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[Continued on next page]

(54) **Title**: PROCESSES FOR MINIMIZING CATALYST FINES IN A REGENERATOR FLUE GAS STREAM

(57) **Abstract**: Process for minimizing the amount of catalyst fines in a flue gas from a catalyst regenerator. Pyrolysis oil is injected into the reaction zone, preferably downstream from the feed stream inlet. The catalyst fines will be passed along with the hydrocarbon effluent stream and can be removed with a filter or other similar device. The amount of pyrolysis oil can be controlled, for example, based upon the opacity of the flue gas from the catalyst regenerator, or based upon the amount of catalyst injected into the reaction zone.

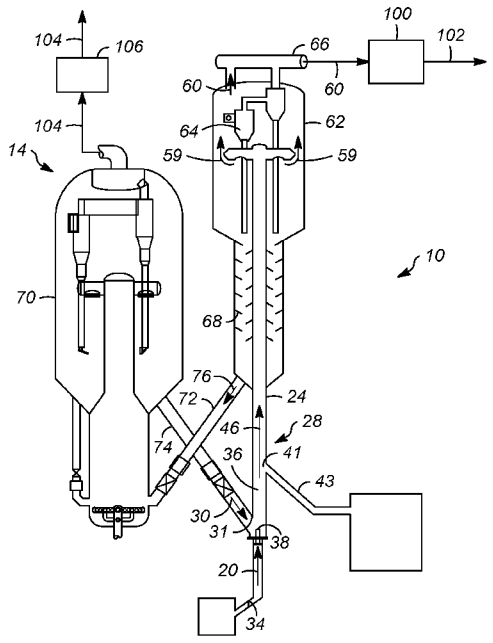


FIG 1

WO 2016/171936 A1

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PROCESSES FOR MINIMIZING CATALYST FINES IN A REGENERATOR FLUE GAS STREAM

STATEMENT OF PRIORITY

This application claims priority to U.S. Application No. 14/693644 which was filed April 22, 2015, the contents of which are hereby incorporated by reference in its entirety.

FIELD OF THE INVENTION

The present invention relates generally to methods for upgrading a hydrocarbon stream to make fuel, and more particularly to processes for catalytically cracking a hydrocarbon stream.

BACKGROUND OF THE INVENTION

Fluid catalytic cracking (FCC) is a well-known process for the conversion of relatively high boiling point hydrocarbons to lower boiling point hydrocarbons in the heating oil or gasoline range. Such processes are commonly referred to in the art as "upgrading" processes. To conduct FCC processes, FCC units are generally provided that have one or more reaction zones, with a hydrocarbon stream contacted in the one or more reaction zones with a particulate cracking catalyst. The particulate cracking catalyst is maintained in a fluidized state under conditions that are suitable for the conversion of the relatively high boiling point hydrocarbons to lower boiling point hydrocarbons. The catalyst particles and cracked hydrocarbon effluent are separated and the catalyst particles can be passed to a regenerator to remove coke to provide a regenerated catalyst. The regenerated catalyst can be used in the reaction zone with fresh feed and the process repeats itself.

Overtime, the catalyst particles can begin to breakdown and produce catalyst fines. The loss of catalyst fines from an FCC regenerator flue stack either to the environment, or to downstream equipment, such as a turbo expander, is a well-known issue. With ever-tightening restrictions on particulate emissions and the addition of power recovery equipment on the flue gas many FCC operators are forced to utilize expensive equipment, such as third stage separators, scrubbers and electrostatic precipitators, to remove the catalyst fines.

Therefore, it would be desirable to provide a process or processes in which the catalyst fines can be effectively and efficiently removed.

It would also be desirable for such processes to minimize the fines in the regenerator flue gas without the use of expensive equipment.

SUMMARY OF THE INVENTION

One or more processes have been invented to reduce the amount of catalyst fines in a flue gas from a catalyst regenerator by utilizing a pyrolysis oil in the reaction zone.

In a first aspect of the invention, the present invention may be broadly characterized as providing a process for reducing an amount of catalyst fines in a regenerator flue gas by injecting a hydrocarbon stream into a reaction zone, the reaction zone including a stream of fluidized catalyst and configured to crack hydrocarbons and form an effluent stream; injecting a biomass-derived pyrolysis oil stream into the reaction zone; and separating the effluent stream from the fluidized catalyst in a separation zone to provide a hydrocarbon effluent stream and a catalyst stream, the hydrocarbon effluent stream including catalyst fines.

In one or more embodiments of the present invention, the process includes regenerating catalyst from the stream of fluidized catalyst to provide a regenerated catalyst, and introducing the regenerated catalyst into the reaction zone.

In at least one embodiment of the present invention, an inlet for the biomass-derived pyrolysis oil stream is downstream of an inlet for the hydrocarbon stream.

