

FLUIDIZED CATALYTIC CRACKING FEED NOZZLE

FIELD OF THE INVENTION

The present invention relates to a spray nozzle for discharging an atomized
5 hydrocarbon feed used in fluidized catalytic cracking reactor. More particularly, the
invention relates to the physical geometry of the slots in a double slot feed nozzle to
improve nozzle efficiency and life.

BACKGROUND OF THE INVENTION

10 Efficiency in a fluidized catalytic cracking (FCC) apparatus is dependent on a
number of factors. One important factor is the energy used to atomize the liquid
hydrocarbon feed introduced into the FCC reactor.

In general, the liquid hydrocarbon feed is atomized by a gas such as steam for
15 discharge through a nozzle into the FCC reactor. The amount of steam used to
atomize the liquid hydrocarbon feed impacts directly on the efficiency of the reaction.
The shape and number of slots in the nozzle have also been found to impact directly on
the atomization of the liquid hydrocarbon feed.

20 Additionally, it is well known that the FCC reaction yields improved results
when the fluidized feed introduced into the reactor has a large surface area. In this
regard, the smaller the size of the droplets, or the finer the spray from the nozzle, the
larger the surface area of the fluidized feed. Creating a fine spray of the hydrocarbon
feed from the nozzle using less steam results in greater efficiency of the fluidized
25 catalytic cracking system.

Earlier nozzles used to atomize the fluid hydrocarbon feed had a generally
hemispherical discharge end formed with a single elongated slot-like orifice adapted to
produce a flat fan-like spray. An example of such a nozzle is described in United
30 States Patent No. 5,306,418 to Dou et al.

Later nozzles utilized two elongated orifices to atomize the fluid hydrocarbon feed. As described in United States Patent No. 5,673,859 to Haruch, the use of a plurality of slot-like outlets atomize the liquid feed into finer particles as the liquid is discharged from the nozzle. US 5,673,859 further described that the use of slots
5 angled relative to one another produce a converging spray, further improving post-discharge atomization of the liquid particles.

However, an FCC hydrocarbon liquid feed nozzle having a plurality of slots is prone to failure over time. The reactor in which the nozzle operates has constantly
10 moving fluidized catalyst particles circulating throughout the reactor. The nozzles are therefore acted upon not only by the hydrocarbon feed passing through the nozzles, but also by the fluidized catalyst. Due to the flow patterns around the nozzle when the liquid hydrocarbon feed is being sprayed into the reactor, the area between the slots is subject to severe erosion of the inter-slot wall.

15 It is therefore an object of the present invention to provide an improved hydrocarbon feed nozzle, resulting in more efficient atomization of the hydrocarbon feed over a longer useful life.

20 SUMMARY OF THE INVENTION

These and other objects are achieved by the present invention, directed to a spray nozzle for use in discharging atomized liquid hydrocarbon feed into a fluidized catalytic cracking reactor. The spray nozzle comprises a plurality elongated slots having at least one lateral slot wall formed at an angle of from about 30 to about 60
25 degrees from the axis of the discharge.

In its preferred embodiment, the slots have a lateral slot wall angle of from about 40 to about 50 degrees from the axis of discharge and most preferably an angle of about 45 degrees.

The objects of the invention will be further described in the following detailed description of the invention, including the attached drawings. The description is intended to describe the preferred embodiment of the present invention, which will be better understood when considered in view of the attached drawings. The detailed description and drawings, however, are not intended to limit the invention in any manner whatsoever.

BRIEF DESCRIPTION OF THE DRAWINGS

The patent of application file contains at least one drawing executed in color. Copies of this patent or patent application publication with color drawings will be provided by the Office upon request and payment of the necessary fee.

FIGURE 1A is a front elevation of a first prior art nozzle with lateral slot walls cut from the interior of the nozzle to the exterior of the nozzle at an angle of 0° , or parallel, to the axis of discharge.

FIGURE 1B is a cross section view of the first prior art nozzle of Figure 1A, taken through line A-A.

FIGURE 1C is a perspective view of the nozzle of Figures 1A and 1B, with the areas most subject to erosion shown in red.

FIGURE 2A is a front elevation of an alternative prior art nozzle with lateral slot walls cut from the interior of the nozzle to the exterior of the nozzle at an angle of 90 degrees from the axis of discharge from the slot.

FIGURE 2B is a cross section view of the alternative prior art nozzle of Figure 2A, taken through line A'-A'.

FIGURE 2C is a perspective view of the nozzle of Figures 2A and 2B, with the areas most subject to erosion shown in red.

FIGURE 3A is a front elevation of the preferred embodiment of the nozzle of the present invention with lateral slot walls cut from the interior of the nozzle to the exterior of the nozzle at an angle of 45 degrees from the axis of discharge.

FIGURE 3B is a cross section view of the preferred embodiment of the nozzle of the present invention of Figure 3A, taken through line A"-A".

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FIGURE 3C is a perspective view of the nozzle of Figures 3A and 3B, with the areas most subject to erosion shown in red.

FIGURE 4A is a schematic of the flow pattern around the prior art nozzle slot of Figures 2A, 2B and 2C.

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FIGURE 4B is a schematic of the flow pattern around the nozzle slot of the present invention as shown in Figures 3A, 3B and 3C.

FIGURE 5A is a front elevation of the nozzle of Figures 1A, 1B and 1C showing typical erosion after being used in an FCC reactor environment.

