

STATIC MIXER FOR HOMOGENIZING A MIXTURE OF AT LEAST TWO LIQUIDS, AND DOSING DEVICE PROVIDED WITH SUCH A MIXER

The invention relates to a static mixer for
5 homogenizing a mixture of at least two liquids, in particular after injection of an auxiliary liquid into a main liquid.

Injection by means of hydraulic dosing pumps of a
10 mixture of water and an auxiliary liquid product in two separate phases is known, in particular from FR 2 967 218 in the name of the applicant company. The auxiliary liquid, in the case of use in an agricultural environment, can be constituted by nutrients in
15 solution, or by veterinary drugs. It is important for the mixing of the main liquid and the auxiliary liquid to be as homogenous as possible. The same requirement may apply in other applications, since the dosing pumps in question can be used in industry, in hospitals, or
20 in other fields which also make it necessary to obtain a homogenous liquid mixture, according to the dose prescribed for the auxiliary liquid.

The objective of the invention is thus to provide a
25 static mixer which is simple and economical to produce, and makes it possible to obtain good homogenization of the liquids mixed.

According to the invention, a static mixer for
30 homogenizing a mixture of at least two liquids, in particular after injection of an auxiliary liquid into a main liquid, is characterized in that it comprises:

- a container closed by walls comprising a top, a bottom and lateral walls;
- 35 - an input duct, starting from a first wall of the container, and extending as far as the vicinity of the opposite wall; and

- an output duct, substantially parallel to the input duct, which starts in the vicinity of the first wall and extends as far as the opposite wall, each duct being provided with a device for connection
5 to the exterior through a wall of the container.

The first wall can be formed by the top of the container, and the opposite wall formed by the bottom, the input duct being vertical when the mixer is in the
10 position of work, starting from the top and extending as far as the vicinity of the bottom, whereas the output duct starts in the vicinity of the top and extends as far as the bottom.

15 According to a variant, the input duct is horizontal, as is the output duct.

Advantageously, the input duct is arranged in the vicinity of the lateral wall of the container, and in
20 particular against the wall.

The output duct can be arranged in the vicinity of the input duct, in particular against the input duct, or it can be offset from it.
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The mixer according to the invention induces an eddy flow of the mixture in order to go from the input duct to the output duct, which gives rise to an effect of high homogenization.
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In the lower part, the input duct can have a partially open transverse cross-section, the open part of this cross-section being closed substantially by the wall of the container.
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The container can have an oval horizontal cross-section, which in particular is elliptical, and the input duct is situated in the vicinity of an end of the

large axis of the cross-section, whereas the output duct is situated substantially against the input duct, on the side of the center of the cross-section. The horizontal cross-section of the container can also be
5 circular. Advantageously, the plane of the parallel axes of the input duct and of the output duct contains the large axis of the horizontal cross-section of the mixer.

10 The top and the bottom of the container can be curved in order to assist the flow of the fluid in the mixer, and ensure good resistance to the pressure.

Preferably, the container is relatively flat, and has a
15 thickness, according to a direction orthogonal to the plane of the axes of the input duct and of the output duct, the ratio of which to the width of the container is between 0.3 and 0.7.

20 In the case when the container has an oval cross-section, and in particular elliptical, the thickness of the container corresponds to the small axis of the cross-section, whereas the width corresponds to the large axis.

25 The mixer can be associated with a single pump. According to a variant, the mixer can be produced with two identical half-parts, which are turned and assembled head-to-tail.

30 The invention also relates to a dosing device for introduction of an auxiliary liquid into a flow of main liquid circulating in a duct, comprising a dosing pump with a differential piston with reciprocal motion in
35 order to collect the auxiliary liquid from a container, this pump comprising a first input for receipt of a flow of main liquid which ensures that the pump is driven, a second input for collection of the auxiliary

liquid, and an output for mixing of the auxiliary liquid and the main liquid, this dosing device being characterized in that it comprises a mixer as previously defined arranged at the output of the pump.

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The dosing device can comprise a flow divider installed inside the main liquid duct, with the dosing pump being connected in parallel to the flow divider, the first input of the pump being connected by a first pipe to the input of the flow divider, whereas the output of the pump is connected by a second pipe to a neck of the flow divider, the mixer being arranged on the second pipe between the output of the pump and the connection to the neck of the flow divider.

