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(71) Applicant: INEOS EUROPE AG [CH/CH]; Avenue des  
Uttings, 3, CH-1180 Rolle, Vaud (CH).

## (72) Inventors; and

(71) Applicants (for US only): MCDONEL, Timothy Robert  
 [US/US]; 2N935 Elodie Drive, Elburn, Illinois 60119  
 (US). COUCH, Jay Robert [US/US]; 2652 Charlestowne  
 Lane, Naperville, Illinois 60564 (US). WAGNER, David  
 Rudolph [US/US]; 2631 Witchurch Lane, Naperville,

Illinois 60564 (US). WACHTENDORF, Paul Trigg  
 [US/US]; 46 Bluestem Street, Victoria, Texas 77904 (US).  
 TRAVERS, Thomas George [US/US]; 4322 Northgate  
 Drive, Carpentersville, Illinois 60110 (US).

(74) Agent: KRUEGER, James P.; Ineos, 3030 Warrenville  
 Road, Suite 650, Lisle, Illinois 60532 (US).

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(54) Title: IMPROVED AIR GRID DESIGN FOR AN OXIDATION OR AMMOXIDATION REACTOR

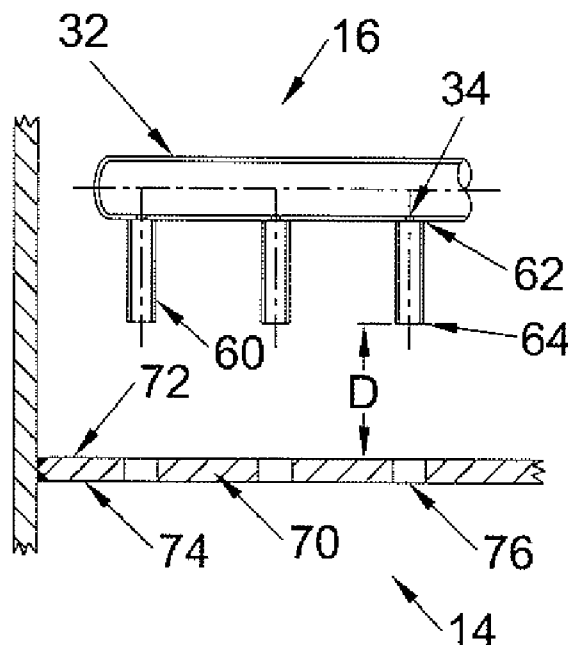


FIG. 5

(57) Abstract: Inadequate reactant mixing as well as local-  
 ized reactor hot spots in a commercial acrylonitrile reactor  
 can be significantly reduced if the distance between sparger  
 system 16 and air grid 14 is controlled to be within 6 to 24  
 inches (~15 to ~61 cm), preferably 8 to 12 inches (~20 to  
 ~30.5 cm). In addition, problems of air grid movement on or  
 off support and air grid mechanical failure can be eliminated  
 essentially completely by means of a modified system for at-  
 taching the air grid to the walls of the reactor as well as its  
 internal support beams.



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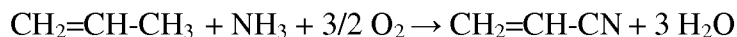
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## IMPROVED AIR GRID DESIGN FOR AN OXIDATION OR AMMOXIDATION REACTOR

**Background**

In the commercial manufacture of acrylonitrile, propylene, ammonia and oxygen are reacted together according to the following reaction scheme:



This process, which is commonly referred to as ammoxidation, is carried out in the gas phase at elevated temperature in the presence of a suitable fluid bed ammoxidation catalyst.

Fig. 1 illustrates a typical ammoxidation reactor used to carry out this process. As shown there, reactor 10 comprises reactor wall 12, air grid 14, feed sparger 16, cooling coils 18 and cyclones 20. During normal operation, process air is charged into reactor 10 through air inlet 22, while a mixture of propylene and ammonia is charged into reactor 10 through feed sparger 16. The flow rates of both are high enough to fluidize a bed 24 of ammoxidation catalyst in the reactor interior, where the catalytic ammoxidation of the propylene and ammonia to acrylonitrile occurs.

Product gases produced by the reaction exit reactor 10 through reactor effluent outlet 26. Before doing so, they pass through cyclones 20, which remove any ammoxidation catalyst these gases may have entrained for return to catalyst bed 24 by diplegs 25. Ammoxidation is highly exothermic, and so cooling coils 18 are used to withdraw excess heat and thereby keep the reaction temperature at an appropriate level.

Propylene and ammonia can form explosive mixtures with oxygen. However, at normal operating temperatures, explosions are prevented inside reactor 10 by the fluidized ammonization catalyst, which preferentially catalyzes the ammoxidation reaction before an explosion can occur. Accordingly, reactor 10 is designed and operated so that the only place process air is allowed to contact propylene and ammonia during normal operation is within the fluidized bed of ammoxidation catalyst 24, and then only when the temperature of the catalyst is high enough to catalyze the ammoxidation reaction.

