

APPARATUS FOR PRODUCING AQUEOUS UREA SOLUTION USED IN VEHICLES AND METHOD OF USING THE SAME

5 Technical Field

The present invention relates to an apparatus for producing aqueous urea solution used in vehicles. The present invention further relates to a method of producing aqueous urea solution used in vehicles using said apparatus.

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Technical Background

As the requirements of domestic emission regulations become increasingly strict, manufacturers of heavy-duty engines have basically chosen the technology of selective catalytic reduction (SCR) for the treatment of exhaust gas, which requires aqueous
15 aqueous urea solution used in vehicles as the reduction agent in selective catalytic reduction reactions. Aqueous urea solution used in vehicles is of high standards, e.g., the content of each of the elements of Na, Mg, Al, K, Ca, Fe, etc. cannot be higher than 0.5 ppm and the content of each of the elements of Cr, Ni, Cu, Zn, etc. cannot be higher than
20 0.2 ppm, which not only requires strict quality control on raw materials such as deionized water and urea granules, but is also extremely demanding in the production equipment, filling equipment and production environment of aqueous urea solution.

In the prior art, there are two methods for producing aqueous urea solution used in
25 vehicles. One is batch production carried out in small quantities of blending tanks; the other, relying on urea production plants, mixes high concentration aqueous urea solution with deionized water in pipelines or blending tanks for filling after the mixing is completed and inspected. In the first method, deionized water and urea granules are mixed according to a certain proportion, urea granules are then dissolved and the
30 solution is filled after being inspected, the whole process of which is carried out manually. Open devices are used in this method, so that the production environment in the entire workshop is highly demanding, and fluctuations in product quality are easily

generated. Besides, manual feeding also leads to unstable product quality. Moreover, this method also requires lots of mixing tanks or large mixing tanks, which requires a large area. Additionally, this method belongs to batch production, which is of low efficiency. The second method must rely on urea production plants, which limits the regional layout and increases the transportation cost of aqueous urea solution.

Summary of the Invention

To solve the above problems, the present invention provides an apparatus for producing aqueous urea solution used in vehicles, which is capable of continuous production and can ensure the stability of product quality. The present invention further relates to a method of using said apparatus.

A first aspect of the present invention aims to provide an apparatus for producing aqueous urea solution used in vehicles, comprising a dissolution device with a stirrer for dissolving urea granules. A charging device is arranged upstream of the dissolution device for introducing urea granules and deionized water independently into the dissolution device. A mixing device is arranged downstream of the dissolution device for adjusting the property of the aqueous urea solution. The stirrer therein comprises a stirring shaft provided with one or a plurality of blades.

In the apparatus according to the present invention, the charging device, the dissolution device and the mixing device connect with one another, so that aqueous urea solution used in vehicles can be continuously produced, thus improving the production efficiency. The entirely closed apparatus avoids the product quality from being affected by the outside environment. Besides, instead of manual feeding, a charging device is adopted by the present invention, which also ensures the stability of the product quality.

In one embodiment of the present invention, the dissolution device and the mixing device are both horizontally arranged cylindrical members. A cavity of the mixing device forms a mixing chamber for aqueous urea solution, and a mixer is provided in

the mixing chamber. In a preferred embodiment, the dissolution device is further provided with a heating device. The dissolution speed of urea granules can be accelerated by heating the fluid.

