

Vacuum vessel for treatment of oils

The present invention relates to a vacuum vessel for continuous or semi-continuous treatment of oils in connection with deodorization, which
5 vessel comprises spaces through which the oil to be treated is brought to pass, means to heat or cool the oil in the form of U-tubes, perforated pipes arranged at the bottom of said spaces to lead stripping gas into said oil, which vessel has a connection to a vacuum source and which spaces in the vessel are arranged such that the oil passes through the
10 vessel by gravity and a heating or cooling medium passing said U-tubes is arranged to be pumped therethrough.

Such a vacuum vessel for treatment of fatty oils is described for example in EP 0 763 082 B1. When producing consumer products as edible oils
15 out of different vegetable or animal oils deodorization is a part of the refining process. During the deodorization the oil is heated to a high temperature 180 – 275 °C in order to remove contaminants and unwanted substances from the oil. These substances have a lower boiling point than the different triglycerides, which constitute the edible oil.
20 The deodorization is carried through under vacuum 1-20 mbar and the removal of the volatiles is facilitated by adding stripping gas to the oil. The stripping gas may consist of an inert gas or steam. The stripping gas ensures agitation of the oil and promotes heat transfer and makes the removal of the unwanted substances easier.

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Vacuum vessels may be used for treatment of many kinds of oils and fats including mineral oil.

For many types of oils it is useful to heat the oil under vacuum with
30 addition of stripping gas during a pretreatment step prior to the

deodorization in order to remove the dissolved air and that hinder an oxidation of the oil.

The deodorized oil is also in many cases subjected to a further treatment
5 with injection of stripping gas during a simultaneous cooling after the deodorization step.

The vessel is specially adapted for exchanging heat between incoming and outgoing edible oils in deodorizing and physical refining plants: The
10 incoming oil to the deodorizing column is heated by outgoing oil under vacuum and sparging conditions

The aim of the invention is to increase the efficiency of the heat exchange between the oil and the heating or cooling medium while limiting the size
15 of the vacuum vessel. This is achieved in that the U-tubes for heating or cooling medium are arranged in such a way in said spaces that the flow of oil is counter-current to the flow of heating or cooling medium all through the vessel and that a number of U-tubes are arranged in groups, parallel and in rows above each other.

20 The vacuum vessel according to the invention may with advantage comprise at least one layer of spaces for the oil to be treated in the vessel. According to a preferred embodiment of the vacuum vessel according to the invention there are two layers of spaces for oil. There is
25 an inlet for the oil to an upper part of the upper layer and an outlet for the oil in a lower part of the lower layer. There is also a channel connecting a lower part of the upper layer to a higher part of the lower layer. This channel may advantageously be situated on the outside of the vacuum vessel. If so is suitable the vessel may contain three or more layers of
30 spaces.

The lower part of the vessel has preferably a square-shaped or rectangular form while the upper side is curved (bended).

In the vessel there are with advantage channel plates separating the spaces for oil from each other in order to create a long path for the oil through the vessel. The channel plates are firmly connected to two sides of the vessel facing each other and are provided with an opening in one end to provide a connection to another space for the oil. The opening is provided in an end firmly connected to a first side of the vessel. It is possible to let the channel plates end at a distance from one of the sides but when the channel plates are firmly connected to both sides the stability of the vessel increases.

Between the channel plates there are walls firmly connected to said first side of the vessel and ending at a distance from the a second side. These walls are situated between the legs of the U-tubes. This arrangement of the walls in relation to the channel plates make it possible to obtain a counter-current flow of the oil in relation to the heating or cooling medium. Of course it is possible to obtain the desirable counter-current flow in some other ways within the scope of the invention.

On the outside of the first side of vacuum vessel there are headers, which define inlets to distribute the heating or cooling medium into the U-tubes and outlets to collect the heating or cooling medium after passage of the U-tubes. By arranging different headers for the inlet and outlet to each group of U-tubes it is easier to seal each header due to the smaller covers. The smaller covers mean that there is less critical machining for the gasket surface, lower risk of warp and a better choice of gasket material. This is important for preventing leakage of oil during operation, but also for preventing entry of air during stock-change.

The second and third headers are connected as well as the fourth and fifth header and so on, counted from the inlet for the heating or cooling medium. In this way the heating or cooling medium is made to flow through the U-tubes in all spaces in the vessel.

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The number of U-tubes in each space for oil depends on the desired capacity of the vacuum vessel.

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The walls between the channel plates in the upper layer of spaces are suitably hollow in order to create a connection between a volume above the oil in the lower layer and a volume above the oil in the upper layer of spaces, which upper volume is connected to the vacuum source.

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The vacuum vessel according to the invention is preferable made up by thin elements, baffles and channel plates, which are arranged in such relation to each other that the structure of the vessel is self-supporting.

