

Description

The present invention relates to a heat exchange system for spent fluid catalytic cracking particles according to the first part of claim 1 and a process for exchanging heat between spent fluid catalytic cracking particles and a heat exchange medium.

In EP-B-0 105 980 and US-A-4 582 120 heat exchange apparatus for use in the regeneration system of a fluid catalytic cracking FCC process are described which each comprise a housing of vertical orientation in which in the upper part an inlet opening for solid particles is provided and in which fluidization means are arranged for introducing fluidizing gas into the housing near the bottom thereof. In the apparatus of US-A-4 582 120 the fluidizing means are arranged so as to introduce fluidizing gas also intermediate the top and bottom of the housing. The inlet opening communicates with a reservoir of solid particles to be cooled, in particular a fluidized bed of fluid catalytic cracking catalyst. Heat exchange tubes are provided at least in the space defined between the fluidization means and the inlet opening. In the apparatus of US-A-4 582 120 and of EP-B-105 980 there are two ways for the cooled solid particles to be withdrawn. A first embodiment provides the withdrawal of solid particles at the bottom of the housing via a conduit and the cooled solid particles are subsequently re-introduced into the reservoir of solid particles by means of a standpipe and riser system. In a second embodiment cooled solid particles are withdrawn via the inlet opening. This is accomplished by the creation of a backmixing zone in the housing by means of the use of the fluidization gas entering the housing via the fluidization means.

The second embodiment eliminates the necessity to use expensive conduits, standpipes, riser pipes and auxiliary means such as valves and expansion joints. However, the mass transfer in this second embodiment is slower than in the first. Hence, the duty of the heat exchange tubes is worse. Moreover, it will be clear that mass transfer of cooled solid particles from the housing to the reservoir and hence the heat exchange duty of the apparatus will be less controllable than in the first embodiment.

It is the object of the invention to improve above apparatus such that the mass flow and hence the heat exchange performance of the apparatus is enhanced compared to the above second embodiment, whereas no need exists for expensive standpipes, valves, joints and the like. The improvement is attained by the features claimed in the characterising part of claim 1 and by the process according to claim 7.

Accordingly, the present invention provides a system for spent fluid catalytic cracking particles having apparatus for exchanging heat between the spent particles and a heat exchange medium, comprising a housing which housing is provided with aeration means with an inlet for an aeration fluid, with an inlet and an outlet opening for the particles, whereby an aeration zone is defined between the aeration means and the outlet opening, and with heat exchange means for the particles having inlet means and outlet means for the heat exchange medium and extending into at least part of the aeration zone, which inlet opening comprises an inlet conduit for the particles that extends into the aeration zone and which outlet opening is located at the end of the aeration zone.

By means of the aeration fluid a decrease in the density occurs, so that there will be a flow of a low-density mixture of solid particles and aeration fluid out of the housing and a flow of high-density solid particles entering the housing through the inlet conduit. By adapting the introduction rate of the aeration fluid the mass flow can easily be controlled. When in operation, the housing is usually in a vertical orientation. Accordingly, the present invention further provides a process for exchanging heat between solid particles and a heat exchange medium, comprising passing the solid particles downwards via an inlet conduit for solid particles into an aeration zone, aerating the solid particles in the aeration zone by introducing an aeration fluid into the aeration zone, thereby decreasing the density of the mixture of solid particles and aeration fluid, allowing the mixture with the decreased density to pass upwards between the inlet conduit and the housing along the inlet conduit and heat exchanger means, through which the heat exchange medium is passed, thereby allowing for the transfer of heat between the solid particles and the heat exchanger medium, and withdrawing the mixture of solid particles and aeration fluid above the aeration zone via an outlet opening.

The housing can have various shapes, depending on the spot where it is to be positioned or on the space that is available to it. Hence, the housing may have such shapes that its cross-section is square, oblong, elliptical or circular, and the housing may be in the shape of a block, a cone, a sphere or any cylinder. Preferably, the housing is substantially cylindrical. Such a shape allows for sufficient space for heat exchange means and avoids the occurrence of dead spots.

Through the outlet opening in the housing the mixture of solid particles and aeration fluid is withdrawn from the housing. It is preferably substantially circular or elliptical. When the housing has a vertical orientation, the outlet opening is suitably

arranged at the top of the aeration zone.