- 5 In one embodiment of the present invention, the stirring shaft is arranged along the flow direction of fluid, and comprises a feeding section, a mixing section and a homogenizing section successively from upstream to downstream, wherein the blade(s) in said feeding section and that/those in the homogenizing section are spiral blades, and the blade(s) in the mixing section is/are straight blade(s). Urea granules and
10 deionized water that have entered into the feeding section can be rapidly and uniformly dispersed in the intervals between and among the blades and continuously flow forward driven by the spiral blades. The straight blade(s) in the mixing section can change the spiral flowing state of the aqueous urea solution, increase the turbulence thereof and improve the dissolution speed and effects of the urea granules. In another
15 embodiment of the present invention, the stirring shaft is arranged along the flow direction of fluid, and comprises a feeding section, a mixing section and a homogenizing section successively from upstream to downstream, wherein the blade(s) in said feeding section and that/those in the homogenizing section are first spiral blades and the blade(s) in the mixing section is/are second spiral blade(s). Specifically
20 speaking, the rotation direction of the second spiral blade(s) is opposite to that of the first spiral blades. The second spiral blade(s) that rotate(s) against the blade(s) in the feeding section can make the flow direction change of aqueous urea solution more violent, which increases the turbulence thereof and improves the speed and effects of the dissolution of urea granules. In one embodiment, the number of blades in the
25 feeding section and/or the number of blades in the mixing section and/or the number of blades in the homogenizing section are all selected in a range from 1 to 5.

- In one embodiment, the blade(s) in said mixing section is/are provided with orifices. In the rotation of the stirring shaft, the fluids on both sides of a blade in the mixing
30 section are mixed by means of passing through the orifices, which further increases the turbulence of fluid, thus improving the dissolution speed of urea granules. In a preferred embodiment, the ratio of the area of each blade in said mixing section to the

sum cross section areas of all the orifices on said blade is in a range from 4:1 to 3:2, preferably 2:1.

5 In one embodiment of the present invention, the ratio of the axial length of the feeding section to the axial length of the mixing section to the axial length of the homogenizing section is in a range from 1:1:1 to 1:2:1.5. The mixing section and the homogenizing section are both comparatively long, so that the residence time of aqueous urea solution in the dissolution device is increased, which facilitates the full dissolution of urea granules.

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In one embodiment of the present invention, a plurality of stirring shafts are arranged in parallel with one another, which can further improve the turbulence of fluid, thus improving the dissolution speed of urea granules. In another embodiment of the present invention, the plurality of stirring shafts are provided in such a way that the distance between two adjacent stirring shafts in the feeding section is larger than that in the homogenizing section. This arrangement first enables the fluid that has entered into the dissolution device split under the function of the stirring shaft and then the distributaries are mixed, which further increases the turbulence of the fluid so as to improve the dissolution speed of urea granules. In one specific embodiment, the stirring shafts are arranged in such a way that every two adjacent stirring shafts form an angle of 5 to 30 degrees.

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In one embodiment, the mixer comprises a mixing shaft provided with one or a plurality of spiral blades and arranged along the flow direction of fluid. The spiral blade(s) provided on the mixing shaft can further adjust aqueous urea solution to make it uniform. In addition, the spiral blade(s) can also drive aqueous urea solution away from the apparatus for producing aqueous urea solution used in vehicles.

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In one embodiment of the present invention, said mixing chamber is provided with a heat exchange jacket on its external side. An outlet of said heat exchange jacket communicates with an inlet of said mixing chamber and/or with an inlet for deionized water of said charging device. Thus, deionized water is heated when flowing through

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the heat exchange jacket. At the same time, the temperature of aqueous urea solution is decreased, which is beneficial for energy saving. On entering into the charging device, the temperature of deionized water is comparatively high, which facilitates the dissolution of urea granules.

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According to a second aspect of the present invention, a method of using the above apparatus is provided, comprising,

Step 1: adding a predetermined amount of urea granules and deionized water into the charging device;

10 Step 2: driving the stirrer to dissolve the urea granules that have entered into the dissolution device into the deionized water; and

Step 3: discharging the aqueous urea solution into the mixing device and driving the stirrer to adjust the aqueous urea solution to comply with a predetermined standard.

15 In one embodiment, in Step 1, the ratio of the adding weight of deionized water to that of urea granules falls within a range from 67.5:32.5 to 67.5:270.

In one embodiment, in Step 3, deionized water is filled in the heat exchange jacket to adjust the temperature of aqueous urea solution to a required temperature. In this step,
20 not only the temperature of aqueous urea solution is reduced, but also the temperature of deionized water is increased, so that the purpose of energy saving is achieved and the filling and quality stability of aqueous urea solution are facilitated.