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The vacuum vessel according to the invention may be used for preheating fatty oils to be deodorized by already deodorized oil and subjecting said deodorized oil to a further treatment with stripping gas.

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A preferred embodiment of a vacuum vessel according to the invention is described in more detail with reference to the attached drawings.

Fig. 1 shows a perspective drawing of the vacuum vessel,

fig. 2 shows a perspective drawing of the vacuum vessel as seen from a point of view, where the front side has been removed,

fig. 3 shows another perspective of the drawing of fig. 2.

fig. 4 shows a horizontal cross-section of the vacuum vessel

and fig. 5 shows the front side of the vacuum vessel and the groups of U-tubes.

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The embodiment of the vacuum vessel 1 shown in fig. 1 has an elongated form with a first side 2. There is an inlet 3 for the oil, which is to be treated in the vessel in an upper corner of the side 2 and an outlet 4 for the treated oil in a lower corner. There are also an inlet 5 and an outlet 6 for a heating or cooling medium. At the top of the vessel 1 there is a connection 7 to a vacuum source. There are also three sight-glasses 8. As may be seen in the drawing there is a leg 9 in the left end of side 2 which is higher than the leg 10 at the right end. This arrangement results in that the bottom of the vessel is inclined in relation to the foundation. There are also headers 11 for distributing the heating or cooling medium over the group of U-tubes.

At the other end of the vessel (not shown in the drawing) there are sparging pipes for stripping steam and further sight-glasses for a lower layer or deck.

In fig. 2 there is shown the spaces 12, 12¹ through which the oil to be treated flows as well as the inlet 3 for the oil. The oil enters the vessel by way of the inlet 3, flows along the long-side of the vessel and returns through space 12¹ to the first side 2 of the vessel. The oil is then directed to the next space 12² through the opening visible in the channel plate between 12 and 12¹ and flows again to the other side of the vessel. In each space for the oil there are legs of a group of U-tubes 13 for heating or cooling the oil to be treated. The spaces for oil are arranged in two layers or decks 14 and 15.

The spaces for the oil 12, 12¹, 12² are shown more clearly in fig. 3. There are longitudinal channel plates 16, 16¹ separating spaces 12 and 12¹ from spaces 12² and the next space and so on. These channel plates extend

from the first 2 to the second side of the vessel and are firmly connected to these sides. As may be seen in the drawing there are openings 17 for the oil in the channel plates 16, 16' at the ends connected to the first side. In this drawing only the ends and parts of the group of U-tubes is to be seen. The arrangement and bends of the U-tubes are shown in fig.4. Between the legs of the U-tubes there are walls 18, 18' firmly connected to the first side. As may be seen in fig. 4 these walls end at a distance from the second side. The walls have such a height that the level of oil is well below the upper edge of the walls. The walls 18 in the lower layer 15 are single, while the walls 19 in the upper layer 14 are double forming a duct 20. The bottom 21 of the upper layer is provided with openings, which cooperate with the ducts 20 between the walls 19 to provide a connection between the volume 22 above the oil in the lower layer 15 and a volume 23 above the oil in the upper layer 14. The volume 23 is connected to the vacuum source. The grey arrows show the connection between the lowermost volume 22 and the vacuum connection 7.

As described earlier the oil to be treated enters through the inlet 3 and flows forwards and backwards until it reaches the last space in the upper layer, where there is an opening in the bottom 21 cooperating with an internal outlet 24. The way for transporting the oil to the lower layer of spaces will be explained later. The oil is transported to the uppermost space of the lower layer (to the left in the drawing) and flows forwards and backwards through the spaces until it reaches the outlet 4 for treated oil.

Fig. 4 shows how the groups of U-tubes are arranged in the spaces 12, 12' and 12². The spaces 12 and 12² are separated by the channel plate 16, which channel plate is firmly connected to the first side 2 and the second side 25. Between the legs of the group of U-tubes in the lower

deck there are walls 18 forcing the oil to flow to the second side 25 of the vessel before returning to the first side again.

In the drawing there are also shown the sparging pipes 26, 26¹ and so on, for introducing stripping gas into the oil. Outside the vessel there are means to distribute the stripping gas to the sparging pipes. As may be seen on the drawing there are also sight-glasses 27 through which the sparging conditions may be supervised. The heating or cooling medium enters through the groups of U-tubes at the upper end of the drawing and flows in counter-current to the oil to be treated all through the spaces in the shown layer. The arrows show how the oil and the heating or cooling medium flow in counter-current. The arrows showing the oil flow is somewhat darker than the arrows showing the flow of heating or cooling medium.

