13X, available from UOP, LLC. MOLSIV-13X is alkali aluminum silicate having the general formula, $Na_x[(AlO_2)_x(SiO_2)_y] \cdot z\ H_2O$, wherein it is not a hybrid with alumina.

The present invention provides a process for recycling the solvent used in an ethylene-based solvent polymerization process, and a system therefor, which results in a catalyst efficiency dip of less than or equal to 20% when purification beds are swapped.

SUMMARY ~~OF THE INVENTION~~

The instant ~~invention~~disclosure is a process for recycling a solvent used in an ethylene-based polymerization reaction and a system therefor.

In one embodiment, the instant ~~invention~~disclosure provides a process for recycling solvent used in an ethylene-based polymerization comprising: passing a solvent stream which has been used in a first ethylene-based solvent polymerization reactor through an online purification bed to produce a recycle solvent stream, wherein the solvent stream prior to being passed through the online purification bed comprises solvent, ethylene, hydrogen, polymerization by-products and optionally comonomer; and passing the recycle solvent stream from the online purification bed to a second ethylene-based solvent polymerization reactor; wherein the second ethylene-based solvent polymerization reactor exhibits a catalyst efficiency dip of less than or equal to 20% for no longer than a forty-eight hour period following a swap of the online purification bed to a regenerated purification bed which contains an adsorbent having low reactivity to alkenes.

In a first aspect, there is provided a process for recycling solvent used in an ethylene-based polymerization comprising:

passing a solvent stream which has been used in a first ethylene-based solvent polymerization reactor through an online purification bed to produce a recycle solvent stream,

wherein the solvent stream prior to being passed through the online purification bed comprises solvent, ethylene, hydrogen, polymerization by-products and optionally comonomer; and

passing the recycle solvent stream from the online purification bed to a second ethylene-based solvent polymerization reactor;

wherein the second ethylene-based solvent polymerization reactor exhibits a catalyst efficiency dip of less than or equal to 20% for no longer than a forty-eight hour period following a swap of the online purification bed to a regenerated purification bed which contains an adsorbent which, upon exposure to a chlorooctane and ethylene produces less than or equal to 650 mg ethylene dimer/(kg adsorbent * h).

In an alternative embodiment, the instant ~~invention~~disclosure further provides a system for recycling a solvent used in an ethylene-based polymerization reaction comprising: an ethylene-based solvent polymerization reactor, wherein the ethylene-based solvent polymerization reactor utilizes a solvent thereby producing a solvent stream; an online purification bed, wherein the purification bed is configured to accept the solvent stream; and a regenerated purification bed containing an adsorbent having a low reactivity to alkenes, wherein the online and regenerated purification beds are configured to permit a swap between the purification beds for accepting the solvent stream.

In a second aspect, there is provided a system for recycling a solvent used in an ethylene-based polymerization reaction comprising:

an ethylene-based solvent polymerization reactor, wherein the ethylene-based solvent polymerization reactor utilizes a solvent thereby producing a solvent stream;

an online purification bed, wherein the purification bed is configured to accept the solvent stream; and

a regenerated purification bed containing an adsorbent which, upon exposure to a chlorooctane and ethylene produces less than or equal to 650 mg ethylene dimer/(kg adsorbent * h), wherein the online and regenerated purification beds are configured to permit a swap between the beds for accepting the solvent stream, and wherein upon such swap, the regenerated purification bed exhibits a catalyst efficiency dip of less than or equal to 20% for no longer than a forty-eight hour period following the swap.

In an alternative embodiment, the instant ~~invention~~disclosure provides a process for recycling solvent used in an ethylene-based polymerization and a system for recycling a solvent used in an ethylene-based polymerization reaction, in accordance with any of the preceding embodiments, except that the first and second ethyelene-based solvent polymerization reactors are the same reactor.

In an alternative embodiment, the instant ~~invention~~disclosure provides a process for recycling solvent used in an ethylene-based polymerization and a system for recycling a solvent used in an ethylene-based polymerization reaction, in accordance with any of the preceding embodiments, except that the first and second ethylene-based solvent polymerization reactors are different reactors.

In an alternative embodiment, the instant ~~invention~~disclosure provides a process for recycling solvent used in an ethylene-based polymerization and a system for recycling a solvent used in an ethylene-based polymerization reaction, in accordance with any of the preceding embodiments, except that the adsorbent is a hybrid zeolite/modified alumina adsorbent.

In an alternative embodiment, the instant ~~invention~~disclosure provides a process for recycling solvent used in an ethylene-based polymerization and a system for recycling a solvent used in an ethylene-based polymerization reaction, in accordance with any of the preceding embodiments, except that the adsorbent is an alumina-zeolite composite or hybrid comprising an alkali metal aluminosilicate having the general formula $Na_x[(AlO_2)_x(SiO_2)_y] \cdot z\ H_2O$ hybrid with alumina.

In an alternative embodiment, the instant ~~invention~~disclosure provides a process for recycling solvent used in an ethylene-based polymerization and a system for recycling a solvent used in an ethylene-based polymerization reaction, in accordance with any of the preceding embodiments, except that the catalyst efficiency dip is 12% or less.