For this purpose, the traditional way in which propylene and ammonia are fed to reactor 10 uses a feed sparger system 16 such as illustrated in U.S. 5, 256,810, the disclosure of which is incorporated herein by reference. As shown in Figs. 1 and 2 of the '810 patent, which are reproduced as Figs. 2 and 3 of this document, feed sparger 16 takes the form of a series of supply pipes or conduits including main header 30 and laterals 32 attached to and branching out from

header 30. A system of downwardly facing feed nozzles 34 is defined in header 30 and laterals 34 through which a mixture of propylene and ammonia is charged during normal reactor operation. The number and spacing laterals 32 and feed nozzles 34 is such that, in the aggregate, about 10 to 30 feed nozzles per square meter are located approximately uniformly across the entire cross-sectional area of reactor 10.

Normally, each feed nozzle 34 is surrounded by a feed shroud 36, which takes the form a short section of conduit having an inside diameter several times larger than the diameter of nozzle 34. Feed shrouds 34 enable the velocity of gas passing out of nozzles 10 to slow considerably before exiting into catalyst bed 24, which prevents disintegration of the catalyst which might otherwise occur.

Process air typically enters catalyst bed 24 (Fig. 1) after passing through air grid 14, which is located below feed sparger 16. As well known, air grid 14 typically takes the form of a continuous metal sheet which defines a series of air holes or nozzles therein. The diameter of the air nozzles, the mass flow rate of process air passing through air grid 14 and the mass flow rate of the propylene/ammonia mixture passing through feed sparger 16 are selected so that the ammoxidation catalyst in catalyst bed 24 is fully fluidized by these gases during normal operation.

Air holes 76 (in Fig. 5) are typically provided with their own protective air shrouds (not shown), which are normally located below air grid 14. In addition, in many cases, feed nozzles 34 are provided in a one-to-one relationship with the air nozzles in air grid 14, with each feed shroud 36 being aimed directly at its corresponding air nozzle to promote rapid and thorough mixing of the gases passing out of these two different nozzles. For the purposes of this application, such air nozzles are referred to as uncapped. See, U.S. 4,801,731. In other cases the air nozzles can have caps installed directly above them to preferentially disperse the air horizontally (in a directional or uniform manner) along the grid rather than vertically directly towards the feed shroud. These caps can be small metal covers welded above such air nozzles. The design of the legs attaching the cap to the grid can be selected to optimized horizontal gas distribution pattern. These caps above the air holes can also be designed to prevent catalyst under de fluidized conditions from (i) falling through the air holes and/or (ii) settling on the cap itself (such as by having a sloping surface or being fabricated from angle iron) .

Although propylene/ammonia feed systems of this general type work well, they can suffer certain disadvantages. For example, mixing of the propylene/ammonia feed mixture passing out of feed sparger 16 with the air passing out of air grid 14 can be inadequate. This can compromise reactor performance, leading to a less than desirable conversion of reactants to products.

In addition, molybdenum scale given off by the ammoxidation catalyst can cause small piles of this molybdenum scale plus additional amounts of entrained catalyst to accumulate on the upper surface of air grid 14 in the form of small catalyst piles. These piles act like mini-stationary or “fixed” catalyst beds in which the ammoxidation reaction continues to occur. Because heat transfer inside a fixed catalyst bed is much poorer than in a fluidized bed, these catalyst piles produce localized hot spots having temperatures which are high enough to damage any fluidized catalyst that happens to come near. For example, these temperatures are high enough to calcine the surface of any fluidized catalyst coming near, which in turn reduces surface area and hence catalyst activity. And, because the individual catalyst particles forming a bed of fluidized catalyst are free to circulate throughout its entire volume, over time, these hot spots can damage the entire charge of fluidized bed catalyst in the reactor.

Additional disadvantages include mechanical problems with the structure of the acrylonitrile reactor. A typical commercial acrylonitrile reactor operates at a relatively constant temperature of approximately 400 to 550° C, although fluctuations do occur. Moreover, an ammoxidation reactor must be shut down periodically for normal maintenance, catalyst change out, *etc.*, as well as for unexpected upsets such as a power failure, for example. Because normal operating temperatures are so high, the change in temperature inside the reactor can be as much as 500° C or more as the reactor transitions between ambient and normal operating temperatures. This cycling between low and high temperatures can exert a considerable stress on the structural members forming the reactor, especially where they are connected to one another, because of the inherent expansion and contraction of these structural members undergo in response to temperature changes. Over time, these stresses can lead to mechanical failure, especially at junctions formed by welding.

For example, the normal way air grid 14 is attached to wall 12 of reactor 10 is illustrated in Fig. 4. As shown there, air grid 14, which takes the form of an essentially flat metal plate 40 with a series of holes therein, is attached to side wall 12 of the reactor by knuckle 44. As shown

in this figure, knuckle 44 in cross section takes the form of a concave section of metal with its upper end 46 being essentially flush with and welded to side wall 36 by weld 48 and its lower end 50 being essentially coplanar with and welded to the facing edge of air grid plate 40 by weld 52.