In some embodiments of the present invention, the process includes removing catalyst fines from the hydrocarbon effluent stream.

In various embodiments of the present invention, the biomass-derived pyrolysis oil stream comprises between 30 to 55 wt % oxygen.

In one or more embodiments of the present invention, an amount of biomass-derived pyrolysis oil injected into the reaction zone is based upon an amount of catalyst injected into the reaction zone.

In various embodiments of the present invention, a ratio of biomass-derived pyrolysis oil carbon injected to catalyst injected comprises, at a minimum, 0.001 kg of pyrolysis oil carbon/kg of catalyst and is calculated by (A x B)/C, wherein A represents a pyrolysis oil weight fraction of total liquid feed, and wherein B represents a non-oxygen

weight fraction of the pyrolysis oil, and wherein C represents a catalyst to hydrocarbon oil mass ratio.

In at least one embodiment of the present invention, an amount of the catalyst fines in the catalyst stream is reduced as compared to an amount of catalyst fines in the catalyst stream when no biomass-derived pyrolysis oil is injected.

In a second aspect of the present invention, the present invention may be broadly characterized as providing a process for reducing an amount of catalyst fines in a regenerator flue gas by: injecting a hydrocarbon stream into a reaction zone, the reaction zone including a stream of fluidized catalyst injected therein and configured to crack hydrocarbons and form an effluent stream; injecting a pyrolysis oil stream into the reaction zone; controlling an amount of pyrolysis oil injected into the reaction zone in order to reduce the catalyst fines in a flue gas stream; and, separating the effluent stream from the fluidized catalyst in a separation zone to provide a hydrocarbon effluent stream and a catalyst stream.

In one or more embodiments of the present invention, an inlet for the pyrolysis oil is disposed downstream an inlet for the hydrocarbon stream. It is contemplated that the process further comprises determining an opacity of the flue gas stream and controlling the amount of pyrolysis oil injected into the reaction zone based upon the opacity of the flue gas.

In some embodiments of the present invention, the pyrolysis oil comprises between 30 to 55 wt% oxygen.

In various embodiments of the present invention, a ratio of pyrolysis oil carbon injected to catalyst injected comprises, at least, 0.001 kg of pyrolysis oil carbon per kg of catalyst and is calculated by (A x B)/C, wherein A represents a pyrolysis oil weight fraction of total liquid feed, and wherein B represents a non-oxygen weight fraction of the pyrolysis oil, and wherein C represents a catalyst to hydrocarbon oil mass ratio.

In one or more embodiments of the present invention, the process includes removing catalyst fines from at least a portion of the hydrocarbon effluent stream. It is contemplated that the catalyst fines are removed from the at least a portion of the hydrocarbon effluent stream in a filtration zone.

In some embodiments of the present invention, the amount of pyrolysis oil injected into the reaction zone is controlled based upon an amount of catalyst injected into the reaction zone.

In various embodiments of the present invention, the process includes passing the catalyst stream to a regeneration zone having at least one regeneration vessel and configured to remove coke from the catalyst and provide a regenerated catalyst. It is contemplated that the process also includes passing the regenerated catalyst to the reaction zone. It is also contemplated that the regeneration zone also provides the flue gas stream. It is further contemplated that the amount of pyrolysis oil injected into the reaction zone is controlled based upon an opacity of the flue gas.

Additional aspects, embodiments, and details of the invention, which may be combined in any manner, are set forth in the following detailed description of the invention.

DETAILED DESCRIPTION OF THE DRAWINGS

One or more exemplary embodiments of the present invention will be described below in conjunction with the following drawing figures, in which:

Figure 1 shows a schematic diagram of a fuel processing apparatus that may be utilized in one or more embodiment of the present invention; and,

Figure 2 shows a graph illustrating the principles of one or more embodiments of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

As mentioned above, one or more processes have been invented to reduce the amount of catalyst fines in a flue gas from a regenerator in a fuel processing for upgrading a hydrocarbon stream are provided herein. As referred to herein, “upgrading” refers to conversion of relatively high boiling point hydrocarbons to lower boiling point hydrocarbons. Upgrading processes generally render the hydrocarbon stream suitable for use as a transportation fuel. In the methods of the present invention, pyrolysis oil is injected into the reaction zone to minimize the amount of catalyst fines vented to the atmosphere in a flue gas.

While not intending to be bound by any particular theory, it is believed that the phenols and heavier molecules in the pyrolysis oil will stick to the catalyst fines. When the effluent and catalyst particles are separated, the catalyst fines (generally understood to be less than 40 micron particle size) (and heavy pyrolysis oil molecules) will pass along with the hydrocarbon effluent—as opposed to being separated with the catalyst particles. This should

result in less catalyst fines passing to the regenerator, and less catalyst particles in the flue gas from the regenerator.