The inlet conduit for solid particles extends into the housing, in particular into the aeration zone, preferably into the region of the introduction of aeration fluid to the solid particles. It may enter the housing at various places but preferably it enters the housing at a place opposite to the aeration means. Advantageously, at least the part of the inlet conduit that extends into the aeration zone, is arranged coaxially to the housing, thereby allowing for a uniform distribution of the solid particles over the cross-section of the housing. From a constructional point of view it is preferred that not only this part, but also the rest of the inlet conduit is coaxially arranged to the housing. Preferably, the inlet conduit enters the housing via the outlet opening. More preferably the inlet conduit is concentric with the outlet opening, thereby providing a substantially annular opening between the housing and the inlet conduit as the outlet for the solid particles and the aeration fluid.

The aeration means can be any conventional means for introducing an aeration fluid into the housing, such as a grid through which aeration fluid is introduced. Preferably, the aeration means with aeration fluid inlet are arranged as a bundle of aeration conduits with on one end one or more perforations acting as the aeration means, and on the other end a connection to a source for the aeration fluid. These conduits may be arranged in the housing. The preferred aeration fluid is air, but it will be appreciated that other suitable fluids can be used, e.g. steam.

The aeration zone may suitably comprise secondary aeration means which are present in the aeration zone. By using such secondary aeration means the aeration rate in the aeration zone can be increased and thus the mass transfer can be enhanced. The secondary aeration means may comprise a separate grid, or conduits that debouch into the aeration zone. Preferably the secondary aeration means is provided by one or more perforations in the side wall of the aeration conduits that are described above.

The heat exchange means can be any conventional device for transferring heat from one medium to another. So, it is possible to provide plates or coils as the heat exchange means. Preferably the heat exchange means is arranged as a bundle of tubes, thereby facilitating the solution to expansion or contraction problems. Even more preferred the heat exchange means is carried out as tubes of the bayonet type wherein tubes are arranged into one another and wherein one end of the tubes is not connected to other components of the heat exchanger means such as a manifold serving as inlet and/or outlet means for the heat exchange medium. Such a construction minimizes any problem that

might occur due to expansion or contraction of the heat exchanger components. The preferred heat exchange medium comprises water and/or steam.

The apparatus according to the invention is suitably used for the transfer of heat between a heat exchange medium and solid particles. It is preferably used for cooling solid particles. The transfer of heat between the solid particles and the heat exchange medium can suitably be integrated with an endothermic reaction to take place within the heat exchange means. For instance, a heat exchange medium may be chosen which will endothermically be converted into more valuable products. Catalytic endothermic reactions can be established by including catalyst in the heat exchange means. If, for example, heat exchange means are provided as a bundle of tubes, the catalyst can suitably be included in the tubes in the form of fixed beds. An example of a reaction which may suitably take place in this manner in the heat exchange means is the endothermic catalytic dehydrogenation of LPG into olefins.

Advantageously the apparatus according to the invention is used in a fluid catalytic cracking process, cooling spent FCC catalyst particles which are regenerated. Spent FCC catalyst particles are catalyst particles that have been used in the FCC reactor to crack a hydrocarbonaceous feedstock thereby allowing for coke to be deposited onto them. The coke-containing particles are subsequently passed to a regenerator in which at least part of the coke is burned off. The thus regenerated catalyst particles are then again introduced into the FCC reactor.

When used in a fluid catalytic cracking process the apparatus according to the invention is suitably connected to the bottom of a fluid catalytic cracking regenerator. The use of the apparatus according to the invention in the regenerating process allows for a higher circulation rate of the catalyst particles through the regenerator, through the FCC reactor and back and/or for a complete combustion of the coke on the spent particles to carbon dioxide without incurring the risk of overheating the catalyst particles.

Figure 1 shows a schematic cross-section of an embodiment of the apparatus according to the invention.

Figure 2 shows schematically the arrangement of an apparatus according to the invention in a FCC regenerator.

In Figure 1 an apparatus is shown, comprising a housing (1), which housing comprises an aeration means (2,3), heat exchange means (4,5), and an outlet opening (15). The aeration means shown comprises the outlet 2 of a tube 3 which outlet is arranged at the bottom end of the tube 3. In the embodiment shown, the outlet 2 is at the bottom of

the tube 3. It will be clear that the tube may be provided with one or more perforations in the side wall of the tube in addition which perforations then may serve as secondary aeration means. The tube 3 is connected with an inlet manifold 6. Together the tube 3 and the manifold 6 serve as inlet for aeration fluid. The figure only shows one aeration tube. It is evident that the apparatus according to the invention may be provided with a multitude thereof. The heat exchange means comprises a bayonet type heat exchange system. It comprises an outer tube 4 and an inner tube 5. The inner tube 5 is in communication with an inlet conduit 8 via an inlet reservoir 7. The outer tube 4 communicates with an outlet conduit 10 via an outlet reservoir 9. The reservoirs 7 and 9 are defined by the housing 1 and walls 11 and 12. The figure only shows one set of an inner and outer tube. It is evident that in practice the apparatus may contain many of such sets. Both the aeration means/inlets and the heat exchange means may be fastened to the housing by securing means (not shown). The apparatus is further provided with an inlet conduit for solid particles 13. This conduit may be provided with a collecting means 14 having the shape of an inverted truncated cone.