In a large commercial acrylonitrile reactor 31 feet (~9.4 meters) in diameter, for example, air grid plate 40 can horizontally expand and contract by as much as ½ inch (1.27 cm) in response to the temperature changes experienced during reactor start up and shut down. This puts large stresses on knuckle 44, and especially on welds 48 and 52 used to attach knuckle 44 to air grid plate 40 and reactor side wall 36. Unfortunately over time, these stresses can lead to mechanical failure, which in turn requires extensive downtime for repair and/or replacement.

Still another disadvantage associated with the above conventional design relates to air grid flexing. Because air grid 16 must support the entire weight of the catalyst charge inside reactor 10 when it is shut down, air grid plate 40 needs to be supported from below to accommodate this weight. Normally, this is done by means of a system of I-beams on which air grid plate 40 sits. In some reactor design, air grid plate 40 simply rests on these I-beams. Unfortunately, in these designs, air grid plate 40 has a tendency to flutter during normal operation, which is due not only to the force of the air moving upwardly through this air grid plate but also due to its inherent expansion when its temperature is raised to normal operating temperatures. In other designs, air grid plate 40 is welded to the tops of these I-beams. Unfortunately, in these designs the force of the upwardly moving air plus the inherent expansion of the air grid plate can cause mechanical failure of these welds.

### **Summary**

In accordance with the technology of this disclosure, it has been found that the above problems of inadequate reactant mixing as well as localized reactor hot spots can be significantly reduced if the distance between sparger system 16 and air grid 14 is controlled to be within 6 to 24 inches (~15 to ~61 cm), preferably 8 to 12 inches (~20 to ~30.5 cm). In addition, it has been further found that the above problems of air grid fluttering and air grid mechanical failure can be eliminated essentially completely by means of a modified system for attaching the air grid to the walls of the reactor as well as its internal support beams.

Thus, this disclosure in accordance with one feature provides an improved feed system for a commercial oxidation or ammoxidation reactor, such as an acrylonitrile reactor, includes a

feed sparger for supplying a mixture of unsaturated and/or saturated C3 to C4 hydrocarbons and ammonia to the inside of the reactor and an air grid system for supplying air to the inside of the reactor, the feed sparger comprising a main header conduit and lateral conduits fluidly attached to and branching out from the main header conduit, both the main header conduit and the lateral conduits defining downwardly facing feed nozzles, the feed sparger system further comprising feed shrouds associated with respective feed nozzles, each feed shroud comprising a proximal end connected to a respective lateral conduit or header conduit and being arranged to direct C3 to C4 hydrocarbons and ammonia passing out of its respective feed nozzle downwardly into the interior of the reactor, the air grid system comprising a continuous metal plate arranged below the feed sparger system, the continuous metal plate defining a series of air holes therein for directing process air from below the continuous metal plate to above the continuous metal plate towards the sparger system, wherein the distance between the upper surface of the continuous metal plate and the distal ends of the feed shrouds are selected to be between about 6 to 24 inches (~15 to ~61 cm). As used herein a mixture of unsaturated and/or saturated C3 to C4 hydrocarbons refers to C3 to C4 hydrocarbons that include propane, propylene, butane, butylene, and mixtures thereof.

In another aspect, a process is provided for supplying an oxidation or ammoxidation reactor that includes supplying a mixture of saturated and/or unsaturated C3 to C4 hydrocarbons and ammonia to the inside of the reactor through a feed sparger. The feed sparger includes a main header conduit and lateral conduits fluidly attached to and branching out from the main header conduit, both the main header conduit and the lateral conduits defining downwardly facing feed nozzles. The feed sparger system further includes feed shrouds associated with respective feed nozzles, each feed shroud comprising a proximal end connected to a respective lateral conduit or header conduit and being arranged to direct saturated and/or unsaturated C3 to C4 hydrocarbons and ammonia passing out of its respective feed nozzle downwardly into the interior of the acrylonitrile reactor. The process further includes supplying air to the inside of the reactor through an air grid system. The air grid system comprising a continuous metal plate arranged below the feed sparger system, the continuous metal plate defining a series of air holes therein for directing process air from below the continuous metal plate to above the continuous metal plate towards the sparger system. In one aspect, the distance between the upper surface of

the continuous metal plate and the distal ends of the feed shrouds is about 6 to about 24 inches (about 15 to about 61 cm).