With these general principles in mind, one or more embodiments of the present invention will be described with the understanding that the following description is not intended to be limiting.

As shown in Figure 1, an exemplary embodiment of a method for minimizing the catalyst fines in will now be addressed with reference to an exemplary fuel processing apparatus 10 which includes a fluid catalytic cracking (FCC) unit 14 that receives a hydrocarbon stream 20. As referred to herein, "hydrocarbon stream" refers to a petroleum-based source of hydrocarbons. The hydrocarbon stream 20 is introduced into a reaction zone 28 via an inlet 38 as described in further detail below. The hydrocarbon stream 20 can include a fresh stream of hydrocarbons, or can include a refined stream of hydrocarbons from other refinement operations. In an embodiment, the hydrocarbon stream 20 is vacuum gas oil (i.e., hydrocarbons with a boiling point between 343 to 552 °C (649 to 1026 °F)), which is a common hydrocarbon stream 20 that is upgraded in FCC units; however other streams may include heavy bottoms from crude oil, heavy bitmen crude oil, shale oil, tar sand extract, deasphalted residue, products from coal liquefaction, atmospheric and vacuum reduced crudes and mixtures thereof. It is to be appreciated that the hydrocarbon stream 20 may be provided from any source, and the methods described herein are not limited to providing the hydrocarbon stream 20 from any particular source.

In the exemplary FCC unit 14 contemplated herein, as shown in Figure 1, the FCC unit 14 includes the reaction zone 28, and a hydrocarbon feed line 34. The hydrocarbon feed line 34 has an inlet 38 for the hydrocarbon stream into the reaction zone 28. In the reaction zone 28, a particulate cracking catalyst 30 is contacted with the hydrocarbon stream 20 to form a mixture 46 of catalyst and hydrocarbons.

An inlet 41 for a pyrolysis oil stream 43 is disposed downstream of the inlet 38 for the hydrocarbon feed line 34, preferably such that the pyrolysis oil is injected into the reaction zone 28 proximate the mixture 46 of catalyst and hydrocarbons. The pyrolysis oil in the pyrolysis oil stream 43 is preferably produced by pyrolyzing a biomass through fast pyrolysis. Fast pyrolysis is a process during which a biomass, such as wood waste, agricultural waste, biomass that is purposely grown and harvested for energy, and the like, is rapidly heated to between 450 to 600° C(842 to 1112 °F) in the absence of air. Under these

conditions, a pyrolysis vapor including organic vapors, water vapor, and pyrolysis gases is produced, along with char (which includes ash and combustible hydrocarbon solids). A portion of the pyrolysis vapor may be condensed in a condensing system to produce the pyrolysis oil stream. Pyrolysis oil is a complex, organic liquid having an oxygen content, and comprising various hydrocarbons and other molecules like phenols and water. The oxygen content of the pyrolysis oil can be from 30 to 60 wt %, such as from 40 to 55 wt %, based on the total weight of the pyrolysis oil stream 43. Pyrolysis oil with a higher weight percentage of oxygen includes a higher amount of water and a lower amount of phenolic compounds. In various embodiments of the present invention, it is preferred that the oxygen content of the pyrolysis oil is between 35 to 55 wt %, or between 35 to 48 wt % so as to provide a pyrolysis oil having an acceptable phenolic composition. Additionally, a preferred biomass may comprise a highly ligneous material such as wood (particularly from conifers), as it is believed that such materials will provide a pyrolysis oil with a high percentage of phenolic compounds. As mentioned above, it is believed that the heavy phenolic compounds in the pyrolysis oil will adhere to the catalyst fines.

The amount of pyrolysis oil is controlled, or determined, preferably based upon the amount of catalyst injected into the reaction zone. In a preferred embodiment, a ratio of pyrolysis oil carbon injected to catalyst injected comprises at least (i.e., +/- 5%) 0.001 kg of pyrolysis oil carbon per kg of catalyst calculated by (A x B)/C, wherein A represents the pyrolysis oil weight fraction of total liquid feed, and wherein B represents the non-oxygen weight fraction of the pyrolysis oil, and wherein C represent the catalyst to hydrocarbon oil mass ratio. In some embodiments of the present invention, the maximum amount of pyrolysis oil may be 20% of the weight fraction of total liquid feed, or 5% of the weight fraction of total liquid feed. This maximum amount may be to minimize fouling of the reactor, separator, stripper or other equipment. However, in various embodiments, the amount of pyrolysis oil may be greater than 20% of the weight fraction of total liquid feed.