The apparatus operates as follows. Via the collecting means 14 and the inlet conduit 13, solid particles, in particular FCC catalyst particles, are passed into the housing 1 and more particularly into the space defined between the aeration means 2 and the outlet opening 15, indicated as aeration zone. By the introduction of aeration medium via the aeration means 2 the density of the solid particles-aeration fluid mixture is lowered when compared with the density of the solid particles entering the housing via the inlet conduit 13. Whereby an upward flow is accomplished of the particles along the heat exchanger system and the inlet conduit 13. During the contact with the heat exchange system the upwardly moving particles are subjected to heat exchange with a heat exchange medium. The heat exchange medium is passed via inlet 8 and reservoir 7 into the inner tube 5 debouching into the outer tube 4. In tube 4 the heat exchange medium is passed downwards and in the meantime heat exchange can occur between the particles and the heat exchange medium. The medium then enters the outlet reservoir 9 and is withdrawn via the outlet conduit 10. When steam of a relatively high pressure, e.g. 40-100 bar is produced, in the case where water is used as heat exchange medium, the wall 12 is preferably curved to withstand such pressures. The particles moving upward are discharged from the housing via the outlet opening 15.

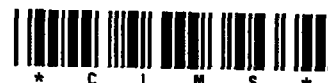
Figure 2 shows a fluid catalytic cracking regenerator 21 comprising an inlet for spent catalyst 22

and an outlet 23 for regenerated catalyst. The level of the catalyst bed in the regenerator 21 is indicated by the dotted line 24. Via a conduit 26 a fluidization fluid, generally air, is passed to a fluidization grid 25, and the catalyst particles in the regenerator are fluidized while coke is burned off them. Fluidization fluid and combustion gases are discharged from the regenerator via outlet 27. Between the outlet 27 and the catalyst level 24 separation means such as cyclones may be provided. At the bottom of the regenerator an apparatus according to the present invention is arranged. The apparatus comprises a housing 28. In the housing an aeration means is present. In the drawing the aeration means is indicated as an aeration grid 32. Aeration fluid, e.g. air, is passed to the aeration means via a line 33. The housing further comprises a heat exchange means 29, indicated as a coil, through which a heat exchange medium is passed via an inlet line 30 and an outlet line 31. From the catalyst bed an inlet conduit 34 for catalyst particles extends into the housing.

The embodiment of figure 2 operates as follows. Spent FCC catalyst particles are passed from a reactor (not shown) to the regenerator via the inlet 22. The catalyst particles are fluidized and coke on the particles is combusted by means of air which also serves as the fluidization fluid, the air being introduced into the regenerator via fluidization means 25. Catalyst particles enter the inlet conduit 34 and, due to the aeration at the bottom of the housing 28, a lowering of the density of the material at the bottom is accomplished and this material, i.e. a mixture of catalyst particles and aeration fluid, is forced upwards between the inlet conduit 34 and housing 1 and along the heat exchange means 29, thereby allowing heat to be transferred between the catalyst particles and the heat exchange medium passed through the means 29. When the mixture of catalyst particles and aeration fluid reaches the outlet opening 35 the aeration fluid is dissipated.

Claims

1. A heat-exchange system for spent fluid catalytic cracking particles having apparatus for exchanging heat between the spent particles and a heat exchange medium, the apparatus comprising a housing (1) which housing is provided with aeration means (2, 3) having inlet means (6) for aeration fluid, with an inlet opening (14) and an outlet opening (15) for the particles, whereby an aeration zone is defined between the aeration means and the outlet opening, and with heat exchange means (4, 5) for the particles having inlet means (8) and outlet means (10) for the heat exchange me-



