

A SAMPLER



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FIELD OF THE INVENTION

The present invention relates to a sampler for retrieving samples of catalyst from a reactor excluding a tubular reactor, having catalyst beds on different levels throughout the reactor while the reactor is offline, a method of retrieving samples of catalyst from a reactor, excluding a tubular reactor, having catalyst beds on different levels throughout the reactor wherein top grids and inert balls are located on the beds, by the sampler and to a method of retrieving samples of catalyst from a reactor, excluding a tubular reactor, having catalyst beds on different levels throughout the reactor but not having top grids or inert balls on the beds by the sampler.

BACKGROUND ART

Catalyst sampler of the general type described herein are known, and usually comprise a sampling chamber or cavity located within a reactor, which chamber or cavity can be operated from outside the reactor to selectively obtain a catalyst sample and deliver same to a sample receiver while the reactor is at normal operating conditions.

The conventional catalyst samplers include a provision for manually operating a rotatable shaft to selectively obtain a catalyst from within the reactor and to deliver the sample to a receiver, all while the reactor is at operating conditions of high temperature

and pressure. The said samplers have proven quite satisfactory in many respects, and have been widely utilised in commercial refineries.

U.S. Patent No. 1,152,133 describes grain-triers having conical shaped bottom ends. In this patent, the relative positioning of the openings on the inner and outer tubes are manipulated by raising or lowering the valve.

A catalyst sampler of the general type to which this invention pertains is described in U.S. Patent No. 4,192,188. The catalyst sampler described therein is slotted into the fixed bed reactor from the bottom of the reactor and is used to safely withdrawing samples of particulate material such as a catalyst from a reaction vessel while it is operating at sub or super atmospheric conditions without altering such conditions. The US patent is provided with a purging connection to allow the introduction of inert gas for purging to ensure that the atmosphere of the environment within the fixed bed reactors remains unchanged. Also, a packing is provided at several levels throughout the length of the catalyst sampler between the outer and inner tubes to insure that catalyst does not enter the annulus between the outer and inner tubes.

All of the currently available samplers exhibit undesirable characteristics which limit their effective utilisation for the retrieval of particulate samples from fixed bed reactors without interrupting the reaction process.

There has accordingly been a need for a catalyst sampler which could enable a catalyst sample to be removed from a reactor whilst it is not operating. Such a sampler is provided by the present invention.

SUMMARY OF THE INVENTION

According to the present invention a sampler is provided for retrieving samples of catalyst from a reactor excluding a tubular reactor, having catalyst beds on different levels throughout the reactor, the sampler comprising an elongated outer tube, the outer tube having a drive means at top end of the outer tube, an opening located towards the bottom of the outer tube and an auger which is located below the opening, and an elongated inner tube, the inner tube having a drive means at top end of the inner tube, an opening located towards the bottom of the inner tube, wherein the inner tube having a dimension which allows the inner tube to be suitably slotted into the outer tube, wherein the openings are positioned suitably such that the openings can coincide when so desired and the tubes are made from a material which does not react physically or chemically with the catalyst, provided that the reactor must be taken offline prior to the retrieving of the samples of catalyst.

Further, there is also provided a method of retrieving samples of catalyst from a reactor, excluding a tubular reactor, having catalyst beds on different levels throughout the reactor wherein top grids and inert balls are located on the beds, by a sampler, the sampler comprising an elongated outer tube, the outer tube having a drive means at top end of the outer tube, an opening located towards the bottom of the outer tube and an auger which is located below the opening, and an elongated inner tube, the inner tube having a drive means at top end of the inner tube, an opening located towards the bottom of the inner tube, wherein the inner tube having a dimension which allows the inner tube to be suitably slotted into the outer tube, wherein the openings are positioned

suitably such that the openings can coincide when so desired and the tubes are made from a material which does not react physically or chemically with the catalyst, the method comprising the steps of a) taking the reactor offline, b) removing top portion of the reactor, c) removing the balls and grids from the beds, d) determining the depth and position of the samples of catalyst, e) marking the levels on the sampler at required heights, f) inserting the inner tube into the outer tube, g) closing the openings, h) inserting the sampler into the reactor, i) driving the drive means of the outer tube until the sampler reaches a predetermined height depth and j) rotating the outer and inner tubes suitably to open the openings which enables the catalyst to flow into the sampler by force of gravity.

