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☒ Claim(s) : paged to paged
☐ Drawing(s) : paged to paged
☒ Abstract : paged to paged

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APPARATUS AND METHOD FOR TREATING A FLUID PRODUCT

The present invention relates to an apparatus for
5 treating a fluid such as for sterilising and/or
pasteurising and/or homogenising fluid products. More
particularly, it relates to an apparatus for
sterilising, pasteurising and/or homogenising a fluid
product by injection of steam into the fluid product.

10

Direct steam injection is e.g. used in the food industry
for pasteurising or sterilising of milk or cereal
products. Various types of apparatus for pasteurising or
sterilising fluid food products by injection of steam
15 are known. The present invention relates to a method and
apparatus wherein steam is injected into a product
stream.

Whereas direct steam injection does not raise particular
20 problems for low viscosity fluids such as milk, whey and
cream, the pasteurisation of e.g. infant cereal based
food, with far higher viscosity, e.g. comprising 20%
starch, is very difficult to control in a homogeneous
mixing. An inhomogeneous mixing will mean that
25 temperature varies through the product mass and
consequently the product is not homogeneously heat
treated. In order to safeguard sufficiently heat
treatment of the product i.e. to make sure that all
parts of the product mass are heated to a high enough
30 temperature, such as is crucial in pasteurising and
sterilising processes, additional steam will need to be
injected. This additional steam consumption is expensive
and undesirable.

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0 1 2 3 4 5 6 7 8 9

Homogenisation and mixing may be improved by passing the product through a venturi shaped nozzle in order to increase turbulence and velocity of the product, however, this may not provide a sufficient enough
5 mixing. Alternatively, a mechanical mixing of the product and the steam may be necessary.

Mixing of the product and steam may be obtained by passing the product through a static mixer. However,
10 substantial wear of the static mixer is likely to result from the passage of highly viscous products there through. Such static mixer will therefore have to frequently be replaced, which increases production costs. Alternatively, a screw may be used for mixing and
15 for building up a pressurised product. However, the product creates a large momentum on the screw when rotated, and hence considerable motor capacity is required for the mixing.

20 The present invention overcomes the above mentioned difficulties by utilising a rotatable shaft along which a plurality of perforated discs comprising product passage openings, are co-axially disposed. Accordingly, the invention provides an improved apparatus and process
25 which accommodates a good mixing and thus a homogeneous heating together with a surprisingly high homogenisation. Among other things, the invention has the following advantages:

- Lowered steam consumption by ensuring a sufficiently
30 homogeneous mixing.
- Improved mixing and homogenising by providing a rotatable shaft along which a plurality of perforated discs comprising product passage openings are co-



axially disposed and by passing the product through said openings while rotating the discs,

- Shock effect due to flowing product hitting the discs and the passage of the product through the opening
5 resulting in turbulent flow and mixing, and homogenisation.
- Cutting through the product mass by rotating the discs to increase the homogenisation of the product.
- Reducing motor capacity requirement due to a reduced
10 momentum from the product surrounding the shaft and the disc,
- Optimising heat distribution by providing an initial homogenising of the product where after the steam is injected and the product and steam are mixing together
15 for a condensation of the steam and a heat transfer to the product.

Accordingly, in a first aspect the present invention relates to an apparatus for heat treating a fluid
20 product by injecting steam into the fluid product, said apparatus comprising

a mixing chamber comprising a steam injection inlet, a product inlet, and an outlet for the treated product,

25 a rotatable shaft disposed within said mixing chamber,

a plurality of discs each comprising at least one product passage opening, said discs being disposed substantially co-axially on said shaft, and

30 means for rotating said shaft with said discs.

It is preferred that the steam is injected at sonic velocity. This will increase the turbulence in the steam



and a good mixing is obtained. Sonic velocity of steam can be obtained by letting the fluid pass through a venturi valve while having upstream a pressure with approximately twice that downstream. The steam velocity
5 after the valve will then be about 450 m/sec.