the tube 3. It will be clear that the tube may be provided with one or more perforations in the side wall of the tube in addition which perforations then may serve as secondary aeration means. The tube 3 is connected with an inlet manifold 6. Together the tube 3 and the manifold 6 serve as inlet for aeration fluid. The figure only shows one aeration tube. It is evident that the apparatus according to the invention may be provided with a multitude thereof. The heat exchange means comprises a bayonet type heat exchange system. It comprises an outer tube 4 and an inner tube 5. The inner tube 5 is in communication with an inlet conduit 8 via an inlet reservoir 7. The outer tube 4 communicates with an outlet conduit 10 via an outlet reservoir 9. The reservoirs 7 and 9 are defined by the housing 1 and walls 11 and 12. The figure only shows one set of an inner and outer tube. It is evident that in practice the apparatus may contain many of such sets. Both the aeration means/inlets and the heat exchange means may be fastened to the housing by securing means (not shown). The apparatus is further provided with an inlet conduit for solid particles 13. This conduit may be provided with a collecting means 14 having the shape of an inverted truncated cone.

The apparatus operates as follows. Via the collecting means 14 and the inlet conduit 13, solid particles, in particular FCC catalyst particles, are passed into the housing 1 and more particularly into the space defined between the aeration means 2 and the outlet opening 15, indicated as aeration zone. By the introduction of aeration medium via the aeration means 2 the density of the solid particles-aeration fluid mixture is lowered when compared with the density of the solid particles entering the housing via the inlet conduit 13. Thereby an upward flow is accomplished of the particles along the heat exchanger system and the inlet conduit 13. During the contact with the heat exchange system the upwardly moving particles are subjected to heat exchange with a heat exchange medium. The heat exchange medium is passed via inlet 8 and reservoir 7 into the inner tube 5 debouching into the outer tube 4. In tube 4 the heat exchange medium is passed downwards and in the meantime heat exchange can occur between the particles and the heat exchange medium. The medium then enters the outlet reservoir 9 and is withdrawn via the outlet conduit 10. When steam of a relatively high pressure, e.g. 40-100 bar is produced, in the case where water is used as heat exchange medium, the wall 12 is preferably curved to withstand such pressures. The particles moving upward are discharged from the housing via the outlet opening 15.

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and an outlet 23 for regenerated catalyst. The level of the catalyst bed in the regenerator 21 is indicated by the dotted line 24. Via a conduit 26 a fluidization fluid, generally air, is passed to a fluidization grid 25, and the catalyst particles in the regenerator are fluidized while coke is burned off them. Fluidization fluid and combustion gases are discharged from the regenerator via outlet 27. Between the outlet 27 and the catalyst level 24 separation means such as cyclones may be provided. At the bottom of the regenerator an apparatus according to the present invention is arranged. The apparatus comprises a housing 28. In the housing an aeration means is present. In the drawing the aeration means is indicated as an aeration grid 32. Aeration fluid, e.g. air, is passed to the aeration means via a line 33. The housing further comprises a heat exchange means 29, indicated as a coil, through which a heat exchange medium is passed via an inlet line 30 and an outlet line 31. From the catalyst bed an inlet conduit 34 for catalyst particles extends into the housing.

The embodiment of figure 2 operates as follows. Spent FCC catalyst particles are passed from a reactor (not shown) to the regenerator via the inlet 22. The catalyst particles are fluidized and coke on the particles is combusted by means of air which also serves as the fluidization fluid, the air being introduced into the regenerator via fluidization means 25. Catalyst particles enter the inlet conduit 34 and, due to the aeration at the bottom of the housing 28, a lowering of the density of the material at the bottom is accomplished and this material, i.e. a mixture of catalyst particles and aeration fluid, is forced upwards between the inlet conduit 34 and housing 1 and along the heat exchange means 29, thereby allowing heat to be transferred between the catalyst particles and the heat exchange medium passed through the means 29. When the mixture of catalyst particles and aeration fluid reaches the outlet opening 35 the aeration fluid is dissipated.

Claims

1. A heat-exchange system for spent fluid catalytic cracking particles having apparatus for exchanging heat between the spent particles and a heat exchange medium, the apparatus comprising a housing (1) which housing is provided with aeration means (2, 3) having inlet means (6) for aeration fluid, with an inlet opening (14) and an outlet opening (15) for the particles, whereby an aeration zone is defined between the aeration means and the outlet opening, and with heat exchange means (4, 5) for the particles having inlet means (8) and outlet means (10) for the heat exchange me-



dium and extending into at least part of the aeration zone, characterized in that the inlet opening comprises an inlet conduit (14) for the particles that extends into the aeration zone and the outlet opening (15) is located at the end of the aeration zone.