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The dosing device can comprise a means for variable throttling of the neck of the flow divider.

The volume of the container is adapted to the dosing pump with which this mixer is used. The volume of the container is advantageously three times the capacity of the dosing pump, or more.

Apart from the above-described arrangements, the invention consists of a certain number of other arrangements which will be described explicitly hereinafter with reference to an embodiment described in relation to the appended drawings, but which is in no way limiting. In these drawings:

figure 1 is an elevated view of a mixer according to the invention;

figure 2 is a vertical cross-section on a smaller scale of a dosing device with a dosing pump and mixer according to the invention;

figure 3 is a view from below in relation to figure 4; figure 4 is an elevated view from above of the mixer; figure 5 is a view in perspective from above laid on one side;

figure 6 is a vertical cross-section from below of the mixer, turned by 180° relative to the view from above in figures 3 and 4;

figure 7 is a plan view relative to figure 6;

5 figure 8 is a view from the left relative to figure 6;

figure 9 is a vertical cross-section of the pump on which the mixer is secured; and

figure 10 is an elevated view of the pump and of the mixer in figure 9.

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With reference to the drawings, and in particular figure 1, a static mixer M can be seen for homogenizing a mixture of at least two liquids. The mixer M comprises a closed container 1 with a top 1a, a bottom 1b and lateral walls.

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The top 1a and the bottom 1b, with the associated lateral walls, are in the form of a shell, as can be seen in figures 3-8, with their concavity facing towards one another, and are assembled according to an equatorial plane P, preferably by welding or by screwing. The container 1 is advantageously made of plastic material. The top 1a comprises two vertical lugs 2 provided with a hole for optional securing of the container on a support.

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The mixer M comprises an input duct 3 which is vertical when the mixer M is in the position of work. The duct 3 starts from the top 1a and extends as far as the vicinity of the bottom of the container, as can be seen in figure 2. The mean distance between the open lower end of the duct 3 and the bottom 1b wall is preferably less than 20 mm. The duct 3 passes through the top 1a in order to form threaded connection piping 3a.

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The mixer M additionally comprises an output duct 4 which is substantially parallel to the input duct 3, starting below and in the vicinity of the top 1a, and

extending as far as the bottom 1b. The mean distance between the open upper end of the duct 3 and the top wall 1a is preferably less than 20 mm. The duct 4 is open at the bottom, and passes through the bottom 1b in order to form output piping 4a which is advantageously provided with annular grooves in order to receive a rapid connection device. The annular grooves permit respectively putting into place a seal and a clip in order to retain a rotary nut which ensures the securing on a threaded joining piece.

As a variant, the input and output ducts could be horizontal between a first lateral wall and an opposite wall.

The top 1a and the bottom 1b are curved, such that the flow of liquid which emerges from the duct 3 in the low part meets a curved surface 5 of the bottom 1b (figure 6) which directs the flow towards the opposite area of the container. The concave surface 6 (figure 2) of the top 1a, distant from the input duct 3, orients the flow towards the output duct 4.

The container 1 preferably has an oval horizontal cross-section, in particular elliptical as can be seen in figures 3 and 7, with a small axis 7 and a large axis 8. However, the horizontal cross-section can be circular.

The input duct 3 is situated in the vicinity of the wall of the container, and preferably at an end of the large axis 8 of the cross-section as can be seen in figures 3-5. The lower part 3b (figures 3 and 5) can have a transverse cross-section in the form of a "U" which is open towards the wall of the container, and can be supported against an area which forms a belt, of the bottom 1b. As a variant, the lower part of the input duct can have the form of a cylindrical pipe.

The output duct 4 is situated substantially against the input duct 3. The geometric axes of the ducts 3 and 4 are situated on a vertical plane which contains the large axis 8 of the horizontal cross-section of the container. As a variant, the output duct can be offset from, i.e. spaced from, the input duct.

The container 1 is relatively flat, i.e. its thickness in a direction orthogonal to the plane of the geometric axes of the ducts 3 and 4 is relatively small in comparison with its width. The thickness of the container 1 corresponds substantially to the dimension of the small axis 7 of the cross-section, whereas the width corresponds substantially to the dimension of the large axis 8. The ratio of the thickness of the container to its width is advantageously between 0.3 and 0.7.