Also provided a method of retrieving samples of catalyst from a reactor, excluding a tubular reactor, having catalyst beds on different levels throughout the reactor but not having top grids or inert balls on the beds, by a sampler, the sampler comprising an elongated outer tube, the outer tube having a drive means at top end of the outer tube, an opening located towards the bottom of the outer tube and an auger which is located below the opening, and an elongated inner tube, the inner tube having a drive means at top end of the inner tube, an opening located towards the bottom of the inner tube, wherein the inner tube having a dimension which allows the inner tube to be suitably slotted into the outer tube, wherein the openings are positioned suitably such that the openings can coincide when so desired and the tubes are made from a material which does not react physically or chemically with the catalyst, the method comprising the steps of a) taking the reactor offline, b) removing top portion of the reactor, c) determining the depth and position of the samples of catalyst, d) marking the levels on

the sampler at required heights, e) inserting the inner tube into the outer tube, f) closing the openings, g) inserting the sampler into the reactor, h) driving the drive means of the outer tube until the sampler reaches a predetermined height depth and i) rotating the outer and inner tubes suitably to open the openings which enables the catalyst to flow into the sampler by force of gravity.

The present invention consists of certain novel features and a combination of parts hereinafter fully described and illustrated in the accompanying drawings, and particularly pointed out in the appended claims, it being understood that various changes in the details may be without departing from the scope of the invention, or sacrificing any of the advantage of the present invention.

BRIEF DESCRIPTION OF THE DRAWINGS

For the purpose of facilitating an understanding of the invention, there is illustrated in the accompanying drawings the preferred embodiments thereof, from an inspection of which, when considered in connection with the following description, the invention, its construction and operation, and many of its advantages should be readily understood and appreciated.

FIG. 1 is a side view of an elongated outer tube according to the preferred embodiment of the invention;

FIG. 2 is a side view of an elongated inner tube according to the preferred embodiment of the invention;

FIG. 3 is an exploded view of an auger and an opening located at the elongated outer tube of FIG. 1 according to the preferred embodiment of the invention;

FIG. 4 is an exploded view of an opening located at the elongated inner tube of FIG. 1 according to the preferred embodiment of the invention;

FIG. 5 is an exploded view of a coupling located at the elongated outer tube of FIG. 1 according to the preferred embodiment of the invention;

FIG. 6 is an exploded view of a coupling located at the elongated inner tube of FIG. 1 according to the preferred embodiment of the invention;

FIG. 7A is a top plan view of a handle for the elongated outer tube according to the preferred embodiment of the invention;

FIG. 7B is a side view of a handle for the elongated outer tube according to the preferred embodiment of the invention;

FIG. 8A is a top plan view of a handle for the elongated inner tube according to the preferred embodiment of the invention;

FIG. 8B is a side view of a handle for the elongated inner tube according to the preferred embodiment of the invention;

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

The present invention relates to a sampler (1) for retrieving samples of catalyst from a reactor excluding a tubular reactor, having catalyst beds on different levels throughout the reactor while the reactor is offline, a method of retrieving samples of catalyst from a reactor, excluding a tubular reactor, having catalyst beds on different levels throughout the reactor wherein top grids and inert balls are located on the beds, by the sampler (10) and to a method of retrieving samples of catalyst from a reactor, excluding a tubular reactor, having catalyst beds on different levels throughout the reactor but not having top grids or inert balls on the beds by the sampler (10).

Hereinafter, this specification will describe the sampler (10) and the methods of the present invention according to the preferred embodiment and by referring to the accompanying drawings. However, it is to be understood that limiting the description to the preferred embodiment of the invention and with reference to the accompanying drawings is merely to facilitate discussion of the present invention and it is envisioned that those skilled in the art may devise various modifications and equivalents without departing from the scope of the appended claims.

FIGS. 1 and 2 show the elongated outer and inner tubes (12, 20) respectively according to the preferred embodiment of the invention. As shown in FIG. 1, the outer tube (12) is provided with a drive means (14) at top end of the outer tube (12), the drive means (14) is preferably but not necessarily a handle. FIGS. 7A and 7B show the top plan view and

side view of the handle for the elongated outer tube (12), respectively according to the preferred embodiment of the invention.

There is also provided an opening (16) located towards the bottom of the outer tube (12) and an auger (18) which is located below the opening (16). The auger (18) preferably but not necessarily to be in the form of a corkscrew-shaped tool.