2. A heat-exchange system according to claim 1, in which the housing (1) is substantially cylindrical.

3. A heat-exchange system according to claim 1 or 2, in which at least the part of the inlet conduit (14) for the particles that extends into the aeration zone is coaxially arranged in the housing (1).

4. A heat-exchange system according to any one of claims 1 to 3, in which the inlet conduit (14) is concentric with the outlet opening (15).

5. A heat-exchange system according to any one of claims 1 to 4, in which the aeration means (2,3) comprises a bundle of aeration conduits (3) each having at one end one or more perforations for introducing of the aeration fluid to the particles, and at the other end a connection (6) to a source for the aeration fluid.

6. A heat-exchange system according to any one of claims 1 to 5, in which the heat exchange means (4,5) comprises a bundle of tubes.

7. Process for exchanging heat between spent fluid catalytic cracking particles and a heat exchange medium, comprising passing the particles downwards via an inlet conduit (14) into an aeration zone of a housing (1), aerating the particles in the aeration zone by introducing an aeration fluid into the aeration zone, thereby decreasing the density of the mixture of particles and aeration fluid, allowing the mixture with the decreased density to pass upwards between the inlet conduit (14) and the housing (1) along the inlet conduit and heat exchanger means (4,5), through which the heat exchange medium is passed, thereby allowing for the transfer of heat between the particles and the heat exchanger medium, and withdrawing the mixture of particles and aeration fluid above the aeration zone via an outlet opening (15).

8. Process according to claim 7, in which the heat exchange medium comprises water and/or steam.

9. Process according to claim 7 or 8, in which the heat exchange medium is capable of undergoing an endothermic reaction.

10. Process according to any one of claims 7 to 9, in which the aeration fluid is air.

Patentansprüche

1. Wärmeaustauschsystem für verbrauchte Teilchen aus dem fluidkatalytischen Cracken mit einer Vorrichtung zum Austauschen von Wärme zwischen den verbrauchten Teilchen und einem Wärmeaustauschmedium, welche Vorrichtung ein Gehäuse (1) aufweist, das mit Belüftungsmitteln (2, 3) mit Einlaßmitteln (6) für ein Belüftungsfuid, mit einer Einlaßöffnung (14) und einer Auslaßöffnung (15) für die Teilchen, wodurch zwischen den Belüftungsmitteln und der Auslaßöffnung eine Belüftungszone definiert wird, und mit sich in zumindest einen Teil der Belüftungszone erstreckenden Wärmeaustauschmitteln (4, 5) für die Teilchen mit Einlaßmitteln (8) und Auslaßmitteln (10) für das Wärmeaustauschmedium versehen ist, dadurch gekennzeichnet, daß die Einlaßöffnung eine Einlaßleitung (14) für die Teilchen aufweist, welche sich in die Belüftungszone erstreckt, und die Auslaßöffnung (15) am Ende der Belüftungszone liegt.

2. Wärmeaustauschsystem nach Anspruch 1, bei welchem das Gehäuse (1) im wesentlichen zylindrisch ist.

3. Wärmeaustauschsystem nach Anspruch 1 oder 2, bei welchem zumindest jener Teil der Einlaßleitung (14) für die Teilchen, der sich in die Belüftungszone hineinerstreckt, coaxial im Gehäuse (1) angeordnet ist.

4. Wärmeaustauschsystem nach einem der Ansprüche 1 bis 3, bei welchem die Einlaßleitung (14) konzentrisch mit der Auslaßleitung (15) ist.

5. Wärmeaustauschsystem nach einem der Ansprüche 1 bis 4, bei welchem die Belüftungsmittel (2, 3) ein Bündel von Belüftungsleitungen (3) aufweisen, von denen jede an einem Ende eine oder mehrere Perforationen zum Zuführen von Belüftungsfuid zu den Teilchen und am anderen Ende einen Anschluß (6) an eine Belüftungsfuidquelle aufweist.

6. Wärmeaustauschsystem nach einem der Ansprüche 1 bis 5, bei welchem die Wärmeaustauschmittel (4, 5) ein Bündel von Rohren aufweisen.