In one embodiment, the deionized water in the heat exchange jacket flows against the
25 flow direction of the aqueous urea solution in the mixing chamber. The countercurrents therein enable an adequate heat exchange between deionized water in the heat exchange jacket and aqueous urea solution in the mixing chamber, so that the temperature of the aqueous urea solution is quickly adjusted.

30 In one embodiment, the deionized water discharged from said heat exchange jacket flows into the mixing chamber, or is added into the charging device after being mixed with the deionized water of Step 1. In one preferred embodiment, a part of the

deionized water discharged from said heat exchange jacket flows into the mixing chamber. At the same time, another part of the deionized water discharged from said heat exchange jacket is added into the charging device after being mixed with the deionized water of Step 1. Thus, as a feeding material, the deionized water discharged
5 from the heat exchange jacket can accelerate the dissolution of urea granules. In addition, that the deionized water discharged from the heat exchange jacket flows into the mixing chamber is beneficial for quick adjustment of the concentration of aqueous urea solution.

10 In the present application, the terms “upstream” and “downstream” are mentioned with reference to the flow direction of fluid.

Comparing with the prior art technology, the present invention is advantageous in many aspects. To begin with, the charging device, the dissolution device and the
15 mixing device of the apparatus according to the present invention connect with one another, so that aqueous urea solution used in vehicles can be continuously produced, thus improving the production efficiency. Besides, the entirely closed device avoids the product quality from being affected by the outside environment. Moreover, instead of manual feeding, a charging device is adopted by the present invention, which also
20 ensures the stability of the product quality. Further, the stirring shaft and the design of blade(s) thereof accelerate the dissolution of urea granules, thus improving the production efficiency. In addition, the apparatus of the present invention and the method of using the same have the advantages of stable product quality, small occupation area, convenient production, etc.

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Brief Description of Drawings

In the following the present invention will be described in detail based on the examples and the drawings, wherein,

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Fig. 1 is a block diagram of the apparatus for producing aqueous urea solution used in vehicles according to the present invention;

Fig. 2 shows the structure of a first example of the stirring shaft of the present invention;

5 Fig. 3 shows the structure of a second example of the stirring shaft of the present invention;

Fig. 4 is a sectional view of a third example of the stirring shaft according to the present invention; and

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Fig. 5 is a structural drawing according to the mixing device of the present invention.

In the drawings the same structures are indicated by the same reference sign. The drawings are not drawn in accordance with an actual scale.

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Detailed Description of Embodiments

The present invention will be further described in combination with the accompanying drawings.

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Fig. 1 is a block diagram of an apparatus 10 for producing aqueous urea solution used in vehicles according to the present invention (hereinafter referred to as the apparatus 10). The apparatus 10 comprises a charging device 11, a dissolution device 12 and a mixing device 13 successively connected with one another from upstream to downstream thereof. The charging device 11 is used for introducing urea granules 15 and deionized water 16 independently into the apparatus 10, the dissolution device 12 is used for dissolving urea granules into deionized water, and the mixing device 13 is used for adjusting the quality of aqueous urea solution to a required standard and discharging an aqueous urea solution product 17. In one embodiment, the charging device 11, the dissolution device 12 and the mixing device 13 are sealed and connected with one another through pipelines (not shown in the drawings), which insulates the

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inside of the apparatus 10 from the outside and avoids aqueous urea solution from being polluted by the outside contamination. These devices will be further described in the following text.

- 5 The charging device 11 can automatically add urea granules and deionized water according to a preset adding amount to ensure that the adding weight ratio of urea granules to deionized water stays consistent in the apparatus 10, which is advantageous for producing aqueous urea solution of constant quality and for reducing operators' work intensity. In one embodiment, the ratio of the adding weight of deionized water
10 to that of urea granules falls within a range from 67.5:32.5 to 67.5:270.