In addition, this disclosure in accordance with another feature provides an improved air grid system for use in a commercial oxidation or ammoxidation reactor, such as an acrylonitrile reactor, the improved air grid system comprising a continuous metal plate defining an upper surface, a lower surface and a periphery extending there between, the continuous metal plate further defining a series of air holes for directing process air from below the continuous metal plate towards a sparger feed system located above the continuous metal plate, and a support system for supporting the weight of the continuous metal plate and any oxidation or ammoxidation catalyst that may be resting on the continuous metal plate, wherein the support system comprises a series of support beams each having an upper support surface engaging the underside of the continuous metal plate and a series of support hold-downs fixedly attached to the underside of the continuous metal plate, each support hold-down being arranged to engage a mating surface defined in a respective support beam below its upper surface in a manner so that the support hold-downs prevent the continuous metal plate from being lifted off the series of support beams.

In another aspect, a process is provided for reducing movement in an air grid system in a commercial oxidation or ammoxidation reactor. The process includes providing an air grid system that includes a continuous metal plate defining an upper surface, a lower surface and a periphery extending there between. The continuous metal plate further defining a series of air holes for directing process air from below the continuous metal plate to above the continuous metal plate, and a support system for supporting the weight of the continuous metal plate and any oxidation or ammoxidation catalyst that may be resting on the continuous metal plate. In one aspect, the support system comprises a series of support beams each having an upper support surface engaging the underside of the continuous metal plate and a series of support hold-downs fixedly attached to the underside of the continuous metal plate. Each support hold-down is arranged to engage a mating surface defined in a respective support beam below its upper surface in a manner so that the support hold-downs prevent the continuous metal plate from being lifted off the series of support beams.

In addition, this disclosure in accordance with still another feature provides an improved air grid system for use in a commercial oxidation or ammoxidation reactor, such as an acrylonitrile reactor, the improved air grid system comprising a continuous metal plate defining an upper surface, a lower surface and a periphery extending therebetween, the continuous metal plate further defining a series of air holes for directing process air from below the continuous metal plate towards a sparger feed system located above the continuous metal plate, and a connection assembly for attaching the periphery of the continuous metal plate to the side wall of the oxidation or ammoxidation reactor, wherein the connection assembly comprises a flex plate and a mating standoff plate each of which comprises an annular sheet of metal defining a top and a bottom, both the flex plate and standoff plates being arranged essentially congruent with the side wall of the oxidation or ammoxidation reactor, wherein the standoff plate is attached to the side wall of the oxidation or ammoxidation reactor, wherein the bottom of the flex plate is attached to the periphery of the continuous metal plate, and wherein the flex plate is attached to the standoff plate in a manner such that the flex plate defines a lower portion which extends below the bottom of the standoff plate so that variations in the diameter of the continuous metal plate due to temperature changes inside the reactor can be accommodated by the flexing of the lower portion of the flex plate.

In another aspect, a process is provided for accommodating flexing in an air grid system, the process includes providing a continuous metal plate defining an upper surface, a lower surface and a periphery extending therebetween. The continuous metal plate further defines a series of air holes for directing process air from below the continuous metal plate to above the continuous metal plate, and a connection assembly for attaching the periphery of the continuous metal plate to the side wall of the reactor. The connection assembly comprises a flex plate and a mating standoff plate each of which comprises an annular sheet of metal defining a top and a bottom. Both the flex plate and standoff plate are arranged essentially congruent with the side wall of the reactor, wherein the standoff plate is attached to the side wall of the reactor, wherein the bottom of the flex plate is attached to the periphery of the continuous metal plate, and wherein the flex plate is attached to the standoff plate in a manner such that the flex plate defines a lower portion which extends below the bottom of the standoff plate so that variations in the diameter of the continuous metal plate due to temperature changes inside the acrylonitrile can be accommodated by the flexing of the lower portion of the flex plate

**Brief Description of the Drawings**

Fig. 1 is a schematic view showing the reactor section of a conventional ammoxidation reactor used for making acrylonitrile;

Fig. 2 is a plan view showing the underside of the conventional sparger system of the ammoxidation reactor of Fig. 1;

Fig. 3 is a cross sectional view taken on line 3-3 of Fig 2, Fig. 3 showing the feed nozzles and associated feed shrouds of the conventional sparger system of Fig 2;

Fig. 4 illustrates a conventional way of attaching the air grid of an acrylonitrile reactor to the wall of the reactor;

Fig. 5 is a partial sectional view of an acrylonitrile reactor illustrating a first feature of this disclosure in which the performance of a conventional acrylonitrile reactor is improved and mechanical damage to certain parts of the acrylonitrile reactor are reduced by spacing the air grid and feed sparger apart from one another by a suitable distance;

Fig. 6 illustrates a second feature of this disclosure in which a novel support system is provided for supporting the air grid of an acrylonitrile reactor; and

Fig. 7 illustrates a third feature of this disclosure in which a unique connection assembly is provided for securing the air grid 14 of an acrylonitrile reactor to the side wall of the reactor.