Advantageously, at least on the downstream end of the mixing chamber only a small gap is left between the discs and the mixing chamber walls. This results in
10 substantially the whole product mass passing through the product passage opening in the discs and substantive homogenising of the fluid product and mixing of steam and product. Conveniently, at least the downstream part of mixing chamber is substantially cylindrical and the
15 rotatable shaft is substantially co-axially fitted within said mixing chamber.

One or more steam injectors may be positioned along the shaft for injection of steam, via the steam injection
20 inlet, into product passing through the mixing chamber. The rotating shaft with discs will, while the product is pumped through the mixing chamber, cut the product stream and act as a shock generator such as discussed above. The shaft with discs will, contrary to a screw,
25 not in any substantial way add to the advancing movement of the product through the mixing chamber. The product will be pumped into the chamber and advanced by further product being supplied. The shaft may be provided with replaceable discs or the shaft and discs may be made one
30 part. The shaft may be rotated by any conventional motor.

Depending on the required throughput, heating, mixing and homogenisation, the number of discs and the openings



therein may be varied. The more discs provided along the products path from the product inlet to the outlet for the treated product the more homogenising and mixing will be provided. Although the number of discs can be
5 freely chosen for practical purposes the number of discs are from 2 to 20, preferably 5 to 15. The diameter of the product passage openings is preferably in the range from 2 to 10 mm, more preferably 6 mm. This will provide a velocity into the product passage openings between 40
10 and 200 m/s, preferably 100 m/s.

In the present context a fluid product is understood to be a solution or suspension, e.g. aqueous, having a viscosity of the order of 1000 to 100.000 mPa.s.

15

The fluid product is pumped into the mixing chamber through the product inlet. It is preferred that the fluid product is first passed through at the product passage opening(s) in at least one and preferably 3
20 rotating discs before steam is injected into the product. This gives an initially homogeneous slurry which is then pressed forward and subjected to steam injection heating, mixing, and homogenising.

25 The homogenising effect is obtained by the shearing of the product passing through the discs' openings. In the particular case of milk-containing products, a good homogenising effect is obtained by the arrangement through shearing of the fatty globules.

30

The steam injection nozzle is connected to a feed pipe feeding steam under pressure, preferably between 10 and 15 bar. The product injection nozzle is connected to a feed pipe feeding the fluid product to be treated. The



outlet from the apparatus is by a back-pressure valve connected to a holding pipe. The back-pressure valve regulates the pressure through the outlet and creates a back pressure in the mixing chamber to maintain the temperature in the mixing chamber. Poor control of the back pressure results in loss of steam which gives an uneconomic production. The back-pressure valve may advantageously be of the membrane type. Advantageously, two pack-pressure valves may be used e.g. CPM or APC valves from Tetra-Laval.

In another aspect, the invention relates to a method for heat treating a fluid product by injecting steam into the fluid product, said method comprising the steps of supplying a fluid product into a mixing chamber through a product inlet,

injecting steam into said fluid product through a steam injection inlet in said mixing chamber, in which mixing chamber being disposed a rotatable shaft and a plurality of discs each comprising at least one product passage opening, said discs being disposed substantially co-axially on said shaft, while

passing at least part of the fluid product through said product passage openings while rotating said shaft with said discs, and

discharging the treated fluid product through an outlet in said mixing chamber.

In a further aspect, the invention relates to a shaft to be used for homogenising and mixing in an apparatus or a process for heating by steam injection a fluid product, said shaft comprising a plurality of discs each comprising at least one product passage opening, said

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discs being disposed substantially co-axially on said shaft.

The invention will now be described in greater detail
5 with reference to the accompanying drawings given by way
of example showing an embodiment of the invention and in
which

Fig. 1 is a schematic illustration of the principle
elements of the apparatus according to the invention,
10 and

Fig. 2 and Fig. 3 are schematic illustrations of the
shaft with discs.