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FIGURE 5B is a side elevation of the nozzle of Figure 4A showing typical erosion after being used in an FCC reactor environment.

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DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

With reference to the appended drawings, a first prior art nozzle 102 is shown in Figures 1A, 1B and 1C. The first prior art nozzle 102 comprises two elongated slot outlets 104 formed with an area 106 between the slots 104. The lateral walls 108 of the slots 104 are preferably rounded when viewed looking into the nozzle 102, as shown in Figure 1A. The lateral slot walls 108 are formed in a straight cut

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configuration, being substantially parallel to the axis of discharge of the atomized liquid hydrocarbon feed from the slot 104.

As shown in Figures 2A, 2B and 2C, an alternative prior art nozzle 202 also comprises two elongated slot outlets 204 formed with an area 206 between the slots 204. The lateral walls 208 of the slots 204 are also preferably rounded when viewed looking into the nozzle 202, as shown in Figure 2A. The lateral slot walls 208, however, are formed in a horizontal cut configuration, being formed about 90 degrees from the axis of discharge of the atomized liquid hydrocarbon feed from the slots 204.

It has been found that the geometry of lateral slot walls 108 and 208, comprising straight cut and horizontal cut configurations, results in the accelerated erosion of the area 106 and 206 between the slots 104 and 204, respectively. Figures 5A and 5B show the conventional prior art dual slot nozzle illustrated in Figure 2A-C, where the area between the slots has eroded.

The preferred embodiment of the nozzle 2 of the present invention, shown in Figures 3A, 3B and 3C, comprises two or more elongated slot outlets 4 formed with an area 6 between the slots 4. The lateral slot walls 8 are preferably rounded when looking into the nozzle 2, as shown in Figure 3A. The lateral slot walls 8, however, are formed in an angled configuration, being from about 30 to about 60 degrees from the axis of discharge of the atomized liquid hydrocarbon feed from the slots 4. The angle is preferably from about 40 to about 50 degrees and most preferably about 45 degrees, as shown in Figure 3B.

The slots 4 of the nozzles 102 of the present invention can be formed parallel to each other, as shown in Figures 3A-3C, or can be angled either toward each other or away from each other, as described in US 5,673,859 referred to above. In any such configuration, however, the lateral slot walls 8 are formed in an angle from about 30 to about 60, preferably from about 40 to about 50 and most preferably about 45 degrees

from the axis discharge from the slot 4. Notwithstanding, the slots 4 are formed parallel to each other in the most preferred embodiment.

Additionally, the edges of the slots 4 of the present invention can be smoothed, if desired, to aid the flow of catalyst particles about the nozzles. The smoothed edges are particularly envisioned as a variation of the outer edges of the lateral slot walls 8.

The benefits of the angled lateral slot walls 8 of the present invention are more clearly demonstrated in comparing Figure 4A to Figure 4B. Figure 4A shows CFD calculation results of the flow pattern around the slots 204 of a conventional nozzle 202 in the prior art nozzle of Figures 2A-C, with blue arrows representing the liquid hydrocarbon feed/steam flow and red arrows representing catalyst flow. In Figure 4A, catalyst appears to be drawn into the slot 204.

In contrast, the CFD calculation results of the flow pattern around the nozzle 2 of the present invention in Figure 4B shows that there is much less of an opportunity for the catalyst to be drawn into and erode the nozzle face, including the area 6 between the slots 4.

In keeping with the above, the present invention includes a method of spraying atomized liquid hydrocarbon feed/steam into an FCC reactor. The method includes the step of passing the feed/steam through a dual slot nozzle 2 having at least one lateral slot wall formed at an angle of from about 30 to about 60 degrees from the axis of the discharge. As described above, the lateral slot walls are preferably from about 40 to about 50 degrees from the axis of discharge and most preferably about 45 degrees from the axis of discharge.

Other variations, modifications and alterations to the preferred embodiment of the present invention described above will make themselves apparent to those skilled in the art. All such deviations to the preferred embodiment described are intended to

fall within the spirit and scope of the present invention, limited solely by the appended claims.

All patents referred to herein are hereby incorporated by reference.

I CLAIM:

1. A nozzle for atomized spray of liquid hydrocarbon feed comprising two or more slots having at least one lateral slot wall formed at an angle of from about 30 to about 60 degrees from the axis of the discharge.

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2. The nozzle of Claim 1 wherein the lateral slot wall is formed at an angle of from about 40 to about 50 degrees from the axis of discharge.

3. The nozzle of Claim 1 wherein the lateral slot wall is formed at an angle of
10 about 45 degrees from the axis of discharge.

4. The nozzle of Claim 1 wherein the lateral slot wall is formed in a semi-circular configuration when viewed looking into the slot.

15 5. The nozzle of Claim 1 wherein the edges of the lateral slot walls are rounded.

6. A method of spraying atomized liquid hydrocarbon feed/steam into a fluidized catalytic cracking reactor comprising the step of passing the feed/steam
20 through a dual slot nozzle wherein at least one of the lateral slot walls is formed at an angle of from about 30 to about 60 degrees from the axis of discharge.

7. The method of Claim 6 wherein the at least one lateral slot wall is formed at an angle of from about 40 to about 50 degrees from the axis of discharge.

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8. The method of Claim 6 wherein the at least one lateral slot wall is formed at an angle of about 45 degrees from the axis of discharge.