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(54) **Process and installation for dry fractionation**

Verfahren und Vorrichtung zur Trockenfraktionierung

Procédé et installation de fractionnement à sec

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Description

[0001] The invention relates to a process and an installation for the dry fractionation of edible oils, fats and related products.

[0002] Dry fractionation of edible oils and fats is practised industrially on a large scale and a number of different processes is used for this purpose. Commonly, the oil to be fractionated is fed to a crystalliser where it is cooled so that fat crystals are formed. These crystallisers can be large vessels provided with cooling coils and an agitator to assist heat transfer and prevent the crystals from settling, but other types of crystallisers such as scraped surface heat exchangers and other dynamic crystallisers, are also being used.

[0003] The resulting crystal slurry is then subjected to a filtration process to separate these crystals from their mother liquor. The filter cake is referred to as the stearin fraction and the filtrate, the mother liquor, is referred to as the olein fraction. Various filtration systems are used, ranging from a simple band or drum filter to high pressure, fully automated membrane filter presses.

[0004] This process works well for oils and fats that form separate, individual crystals on cooling such as palm oil and its fractions, anhydrous milkfat, edible tallow, cottonseed oil, hydrogenated vegetable oils etc.

[0005] However, certain oils and fats, notably lard, palm kernel oil and coconut oil tend to form a network of fine crystals rather than separate crystals on cooling, so that a solid mass instead of a pumpable slurry results.

[0006] Therefore, other types of fractionation processes are used for such materials. Solvent fractionation is one of these processes, but this is an expensive process. Because of the inflammable nature of the solvent, the plant has to be explosion proof and this greatly increases the investment required. In addition, the evaporation and rectification of the solvent are energy intensive processes.

[0007] Therefore, the most commonly used fractionation process for oils like palm kernel oil comprises the solidification of the oil in trays or pans to form blocks, wrapping these blocks individually in a filter cloth and loading the blocks into a hydraulic press to squeeze the olein from between the crystals. The investment required for this process may be fairly low but wrapping the blocks and the subsequent unwrapping of the filter cake make it very labour intensive.

[0008] Accordingly, attempts have been made to develop processes that require less labour and that use for instance an automated membrane filter press. U.S. Patent 4.795.569 to Higuchi *et al*. describes such a process in which the oil is introduced into a filter chamber and allowed to crystallise inside that chamber by circulating a coolant such as water through the space between the membrane and a filter frame.

[0009] However, this process requires the filter cloth to be sealed first with a coagula of the material to be treated. This makes it a lengthy process that makes inefficient use of the expensive membrane press.

[0010] Accordingly, an improvement has been described in U.S. Patent 5.045.243 to Kuwabara *et al*. in which the oil or fat to be fractionated is first of all solidified in trays to form solid blocks which are then crushed to yield a pumpable paste that is then introduced into a membrane press to separate this paste into an olein fraction and a stearin fraction. The solidification process is commonly carried out in cooling tunnels. However, these have the disadvantage that the oil is exposed to the air while being cooled and that it is virtually impossible to control the rate of cooling inside the individual trays.

[0011] Therefore, an apparatus has been described in European Patent Application 1.028.159 by Yoneda *et al*. that permits stationary crystallisation. In this apparatus, the oil or fat to be fractionated is not solidified into a solid block, but the crystallisation process is halted when the partially crystallised mass is still sufficiently fluid to be pumped into the membrane filter press. However, this means that the material to be fractionated has to be diluted with olein before being cooled. This recycling of olein greatly reduces the actual capacity of the apparatus.

[0012] Furthermore, a process for the dry fractionation of oils and fats has been described in U.S. Patent 6.060.028. This process is based on (1) recycling a part of a fractionated low melting point fraction and (2) allowing the pre-cooled fat-and-oil feedstock to stand while further cooling the feedstock to form fat crystals. This process is carried out by means of an apparatus for the formation of fat crystals by standing, said apparatus having crystallization trays arranged in parallel. There is no suggestion in this document of providing a cooling chamber with vertical walls permitting heat transfer to form solid blocks of crystallised material.

[0013] It is therefore an object of the invention to provide a dry fractionation process for edible oils and fats and related products that hardly require manual labour.

[0014] It is a further object of the invention to provide a dry fractionation process that fully utilises the filtration capacity of the membrane press.