Fig. 1 shows the apparatus 10 according to the
15 invention. The apparatus 10 comprises a mixing chamber
11 defined by walls 21 wherein a steam injection inlet
13, a product inlet 12, and an outlet 16 are formed. A
rotatable shaft 14 is disposed within said mixing
chamber 11 and mounted in bearings 18 within an
20 intermediate support 22. It is connected to an output
rotary shaft 23 of a motor 17 which drives the rotation
of the shaft 14. Said motor may e.g. be a 1.1 Kw, 1400
t/min motor. A sealing 24 is provided to prevent fluid
product from escaping the mixing chamber 11. Said
25 sealing 24 is cooled by means of water supplied via a
water inlet 25.

The shaft 14 is provided with a plurality of discs 15.
Each disc 15 comprises at least one product passage
30 opening. The discs are disposed substantially co-axially
on said shaft. Fig. 2 shows a perspective view of the
discs 15 mounted on the shaft 14. Said discs comprises
product passage opening 26. Fig. 3 shows a cross-

sectional view of the shaft 14 with a disc 15 fitted within the chamber 11.

5 The flow through the outlet 16 is regulated by means of a back-pressure valve not shown in the drawings. To use the apparatus a steam inlet 13 is be connected to steam injector and a feed pipe for supplying steam under pressure and the product inlet is be connected to a feed pipe and a pump for supplying the fluid product to be
10 treated under pressure. The outlet is preferably connected to a holding pipe by the back-pressure valve.

EXAMPLE

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The following example illustrates the substantial and surprising steam reduction obtained with the apparatus according to the invention when compared with processing of a similar fluid product in a steam injection nozzle
20 i.e. a nozzle wherein both streams of steam and fluid product are injected into a mixing chamber in counter-currency without any further mechanical mixing (S&P injection). The apparatus according to the invention used comprises a shaft with 10 discs. The diameter of
25 the discs was $\varnothing$ 44 mm and each disc had 6 product passage openings of $\varnothing$ 8 mm. The example shows test results of heat treatment of fluid products with varying solid matter content. The products were heated to 140°C:

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	Product	Solid matter	Steam consumption (Kg/Hour)	
		Ts soup %	S&P injection	Invention
	A	60-62%	320	195
5	B	56-58%	330	195
	C	58-60%	330	195
	D	58-60%	335	200
	E	60%	350	215
	F	56-58%	355	200

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CLAIMS

1. Apparatus for heat treating a fluid product by injecting steam into the fluid product, said apparatus
5 comprising
a mixing chamber comprising a steam injection inlet, a product inlet, and an outlet for the treated product,
a rotatable shaft disposed within said mixing
10 chamber,
a plurality of discs each comprising at least one product passage opening, said discs being disposed substantially co-axially on said shaft, and
means for rotating said shaft with said discs.
15
2. Apparatus according to claim 1, wherein the apparatus comprises a back-pressure valve for regulating the flow through the outlet.
- 20 3. Apparatus according to claims 1 and 2, wherein the mixing chamber is substantially cylindrical and the rotatable shaft is substantially co-axially disposed within said mixing chamber.
- 25 4. Apparatus according to claims 1 and 3, wherein at least one disc is disposed between the product inlet and the steam inlet.
5. Apparatus according to any of claims 1 to 4, wherein
30 a plurality of steam inlets are positioned along the rotatable shaft.
6. Apparatus according to any of the claims 1 to 5, wherein the apparatus is provided with 5 to 15 discs.





7. Apparatus according to any of the claims 1 to 6, wherein each disc is provided with 2 to 50 product passage openings.

5

8. Apparatus according to any of the claims 1 to 7, wherein the openings have a diameter in the range from 2 to 10 mm.

10 9. Method for heat treating a fluid product by injecting steam into the fluid product, said method comprising the steps of

supplying a fluid product into a mixing chamber through a product inlet,

15 injecting steam into said fluid product through a steam injection inlet in said mixing chamber, in which mixing chamber being disposed a rotatable shaft and a plurality of discs each comprising at least one product passage opening, said discs being disposed substantially
20 co-axially on said shaft, while

passing at least part of the fluid product through said product passage openings while rotating said shaft with said discs, and

25 discharging the treated fluid product through an outlet in said mixing chamber.