7. Verfahren zum Austauschen von Wärme zwischen verbrauchten Teilchen aus dem fluidkatalytischen Cracken und einem Wärmeaustauschmedium, welches das Leiten der Teilchen abwärts über eine Einlaßleitung (14) in eine Belüftungszone eines Gehäuses (1) umfaßt, das Belüften der Teilchen in der Belüftungszone durch Einbringen eines Belüftungsfluides in die Belüftungszone, wodurch die Dichte der Mischung aus Teilchen und Belüftungsfluid herabgesetzt wird, was es der Mischung verringerter Dichte gestattet, aufwärts zwischen die Einlaßleitung (14) und das Gehäuse (1) entlang der Einlaßleitung und Wärmeaustauschmitteln (4, 5) zu gelangen, durch welche das Wärmeaustauschmedium geleitet wird, wodurch eine Wärmeübertragung zwischen den Teilchen und dem Wärmeaustauschmedium ermöglicht wird, und das Abziehen der Mischung aus Teilchen und Belüftungsfluid oberhalb der Belüftungszone über eine Auslaßöffnung (15) umfaßt.
8. Verfahren nach Anspruch 7, bei welchem das Wärmeaustauschmedium Wasser und/oder Dampf umfaßt.
9. Verfahren nach Anspruch 7 oder 8, bei welchem das Wärmeaustauschmedium in der Lage ist, einer endothermen Reaktion zu unterliegen.
10. Verfahren nach einem der Ansprüche 7 bis 9, bei welchem das Belüftungsfluid Luft ist.

Revendications

Un système d'échange de chaleur pour des particules de craquage catalytique fluide usées comportant un appareil pour échanger de la chaleur entre les particules usées et un fluide d'échange de chaleur, l'appareil comprenant un logement (1) qui est pourvu d'un moyen d'aération (2,3) avec une entrée (6) pour un fluide d'aération, avec une ouverture d'entrée (14) et une ouverture de sortie (15) pour les particules, de sorte qu'une zone d'aération est définie entre le moyen d'aération et l'ouverture de sortie, et avec un moyen d'échange de chaleur (4,5) pour les particules comportant un moyen d'entrée (8) et un moyen de sortie (10) pour le fluide d'échange de chaleur et s'étendant dans au moins une partie de la zone d'aération, caractérisé en ce que l'ouverture d'entrée comprend un conduit d'entrée (14) pour les particules qui s'étend dans la zone d'aération et en ce que l'ouverture de sortie (15) est située à l'extrémité de la zone d'aéra-

tion.

2. Un système d'échange de chaleur selon la revendication 1, dans lequel le logement (3) est substantiellement cylindrique.
3. Un système d'échange de chaleur selon la revendication 1 ou 2, dans lequel au moins la partie du conduit d'entrée (14) pour les particules qui s'étend dans la zone d'aération est disposée coaxialement dans le logement (1).
4. Un système d'échange de chaleur selon l'une quelconque des revendications 1 à 3, dans lequel le conduit d'entrée (14) est concentrique avec l'ouverture de sortie (15).
5. Un système d'échange de chaleur selon l'une quelconque des revendications 1 à 4, dans lequel le moyen d'aération (2,3) comprend un faisceau de conduits d'aération (3) ayant chacun à une extrémité une ou plusieurs perforations pour faire arriver le fluide d'aération aux particules, et à l'autre extrémité une jonction (6) avec une source de fluide d'aération.
6. Un système d'échange de chaleur selon l'une quelconque des revendications 1 à 5, dans lequel le moyen d'échange de chaleur (4,5) comprend un faisceau de tubes.
7. Procédé pour échanger de la chaleur entre des particules de craquage catalytique fluide usées et un fluide d'échange de chaleur, selon lequel on fait passer les particules de haut en bas par un conduit d'entrée (14) dans une zone d'aération d'un logement (1), on aère les particules dans la zone d'aération en introduisant un fluide d'aération dans la zone d'aération, réduisant ainsi la densité du mélange de particules et de fluide d'aération, on permet au mélange de densité réduite de passer de bas en haut entre le conduit d'entrée (14) et le logement (1) le long du conduit d'entrée et du moyen d'échange de chaleur (4,5), dans lequel passe le fluide d'échange de chaleur, permettant ainsi le transfert de chaleur entre les particules et le fluide d'échange de chaleur, et on fait sortir le mélange de particules et de fluide d'aération au-dessus de la zone d'aération par une ouverture de sortie (15).
8. Procédé selon la revendication 7, dans lequel le fluide d'échange de chaleur comprend de l'eau et/ou de la vapeur d'eau.
9. Procédé selon la revendication 7 ou 8, dans lequel le fluide d'échange de chaleur est capa-



ble de subir une réaction endothermique.

10. Procédé selon l'une quelconque des revendications 7 à 9, dans lequel le fluide d'aération est de l'air.

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