Returning to Figure 1, in the reaction zone 28, the hydrocarbons will catalytically crack in the presence of the particulate cracking catalyst 30. In a preferred embodiment, the reaction zone 28 of the FCC unit 14 is included in a vertical conduit or riser 24. The catalytic cracking of the mixture 46 of the hydrocarbon stream 20 and catalyst particles 30 produces an effluent 59 that includes coked particulate cracking catalyst 76 and a gaseous component 60. The gaseous component 60 includes products from the reaction in the

reaction zone 28 such as cracked hydrocarbons, and, as known in the art, the cracked hydrocarbons may be condensed to obtain upgraded fuel products that have a range of boiling points. Examples of upgraded fuel products include, but are not limited to, propane, butane, naphtha, light cycle oil, and heavy fuel oil. In accordance with an embodiment of the contemplated method, the coked particulate cracking catalyst 76 and the gaseous component 60 are separated.

In this embodiment, and as shown in Figure 1, the FCC unit 14 further includes a separator vessel 62 that is in fluid communication with the reaction zone 28. The separator vessel 62 facilitates separation of the effluent 59 into the coked particulate cracking catalyst 76 and the gaseous component 60. The separator vessel 62 may include a solids-vapor separation device 64, which is normally located within and at the top of the separator vessel 62. The gaseous component 60 of the effluent 59 is separated from the coked particulate cracking catalyst 76 in the separator vessel 62, and the gaseous component 60 may be vented from the separator vessel 62 via a product line 66. As mentioned above, the catalyst fines are believed to be located within the gaseous component 60. Therefore, the present invention contemplated that the gaseous component be passed to a filtration zone 100 having a filter or other similar media that can remove the catalyst fines from the gaseous stream 60. From the filtration zone 100, a purified hydrocarbon stream 102 comprising the hydrocarbons from the gaseous component 60 can be processed further as is known in the art. It is contemplated that the filtration zone 100 is disposed after a separation column (not shown) in which the filtration zone 100 removes catalyst fines from a liquid bottom stream from the separation column. In such a configuration, the purified hydrocarbon stream 102 would comprise a slurry oil stream or a decanted oil stream.

Returning to Figure 1, the coked particulate cracking catalyst 76 may pass downward to a stripper 68 that is located in a lower part of the separator vessel 62. The stripper 68 assists with removing deposited compounds from the coked particulate cracking catalyst 76 prior to further catalyst regeneration. In an embodiment, the FCC unit 14 further includes a catalyst regenerator 70 that is in fluid communication with the separator vessel 62 and that is also in fluid communication with the reaction zone 28. The coked particulate cracking catalyst 76 that is separated from the gaseous component 60 is introduced into the catalyst regenerator 70 from the stripper 68, and deposited compounds are removed from the coked particulate cracking catalyst 76 in the catalyst regenerator 70 by contacting the coked

particulate cracking catalyst 76 with oxygen-containing regeneration gas. In one embodiment, the coked particulate cracking catalyst 76 is transferred to the catalyst regenerator 70 by way of a first transfer line 72 connected between the catalyst regenerator 70 and the stripper 68. Furthermore, the catalyst regenerator 70, being in fluid communication with the reaction zone 28, passes regenerated particulate catalyst 30 to the reaction zone 28. In the FCC unit 14 as depicted in the Figure, the particulate cracking catalyst 30 is continuously circulated from the reaction zone 28 to the catalyst regenerator 70 and then again to the reaction zone 28, such as through a second transfer line 74.

A flue gas 104 that is removed from the catalyst regenerator 70 will have lower amounts of catalyst fines. Therefore, it is contemplated that an opacity of the flue gas 104 is monitored, for example with an opacity dust density monitor 106 or other such equipment. Based upon the opacity of the flue gas 104, the amount of pyrolysis oil to be injected into the reaction zone can be determined. More specifically, if catalyst fines in the flue gas 104 are considered too high, the amount of pyrolysis oil being injected into the reaction zone 28 may be increased. This process may be automated, through the use of a control system (not shown), or it may be manual.

In the attached Figure 2 it is shown that the addition of pyrolysis oil to an FCC unit reduced the opacity of the regenerator flue gas. At 35.5 hours elapsed 1.5 gallons per minute of pyrolysis oil was added to the FCC. This resulted in the flue gas opacity dropping to zero in 1.5 hours. The opacity stayed at zero as the pyrolysis oil addition was increased. At 50 hours elapsed the opacity of the flue gas again rose slightly above zero at a slower rate than was found that it decreased. Between 35.5 and 50 hours elapsed the carbon content of the pyrolysis oil dropped from 54 wt % to 39 wt %. The FCC petroleum charge rate was 794 kg/min (1750 lbs/min) with the pyrolysis oil charge rate at 50 hours elapsed at 9 kg/min (20 lbs/min). The catalyst to hydrocarbon oil ratio was 4.8. The pyrolysis oil content was 39 wt%. At this point of breakthrough of fines to the regenerator flue gas at 50 hours elapsed time, the ratio of pyrolysis oil carbon to catalyst was (20 / 1750 x .39)/4.8 = .00092, just below the 0.001 ratio established as a minimum.