10. A shaft to be used for homogenising and mixing in an apparatus or a process for heating by steam injection a fluid product, said shaft comprising a plurality of
30 discs each comprising at least one product passage opening, said discs being disposed substantially co-axially on said shaft.

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ABSTRACT

The present invention relates to an apparatus and a method for heat treating a fluid product by injection of steam therein in order to provide a sterilisation, pasteurisation and/or a homogenisation of the product. Said apparatus comprising a mixing chamber comprising a steam injection inlet, a product inlet, and an outlet for the treated product, a rotatable shaft disposed within said mixing chamber, a plurality of discs each comprising at least one product passage opening, said discs being disposed substantially co-axially on said shaft, and means for rotating said shaft with said discs. The invention also relates to a shaft to be used for homogenising and mixing in an apparatus or a process for heating by steam injection a fluid product.

Figure 1



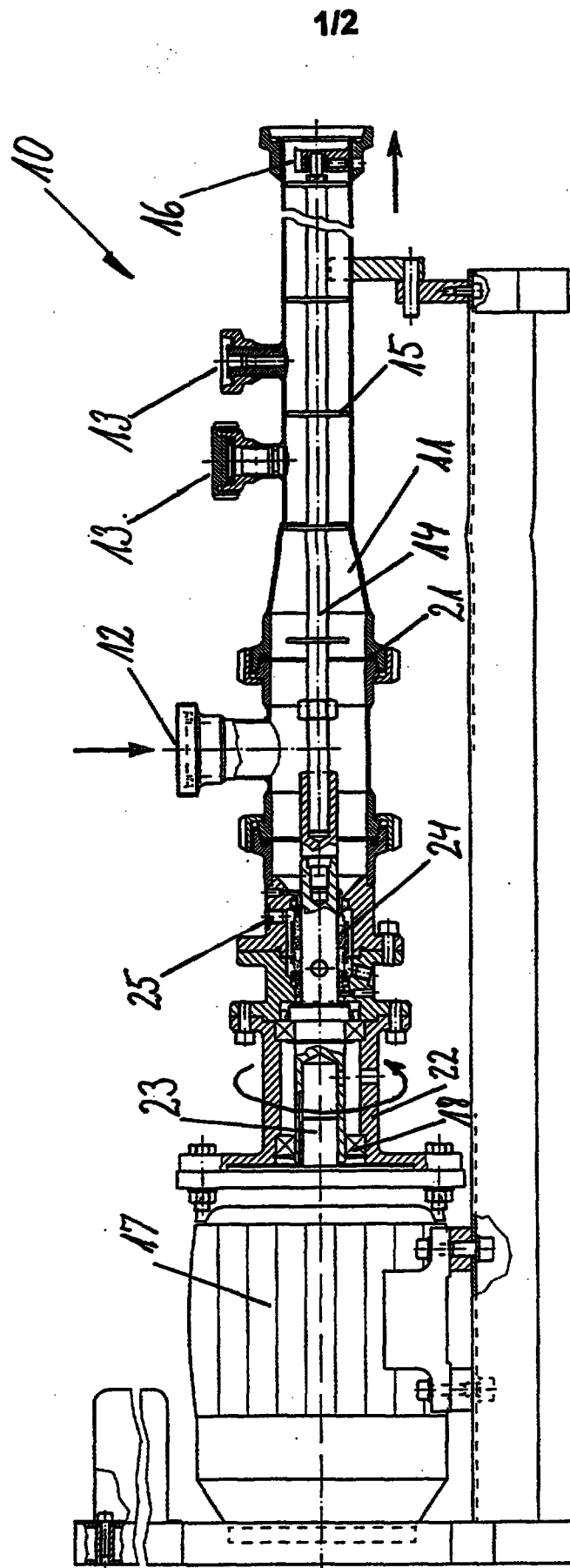


Fig. 1

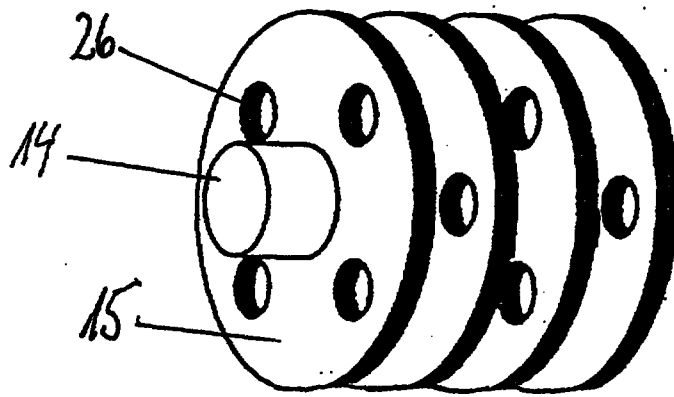


Fig. 2

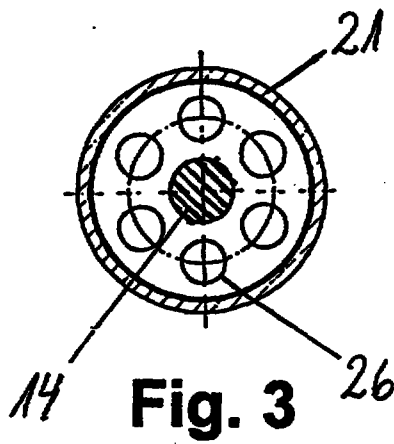


Fig. 3

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The present invention relates to an apparatus for
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 product by injection of steam into the fluid product.

10

Direct steam injection is e.g. used in the food industry
 for pasteurising or sterilising of milk or cereal
 products. Various types of apparatus for pasteurising or
 sterilising fluid food products by injection of steam
 15 are known. The present invention relates to a method and