The volume of the container 1 is preferably equal to at least three times the capacity of a dosing pump with a piston with reciprocal motion for which the mixer M would be designed. A volume of 1.5 L for the mixer M is an example of a possible value, for a 3 m³/hour pump with a capacity of 0.5 L.

The top 1a and the bottom 1b are molded separately, then are assembled by arranging the upper half 1a on the lower half 1b, such that the input duct 3 is between the output duct 4 and the adjacent wall of the bottom 1b. The assembly according to the equatorial plane P is ensured by any appropriate connection means, in particular by welding or by adhesion.

The mixer M is then installed in a position such that the geometric axes of the ducts 3 and 4 are vertical, the input piping 3a being in the high part whereas the output piping 4a is in the low part. The input piping 3a is connected to an intake duct in which a mixture of

at least two liquids circulates, and must be made more homogenous. The flow of liquid opens into the low part of the duct 3 at a reduced distance, generally of less than 20 mm, from the bottom wall. When the flow of liquid meets the concave surface 5 of the bottom wall, it describes a short trajectory in the direction of the opposite end of the container 1, and rises again, producing eddies, towards the upper end of the output duct 4, in order to flow out via this duct. The upper end of the duct 4 is situated at a short distance from the upper wall of the top 1a, this distance being in particular less than 20 mm.

The eddies created in the mixture 1 for the passage of the flow of liquid from the lower end of the duct 3 to the upper end of the duct 4, in a sufficient volume, makes it possible to homogenize the mixture.

Figure 2 illustrates a dosing device D for introduction of an auxiliary liquid L1 into a flow of main liquid L circulating in a duct C. The auxiliary liquid L1 is contained in a tank R from which it is taken by a dosing pump 9 with a differential piston 10 with reciprocating straight motion. A dosing pump of this type is known, in particular from EP0255791.

The pump 9 comprises a first input 11 in order to receive a flow of main liquid which ensures that the pump is driven, a second input 12 in order to collect the auxiliary liquid L1 by means of a pipe 13 which is immersed in the tank R, and an output 14 for the mixing of auxiliary liquid and main liquid.

The mixer M is arranged such that its ducts 3, 4 are vertical, and the input connection piping 3a is connected to the output 14 of the pump 9 by a pipe 15, in particular a flexible pipe. The output piping 4a of the mixer is connected to the duct C.

In the particular example illustrated in figure 2, a flow divider V, comprising a Venturi, is inserted in the duct C, and the pump 9 is connected in parallel
5 with the flow divider. The first input 11 of the pump is connected by first piping 16 to the input of the flow divider, whereas the output 14 of the pump is connected by the pipe 15 to the mixer M, the output 4a of which is connected to the neck of the flow divider,
10 constituting part of the pipe C.

According to the arrangement in figure 2, only a fraction of the main current flow passes through the pump 9. The dosing device D in figure 2 can also
15 comprise a means 17 for variable throttling of the neck of the flow divider.

A flap valve 18 which can break a possible vacuum is advantageously provided at the orifice for connection
20 of the flow divider V to the output piping 4a of the mixer.

The diameter of the input piping 3a is at least equivalent to the diameter of the output 14 of the
25 pump.

The volume of the container of the mixer M is at least equal to three times the capacity of the pump 9. The capacity corresponds to the volume which is displaced
30 during an outward and return course of the differential piston 10.

According to a variant, as illustrated in figures 9 and 10, the mixer M can be produced with two identical half
35 parts 1a which are turned and assembled head-to-tail, according to the vertical assembly plane Q. The mixer comprises an identical threaded $\frac{3}{4}$ input and output. The input is connected by a connection J to the output of

the pump 9. According to the example in figure 9, the ducts 3 and 4 are horizontal and offset.

5 Whilst being simple and economical to produce, the mixer according to the invention makes it possible to obtain a homogenous mixture of at least two liquids, particularly with a relatively small dose of auxiliary liquid, which in particular is less than 5% of the main liquid.