As will be appreciated, by utilizing pyrolysis oil in the FCC, the amount of catalyst fines in the flue gas of the catalyst regeneration zone can be reduced. Thus the particulate emissions of the flue gas can be lowered to achieve governmental or regulatory standards.

It should be appreciated and understood by those of ordinary skill in the art that various other components such as valves, pumps, filters, coolers, etc. were not shown in the drawings as it is believed that the specifics of same are well within the knowledge of those of ordinary skill in the art and a description of same is not necessary for practicing or understating the embodiments of the present invention.

SPECIFIC EMBODIMENTS

While the following is described in conjunction with specific embodiments, it will be understood that this description is intended to illustrate and not limit the scope of the preceding description and the appended claims.

A first embodiment of the invention is a process for reducing an amount of catalyst fines in a regenerator flue gas, the process comprising injecting a hydrocarbon stream into a reaction zone, the reaction zone including a stream of fluidized catalyst and configured to crack hydrocarbons and form an effluent stream; injecting a biomass-derived pyrolysis oil stream into the reaction zone; separating the effluent stream from the fluidized catalyst in a separation zone to provide a hydrocarbon effluent stream and a catalyst stream, the hydrocarbon effluent stream includes catalyst fines. An embodiment of the invention is one, any or all of prior embodiments in this paragraph up through the first embodiment in this paragraph further comprising regenerating the catalyst from the stream of fluidized catalyst to provide a regenerated catalyst; and, introducing the regenerated catalyst into the reaction zone. An embodiment of the invention is one, any or all of prior embodiments in this paragraph up through the first embodiment in this paragraph wherein an inlet for the biomass-derived pyrolysis oil stream is downstream of an inlet for the hydrocarbon stream. An embodiment of the invention is one, any or all of prior embodiments in this paragraph up through the first embodiment in this paragraph further comprising removing catalyst fines from the hydrocarbon effluent stream. An embodiment of the invention is one, any or all of prior embodiments in this paragraph up through the first embodiment in this paragraph wherein the biomass-derived pyrolysis oil stream comprises between 30 to 55 wt % oxygen. An embodiment of the invention is one, any or all of prior embodiments in this paragraph up through the first embodiment in this paragraph wherein an amount of biomass-derived pyrolysis oil injected into the reaction zone is based upon an amount of catalyst injected into

the reaction zone. An embodiment of the invention is one, any or all of prior embodiments in this paragraph up through the first embodiment in this paragraph wherein a ratio of biomass-derived pyrolysis oil carbon injected to catalyst injected comprises at least 0.001 kg of pyrolysis oil carbon/kg of catalyst and is calculated by (A x B)/C, wherein A represents a pyrolysis oil weight fraction of total liquid feed, and wherein B represents a non-oxygen weight fraction of the pyrolysis oil and wherein C represents a catalyst to hydrocarbon oil mass ratio. An embodiment of the invention is one, any or all of prior embodiments in this paragraph up through the first embodiment in this paragraph wherein an amount of the catalyst fines in the catalyst stream is reduced as compared to an amount of catalyst fines in the catalyst stream when no biomass-derived pyrolysis oil is injected.

A second embodiment of the invention is a process for reducing an amount of catalyst fines in a regenerator flue gas, the process comprising injecting a hydrocarbon stream into a reaction zone, the reaction zone including a stream of fluidized catalyst injected therein and configured to crack hydrocarbons and form an effluent stream; injecting a pyrolysis oil stream into the reaction zone; controlling an amount of pyrolysis oil injected into the reaction zone in order to reduce the catalyst fines in a flue gas stream; and, separating the effluent stream from the fluidized catalyst in a separation zone to provide a hydrocarbon effluent stream and a catalyst stream. An embodiment of the invention is one, any or all of prior embodiments in this paragraph up through the second embodiment in this paragraph wherein an inlet for the pyrolysis oil stream is disposed downstream an inlet for the hydrocarbon stream. An embodiment of the invention is one, any or all of prior embodiments in this paragraph up through the second embodiment in this paragraph further comprising determining an opacity of the flue gas stream and controlling the amount of pyrolysis oil injected into the reaction zone based upon the opacity of the flue gas. An embodiment of the invention is one, any or all of prior embodiments in this paragraph up through the second embodiment in this paragraph wherein the pyrolysis oil comprises between 30 to 55 wt% oxygen. An embodiment of the invention is one, any or all of prior embodiments in this paragraph up through the second embodiment in this paragraph wherein a ratio of pyrolysis oil carbon injected to catalyst injected comprises minimally 0.001 kg of pyrolysis oil carbon/kg of catalyst and is calculated by (A x B)/C, wherein A represents a pyrolysis oil weight fraction of total liquid feed, and wherein B represents a non-oxygen weight fraction of the pyrolysis oil and wherein C represents a catalyst to hydrocarbon oil mass ratio. An