 apparatus wherein steam is injected into a product
 stream.

Whereas direct steam injection does not raise particular
 20 problems for low viscosity fluids such as milk, whey and
 cream, the pasteurisation of e.g. infant cereal based
 food, with far higher viscosity, e.g. comprising 20%
 starch, is very difficult to control in a homogeneous
 mixing. An inhomogeneous mixing will mean that
 25 temperature varies through the product mass and
 consequently the product is not homogeneously heat
 treated. In order to safeguard sufficiently heat
 treatment of the product i.e. to make sure that all
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 30 temperature, such as is crucial in pasteurising and
 sterilising processes, additional steam will need to be
 injected. This additional steam consumption is expensive
 and undesirable.

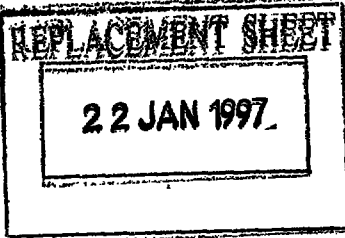
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Homogenisation and mixing may be improved by passing the product through a venturi shaped nozzle in order to increase turbulence and velocity of the product, however, this may not provide a sufficient enough
5 mixing. Alternatively, a mechanical mixing of the product and the steam may be necessary.

Mixing of the product and steam may be obtained by passing the product through a static mixer. However,
10 substantial wear of the static mixer is likely to result from the passage of highly viscous products there through. Such static mixer will therefore have to frequently be replaced, which increases production costs. Alternatively, a screw may be used for mixing and
15 for building up a pressurised product. However, the product creates a large momentum on the screw when rotated, and hence considerable motor capacity is required for the mixing.