CLAIMS

1. A static mixer for homogenizing a mixture of at least two liquids, in particular after injection of an auxiliary liquid into a main liquid, said mixer comprising:
 - a container (1) closed by walls comprising a top (1a), a bottom (1b) and lateral walls;
 - an input duct (3), starting from a first wall of the container, and extending as far as the vicinity of the opposite wall; and
 - an output duct (4), substantially parallel to the input duct, which starts in the vicinity of the first wall and extends as far as the opposite wall,each duct being provided with a device (3a, 4a) for connection to the exterior through a wall of the container, wherein the container is relatively flat, and has a thickness, according to a direction orthogonal to the plane of the axes of the input duct and of the output duct, the ratio of which to the width of the container is between 0.3 and 0.7.
2. The mixer as claimed in claim 1, wherein the first wall is formed by the top (1a) of the container, and the opposite wall is formed by the bottom (1b), the input duct (3) being vertical when the mixer is in the position of work, starting from the top and extending as far as the vicinity of the bottom, whereas the output duct (4) starts in the vicinity of the top and extends as far as the bottom.
3. The mixer as claimed in claim 1, wherein the input duct is horizontal, as is the output duct.
4. The mixer as claimed in any one of the preceding claims, wherein the input duct (3) is arranged in

the vicinity of the wall of the container (1), and in particular against the wall.

- 5 5. The mixer as claimed in any one of the preceding claims, wherein the output duct (4) is arranged in the vicinity of the input duct (3), and in particular against the input duct.
- 10 6. The mixer as claimed in claim 2, wherein in the lower part the input duct (3) has a partially open transverse cross-section (3b), the open part of this cross-section being closed substantially by the wall of the container.
- 15 7. The mixer as claimed in any one of the preceding claims, wherein the container (1) has an oval horizontal cross-section, which in particular is elliptical, and the input duct (3) is situated in the vicinity of an end of the large axis (8) of the cross-section, whereas the output duct (4) is
20 situated substantially against the input duct, on the side of the center of the cross-section.
- 25 8. The mixer as claimed in claim 7, wherein the plane of the parallel axes of the input duct (3) and of the output duct (4) contains the large axis (8) of the horizontal cross-section of the mixer.
- 30 9. The mixer as claimed in any one of the preceding claims, wherein the bottom (1b) and the top (1a) of the container are curved.
- 35 10. The mixer as claimed in any one of the preceding claims, wherein it is produced with two identical half-parts, which are turned and assembled head-to-tail.

11. A dosing device (D) for introduction of an auxiliary liquid (L1) into a flow of main liquid (L) circulating in a duct (C), comprising a dosing pump (9) with a differential piston with reciprocal motion in order to collect the auxiliary liquid from a container, this pump comprising a first input (11) for receipt of a flow of main liquid which ensures that the pump is driven, a second input (12) for collection of the auxiliary liquid, and an output (14) for mixing of auxiliary liquid and main liquid, wherein the dosing device (D) comprises a static mixer (M) arranged at the output (14) of the pump, the static mixer being intended for homogenizing a mixture of at least two liquids, in particular after injection of an auxiliary liquid into a main liquid, said mixer comprising:
- a container (1) closed by walls comprising a top (1a), a bottom (1b) and lateral walls;
 - an input duct (3), starting from a first wall of the container, and extending as far as the vicinity of the opposite wall; and
 - an output duct (4), substantially parallel to the input duct, which starts in the vicinity of the first wall and extends as far as the opposite wall,
- each duct being provided with a device (3a, 4a) for connection to the exterior through a wall of the container.
12. The dosing device as claimed in claim 11, wherein the static mixer is in accordance with any one of claims 1 to 10.
13. The dosing device as claimed in claims 11 or 12, comprising a flow divider (V) installed inside the main liquid duct (C), with the dosing pump (9) being connected in parallel to the flow divider, the first input (11) of the pump being connected

- 5 by a first pipe (16) to the input of the flow divider, whereas the output (14) of the pump is connected by a second pipe (15) to a neck of the flow divider, wherein the mixer (M) is arranged on the second pipe (15) between the output of the pump and the connection to the neck of the flow divider.
- 10 14. The dosing device as claimed in claims 11, 12 or 13, wherein the volume of the container (1) is three times the capacity of the dosing pump (9), or more.