embodiment of the invention is one, any or all of prior embodiments in this paragraph up through the second embodiment in this paragraph further comprising removing catalyst fines from at least a portion of the hydrocarbon effluent stream. An embodiment of the invention is one, any or all of prior embodiments in this paragraph up through the second embodiment in this paragraph wherein the catalyst fines are removed from the at least a portion of the hydrocarbon effluent stream in a filtration zone. An embodiment of the invention is one, any or all of prior embodiments in this paragraph up through the second embodiment in this paragraph wherein the amount of pyrolysis oil injected into the reaction zone is controlled based upon an amount of catalyst injected into the reaction zone. An embodiment of the invention is one, any or all of prior embodiments in this paragraph up through the second embodiment in this paragraph further comprising passing catalyst from the stream of fluidized catalyst to a regeneration zone having at least one regeneration vessel and configured to remove coke from the catalyst and provide a regenerated catalyst. An embodiment of the invention is one, any or all of prior embodiments in this paragraph up through the second embodiment in this paragraph further comprising passing the regenerated catalyst to the reaction zone. An embodiment of the invention is one, any or all of prior embodiments in this paragraph up through the second embodiment in this paragraph wherein the regeneration zone also provides the flue gas stream. An embodiment of the invention is one, any or all of prior embodiments in this paragraph up through the second embodiment in this paragraph wherein the amount of pyrolysis oil injected into the reaction zone is controlled based upon an opacity of the flue gas.

Without further elaboration, it is believed that using the preceding description that one skilled in the art can utilize the present invention to its fullest extent and easily ascertain the essential characteristics of this invention, without departing from the spirit and scope thereof, to make various changes and modifications of the invention and to adapt it to various usages and conditions. The preceding preferred specific embodiments are, therefore, to be construed as merely illustrative, and not limiting the remainder of the disclosure in any way whatsoever, and that it is intended to cover various modifications and equivalent arrangements included within the scope of the appended claims.

In the foregoing, all temperatures are set forth in degrees Celsius and, all parts and percentages are by weight, unless otherwise indicated.

CLAIMS

1. A process for reducing an amount of catalyst fines in a regenerator flue gas, the process comprising:

injecting a hydrocarbon stream (20) into a reaction zone (28), the reaction zone (28) including a stream of fluidized catalyst (38) injected therein and configured to crack hydrocarbons and form an effluent stream (59);

injecting a pyrolysis oil stream (43) into the reaction zone (28);

controlling an amount of pyrolysis oil injected into the reaction zone (28) in order to reduce the catalyst fines in a flue gas stream (104); and,

separating the effluent stream (59) from the fluidized catalyst (38) in a separation zone (62) to provide a hydrocarbon effluent stream (60) and a catalyst stream (76).

2. The process of claim 1 wherein an inlet (41) for the pyrolysis oil stream (43) is disposed downstream an inlet (38) for the hydrocarbon stream (20).

3. The process of claim 1 further comprising:

determining an opacity of the flue gas stream(104) and controlling the amount of pyrolysis oil (43) injected into the reaction zone (28) based upon the opacity of the flue gas (104).

4. The process of claim 1 wherein the pyrolysis oil (43) comprises between 30 to 55 wt% oxygen.

5. The process of any one of claims 1 to 4 wherein a ratio of pyrolysis oil carbon injected to catalyst injected comprises minimally 0.001 kg of pyrolysis oil carbon/kg of catalyst and is calculated by (A x B)/C, wherein A represents a pyrolysis oil weight fraction of total liquid feed, and wherein B represents a non-oxygen weight fraction of the pyrolysis oil, and wherein C represents a catalyst to hydrocarbon oil mass ratio.

6. The process of any one of claims 1 to 4 further comprising:

removing catalyst fines from at least a portion of the hydrocarbon effluent stream (60).

7. The process of claim 6 wherein the catalyst fines are removed from the at least a portion of the hydrocarbon effluent stream in a filtration zone 100.

8. The process of any one of claims 1 to 4 wherein the amount of pyrolysis oil (43) injected into the reaction zone (28) is controlled based upon an amount of catalyst injected into the reaction zone (28).

9. The process of any one of claims 1 to 4further comprising:

passing the catalyst stream (76) to a regeneration zone having at least one regeneration vessel (70) and configured to remove coke from the catalyst and provide a regenerated catalyst (30).