20 The present invention overcomes the above mentioned difficulties by utilising a rotatable shaft along which a plurality of perforated discs comprising product passage openings, are co-axially disposed. Accordingly, the invention provides an improved apparatus and process
25 which accommodates a good mixing and thus a homogeneous heating together with a surprisingly high homogenisation. Among other things, the invention has the following advantages:

- Lowered steam consumption by ensuring a sufficiently
30 homogeneous mixing.
- Improved mixing and homogenising by providing a rotatable shaft along which a plurality of perforated discs comprising product passage openings are co-



axially disposed and by passing the product through said openings while rotating the discs,

- Shock effect due to flowing product hitting the discs and the passage of the product through the opening
5 resulting in turbulent flow and mixing, and homogenisation.
- Cutting through the product mass by rotating the discs to increase the homogenisation of the product.
- Reducing motor capacity requirement due to a reduced
10 momentum from the product surrounding the shaft and the disc,
- Optimising heat distribution by providing an initial homogenising of the product where after the steam is injected and the product and steam are mixing together
15 for a condensation of the steam and a heat transfer to the product.

Accordingly, in a first aspect the present invention relates to an apparatus for heat treating a fluid
20 product by injecting steam into the fluid product, said apparatus comprising

- a mixing chamber comprising a steam injection inlet, a product inlet, and an outlet for the treated product,
- 25 a rotatable shaft disposed within said mixing chamber,
- a plurality of discs each comprising at least one product passage opening, said discs being disposed substantially co-axially on said shaft, and
- 30 means for rotating said shaft with said discs.

It is preferred that the steam is injected at sonic velocity. This will increase the turbulence in the steam

and a good mixing is obtained. Sonic velocity of steam can be obtained by letting the fluid pass through a venturi valve while having upstream a pressure with approximately twice that downstream. The steam velocity
5 after the valve will then be about 450 m/sec.

Advantageously, at least on the downstream end of the mixing chamber only a small gap is left between the discs and the mixing chamber walls. This results in
10 substantially the whole product mass passing through the product passage opening in the discs and substantive homogenising of the fluid product and mixing of steam and product. Conveniently, at least the downstream part of mixing chamber is substantially cylindrical and the
15 rotatable shaft is substantially co-axially fitted within said mixing chamber.

One or more steam injectors may be positioned along the shaft for injection of steam, via the steam injection
20 inlet, into product passing through the mixing chamber. The rotating shaft with discs will, while the product is pumped through the mixing chamber, cut the product stream and act as a shock generator such as discussed above. The shaft with discs will, contrary to a screw,
25 not in any substantial way add to the advancing movement of the product through the mixing chamber. The product will be pumped into the chamber and advanced by further product being supplied. The shaft may be provided with replaceable discs or the shaft and discs may be made one
30 part. The shaft may be rotated by any conventional motor.

Depending on the required throughput, heating, mixing and homogenisation, the number of discs and the openings

therein may be varied. The more discs provided along the products path from the product inlet to the outlet for the treated product the more homogenising and mixing will be provided. Although the number of discs can be
5 freely chosen for practical purposes the number of discs are from 2 to 20, preferably 5 to 15. The diameter of the product passage openings is preferably in the range from 2 to 10 mm, more preferably 6 mm. This will provide a velocity into the product passage openings between 40
10 and 200 m/s, preferably 100 m/s.

In the present context a fluid product is understood to be a solution or suspension, e.g. aqueous, having a viscosity of the order of 1000 to 100.000 mPa.s.

15

The fluid product is pumped into the mixing chamber through the product inlet. It is preferred that the fluid product is first passed through at the product passage opening(s) in at least one and preferably 3
20 rotating discs before steam is injected into the product. This gives an initially homogeneous slurry which is then pressed forward and subjected to steam injection heating, mixing, and homogenising.

25 The homogenising effect is obtained by the shearing of the product passing through the discs' openings. In the particular case of milk-containing products, a good homogenising effect is obtained by the arrangement through shearing of the fatty globules.