FIG. 3 shows an exploded view of the auger (18) and an opening (16) located at the elongated outer tube (12) of FIG. 1 according to the preferred embodiment of the invention. The pushing and screwing effects of the auger (18), as applied manually by an operator, facilitates and assists smooth entry of the sampler (10) into the beds of hard densely packed catalyst beads. The corkscrew configuration of the bottom of the outer tube (12) also ensures minimal (if any) damage to the brittle catalyst beads by virtue of its smooth rounded edges.

FIG. 2 is now referred. There is shown an elongated inner tube (20) which is provided with a drive means (22) at top end of the inner tube (20), the drive means (22) preferably but not necessarily is a handle. FIGS. 8A and 8B show the top plan view and the side view of a handle for the elongated inner tube (20), respectively according to the preferred embodiment of the invention.

Understandably, the inner tube (20) having a dimension, which allows the inner tube (20) to be suitably slotted into the outer tube (12). For instance, the diameter of the inner

tube (20) is smaller than the outer tube (12) such that the inner tube (20) can be slotted into the outer tube (12).

FIG. 4 is an exploded view of an opening (24) located at the elongated inner tube (20) of FIG. 1 according to the preferred embodiment of the invention. The openings (16, 24) of the outer and inner tubes (12, 20) are positioned suitably such that the openings (16, 24) can coincide when so desired and the tubes (12, 20) are made from a material which does not react physically or chemically with the catalyst. Even though not shown in any of the accompanying drawings, there are markings in the handle and top part of the sampler (10) (i.e. the top part which is not submerged) to indicate to the operator the required angles of turning of the inner tube (20) to ensure that first the two openings (16, 24) coincide, and then to ensure that the openings (16, 24) do not coincide so that the catalyst sample is retained inside the sampler (10).

FIGS. 5 and 6 are the exploded views of couplings (26, 28) located at the elongated outer and inner tubes (12, 20), respectively, of FIG. 1 according to the preferred embodiment of the invention. These couplings (26, 28) are provided to enable the handles to be attached to the tubes (12, 20) and to enable the handles to be rotated.

The tubes (12, 20) are made from a material which does not react physically or chemically with the catalyst. Preferably, the material is stainless-steel.

Another advantage of the sampler (10) is that the various tubes joined to give the required total height and/or length can be easily dismantled, and the dimensions of the

tubes (12, 20) (about 5 cm in diameter) enables the sampler (10) to be packed and unpacked using portable containers/suitcases thus facilitating its transportation.

Some of the reactors are provided with top grids and inert balls at the catalyst beds and some are not. The sampler (10) of the present invention is capable to retrieve samples of catalyst from both types of reactors.

As mentioned earlier, the present invention also provides a method of retrieving samples of catalyst from a reactor, excluding a tubular reactor, having catalyst beds on different levels throughout the reactor wherein top grids and inert balls are located on the beds, by a sampler (10), the sampler (10) comprising an elongated outer tube (12), the outer tube (12) having a drive means (14) at top end of the outer tube (12), an opening (16) located towards the bottom of the outer tube (12) and an auger (18) which is located below the opening (16), and an elongated inner tube (20), the inner tube (20) having a drive means (22) at top end of the inner tube (20), an opening (24) located towards the bottom of the inner tube (20), wherein the inner tube (20) having a dimension which allows the inner tube (20) to be suitably slotted into the outer tube (12), wherein the openings (16, 24) are positioned suitably such that the openings (16, 24) can coincide when so desired and the tubes (12, 20) are made from a material which does not react physically or chemically with the catalyst, the method comprising the steps of a) taking the reactor offline, b) removing top portion of the reactor, c) removing the balls and grids from the beds, d) determining the depth and position of the samples of catalyst, e) marking the levels on the sampler (10) at required heights, f) inserting the inner tube (20) into the outer tube (12), g) closing the openings (16, 24), h) inserting the

sampler (10) into the reactor, i) driving the drive means (14) of the outer tube (12) until the sampler (10) reaches a predetermined height depth, and j) rotating the outer and inner tubes (12, 20) suitably to open the openings (16, 24) which enables the catalyst to flow into the sampler (10) by force of gravity.