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Fig. 5 shows the first side 2 of the vessel, the inlet 3 for the oil to be treated and the outlet 4 for the treated oil. There is also shown the inlet 5 for heating or cooling medium and the outlet 6 for the same. In the shown embodiment of the invention there are six groups of U-tubes in each layer. The heating or cooling medium enters one leg of an U-tube and returns through the other leg. In the shown embodiment there are five U-tubes in nine rows above each other. The heating or cooling medium enters the first header 28 and is distributed over and into the first leg of the forty-five tubes. When the heating or cooling medium has flown through the U-tubes it is collected in the second header 28¹. There is a connection between the second header 28¹ and a third header 28² and the heating or cooling medium flows into the third header and is distributed into the second group of U-tubes. Also the heating or cooling medium flows forwards and backwards in the U-tubes until it reaches the last header 29 in the lower layer. Between this header 29 and another

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header 30 in the upper layer there is a channel 31 through which the heating or cooling medium may flow (be pumped) to the upper layer. The heating or cooling medium flows forwards and backwards within the U-tubes until it reaches the last header 32 in the upper layer. The heating
5 or cooling medium leaves the vessel through the outlet 6.

As was mentioned earlier the oil to be treated is transported from the upper layer of spaces to the lower layer of spaces. This transport takes place by way of channel 33 situated inside of the channel 31.

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The vacuum vessel may be self-supporting in that the channel plates 16, 16' and the baffles 34 (fig.4) cooperate.

Claims

1. Vacuum vessel for continuous or semi-continuous treatment of oils in connection with deodorization, which vessel comprises spaces through which the oil to be treated is brought to pass, means to heat or cool the oil in form of U-tubes, perforated pipes arranged at the bottom of said spaces to lead stripping gas into said oil, which vessel has a connection to a vacuum source and which spaces in the vessel are arranged such that the oil passes through the vessel by gravity and a heating or cooling medium passing said means is arranged to be pumped there through, **characterized in** that the U-tubes for heating or cooling medium are arranged in such a way in said spaces (12, 12¹, 12²) that the flow of oil is counter-current to the flow of heating or cooling medium all through the vessel and that a number of U-tubes are arranged in groups (13), parallel and in rows above each other in said spaces.
2. Vacuum vessel according to claim 1, **characterized in** that the vessel (1) comprises at least one layer of spaces for the oil to be treated in the vessel.
3. Vacuum vessel according to claim 1-2, **characterized in** that the vessel comprises two layers (14, 15) of spaces for the oil to be treated in the vessel and that there is an inlet (3) for the oil to an upper part of the upper layer (14) in the vessel and an outlet (4) for the oil from a lower part of the lower layer (15) in the vessel and that there is a channel (33) connecting a lower part of the upper layer (14) with a higher part of the lower layer (15).
4. Vacuum vessel according to any of the preceding claims, **characterized in** that the lower part of the vessel has the form of a

square-shaped or rectangular container with a curved (bended) upper side.

5 5. Vacuum vessel according to any of the preceding claims, **characterized in** that there are channel plates (16) separating the spaces (12, 12¹, 12²) for oil from each other in order to create a long path for the oil, which channel plates are firmly connected to two sides (2, 25) of the vessel facing each other and are provided with openings (17) for the oil to pass on to an adjacent space in the end of the channel plate
10 firmly connected to a first side (2) of the vessel.

6. Vacuum vessel according to claim 5, **characterized in** that there are walls (18, 19) between the channel plates (16), which walls are firmly connected to said first side (2) and ending at a distance from a second
15 side (25) of the vessel, which walls are situated between the legs of the U-tubes.

7. Vacuum vessel according to claim 6, **characterized in** that there are headers (28, 29, 30, 32) outside said first side (2) of the vessel, which
20 headers define inlets to distribute the heating or cooling medium into the U-tubes and outlets to collect the heating or cooling medium after the passage through the U-tubes.

8. Vacuum vessel according to claim 7, **characterized in** that heating or
25 cooling medium are distributed by the headers (28, 29, 30, 32), where the second and third headers as well as the fourth and fifth headers and so on, counted from the inlet (5) for heating or cooling medium are connected in order to make the heating or cooling medium flow through the groups of U-tubes in all spaces in the vessel.

9. Vacuum vessel according claim 6, **characterized in** that the walls (19) between the channel plates (16) in the upper layer of spaces are hollow in order to create a connection between a volume (22) above the oil in the lower layer of spaces and a volume (23) above the oil in the upper layer,
5 which upper volume is connected to the vacuum source.

10. Vacuum vessel according to any of the preceding claims, **characterized in** that the vessel comprises elements in the form of baffles (34) and channel plates (16, 16') making the structure of the
10 vessel self-supporting.

11. Use of the vacuum vessel according to claim 1 for preheating fatty oils to be deodorized by already deodorized oil and subjecting said deodorized oil to a further treatment with stripping gas.