[0015] It is also an object of the invention to protect the material to be fractionated from exposure to air as much as possible.

[0016] A further object of the invention is to attain a reproducible crystallisation by introducing a controlled temperature profile during cooling and the ensuing crystal development.

[0017] It is also an object of the invention to produce fats that can be profitably used in the confectionery industry.

[0018] A final object of the invention is to avoid the need to recycle the olein fraction.

[0019] The objects of the invention have been attained by a process for the dry fractionation of lauric oils, fatty acids and fatty acid esters, comprising the steps of :

(a) solidifying the product to be fractionated in a crystalliser (3) to form a solid block of crystallised material,
(b) discharging and collecting the said solid block, and
(c) crushing the said solid block into a pumpable paste;
characterized in that the said crystallizer (3) comprises at least one cooling chamber (10) that is provided with at least one wall (11) positioned vertically and permitting heat transfer to form at least one solid block of crystallised material.
In one embodiment of this invention the process further comprises the steps of:
(d) pumping the said paste into a filter press (7),
(e) separating the said paste into a liquid fraction (8) and a solids fraction (9) by filtration, and
(f) collecting both fractions (8) and (9).

[0020] Within this embodiment of the invention, it may be provided that the period of time between crushing the said at least one solid block of crystallized material in step

(c) and pumping the said paste to the filter press (7) in step (d) does not exceed 1 hour and is preferably less than 30 minutes.

[0021] In another embodiment of this invention the process further comprises pre-cooling and / or pre-crystallising the product to be fractionated. Within this other embodiment of the invention, it may be provided that the product to be fractionated is pre-crystallised to an extent of at most 5 %, or the product to be fractionated is pre-crystallised to an extent of at most 2 %.

[0022] In another embodiment of this invention, the said at least one solid block of crystallised material is provided with a resting period during which it can equilibrate after having been discharged from the crystalliser (3) and before being crushed in step (c).

[0023] In another embodiment of this invention, the crystalliser (3) is placed in a temperature controlled room.

[0024] In another embodiment of this invention, in step (b) the chamber (10) is emptied by opening the crystalliser (3).

[0025] In another embodiment of this invention, step (b) includes raising the temperature of the wall (11) of the cooling chamber (10).

[0026] The process according to the invention offers specific advantages for lauric oils like palm kernel oil which tend to solidify when cooled in an agitated crystallisation vessel but is not limited to such oils. Palm oil, hydrogenated vegetable oils like soybean oil and other oils and fats used for example to produce for instance confectionery fats can also be profitably fractionated by the process according to the invention. Fat related products like fatty acids or fatty acid esters such as methyl or ethyl esters have also been found to be amenable to being fractionated by the process according to the invention.

[0027] The degree of purification of the oils and fats to be fractionated by the process according to the invention has been found not to be critical. Accordingly, crude palm kernel oil can be processed as such, but degummed and/or bleached palm kernel oil and fully refined palm kernel oil also constitute suitable raw materials for the process according to the invention. Similarly, crude palm oil, chemically neutralised palm oil and physically refined oils can all be fractionated according to the invention.

[0028] Preferably, the product is solidified in a crystalliser comprising a series of chambers that each are provided with at least one wall permitting heat transfer to form a number of solid blocks of crystallised material, the chambers are discharged and the blocks collected and crushed to pumpable paste.

[0029] The raw materials to be fractionated by the process according to the invention will normally be stored in tanks in a molten state since this allows them to be transferred by pumping. Accordingly, their temperatures will be above their melting points and these will have to be lowered considerably to attain the required crystal content.

[0030] Accordingly, the process according to the invention comprises preferably a cooling step before solidifying, in which cooling step the oil coming from its storage tank is pre-cooled and/or even pre-crystallised.

[0031] This pre-cooling and/or pre-crystallisation step will shorten the time needed to attain the required degree of crystallisation in the cooling chambers used subsequently in the solidifying step. Seeding the oil with the appropriate fatty crystals can also shorten this time.

[0032] In general, the pre-crystallised melt should not contain more than 5 % or preferably 2 % by weight of fat crystals in the case of lauric oils such as palm kernel oil. For oils such as palm oil, a higher extent of crystallisation in the pre-crystalliser, for example 10%, has been found to be fully acceptable.