Also as described, the present invention also describes a method of retrieving samples of catalyst from a reactor, excluding a tubular reactor, having catalyst beds on different levels throughout the reactor but not having top grids or inert balls on the beds, by a sampler (10), the sampler (10) comprising an elongated outer tube (12), the outer tube (12) having a drive means (14) at top end of the outer tube (12), an opening (16) located towards the bottom of the outer tube (12) and an auger (18) which is located below the opening (16), and an elongated inner tube (20), the inner tube (20) having a drive means (22) at top end of the inner tube (20), an opening (24) located towards the bottom of the inner tube (20), wherein the inner tube (20) having a dimension which allows the inner tube (20) to be suitably slotted into the outer tube (12), wherein the openings (16, 24) are positioned suitably such that the openings (16, 24) can coincide when so desired and the tubes (12, 20) are made from a material which does not react physically or chemically with the catalyst, the method comprising the steps of a) taking the reactor offline, b) removing top portion of the reactor, c) determining the depth and position of the samples of catalyst, d) marking the levels on the sampler (10) at required heights, e) inserting the inner tube (20) into the outer tube (12), f) closing the openings (16, 24), g) inserting the sampler (10) into the reactor, h) driving the drive means (14) of the outer tube (12) until the sampler (10) reaches a predetermined height depth, and i) rotating the

outer and inner tubes (12, 20) suitably to open the openings (16, 24) which enables the catalyst to flow into the sampler (10) by force of gravity.

While in the foregoing specification this invention has been described in relation to certain preferred embodiments thereof, and many details have been set forth for purpose of illustration, it will be apparent to those skilled in the art that the invention is susceptible to additional embodiments and that certain of the details described herein can be varied considerably without departing from the basic principles of the invention.

CLAIMS

1. A sampler (10) for retrieving samples of catalyst from a reactor excluding a tubular reactor, having catalyst beds on different levels throughout the reactor, the sampler comprising:
 - a) an elongated outer tube (12), the outer tube (12) having a drive means (14) at top end of the outer tube (12), an opening (16) located towards the bottom of the outer tube (12) and an auger (18) which is located below the opening (16), and
 - b) an elongated inner tube (20), the inner tube (20) having a drive means (22) at top end of the inner tube (20), an opening (24) located towards the bottom of the inner tube (20), wherein the inner tube (20) having a dimension which allows the inner tube (20) to suitably slotted into the outer tube (12),wherein the openings (16, 24) are positioned suitably such that the openings (16, 24) can coincide when so desired and the tubes (12, 20) are made from a material which does not react physically or chemically with the catalyst, provided that the reactor must be taken offline prior to the retrieving of the samples of catalyst.
2. A sampler (10) as claimed in claim 1, wherein the drive means (14) of the outer tube (12) is a handle.
3. A sampler (10) as claimed in claim 1, wherein the drive means (22) of the inner tube (20) is a handle.

4. A sampler (10) as claimed in claim 1, wherein the auger (18) is a corkscrew-shaped tool.
5. A sampler (10) as claimed in claim 1, wherein the diameter of the inner tube (20) is smaller than the outer tube (12) such that the inner tube (20) can be slotted into the outer tube (12).
6. A sampler (10) as claimed in claim 1, wherein the material is stainless-steel.
7. A sampler (10) as claimed in claim 1, wherein the outer tube (12) is joined with as many numbers of tubes as possible to increase the total length and/or height of the sampler (10).
8. A sampler (10) as claimed in claim 1, wherein the inner tube (20) is joined with as many numbers of tubes as possible to increase the total length and/or height of the sampler (10).
9. A sampler (10) as claimed in claims 7 and 8, wherein various tubes joined to give the required total height and/or length can be dismantled.
10. A sampler (10) as claimed in claim 9, wherein the sampler (10) can be packed and unpacked using portable containers/suitcases thus facilitating its transportation.

11. A sampler (10) as claimed in claim 1, wherein the sampler (10) is able to retrieve samples of catalyst from a reactor having top grids and inert balls.
12. A sampler (10) as claimed in claim 1, wherein the sampler (10) is able to retrieve samples of catalyst from a reactor having no top grids or inert balls.
13. A method of retrieving samples of catalyst from a reactor, excluding a tubular reactor, having catalyst beds on different levels throughout the reactor wherein top grids and inert balls are located on the beds, by a sampler (10), the sampler (10) comprising an elongated outer tube (12), the outer tube (12) having a drive means (14) at top end of the outer tube (12), an opening (16) located towards the bottom of the outer tube (12) and an auger (18) which is located below the opening (16), and an elongated inner tube (20), the inner tube (20) having a drive means (22) at top end of the inner tube (20), an opening (24) located towards the bottom of the inner tube (20), wherein the inner tube (20) having a dimension which allows the inner tube (20) to be suitably slotted into the outer tube (12), wherein the openings (16, 24) are positioned suitably such that the openings (16, 24) can coincide when so desired and the tubes (12, 20) are made from a material which does not react physically or chemically with the catalyst, the method comprising the steps of:
 - a) taking the reactor offline,
 - b) removing top portion of the reactor,
 - c) removing the balls and grids from the beds,
 - d) determining the depth and position of the samples of catalyst,
 - e) marking the levels on the sampler (10) at required heights,

- f) inserting the inner tube (20) into the outer tube (12),
- g) closing the openings (16, 24),
- h) inserting the sampler (10) into the reactor,
- i) driving the drive means (14) of the outer tube (12) until the sampler (10) reaches a predetermined height depth, and
- j) rotating the outer and inner tubes (12, 20) suitably to open the openings (16, 24) which enables the catalyst to flow into the sampler (10) by force of gravity.