**DETAILED DESCRIPTION**

Fig. 5 illustrates a first feature of the technology of this disclosure in which air grid 14 is spaced from feed sparger 16 by a suitable distance, in particular 6 to 24 inches (~15 to ~61 cm). Specifically, as shown there, feed sparger 16 includes multiple feed shrouds 60, each of which is associated with a respective feed nozzle defined in header 30 or a lateral 32 of the sparger system. Each feed shroud defines a proximal end 62 which is connected to its respective header 30 or a lateral 32 and distal end 64 remote therefrom, with feed shrouds 60 being arranged to direct propylene and ammonia passing feed out of their respective feed nozzles downwardly into the interior of the acrylonitrile reactor, towards air grid 14. Meanwhile, air grid 14 takes the form of a continuous metal plate 70 which is arranged below feed sparger 16, and which defines

an upper surface 72, a lower surface 74 and series of air holes 76 extending therebetween for directing process air entering the ammoxidation reactor from below the continuous metal plate upwards towards feed sparger 16.

In accordance with this feature of the invention, distal ends 64 of feed shrouds 60 are arranged to be at a distance of 6 to 24 inches (~15 to ~61 cm) from upper surface 72 of continuous metal plate 70. Preferably, distal ends 64 of feed shrouds 60 are arranged to be at a distance of 8 to 12 inches (~20 to ~30.5 cm) from upper surface 72 of continuous metal plate 70. In accordance with this feature of this disclosure, it has been found not only that poor reactor performance due to inadequate reactant mixing can be largely eliminated by following this approach but also that damage to the ammoxidation catalyst and other problems arising from localized reactor hot spots can also be eliminated or at least substantially reduced by following this approach as well.

From a theoretical/conceptual standpoint, it would appear to be beneficial to minimize the distance between air grid 14 and feed sparger 16, since this would appear to promote the greatest degree possible of mixing between the feed gases passing out of sparger 16 and the process air passing out of air grid 16. However, in practice it has been found that arranging air grid 14 too close to feed sparger 16 promotes formation of reactor hot spots, as mentioned above. When the distance between air grid 14 and feed sparger 16 is too small, some of air holes 76 in continuous metal plate 70 or distal ends 64 of feed shrouds 60 or both become located within the piles of catalyst/molybdenum scale that inherently build up on upper surface 72 of continuous metal plate 70. This results in the propylene, ammonia and air reactants contacting one another inside these catalyst piles, which act like fixed catalyst beds where heat transfer is poor and hence temperature rapidly builds. Accordingly, the distance between air grid 14 and feed sparger 16, as measured between the distal ends 64 of feed shrouds 60 and the upper surface 72 of continuous metal plate, should be at least 6 inches (~15 cm) and preferably at least about 8 inches (~20 cm) to avoid this problem.

Regarding the maximum distance between air grid 14 and feed sparger 16, it has been found that at distances greater than about 24 inches (~61 cm), a portion of the catalyst in the reactor, in particular the portion which is located between air grid 14 and feed sparger 16, is effectively not being used in the reaction. This reduces the conversion of the propylene and ammonia reactants into product acrylonitrile, which is obviously disadvantageous. Accordingly,

the maximum distance between air grid 14 and feed sparger 16, as measured between the distal ends 64 of feed shrouds 60 and the upper surface 72 of continuous metal plate 70, is kept at no more than about 24 inches (~61 cm), preferably no more than 18 inches (~45.7 cm), in another aspect, no more than 14 inches (~35.5 cm), and in another aspect, no more than 12 inches (~30.5 cm), to prevent this from occurring.

Fig. 6 illustrates a second feature of the technology of this disclosure in which a novel support system, generally indicated at 80, is provided for supporting the weight of continuous metal plate 70 of air grid 14, including the weight of any ammoxidation catalyst that may be resting on this continuous metal plate. As shown in this figure, support system 80 takes the form of a series of support beams 82, which in the particular embodiment shown are conventional I-beams. Each I-beam 82 includes an upper transverse section 84 which defines an upper surface 86 on which continuous metal plate 70 rests. In addition, the underside of each upper transverse section 86 defines mating surface 88 for engaging with a support hold-down carried by continuous metal plate 70 of air grid 14, as further discussed below.

As further shown in Fig. 6, welded to the underside of continuous metal plate 70 is a series of support bars 90, each end of which defines a nose 92. As further shown in this figure, each nose 92 extends beneath the upper transverse section 84 of a respective I-beam 82 where it engages mating surface 88. With this structure, each support bar 90 serves as a hold-down for holding continuous metal plate 70 in contact with the upper surfaces 86 of I-beams 82, thereby preventing this continuous metal plate from being lifted off these I-beams as a result of the force of the process air flowing upwardly through air holes 76 in this metal plate.

As further shown in Fig. 6, suitable spaces 94 and 96 are arranged between the end of each support bar 82 and the facing portions of I-beams 82 for accommodating changes in the lengths of these support bars which inherently occur as a result of the temperature changes experienced inside the reactor during startup and shutdown.