30

The steam injection nozzle is connected to a feed pipe feeding steam under pressure, preferably between 10 and 15 bar. The product injection nozzle is connected to a feed pipe feeding the fluid product to be treated. The

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outlet from the apparatus is by a back-pressure valve connected to a holding pipe. The back-pressure valve regulates the pressure through the outlet and creates a back pressure in the mixing chamber to maintain the temperature in the mixing chamber. Poor control of the back pressure results in loss of steam which gives an uneconomic production. The back-pressure valve may advantageously be of the membrane type. Advantageously, two pack-pressure valves may be used e.g. CPM or APC valves from Tetra-Laval.

In another aspect, the invention relates to a method for heat treating a fluid product by injecting steam into the fluid product, said method comprising the steps of supplying a fluid product into a mixing chamber through a product inlet,

injecting steam into said fluid product through a steam injection inlet in said mixing chamber, in which mixing chamber being disposed a rotatable shaft and a plurality of discs each comprising at least one product passage opening, said discs being disposed substantially co-axially on said shaft, while

passing at least part of the fluid product through said product passage openings while rotating said shaft with said discs, and

discharging the treated fluid product through an outlet in said mixing chamber.

In a further aspect, the invention relates to a shaft to be used for homogenising and mixing in an apparatus or a process for heating by steam injection a fluid product, said shaft comprising a plurality of discs each comprising at least one product passage opening, said

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discs being disposed substantially co-axially on said shaft.

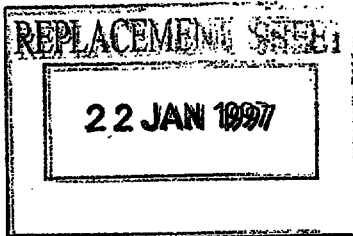
The invention will now be described in greater detail with reference to the accompanying drawings given by way of example showing an embodiment of the invention and in which

Fig. 1 is a schematic illustration of the principle elements of the apparatus according to the invention, and

Fig. 2 and Fig. 3 are schematic illustrations of the shaft with discs.

Fig. 1 shows the apparatus 10 according to the invention. The apparatus 10 comprises a mixing chamber 11 defined by walls 21 wherein a steam injection inlet 13, a product inlet 12, and an outlet 16 are formed. A rotatable shaft 14 is disposed within said mixing chamber 11 and mounted in bearings 18 within an intermediate support 22. It is connected to an output rotary shaft 23 of a motor 17 which drives the rotation of the shaft 14. Said motor may e.g. be a 1.1 Kw, 1400 t/min motor. A sealing 24 is provided to prevent fluid product from escaping the mixing chamber 11. Said sealing 24 is cooled by means of water supplied via a water inlet 25.

The shaft 14 is provided with a plurality of discs 15. Each disc 15 comprises at least one product passage opening. The discs are disposed substantially co-axially on said shaft. Fig. 2 shows a perspective view of the discs 15 mounted on the shaft 14. Said discs comprises product passage opening 26. Fig. 3 shows a cross-



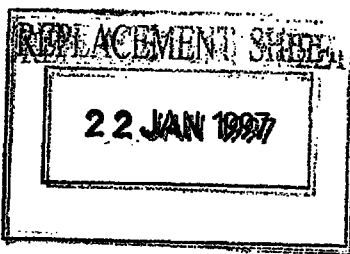
sectional view of the shaft 14 with a disc 15 fitted within the chamber 11.

5 The flow through the outlet 16 is regulated by means of a back-pressure valve not shown in the drawings. To use the apparatus a steam inlet 13 is be connected to steam injector and a feed pipe for supplying steam under pressure and the product inlet is be connected to a feed pipe and a pump for supplying the fluid product to be
10 treated under pressure. The outlet is preferably connected to a holding pipe by the back-pressure valve.