[0033] The invention also relates to an installation for the dry fractionation of lauric oils, fatty acids and fatty acid esters, comprising a crystallizer (3), a crusher (5), means for transporting solid blocks of crystallised material formed in the crystalliser (3) to the crusher (5), a filter press (7), and means for transporting the paste obtained in the crusher (5) to the filter press (7),

characterised in that the said crystalliser (3) comprises at least one cooling chamber (10) that is provided with at least one wall (11) positioned vertically permitting heat transfer to form at least one solid block of crystallised material.

[0034] In one embodiment of this invention the width of the cooling chamber (10) of the crystalliser (3) is from 1 to 10 cm. In another embodiment of this invention the width of the cooling chamber (10) of the crystalliser (3) is from 3 to 6 cm.

[0035] In one embodiment of this invention, the cooling chamber (10) is mounted in a hydraulic press and connected to a heat exchange medium supply system (16, 17).

[0036] In another embodiment of this invention, the cooling chamber (10) of the crystalliser (3) is provided with thermocouples (21) to measure the temperature of the product to be fractionated and / or of the heat exchange medium.

[0037] In order to better define the characteristics of the invention, a preferred embodiment of a process and installation for the dry fractionation is described in the following, as an example without any limiting character, with reference to the accompanying drawings, wherein:

Figure 1 shows a block diagram of an installation for performing the process according to the invention;
Figure 2 schematically shows, partially cut away, a portion of the crystalliser from the installation of figure 1;
Figure 3 shows one of the plates of the crystalliser of figure 2.

[0038] Referring to figure 1, the process for the dry fractionation of edible oils, fats and related products, comprises successively a pre-cooling and possibly pre-crystallisation in a pre-cooler 1, pumping by means of pump 2 of the obtained slurry to a crystalliser 3 where a solidifying of the slurry to solid blocks takes place, discharging and collecting these blocks into a hopper 4, crushing these blocks in a crusher 5 so that a pumpable paste is obtained; pumping this paste by means of a pump 6 into a filter press 7 and separating this paste into a liquid fraction 8 and a solids fraction 9 by filtrating and collecting both fractions 8 and 9.

[0039] Since the pre-cooler or pre-crystallisor can be a simple equipment like tubular or plate heat exchangers or agitated batch crystallisers provided with cooling coils, their use may constitute a saving in comparison with the direct introduction of the non-cooled raw material to be fractionated into the crystalliser and cooling it in the cooling chambers of the crystalliser.

[0040] Nevertheless, this pre-cooling and possibly pre-crystallising is optional.

[0041] Cooling in tubular heat exchangers should employ a high product flow rate and a small temperature difference between the product and the cooling medium to avoid crystal deposition on the cooling surface. This is especially important when the material to be fractionated is also to be pre-crystallised.

[0042] The crystalliser 3 used is of a type comprising a number of cooling chambers 10.

[0043] As shown in Figure 2, each cooling chamber 10 consists of the space enclosed by two plates 11. The crystalliser 3 comprises a series of such cooling plates 11, assembled like in a filter press, allowing the plates 11 enclosing the cooling chambers 10, to be hydraulically compressed or withdrawn. During operation, the chambers 10 are compressed and therefore closed, and to discharge the solidified blocks of crystallised fat, the press forming the crystalliser 3 is opened so that the blocks can drop down by gravity. This opening and closing can be fully automated.

[0044] In general, the plates 11 of the crystalliser 3 will be positioned vertically above the hopper 4 into which the solidified blocks will drop during the discharge of the crystalliser 3.

[0045] However, a vertical crystalliser 3 with horizontal cooling plates 11 also falls within the scope of the invention. The solidified blocks can be removed from such a vertical crystalliser 3 by a device that is known *per* se, comprising a pusher that moves along the crystalliser and empties each cooling chamber in succession. Several of such vertical crystallisers can then be located around a central hopper 4.

[0046] To allow the chambers 10 to be filled with the material to be fractionated, a preferred embodiment of the invention entails that each plate 11 is provided with a hole 12 in one of the chamber corners as illustrated in Figure 3, but holes in the plate recess or on top of the plate also fall within the scope of the invention. Oil that may have been pre-cooled and/or pre-crystallised is fed through this hole 12. Since the presence of the holes 12 makes the chambers 10 communicating vessels, all chambers 10 will be filled to the same height. Care should be taken to avoid stagnant zones in the oil conduits since these may lead to blockage on cooling. The air in the chambers 10 is allowed to escape to atmosphere through a hole 13 in a top corner or on top of the plate 11. This vent hole 13 may be connected to a chimney within the plate that leads to a common exhaust system. Such a system allows the chambers 10 to be evacuated prior to their being filled with the material to be cooled and solidified, thereby minimising its exposure to air. This evacuation can also be used to ensure that the plates 11 surrounding the cooling chambers 10 are in close contact and that no oil will leak away from the system on filling.

