the product parameter of the polyethylene product wherein the catalyst precursor is activated and forms at least one of the catalyst compounds of the supported catalysts in the gas phase reactor and wherein the adjusted amount of catalyst precursor is based upon data obtained in c) and the deviation determined in e).

[0008] A non-transitory computer-readable storage medium comprising instructions when executed by a processor are to perform a) to f), as described above. The above summary of the disclosure is not intended to describe each disclosed embodiment or every implementation of the disclosure.

[0008a] In another aspect, the present disclosure refers to a non-transitory computer-readable storage medium comprising instructions to control reactor split and a product parameter of polyethylene product in a multimodal polymerization reaction that when executed by a processor are to:

a) polymerize at least one monomer in a gas phase reactor in the presence of a supported catalyst comprising at least two different catalyst compounds to form a multimodal polyethylene product having a reactor split equal to respective weight fractions of resin components in the polyethylene product;

b) apply a predetermined formula for flow index of the multimodal polyethylene product, wherein the product parameter is flow index and the predetermined formula is Flow Index = $e^{\{A+C[H2_{mol}:C2_{mol}]+D[C6_{mol}:C2_{mol}]+E(ICA_{pp})\}} * (HMW_{mol}: LMW_{mol})^{B}$

wherein A is an intercept determined from a best fit line, and B, C, D, and E are slope terms determined from the best fit line, $H2_{mol}$:$C2_{mol}$ is the molar ratio of hydrogen to ethylene, $C6_{mol}$:$C2_{mol}$ is the molar ratio of hexene to ethylene, ICApp is the induced condensing agent partial pressure, and HMW_{mol}: LMW_{mol} is the molar ratio of the high molecular weight fraction to the low molecular weight fraction;

c) obtain incorporation data and production rate data from the reaction based upon the predetermined formula;

d) determine an actual hydrogen leading indicator, wherein the hydrogen leading indicator is a H2/C2 flow ratio;

e) compare the actual hydrogen leading indicator to a target value for a hydrogen leading indicator to determine a deviation of the actual hydrogen leading indicator from the target value for the hydrogen leading indicator; and

f) adjust an amount of a catalyst precursor for forming at least one of the two different catalyst compounds and being fed to the gas phase reactor to control reactor split equal to respective weight fractions of resin components in the polyethylene product and the product parameter of the polyethylene product wherein the catalyst precursor is activated and forms at least one of the catalyst compounds of the supported catalysts in the gas phase reactor and wherein the adjusted amount of catalyst precursor is based upon data obtained in c) and the deviation determined in e).

Detailed Description

[0009] Methods and non-transitory computer-readable storage medium for controlling reactor split and a product parameter based on a hydrogen leading indicator are described

Claims

What is claimed:

1. A method to control reactor split and a product parameter of a polyethylene product in a multimodal polymerization reaction comprising:

a) polymerizing at least one monomer in a gas phase reactor in the presence of a supported multimodal catalyst system comprising at least two different catalyst compounds to form a multimodal polyethylene product having a reactor split equal to respective weight fractions of resin components in the polyethylene product;

b) applying a predetermined formula for a product parameter of the multimodal polyethylene product, wherein the product parameter is flow index and the predetermined formula is Flow Index = $e^{\{A+C[H2_{mol}:C2_{mol}]+D[C6_{mol}:C2_{mol}]+E(ICA_{pp})\}} * (HMW_{mol}: LMW_{mol})^{B}$

wherein A is an intercept determined from a best fit line, and B, C, D, and E are slope terms determined from the best fit line, $H2_{mol}$:$C2_{mol}$ is the molar ratio of hydrogen to ethylene, $C6_{mol}$:$C2_{mol}$ is the molar ratio of hexene to ethylene, ICApp is the induced condensing agent partial pressure, and HMW_{mol}: LMW_{mol} is the molar ratio of the high molecular weight fraction to the low molecular weight fraction;

c) obtaining incorporation data and production rate data from the reaction based upon the predetermined formula;

d) determining an actual hydrogen leading indicator, wherein the hydrogen leading indicator is a H2/C2 flow ratio;

e) comparing the actual hydrogen leading indicator to a target value for a hydrogen leading indicator to determine a deviation of the actual hydrogen leading indicator from the target value for the hydrogen leading indicator; and

f) adjusting an amount of a catalyst precursor for forming at least one of the two different catalyst compounds and being fed to the gas phase reactor to control reactor split equal to respective weight fractions of resin components in the polyethylene product and the product parameter of the polyethylene product wherein the catalyst precursor is activated and forms at least one of the catalyst compounds of the supported catalysts in the gas phase reactor and wherein the adjusted amount of catalyst precursor is based upon data obtained in c) and the deviation determined in e).