The dissolution device 12 will be described in the following. The dissolution device 12 is a horizontally arranged cylindrical member. A stirring shaft 20 with a blade or a plurality of blades is arranged inside the dissolution device 12. In order to facilitate the
15 flowing of fluid, the stirring shaft 20 is arranged along the flow direction of fluid. A heating device 26 can be further arranged on the dissolution device 12 to accelerate the dissolution speed of urea granules in deionized water. Fig. 2 shows a first embodiment of the stirring shaft 20. The stirring shaft comprises a feeding section I, a mixing section II and a homogenizing section III successively from upstream to downstream.
20 A blade/blades 21 and a blade/blades 22 respectively in the feeding section I and the homogenizing section III are both selected as spiral blades while a straight blade/straight blades 23 is/are arranged in the mixing section II. The spiral blade(s) 21 in the feeding section I can drive the introduced urea granules and deionized water into the dissolution device 12. The straight blade(s) 23 in the mixing section II can change
25 the spiral flowing state of the fluid so as to increase the turbulence of the fluid and accelerate the dissolution of urea granules. The spiral blade(s) 22 in the homogenizing section III is/are used to drive the fluid away from the dissolution device 12. In one embodiment, the rotation direction of the spiral blade(s) 21 is opposite to that of the spiral blade(s) 22. In one embodiment, the number of the blade(s) 21 in said feeding
30 section I, the number of the blade(s) 23 in said mixing section II and the number of the blade(s) 22 in said homogenizing section III are all selected from 1 to 5.

The straight blade/blades 23 is/are preferably provided with orifices 24 as shown in Figs. 2 and 4. Under the rotation of the stirring shaft 20, the fluids at both sides of one straight blade 23 mix together through the orifices 24, which further increases turbulence of the fluids. In one specific embodiment, the ratio of the area of each straight blade 23 to the sum cross section areas of all the orifices on said blade is in a range from 4:1 to 3:2, preferably 2:1.

Fig. 3 shows a second example of the stirring shaft 20. In the example, the blade(s) in the mixing section II is/are a spiral blade 25/spiral blades 25 and other conditions are the same as those in the first example of the stirring shaft 20. Preferably, the rotation direction of the spiral blade/blades 25 in the mixing section II is opposite to that of the spiral blade(s) 21 in the feeding section I, so that the flow direction of the fluid that has entered can be changed more violently, thus increasing the turbulence thereof. Similarly, the spiral blade(s) 25 is/are also provided with similar orifices 24. It should be understood that any structures or apparatuses that can increase the turbulence of fluid can be used as the stirring shaft 20. For example, the number of the blade(s) 25 can be arranged as different from the number of the spiral blade(s) 21, which is not a limitation though.

The ratio of the axial length of the feeding section I to the axial length of the mixing section II to the axial length of the homogenizing section III is selected as 1:2:1. The mixing section II is the longest so that the residence time of fluid in the mixing section II is the longest, which facilitates the full dissolution of urea granules.

In order to further increase the turbulence of fluid in the dissolution device 12, a plurality of stirring shafts can be provided in parallel in the dissolution device 12. The distances between and among these stirring shafts are arranged as not being bothered by one another as shown in Fig. 4. The plurality of stirring shafts can also be arranged as forming an angle between and among one another. For example, said plurality of stirring shafts can be arranged in such a way that the distance between two adjacent stirring shafts in the feeding section is larger than that in the homogenizing section. Thus, introduced by the inclined stirring shafts, the fluid that has entered into the dissolution device 12 splits first, and then the split streams mix together. This process,

together with the blade(s) recited above, further increases the turbulence of the fluid in the dissolution device 12, especially the fluid in the mixing section II. In one specific embodiment, the stirring shafts are arranged in such a way that every two adjacent stirring shafts form an angle of 5 to 30 degrees.