[0047] Within the recessed part 14 of the plates 11, channels 15 to guide a cooling or heating medium are to be provided. This medium is preferably supplied from a header 16 to a distribution channel 17 situated in the lower part of the plates 11 and connected to the channels 15, and collected in a collector 18 through a collecting channel 19 situated in the upper part of the plates 11 and also connected to the channels 15. To allow the crystalliser 3 to be opened, the channels 17 are to be connected with the header 16 and the channels 19 with the collector 18 by flexible tubing 20. Preferably, the plates 11 are provided with thermocouples 21 that permit the temperatures of the oil and the heat exchange medium to be monitored and/or controlled.

[0048] The plates 11 surrounding the cooling chambers 10 are preferably made from a thermoplastic material like for instance polypropylene. This material provides a good seal between the plates, provided a certain hydraulic pressure is maintained by the crystalliser 3. This is especially important during the cooling period when the plates 11 will shrink as their temperature drops. However, thermoplastic materials have a lower thermal conductivity than metals so that metal plates may have some advantages over thermoplastic plates. Both fall within the scope of the invention. A plate 11 made with a thermoplastic surround that encloses a metal insert to channel the cooling medium also falls within the scope of the invention.

[0049] The width of the chambers 10 has been found to be hardly critical for the process according to the invention, in that chambers 10 of 1-10 cm width have been found to be able to produce solidified blocks that could be satisfactorily further processed according to the present invention. Widths near the lower end of the above range allow a faster crystallisation but entail a higher investment for a given loading than widths at the upper end of the range. Taking the necessary investment and the cycle times into account, the optimum chamber width looks like being 3-6 cm but other widths also fall within the scope of the invention.

[0050] In the process according to the invention, the cooling chambers 10 are filled with the oil or fat to be fractionated and the fat is then cooled and solidified within these chambers 10 by heat transfer through the chamber walls. This filling will take place after the previous batch has been discharged and the crystalliser 3 has been closed again. At this stage, the plates 11 enclosing the chambers 10 will have a temperature that is close to the final crystallisation temperature. However, in an embodiment of the invention, the plates 11 may be heated to a pre-set temperature in order to melt all residual crystals from the previous cycle.

[0051] After the chambers 10 have been filled, their contents are cooled by means of the channels 15 in the plate recesses. Cooling is preferably gradual since using a high temperature difference between oil and cooling medium will lead to a rapid formation of fat crystals against the heat exchange surface, which crystals have a lower thermal conductivity than oil and thus lower the rate of heat transfer. On the other hand, a temporary low cooling medium temperature may induce the formation of crystal nuclei and thus promote the crystallisation of the fatty mass within each chamber 10.

[0052] The period of time required to achieve a degree of crystallisation within the chambers 10 that allows further processing according to the invention will generally take several hours, for instance 4-6 hours. However, it depends on a large extent upon the optional pre-cooling or pre-crystallisation, the type of raw material and the degree of crystallisation aimed for.

[0053] This degree of crystallisation can be estimated by calculating a heat balance, for instance by measuring the power consumption of the compressor used to cool the cooling medium and by taking the thermal capacity of the crystalliser 3 into account. The latter can be worked out during a trial run during which the chambers 10 are for instance filled with water. In addition, the calculation can be made more precise by measuring the solid fat content (SFC) of a batch that has been processed according to the invention and adjusting the calculation parameters in line with the measured SFC-value.

[0054] Accordingly, measurements of temperature and power consumption of the compressor allow the degree of crystallisation within the crystalliser chambers 10 to be monitored during the crystallisation process. Therefore, it is possible to use the degree of crystallisation as an input parameter for the crystallisation control by adjusting the cooling medium temperature. In this way, highly reproducible crystallisation is achieved. Optimal cooling profiles have to be worked out in practice. Such cooling profiles can also be used to steer the stearin properties. In the case of palm kernel oil for instance, it has been found possible to produce a stearin with an iodine value below 5 by prescribing a somewhat higher cooling medium temperature.