2. The method of Claim 1 wherein the catalyst precursor is an unsupported catalyst precursor compound.

3. The method of any one of the preceding claims, wherein the supported multimodal catalyst comprises at least one metallocene catalyst compound, a Group 15 metal-containing compound, or a combination thereof.

4. The method of any one of the preceding claims wherein the multimodal catalyst system comprises two of more of (pentamethylcyclopentadienyl)(propylcyclopentadienyl)MX_2, (tetramethylcyclopentadienyl)(propylcyclopentadienyl)MX_2, (tetramethylcyclopentadienyl)(butylcyclopentadienyl)MX_2, $Me_2Si(indenyl)_2MX_2$, $Me_2Si(tetrahydroindenyl)_2MX_2$, (n-propyl cyclopentadienyl)$_2MX_2$, (n-butyl cyclopentadienyl)$_2MX_2$, (1-methyl, 3-butyl cyclopentadienyl)$_2MX_2$, $HN(CH_2CH_2N(2,4,6\text{-}Me_3phenyl))_2MX_2$, $HN(CH_2CH_2N(2,3,4,5,6\text{-}Me_5phenyl))_2MX_2$, (propyl cyclopentadienyl)(tetramethylcyclopentadienyl)MX_2, (butyl cyclopentadienyl)$_2MX_2$, and (propyl cyclopentadienyl)$_2MX_2$, wherein M is zirconium or hafnium, and X is selected from F, Cl, Br, I, Me, benzyl, CH_2SiMe_3, C_2 to C_5 alkyls, and C_2 to C_5 alkenyls.

5. The method of claim 1 wherein the multimodal polyethylene product is a bimodal polyethylene.

6. The method of claim 1 wherein the hydrogen leading indicator is the H2/C2 flow ratio divided by a H2/C2 molar composition ratio.

7. The method of claim 1 including activating the catalyst precursor by contacting the catalyst precursor with methylaluminoxane in the gas phase reactor.

8. A non-transitory computer-readable storage medium comprising instructions to control reactor split and a product parameter of polyethylene product in a multimodal polymerization reaction that when executed by a processor are to:

a) polymerize at least one monomer in a gas phase reactor in the presence of a supported catalyst comprising at least two different catalyst compounds to form a multimodal

polyethylene product having a reactor split equal to respective weight fractions of resin components in the polyethylene product;

b) apply a predetermined formula for flow index of the multimodal polyethylene product, wherein the product parameter is flow index and the predetermined formula is Flow Index = $e^{\{A+C[H2_{mol}:C2_{mol}]+D[C6_{mol}:C2_{mol}]+E(ICA_{pp})\}} * (HMW_{mol}: LMW_{mol})^{B}$

wherein A is an intercept determined from a best fit line, and B, C, D, and E are slope terms determined from the best fit line, $H2_{mol}$:$C2_{mol}$ is the molar ratio of hydrogen to ethylene, $C6_{mol}$:$C2_{mol}$ is the molar ratio of hexene to ethylene, ICApp is the induced condensing agent partial pressure, and HMW_{mol}: LMW_{mol} is the molar ratio of the high molecular weight fraction to the low molecular weight fraction;

c) obtain incorporation data and production rate data from the reaction based upon the predetermined formula;

d) determine an actual hydrogen leading indicator, wherein the hydrogen leading indicator is a H2/C2 flow ratio;

e) compare the actual hydrogen leading indicator to a target value for a hydrogen leading indicator to determine a deviation of the actual hydrogen leading indicator from the target value for the hydrogen leading indicator; and

f) adjust an amount of a catalyst precursor for forming at least one of the two different catalyst compounds and being fed to the gas phase reactor to control reactor split equal to respective weight fractions of resin components in the polyethylene product and the product parameter of the polyethylene product wherein the catalyst precursor is activated and forms at least one of the catalyst compounds of the supported catalysts in the gas phase reactor and wherein the adjusted amount of catalyst precursor is based upon data obtained in c) and the deviation determined in e).