With this structure, continuous metal plate 70 is securely held down on the upper surfaces 86 of I-beams by noses 92 of support bars 90 engaging respective mating surfaces 88 of I-beams 82. As will be appreciated, other structures which provide a similar manner of attachment can be used in place of support bars 90 and their associated noses 92. In any event, because of spaces 94 and 96 arranged between the ends of each support bar 82 and the facing portions of I-beams 82, variations in the lengths of support bars 90 which occur as a result of the significant changes

in temperature occurring inside reactor 10 during start up and shut down are easily accommodated by these spaces. As a result, mechanical failure of support system 80 is largely eliminated.

Fig. 7 illustrates a third feature of the technology of this disclosure in which a unique connection assembly is provided for securing the periphery of continuous metal plate 70 of air grid 14 to side wall 36 of reactor 10. As shown in this figure, this connection assembly, which is generally indicated at 100, comprises flex plate 102 and mating standoff plate 104. Flex plate 102 comprises an elongated sheet of metal whose two ends are welded together so that flex plate 102 assumes an annular shape, in particular the shape of a right section of a cylinder. With this shape, flex plate 102 is essentially congruent with side wall 36 of reactor 10 to which air grid 14 is attached, since the midsection of reactor 10 is also shaped in the form of a cylinder. In the same way, standoff plate 104 also comprises an elongated sheet of metal whose two ends are welded together so that standoff plate 104 also assumes an annular shape.

As further shown in Fig. 7, standoff plate 104 is arranged between flex plate 102 and side wall 36 of reactor 10 in a manner such that flex plate 102 defines a lower portion 114 which extends below the bottom 112 of standoff plate 104. Preferably, the bottom 110 of flex plate 102 extends below the bottom 112 of standoff plate 104 by a distance of about 6 to about 10 inches (about 15 to about 25 cm), more desirably about 7 to about 9 inches (about 18 to about 23 cm).

As further shown in Fig. 7, bottom 110 of flex plate 102 is attached, preferably by welding, to the periphery of continuous metal plate 70 of air grid 14. With this structure, changes in the diameter of continuous metal plate 70 of air grid 14, which occur as a result of the significant changes in temperature occurring inside reactor 10 during start up and shut down, are easily accommodated by the flexing of lower portion 114 of flex plate 102, *i.e.*, the portion of flex plate 102 which extends below bottom 112 of standoff plate 102. As a result, mechanical failure of the joints connecting the periphery of continuous metal plate 70 of air grid 14 to side wall 12 of reactor 10 are largely eliminated.

The various aspects described herein, more particularly those illustrated in Figures 4-7 may be utilized with reactors having various size diameters. In a preferred aspect, reactors may have external diameters from about 5 to about 12 meters, in another aspect, about 8 to about 12 meters, and in another aspect, about 9 to about 11 meters. In another preferred embodiment when using external reactor diameters between about 8 to about 12 meters, or about 9 to about

11 meters, air nozzles are uncapped, the air being introduced vertically into the reactor, most preferably directed vertically towards a feed shroud. In an alternative embodiment when using external reactor diameters between about 8 to about 12 meters, or about 9 to about 11 meters, air nozzles in air grid are capped, the air being preferentially distributed horizontally into the reactor by the cap

Although only a few embodiments of technology of this disclosure are described herein, it should be appreciated many modifications can be made without departing from the spirit and scope of this technology. All such modifications are intended to be included within the scope of this technology, which is to be limited only by the following claims:

## Claims:

1. An improved feed system for a commercial oxidation or ammoxidation reactor comprising:

a feed sparger for supplying a mixture of saturated and/or unsaturated C3 to C4 hydrocarbons and ammonia to the inside of the reactor; and

an air grid system for supplying air to the inside of the reactor,

wherein the feed sparger comprising a main header conduit and lateral conduits fluidly attached to and branching out from the main header conduit, both the main header conduit and the lateral conduits defining downwardly facing feed nozzles, the feed sparger system further comprising feed shrouds associated with respective feed nozzles, each feed shroud comprising a proximal end connected to a respective lateral conduit or header conduit and being arranged to direct saturated and/or unsaturated C3 to C4 hydrocarbons and ammonia passing out of its respective feed nozzle downwardly into the interior of the acrylonitrile reactor,

wherein the air grid system comprises a continuous metal plate arranged below the feed sparger system, the continuous metal plate defining a series of air holes therein for directing process air from below the continuous metal plate to above the continuous metal plate, wherein the distance between the upper surface of the continuous metal plate and the distal ends of the feed shrouds is between about 6 to about 24 inches (about 15 to about 61 cm).

2. The improved feed system of claim 1, wherein the C3 to C4 hydrocarbons are selected from the group consisting of propane, propylene, butane, butylene, and mixtures thereof.

3. The improved feed system of claim 1, wherein the distance between the upper surface of the continuous metal plate and the distal ends of the feed shrouds is about 8 to about 12 inches (about 20 to about 30.5 cm).