EXAMPLE

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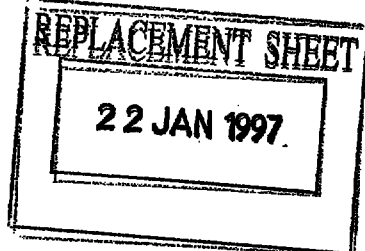
The following example illustrates the substantial and surprising steam reduction obtained with the apparatus according to the invention when compared with processing of a similar fluid product in a steam injection nozzle
20 i.e. a nozzle wherein both streams of steam and fluid product are injected into a mixing chamber in counter-currency without any further mechanical mixing (S&P injection). The apparatus according to the invention used comprises a shaft with 10 discs. The diameter of
25 the discs was $\varnothing$ 44 mm and each disc had 6 product passage openings of $\varnothing$ 8 mm. The example shows test results of heat treatment of fluid products with varying solid matter content. The products were heated to 140°C:



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	Product	Solid matter Ts soup %	Steam consumption (Kg/Hour) S&P injection	Invention
	A	60-62%	320	195
5	B	56-58%	330	195
	C	58-60%	330	195
	D	58-60%	335	200
	E	60%	350	215
	F	56-58%	355	200

10



CLAIMS

1. Apparatus for heat treating a fluid product by injecting steam into the fluid product, said apparatus
5 comprising
 a mixing chamber comprising a steam injection inlet, a product inlet, and an outlet for the treated product,
 a rotatable shaft disposed within said mixing
10 chamber,
 a plurality of discs each comprising at least one product passage opening, said discs being disposed substantially co-axially on said shaft, and
 means for rotating said shaft with said discs.
15
2. Apparatus according to claim 1, wherein the apparatus comprises a back-pressure valve for regulating the flow through the outlet.
- 20 3. Apparatus according to claims 1 and 2, wherein the mixing chamber is substantially cylindrical and the rotatable shaft is substantially co-axially disposed within said mixing chamber.
- 25 4. Apparatus according to claims 1 and 3, wherein at least one disc is disposed between the product inlet and the steam inlet.
5. Apparatus according to any of claims 1 to 4, wherein
30 a plurality of steam inlets are positioned along the rotatable shaft.
6. Apparatus according to any of the claims 1 to 5, wherein the apparatus is provided with 5 to 15 discs.

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7. Apparatus according to any of the claims 1 to 6, wherein each disc is provided with 2 to 50 product passage openings.

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8. Apparatus according to any of the claims 1 to 7, wherein the openings have a diameter in the range from 2 to 10 mm.

10 9. Method for heat treating a fluid product by injecting steam into the fluid product, said method comprising the steps of

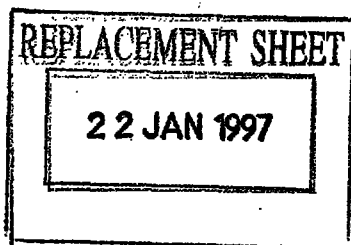
supplying a fluid product into a mixing chamber through a product inlet,

15 injecting steam into said fluid product through a steam injection inlet in said mixing chamber, in which mixing chamber being disposed a rotatable shaft and a plurality of discs each comprising at least one product passage opening, said discs being disposed substantially
20 co-axially on said shaft, while

passing at least part of the fluid product through said product passage openings while rotating said shaft with said discs, and

25 discharging the treated fluid product through an outlet in said mixing chamber.

10. A shaft to be used for homogenising and mixing in an apparatus or a process for heating by steam injection a fluid product, said shaft comprising a plurality of
30 discs each comprising at least one product passage opening, said discs being disposed substantially co-axially on said shaft.



APPARATUS AND METHOD FOR TREATING A FLUID PRODUCT

ABSTRACT

The present invention relates to an apparatus and a method for heat treating a fluid product by injection of steam therein in order to provide a sterilisation, pasteurisation and/or a homogenisation of the product. Said apparatus comprising a mixing chamber comprising a steam injection inlet, a product inlet, and an outlet for the treated product, a rotatable shaft disposed within said mixing chamber, a plurality of discs each comprising at least one product passage opening, said discs being disposed substantially co-axially on said shaft, and means for rotating said shaft with said discs. The invention also relates to a shaft to be used for homogenising and mixing in an apparatus or a process for heating by steam injection a fluid product.

Figure 1