10. The process of claim 9 wherein the regeneration zone also provides a flue gas stream (104) and wherein an amount of pyrolysis oil (43) injected into the reaction zone (28) is controlled based upon an opacity of the flue gas (104).

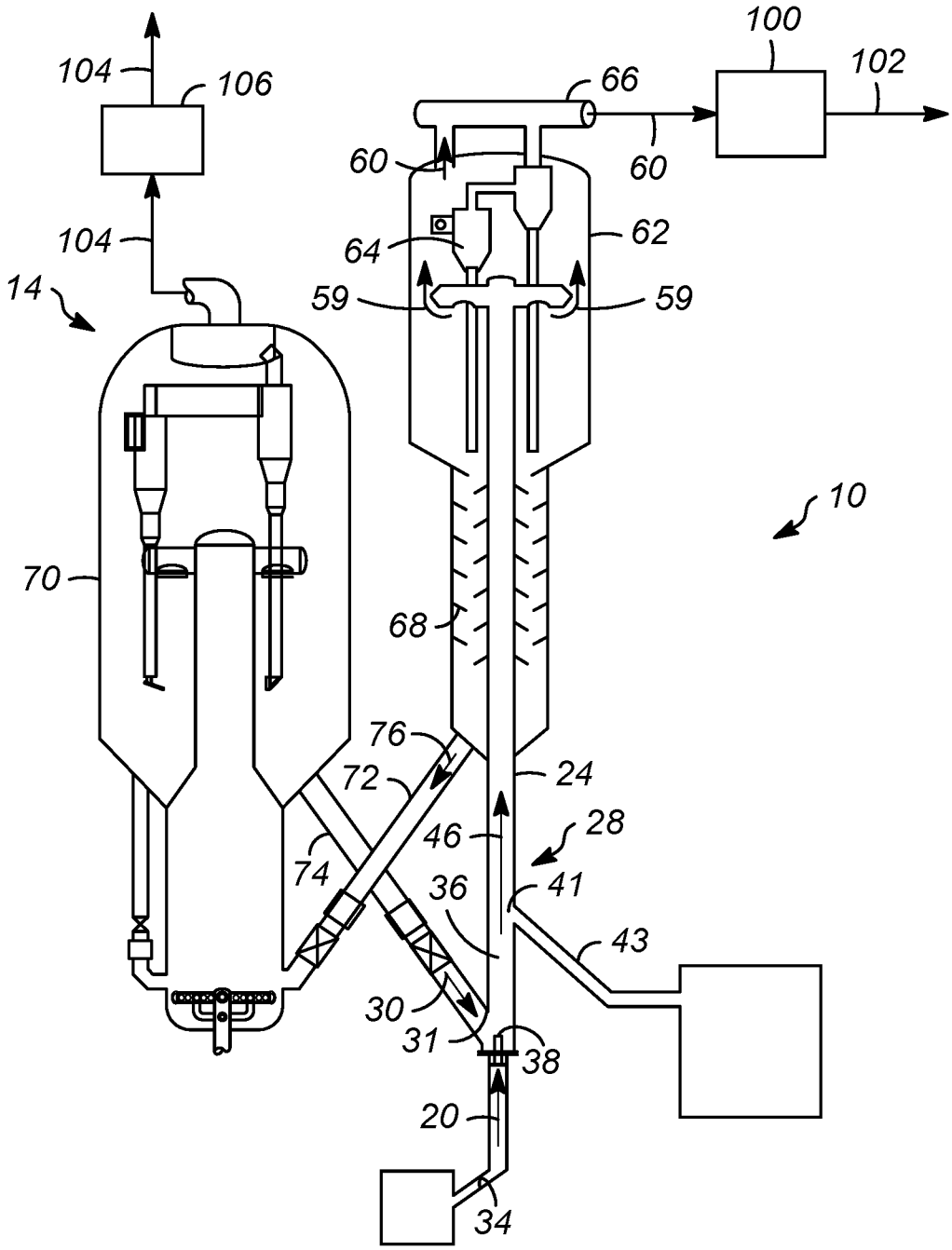

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FIG 1

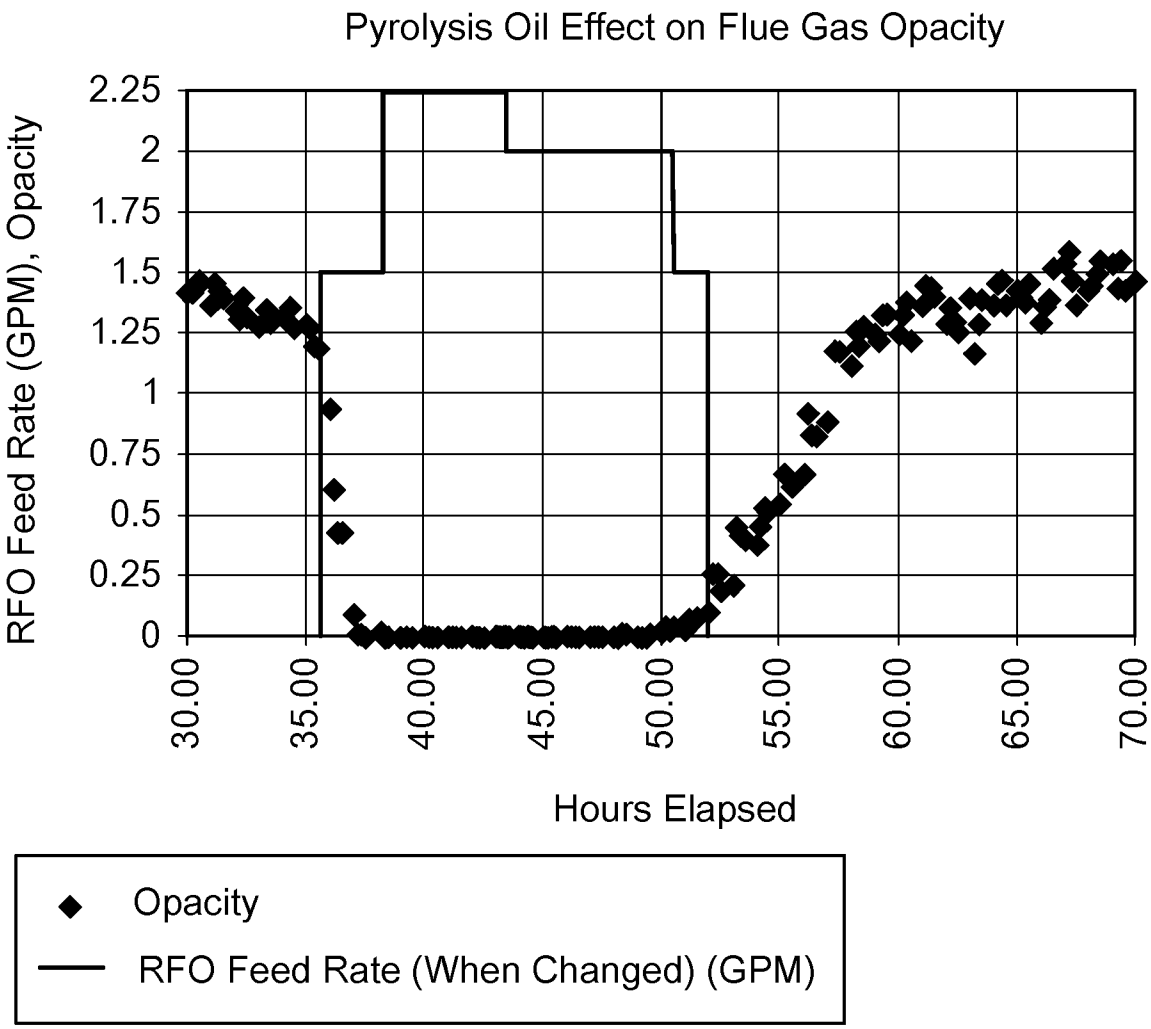

Pyrolysis Oil Effect on Flue Gas Opacity
RFO Feed Rate (GPM), Opacity
2.25
2
1.75
1.5
1.25
1
0.75
0.5
0.25
0
30.00
35.00
40.00
45.00
50.00
55.00
60.00
65.00
70.00
Hours Elapsed
Opacity
RFO Feed Rate (When Changed) (GPM)

FIG 2

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US 2016/026907

A. CLASSIFICATION OF SUBJECT MATTER

C10G 11/18 *(2006.01)*
B01D 47/00 *(2006.01)*

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

C10G 11/18, B01J 31/40, B01D 47/00

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EAPATIS, Espacenet, Google, PatSearch (RUPTO internal), RUPAT, RUPTO, ScienceDirect, USPTO, Patentscope

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 2014/0034554 A1 (UOP LLC) 06.02.2014, paragraphs [0003], [0007], [0009], [0017], [0019], [0021], [0032], [0033]	1-10
A	US 2014/0034550 A1 (UOP LLC) 06.02.2014, claims	1-10
A	US 6324895 B1 (MOBIL OIL CORPORATION) 04.12.2001, abstract, col. 2, lines 24-67	1-10

☐ Further documents are listed in the continuation of Box C.

☐ See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

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"O" document referring to an oral disclosure, use, exhibition or other means

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"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
11 July 2016 (11.07.2016)	08 September 2016 (08.09.2016)

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