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The mixing device 13 will be described in the following. Fig. 5 schematically shows the structure of the mixing device 13. A house of the mixing device 13 is a horizontally arranged cylindrical member, a cavity of which forming a mixing chamber 33 for aqueous urea solution, said mixing chamber 33 being provided with a mixer therein. In one embodiment as shown in Fig. 5, the mixer is constructed as a stirring shaft 32 with a spiral blade/spiral blades 31, so that aqueous urea solution can be discharged as being further mixed. In one embodiment, it can be understood that the mixing shaft 32 and the blade(s) 31 thereof can be respectively the same with the above-recited stirring shaft 20 in the dissolution device 12 and the blade(s) thereof.

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In order to adjust the temperature of the aqueous urea solution to be discharged to a required value, a heat exchange jacket 34 is provided outside the mixing chamber 33. A three-way valve is provided in an outlet pipeline of the heat exchange jacket 34, wherein a branch 35 communicates with an inlet of the mixing chamber 33 and a branch 36 communicates with an inlet of the charging device 11 for deionized water. A valve is arranged both in the branch 35 and the branch 36 so that deionized water can be supplied into the mixing chamber 33 or the charging device 11 as required or into the mixing chamber 33 and the charging device 11 at the same time, as shown in Fig. 1.

25 The apparatus 10 can be of stainless steel or high polymer materials, such as stainless steel of grades 316L, 316, 304, etc. and high polymer materials of polyethylene, polypropylene, polytetrafluoroethylene, etc.

A method for producing aqueous urea solution used in vehicles with the apparatus 10 will be described in the following.

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First, a predetermined amount of urea granules and deionized water are added into the

charging device 11. Second, the stirring shaft 20 is driven to make urea granules that have entered into the dissolution device 12 dissolve into the deionized water. In one embodiment, the rotational speed of the stirring shaft 20 is in a range from 2,000 rpm to 6,000 rpm. Finally, aqueous urea solution is discharged into the mixing device 13 so as to drive the mixer to adjust aqueous urea solution to meet a predetermined standard. During the process, deionized water is filled into the heat exchange jacket 34 to reduce the temperature of aqueous urea solution to meet a predetermined standard, for example, to 20~30 DEG.C. Deionized water discharged from the heat exchange jacket 34 is further supplied into the mixing chamber 33 and/or the charging device 11 as required.

Example 1

Deionized water and urea granules with a weight ratio of 67.5:32.5 are respectively and simultaneously added into the apparatus 10 through the charging device 11. And the rotational speed of the stirring shaft 20 in the dissolution device 12 is adjusted to 2,500 rpm. Deionized water with a temperature of 20 DEG. C. is filled into the heat exchange jacket 34 so as to control the aqueous urea solution used in vehicles finally obtained at 25 DEG.C. The product is obtained and the analysis results are shown in Table 1.

Example 2

Deionized water and urea granules with a weight ratio of 67.5:67.5 are respectively and simultaneously added into the apparatus 10 through the charging device 11. And the rotational speed of the stirring shaft 20 in the dissolution device 12 is adjusted to 3,000 rpm. Deionized water of 25 DEG. C. is filled into the heat exchange jacket 34. The branch 35 is simultaneously opened and deionized water is filled into the mixing chamber 33 so as to control the aqueous urea solution used in vehicles finally obtained at 30 DEG.C. The product is obtained and the analysis results are shown in Table 1.

Example 3

Deionized water and urea granules with a weight ratio of 67.5:270 are respectively and simultaneously added into the apparatus 10 through the charging device 11. And the rotational speed of the stirring shaft 20 in the dissolution device 12 is adjusted to 3,200 rpm. Deionized water of 25 DEG. C. is filled into the heat exchange jacket 34 so as to control the aqueous urea solution used in vehicles finally obtained at 30 DEG.C. The product is obtained. The branch 36 is simultaneously opened to add the deionized water coming from the heat exchange jacket 34 into the charging device 11 for dissolution. The analysis results are shown in Table 1.