In an alternative embodiment, the instant ~~invention~~disclosure provides a process for recycling solvent used in an ethylene-based polymerization and a system for recycling a solvent used in an ethylene-based polymerization reaction, in accordance with any of the preceding embodiments, except that the catalyst efficiency dip is 6% or less.

In an alternative embodiment, the instant ~~invention~~disclosure provides a process for recycling solvent used in an ethylene-based polymerization and a system for recycling a solvent used in an ethylene-based polymerization reaction, in accordance with any of the preceding embodiments, except that the catalyst efficiency dip is 2% or less.

In an alternative embodiment, the instant ~~invention~~disclosure provides a process for recycling solvent used in an ethylene-based polymerization and a system for recycling a solvent used in an ethylene-based polymerization reaction, in accordance with any of the preceding embodiments, except that at least one of the first and second ethylene-based solvent polymerization reactors contains a coordination catalyst.

In an alternative embodiment, the instant ~~invention~~disclosure provides a process for recycling solvent used in an ethylene-based polymerization and a system for recycling a solvent used in an ethylene-based polymerization reaction, in accordance with any of the preceding embodiments, except that at least one of the first and second ethylene-based solvent polymerization reactors contains a Ziegler-Natta catalyst.

In an alternative embodiment, the instant ~~invention~~disclosure provides a process for recycling solvent used in an ethylene-based polymerization and a system for recycling a solvent used in an ethylene-based polymerization reaction, in accordance with any of the preceding embodiments, except that at least one of the first and second ethylene-based solvent polymerization reactors contains a molecular catalyst, such as a constrained geometry catalyst.

In an alternative embodiment, the instant ~~invention~~disclosure provides a process for recycling solvent used in an ethylene-based polymerization and a system for recycling a solvent used in an ethylene-based polymerization reaction, in accordance with any of the preceding embodiments, except that the recycle solvent further comprises a component selected from the group consisting of calcium stearate, the reaction by-products of calcium stearate, and combinations thereof.

In an alternative embodiment, the instant ~~invention~~disclosure provides a process for recycling solvent used in an ethylene-based polymerization and a system for recycling a solvent used in an ethylene-based polymerization reaction, in accordance with any of the preceding embodiments, except that the recycle solvent further comprises a component selected from the group consisting of a hydrotalcite or hydrotalcite-type material the reaction by-products of the hydrotalcite or hydrotalcite-type material , and combinations thereof.

In an alternative embodiment, the instant ~~invention~~disclosure provides a process for recycling solvent used in an ethylene-based polymerization and a system for recycling a solvent used in an ethylene-based polymerization reaction, in accordance with any of the preceding embodiments, except that the adsorbent having low reactivity to alkenes is an alumina-zeolite composite comprising an alkali metal aluminosilicate having the general formula $Na_x[(AlO_2)_x(SiO_2)_y] \cdot z\ H_2O$ hybrid with alumina.

In an alternative embodiment, the instant ~~invention~~disclosure provides a process for recycling solvent used in an ethylene-based polymerization and a system for recycling a solvent used in an ethylene-based polymerization reaction, in accordance with any of the preceding embodiments,

except that the ethylene-based solvent polymerization reactor is a solution polymerization reactor.

In an alternative embodiment, the instant ~~invention~~disclosure provides a process for recycling solvent used in an ethylene-based polymerization and a system for recycling a solvent used in an ethylene-based polymerization reaction, in accordance with any of the preceding embodiments, except that the ethylene-based solvent polymerization reactor is a slurry reactor.

In an alternative embodiment, the instant ~~invention~~disclosure provides a process for recycling solvent used in an ethylene-based polymerization and a system for recycling a solvent used in an ethylene-based polymerization reaction, in accordance with any of the preceding embodiments, except that the solution polymerization or slurry reactor comprises one or more loop reactors, isothermal reactors, pipe flow reactors, stirred tank reactors, batch reactors in parallel or series or combinations thereof.

In an alternative embodiment, the instant ~~invention~~disclosure provides a process for recycling solvent used in an ethylene-based polymerization consisting essentially of: passing a solvent stream which has been used in a first ethylene-based solvent polymerization reactor through an online purification bed to produce a recycle solvent stream, wherein the solvent stream prior to being passed through the online purification bed comprises solvent, ethylene, hydrogen, polymerization by-products and optionally comonomer; and passing the recycle solvent stream from the online purification bed to a second ethylene-based solvent polymerization reactor; wherein the second ethylene-based solvent polymerization reactor exhibits a catalyst efficiency dip of less than or equal to 20% for no longer than a forty-eight hour period following a swap of the online purification bed to a regenerated purification bed which contains an adsorbent having low reactivity to alkenes.

In an alternative embodiment, the instant ~~invention~~disclosure further provides a system for recycling a solvent used in an ethylene-based polymerization reaction consisting essentially of: an ethylene-based solvent polymerization reactor, wherein the ethylene-based solvent polymerization reactor utilizes a solvent thereby producing a solvent stream; an online purification bed, wherein the purification bed is configured to accept the solvent stream; and a regenerated purification bed containing an adsorbent having a low reactivity to alkenes, wherein the online and regenerated purification beds are configured to permit a swap between the purification beds for accepting the solvent stream.