4. The improved feed system of claim 1, wherein an external diameter of the reactor is between about 8 to about 12 meters,

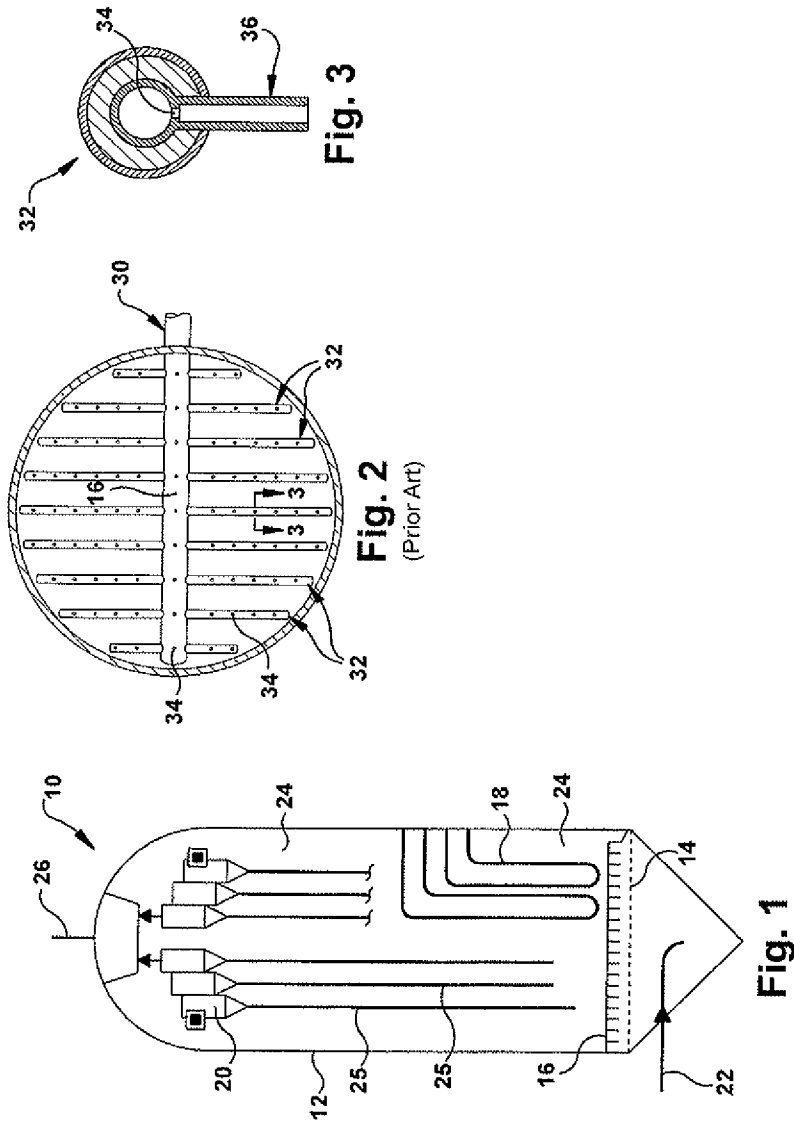
5. The improved feed system of claim 4, wherein the external diameter of the reactor is between about 9 to about 11 meters.

6. The improved feed system of claim 4, wherein the air nozzles are uncapped.
7. The improved feed system of claim 4, wherein the air nozzles are capped.
8. A process for supplying an oxidation or ammoxidation reactor comprising:  
supplying a mixture of saturated and/or unsaturated C3 to C4 hydrocarbons and ammonia to the inside of the reactor through a feed sparger, the feed sparger comprising a main header conduit and lateral conduits fluidly attached to and branching out from the main header conduit, both the main header conduit and the lateral conduits defining downwardly facing feed nozzles, the feed sparger system further comprising feed shrouds associated with respective feed nozzles, each feed shroud comprising a proximal end connected to a respective lateral conduit or header conduit and being arranged to direct saturated and/or unsaturated C3 to C4 hydrocarbons and ammonia passing out of its respective feed nozzle downwardly into the interior of the acrylonitrile reactor; and  
supplying air to the inside of the reactor through an air grid system, the air grid system comprising a continuous metal plate arranged below the feed sparger system, the continuous metal plate defining a series of air holes therein for directing process air from below the continuous metal plate to above the continuous metal plate towards the sparger system, wherein the distance between the upper surface of the continuous metal plate and the distal ends of the feed shrouds is about 6 to about 24 inches (about 15 to about 61 cm).
9. The process of claim 8, wherein the C3 to C4 hydrocarbons are selected from the group consisting of propane, propylene, butane, butylene, and mixtures thereof.
10. The process of claim 8, wherein the distance between the upper surface of the continuous metal plate and the distal ends of the feed shrouds is about 8 to about 12 inches (about 20 to about 30.5 cm).
11. The process of claim 8, wherein an external diameter of the reactor is between about 8 to about 12 meters.