[0055] The crystalliser 3 is preferably located in a room that is kept at a temperature that is close to the final crystallisation temperature. This temperature control is not that important during the actual crystallisation process but it is much more important during the discharge step. Since a plant operating the process according to the invention may comprise several crystallisers, it is advisable to locate these into the same room; this allows temperature control to be limited to just this room.

[0056] In the discharge step of the process according to the invention, the chambers 10 are emptied. This is achieved by opening the crystalliser 3 as a result of which the solidified blocks will drop out by gravity. They are collected in the hopper 4 located underneath the crystalliser 3. Complete emptying of the crystalliser 3 is preferably realised by mechanical means that are known *per se*.

[0057] Raising the temperature of the walls of the crystallisation chambers 10 at the control panel of the fractionation plant constitutes another means of ensuring complete crystalliser discharge. This rise in temperature has been found to hardly affect the degree of crystallisation within the blocks; it only facilitates their being discharged. Shock cooling the blocks may also facilitate their being discharged.

[0058] Since heat transfer is a dynamic process requiring a temperature difference, the blocks on discharge may well be cooler on the outside than in the centre. In addition, the degree of crystallisation on the outside may be higher than in the centre. It can therefore be advantageous to provide the blocks with a resting period during which they can equilibrate before crushing them. Therefore, the room housing the crystalliser 3 is preferably temperature controlled. During this resting period, the blocks will be exposed to air but since the blocks are solid and cold, this exposure will hardly lead to product deterioration. The length of this resting period has been found not to be critical but the period of time between the crushing of the blocks and the resulting paste being fed to the membrane filter press 7 should preferably not exceed 1 hour and even more preferably be less than 30 minutes to prevent the paste from stiffening.

[0059] The blocks are crushed in the crusher 5 by methods that are known *per se*. Such a method may for instance involve screw feeding the blocks from the hopper 4 to the mono-pump 7 used to feed the membrane filter press 7. Positioning this mono-pump 7 immediately downstream of the crushing stage also has the advantage that the fatty paste formed by the crushing step has no time to stiffen again so that its pumpability and fluidity are maintained.

[0060] In the final step of the process according to the invention, the fatty paste inside the membrane filter press 7 is compressed so that the liquid fraction 8, this is liquid olein passes through the filter cloth to be collected as such and the solids fraction 9, this is stearin cake is discharged by opening the press. Standard equipment as used in the dry fractionation of edible oils and fats and that is preferably fully automated can be used for this purpose. The pressure to be applied during the membrane filtration process has been found to fall within the range offered by commonly used membrane presses. A pressure of for example 2-3 MPa is fully adequate for the process according to the invention.

[0061] The following examples further illustrate the present invention in detail but are not to be construed to limit the scope thereof.

Example 1

[0062] In this Example, crude palm kernel oil of Malaysian origin was used as the raw material. Its free fatty acid content was 3,0% expressed as oleic acid and its iodine value (Wijs) was 18,3 (g iodine per 100 g of oil). This oil was cooled and partially crystallised to a Solid Fat Content (SFC) of about 1% from a temperature of 60°C to 24,5°C over a period of almost 3 hours while being gently agitated in a dynamic crystalliser (initially at 40 rpm; finally at 30 rpm).

[0063] This partially crystallised melt was then pumped into a crystalliser according to the invention having cooling chambers of 50 mm width. The cooling water temperature was maintained at 18°C throughout the crystallisation period of 5 hours. After this period, the palm kernel oil had solidified into solid blocks that were taken out of the cooling chambers and then crushed. A sample of the crushed material showed an SFC of 28% and a temperature of 20°C. When subjected to filtration under a pressure of 2,5 MPa, palm kernel olein was liberated in a yield of 62,5%. The palm kernel stearin obtained in a yield of 37,5% had an iodine value of 6,6. This example shows that the crystal paste obtained by the process according to the invention allows of a good separation during the pressure filtration step in that the resulting filter cake had a calculated SFC of almost 75%.