14. A method as claimed in claim 13, wherein the drive means (14) of the outer tube (12) is a handle.

15. A method as claimed in claim 13, wherein the drive means (22) of the inner tube (20) is a handle.

16. A method as claimed in claim 13, wherein the auger (18) is a corkscrew-shaped tool.

17. A method as claimed in claim 13, wherein the diameter of the inner tube (20) is smaller than the outer tube (12) such that the inner tube (20) can be slotted into the outer tube (12).

18. A method as claimed in claim 13, wherein the material is stainless-steel.

19. A method as claimed in claim 13, wherein the outer tube (12) is joined with as many numbers of tubes as possible to increase the total length and/or height of the sampler (10).
20. A method as claimed in claim 13, wherein the inner tube (20) is joined with as many numbers of tubes as possible to increase the total length and/or height of the sampler (10).
21. A method as claimed in claims 19 and 20, wherein various tubes joined to give the required total length and/or height can be dismantled.
22. A method as claimed in claim 21, wherein the sampler (10) can be packed and unpacked using portable containers/suitcases thus facilitating its transportation.
23. A method as claimed in claim 13, wherein the outer and inner tubes (12, 20) are rotated clockwise and anticlockwise to open the openings (16, 24).
24. A method of retrieving samples of catalyst from a reactor, excluding a tubular reactor, having catalyst beds on different levels throughout the reactor but not having top grids or inert balls on the beds, by a sampler (10), the sampler (10) comprising an elongated outer tube (12), the outer tube (12) having a drive means (14) at top end of the outer tube (12), an opening (16) located towards the bottom of the outer tube (12) and an auger (18) which is located below the opening (16), and an elongated inner tube (20), the inner tube (20) having a drive means (22) at top

end of the inner tube (20), an opening (24) located towards the bottom of the inner tube (20), wherein the inner tube (20) having a dimension which allows the inner tube (20) to be suitably slotted into the outer tube (12), wherein the openings (16, 24) are positioned suitably such that the openings (16, 24) can coincide when so desired and the tubes (12, 20) are made from a material which does not react physically or chemically with the catalyst, the method comprising the steps of:

- a) taking the reactor offline,
- b) removing top portion of the reactor,
- c) determining the depth and position of the samples of catalyst,
- d) marking the levels on the sampler (10) at required heights,
- e) inserting the inner tube (20) into the outer tube (12),
- f) closing the openings (16, 24),
- g) inserting the sampler (10) into the reactor,
- h) driving the drive means (14) of the outer tube (12) until the sampler (10) reaches a predetermined height depth, and
- i) rotating the outer and inner tubes (12, 20) suitably to open the openings (16, 24) which enables the catalyst to flow into the sampler (10) by force of gravity.

25. A method as claimed in claim 24, wherein the drive means (14) of the outer tube (12) is a handle.

26. A method as claimed in claim 24, wherein the drive means (22) of the inner tube (20) is a handle.

27. A method as claimed in claim 24, wherein the auger (18) is a corkscrew-shaped tool.
28. A method as claimed in claim 24, wherein the diameter of the inner tube (20) is smaller than the outer tube (12) such that the inner tube (20) can be slotted into the outer tube (20).
29. A method as claimed in claim 24, wherein the material is stainless-steel.
30. A method as claimed in claim 24, wherein the outer tube (12) is joined with as many numbers of tubes as possible to increase the total length and/or height of the sampler (10).
31. A method as claimed in claims 29 and 30, wherein the inner tube (20) is joined with as many numbers of tubes as possible to increase the total length and/or height of the sampler (10).
32. A method as claimed in claim 31, wherein the inner tube (20) is joined with as many numbers of tubes as possible to increase the total height and/or length of the sampler (10).
33. A method as claimed in claim 20, wherein the outer and inner tubes (12, 20) are rotated clockwise and anticlockwise to open the openings (16, 24).