12. The process of claim 11, wherein the external diameter of the reactor is between about 9 to about 11 meters.

13. The process of claim 11, wherein the air nozzles are uncapped.

14. The process of claim 11, wherein the air nozzles are capped.



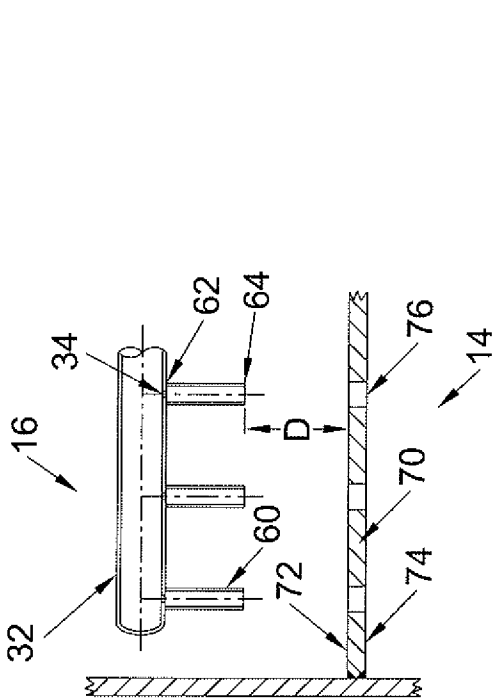


FIG. 5

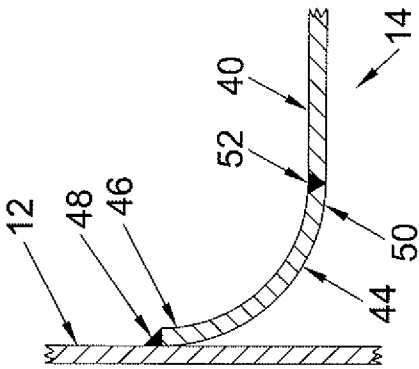


FIG. 4

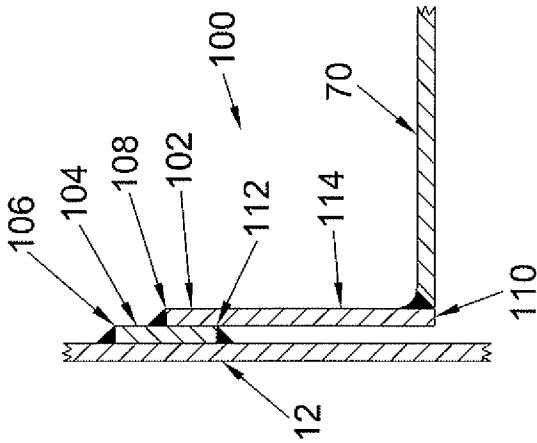


FIG. 7

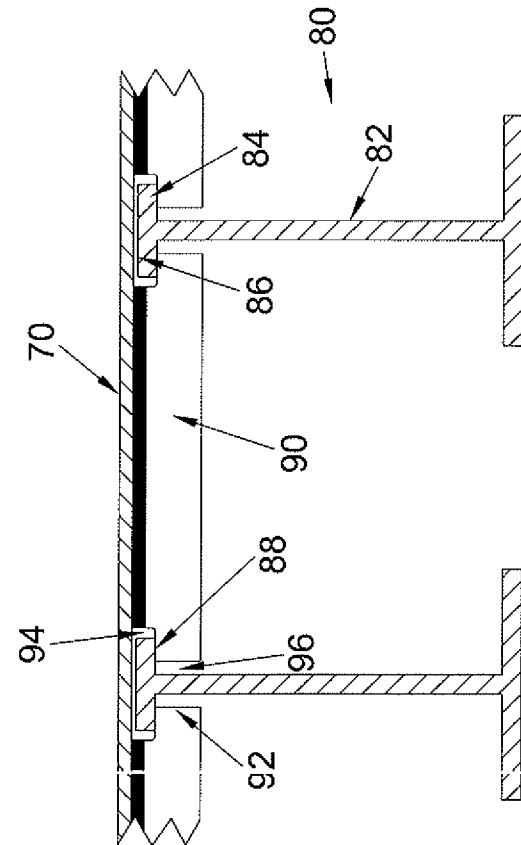


FIG. 6

## INTERNATIONAL SEARCH REPORT

International application No  
PCT/US2015/022190

## A. CLASSIFICATION OF SUBJECT MATTER

INV. B01J8/18 B01J8/44 C07C253/24 C07C255/08  
ADD.

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)

C07C B01J

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)

EPO-Internal, WPI Data

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

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Further documents are listed in the continuation of Box C.



See patent family annex.

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Date of the actual completion of the international search

24 June 2015

Date of mailing of the international search report

01/07/2015

Name and mailing address of the ISA/

European Patent Office, P.B. 5818 Patentlaan 2  
NL - 2280 HV Rijswijk  
Tel. (+31-70) 340-2040,  
Fax: (+31-70) 340-3016

Authorized officer

Baumlin, Sébastien

## INTERNATIONAL SEARCH REPORT

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C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

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International application No

PCT/US2015/022190

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