[0064] In a similar experiment, the same crude palm kernel oil was crystallised under the same conditions but after the 5 hour crystallisation period, the cooling water temperature was raised to 30°C for a period of 15 min after which period the cooling chambers were opened. The solidified blocks were then crushed and a sample of the crushed material showed an SFC of 26% and a temperature of 22°C. When this material was then filtered under pressure (2,5 MPa), a 32% yield of palm kernel stearin with an iodine value of 5,5 resulted. This experiment clearly shows that stearin properties can be effectively controlled by adopting an appropriate temperature profile during the crystallisation step of the process according to the invention.

Example 2

[0065] In this example, fully refined (i.e. degummed, bleached and physically refined) palm kernel oil with a free fatty acid content of 0.1% was used as raw material. It was pre-cooled to a temperature of 22°C over a period of 130 min, which led to a pre-crystallisation of about 1%. The pre-crystallised palm kernel oil was then fed into cooling chambers of 40 mm width where it was cooled by circulating water of 18°C through the walls of the chambers. After 3,5 hours, the chambers were opened and the solidified blocks were crushed. The SFC of the crystal paste was 27% and its temperature was 23°C.

[0066] Subjecting this paste to a pressure filtration at 2,5 MPa led to a 40% yield of palm kernel stearin with an iodine value of 6,9. This example therefore shows that a decrease in cooling chamber width allows a faster crystallisation and also that palm kernel stearin of fully acceptable quality can be produced in a very high yield by using the process according to the invention.

Example 3

[0067] In this example, a cooling chamber width of 30 mm was used and the period of crystallisation was varied. Palm kernel oil of Malaysian origin having a free fatty acid content of 2,2% and an iodine value of 17,8 was pre-crystallised over a period of 135 min and then fed to these cooling chambers. Samples of the solidified material were taken at the end of each crystallisation period for SFC determination and then the material was crushed and subjected to filtration under pressure (2,5 MPa)

Table 1. Process conditions and properties during palm kernel oil fractionation

Period of crystallization (hours)	2,0	3,5	5,0
SFC of solidified material (%)	26	30	34
Stearin yield after filtration (%)	39	43	45
Calculated SFC of stearin (%)	67	70	76
Iodine value of stearin	6,9	6,7	7,0

[0068] As shown by Table 1, increasing the period of crystallization leads to a higher degree of crystallization in the cooling chambers of the crystalliser. It also leads to a higher calculated SFC of the stearin as a result of which the iodine value of the stearin remains within specification.

Example 4

[0069] In this example, the crystallization temperature was varied as well as the length of solidification time. The same crude palm kernel oil as used in Example 3 was pre-crystallised and then solidified in the cooling chambers of 30 mm width that were also used in Example 3. The experimental details and results have been summarized in Table 2.

Table 2. Process conditions and stearin data for palm kernel oil

Period of crystallization (hours)	2,0	3,5	5,0
Cooling water temperature (°C)	18	20	22
SFC of solidified material (%)	24	23	23
Stearin yield after filtration (%)	38	35	31
Calculated SFC of stearin (%)	63	66	74
Iodine value of stearin	6,9	5,2	4,4

[0070] Table 2 shows that the process according to the invention allows palm kernel stearin with a very low iodine value to be produced by slightly raising the cooling water temperature during the solidification step. As is only to be expected, a low iodine value implies a somewhat reduced stearin yield. However, the ability to produce stearins with such low iodine values permits the production of stearins with a somewhat higher and standard iodine value by blending the low iodine value stearin with palm kernel oil. This greatly facilitates final product quality control.

Example 5

[0071] In this example, a fully refined palm oil mid fraction was processed according to the invention. This mid fraction had a free fatty acid content of 0,04%, an iodine value of 45 and contained 45% symmetrical dipalmito-oleate triglycerides (POP). The mid fraction was slowly pre-crystallised over a period of 4 hours from a temperature of 70°C down to 20°C, while the rate of agitation was gradually reduced from 40 rpm to 25 rpm. This led to an SFC of the pre-crystallised melt of about 9%.

[0072] This pre-crystallised melt was then further solidified in cooling chambers according to the invention having a width of 40 mm for a period of 4 hours while maintaining a cooling water temperature of 18°C. After this period of 4 hours, the solidified blocks were crushed and a sample of the crushed material showed an SFC of 30% and a temperature of 21°C. The crushed material was filtered at a pressure of 2,5 MPa. A stearin with an iodine value of 33,9 and a POP content of 62% was obtained as the filter cake in a yield of 41%. The resulting olein had an iodine value of 53,2 and a POP content of 35%.