10 Example 4

Deionized water and urea granules with a weight ratio of 67.5:101 are respectively and simultaneously added into the apparatus 10 through the charging device 11. And the rotational speed of the stirring shaft 20 in the dissolution device 12 is adjusted to 3,200 rpm. Deionized water of 20 DEG. C. is filled into the heat exchange jacket 34 and the branch 35 and the branch 36 are simultaneously opened. A part of the deionized water coming from the heat exchange jacket 34 enters into the mixing chamber 33 so as to control the aqueous urea solution used in vehicles at 25 DEG. C. The product is obtained. Another part of the deionized water is added into the charging device 11 for the dissolution therein. The analysis results are shown in Table 1.

Table 1

Item	Standard	Example 1	Example 2	Example 3	Example 4
Urea content w/(%)	31.8 -3.2	32.7	32.6	32.5	32.6
Density (20 DEG.C.)/(Kg/m ³)	1087.0-1093.0	1090.5	1090.4	1090.2	1089.8
Refractive index (20 DEG.C.)/(n _D)	1.3814-1.3843	1.3831	1.3826	1.3827	1.3825
Insolubles /(mg/Kg) not more than	20	5.6	5.5	6.0	5.3
Alkalinity (based on NH ₃) w/(%) not more than	0.2	<0.01	<0.01	<0.01	<0.01
Phosphates (based on PO ₄ ³⁻) /(mg/Kg) not more than	0.5	0.09	0.11	0.10	0.09
Aluminum /(mg/Kg) not more than	0.5	0.3	0.31	0.32	0.30
Calcium/(mg/Kg) not more than	0.5	0.10	0.11	0.10	0.10
Ion/(mg/Kg) not more than	0.5	0.10	0.12	0.12	0.13
Chromium/(mg/Kg) not more than	0.2	0.17	0.15	0.17	0.16
Potassium/(mg/Kg) not more than	0.5	0.20	0.21	0.23	0.22

Magnesium/(mg/Kg) not more than	0.5	0.10	0.12	0.10	0.13
Sodium/(mg/Kg) not more than	0.5	0.40	0.42	0.42	0.40
Nickel/(mg/Kg) not more than	0.2	0.15	0.15	0.15	0.13
Copper/(mg/Kg) not more than	0.2	0.10	0.10	0.12	0.12
Zinc/(mg/Kg) not more than	0.2	0.05	0.05	0.05	0.06
Formaldehyde/(mg/Kg) not more than	5	1.9	1.8	2.0	1.9
Biuret/(mg/Kg) not more than	0.3	0.21	0.20	0.21	0.20

It can be seen from Table 1 that aqueous urea solution used in vehicles prepared by the apparatus 10 for producing aqueous urea solution used in vehicles according to the present invention is of good and stable quality. In addition, the apparatus 10 for producing aqueous urea solution according to the present invention has achieved continuous operation, such that the production efficiency is greatly improved. For example, to produce 10 tons of urea products used in vehicles, 20 hours are needed by the batch production process in the prior art. However, only 8 hours will be needed when the apparatus and the method according to the present invention are adopted.

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Although this invention has been discussed with reference to preferable examples, it extends beyond the specifically disclosed examples to other alternative examples and/or use of the invention and obvious modifications and equivalents thereof. Particularly, as long as there are no structural conflicts, the technical features disclosed in each and every example of the present invention can be combined with one another in any way. The scope of the present invention herein disclosed should not be limited by the particular disclosed examples as described above, but encompasses any and all technical solutions following within the scope of the following claims.

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Claims

1. An apparatus for producing aqueous urea solution used in vehicles, comprising a dissolution device with a stirrer for dissolving urea granules,
5 wherein a charging device is arranged upstream of said dissolution device for introducing urea granules and deionized water independently into said dissolution device, and a mixing device is arranged downstream of said dissolution device for adjusting the property of aqueous urea solution, and
 wherein said stirrer comprises a stirring shaft provided with one or a plurality of
10 blades.
2. The apparatus according to claim 1, characterized in that said stirring shaft is arranged along the flow direction of fluid, and comprises a feeding section, a mixing section and a homogenizing section successively from upstream to downstream,
15 wherein the blade(s) in said feeding section and that/those in the homogenizing section are spiral blades, and the blade(s) in the mixing section is/are straight blade(s).
3. The apparatus according to claim 1, characterized in that said stirring shaft is arranged along the flow direction of fluid, and comprises a feeding section, a mixing
20 section and a homogenizing section successively from upstream to downstream, wherein the blade(s) in said feeding section and that/those in the homogenizing section are first spiral blades and the blade(s) in the mixing section is/are second spiral blade(s).
- 25 4. The apparatus according to claim 3, characterized in that the rotation direction of the second spiral blade(s) is opposite to that of the first spiral blades.
5. The apparatus according to any one of claims 2 to 4, characterized in that the blade(s) in said mixing section is/are provided with orifices.
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6. The apparatus according to claim 5, characterized in that the ratio of the area of each blade in said mixing section to the sum cross section areas of all the orifices on

said blade is in a range from 4:1 to 3:2.

7. The apparatus according to claim 6, characterized in that said ratio equals to 2:1.

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8. The apparatus according to any one of claims 2 to 7, characterized in that the ratio of the axial length of the feeding section to the axial length of the mixing section to the axial length of the homogenizing section is in a range from 1:1:1 to 1:2:1.5.

10 9. The apparatus according to any one of claims 1 to 8, characterized in that a plurality of stirring shafts are arranged in parallel with one another.

10. The apparatus according to any one of claims 1 to 8, characterized in that said plurality of stirring shafts are provided in such a way that the distance between two adjacent stirring shafts in the feeding section is larger than that in the homogenizing section.

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11. The apparatus according to claim 10, characterized in that the stirring shafts are arranged in such a way that every two adjacent stirring shafts form an angle of 5 to 30 degrees.

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12. The apparatus according to any one of claims 1 to 11, characterized in that the number of blades in said feeding section and/or the number of blades in said mixing section and/or the number of blades in said homogenizing section are all selected from 1 to 5.

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13. The apparatus according to any one of claims 1 to 12, characterized in that said dissolution device and said mixing device are both horizontally arranged cylindrical members, a cavity of said mixing device forms a mixing chamber for aqueous urea solution, and a mixer is provided in said mixing chamber.

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14. The apparatus according to claim 13, characterized in that the dissolution

device is further provided with a heating device.

15. The apparatus according to claim 13 or 14, characterized in that said mixing chamber is provided with a heat exchange jacket on its external side.

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16. The apparatus according to claim 15, characterized in that an outlet of said heat exchange jacket communicates with an inlet of said mixing chamber and/or with an inlet for deionized water of said charging device.

10 17. The apparatus according to any one of claims 13 to 16, characterized in that said mixer comprises a mixing shaft provided with one or a plurality of spiral blades and arranged along the flow direction of fluid.

15 18. A method of using the apparatus according to any one of claims 1 to 17, comprising,

Step 1: adding a predetermined amount of urea granules and deionized water into the charging device;

Step 2: driving the stirrer to dissolve the urea granules that have entered into the dissolution device into the deionized water; and

20 Step 3: discharging aqueous urea solution into the mixing device and driving the stirrer to adjust the aqueous urea solution to comply with a predetermined standard.

25 19. The method according to claim 18, characterized in that in Step 3, filling in the heat exchange jacket of said mixing device with deionized water so as to adjust the temperature of aqueous urea solution to a required temperature.

20. The method according to claim 19, characterized in that the deionized water discharged from said heat exchange jacket flows into the mixing chamber, or is added into the charging device after being mixed with the deionized water of Step 1.

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21. The method according to claim 19, characterized in that a part of the deionized water discharged from said heat exchange jacket flows into the mixing

chamber and another part of the deionized water discharged from said heat exchange jacket is added into the charging device after being mixed with the deionized water of Step 1.

5 22. The method according to any one of claims 18 to 21, characterized in that the deionized water in the heat exchange jacket flows against the flow direction of the aqueous urea solution in the mixing chamber.

 23. The method according to any one of claims 18 to 22, characterized in that in
10 Step 1, the ratio of the adding weight of deionized water to that of urea granules falls within a range from 67.5:32.5 to 67.5:270.

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