[0073] In a similar experiment the same palm mid fraction was pre-crystallised as described above and allowed to solidify in the same cooling chambers but instead of a cooling water temperature of 18°C, a temperature of 16°C was chosen. The period of solidification remained the same at 4 hours. This lowering of the cooling water temperature during the solidification step led to an increase of the SFC after crushing from 30% to 34%, an increase in filter cake yield from 41% to 42%, an increase in the iodine value of the filter cake from 33,9 to 36,3 and a decrease in its POP content from 62% to 59%. It also led to an increase of the SFC of the filter cake from 73%, which is already a high value, to an even higher value of 81%.

[0074] These experiments show that the process according to the invention can be profitably used for the production of cocoa butter equivalents by allowing the production of vegetable oil fractions with a high POP content. In comparison with other existing dry fractionation processes for such confectionery fats, the process according to the invention is very fast indeed. It only requires 4 hours pre-crystallisation and another 4 hours solidification.

Example 6

[0075] Anhydrous milk fat with a dropping point of 30.5°C was pre-crystallised by first heating the oil to 55°C and then cooling it to 24,7°C over a period of 240 min using a well defined cooling curve under controlled agitation. When the SFC of the melt had reached 7%, the partially crystallised melt was introduced into cooling chambers of 50 mm width being supplied with cooling water of 15°C. After 240 min, solid blocks with a temperature of about 18°C had been formed that were taken out of the chambers. Samples were taken from the blocks and these showed an SFC of 15-17%. The blocks were crushed and the SFC of the crushed paste was 16 % and its temperature had risen to 20,5°C. Filtration under pressure (0,6 MPa) led to a 55 % yield of olein having a dropping point of 15,2°C, the dropping point of the stearin was 36°C.

Example 7

[0076] Tallow fatty acids with an iodine value of 54,7 were pre-crystallised by heating them to 70°C and then cooling them to 39,6°C over a period of 180 min using a well defined cooling curve under controlled agitation. When the SFC of the melt had reached 3,5%, the partially crystallized melt was introduced into cooling chambers of 50 mm width employing a cooling water of 5°C. After 270 min, solid blocks with a temperature of about 12°C had been formed that were taken out of the chambers. Samples were taken from the edges of the blocks and these showed an SFC of 38-40% whereas samples from the middle of the blocks showed SFC values of 36-37%. The blocks were crushed and the SFC of the crushed paste was 37 % and its temperature had risen to 19,0°C. Filtration under pressure (2,5 MPa) led to a 46 % yield of olein having an IV of 87,8. The IV of the stearin was 22,8.

[0077] In a similar experiment using the same tallow fatty acids, the crushed cakes had an SFC of 37% and a temperature of 18,8°C. When this was subjected to pressure filtration, a yield of 51% of olein with an IV of 92,2 was obtained. The IV of the stearin was 18.

[0078] This example clearly shows that the process according to the invention is not limited to triglyceride oils, but can also be profitably used for fat related products such as for instance fatty acids.

[0079] Therefore, the invention, is well adapted to carry out the objects and attain the ends and advantages mentioned, as well as others inherent therein.

Claims

1. A process for the dry fractionation of lauric oils, fatty acids and fatty acid esters, comprising the steps of :

    (a) solidifying the product to be fractionated in a crystalliser (3) to form a solid block of crystallised material,
    (b) discharging and collecting the said solid block, and
    (c) crushing the said solid block into a pumpable paste;
    characterized in that the said crystallizer (3) comprises at least one cooling chamber (10) that is provided with at least one wall (11) positioned vertically and permitting heat transfer to form at least one solid block of crystallised material.

2. A process according to claim 1, further comprising the steps of:

    (d) pumping the said paste into a filter press (7),
    (e) separating the said paste into a liquid fraction (8) and a solids fraction (9) by filtration, and
    (f) collecting both fractions (8) and (9).

3. A process according to claim 1 or claim 2, **characterised in that** it comprises pre-cooling and / or pre-crystallising the product to be fractionated.

4. A process according to claim 3, **characterised in that** the product to be fractionated is pre-crystallised to an extent of at most 5 %.

5. A process according to claim 3, **characterised in that** the product to be fractionated is pre-crystallised to an extent of at most 2 %.

6. A process according to any of claims 1 to 5, **characterised in that** the said at least one solid block of crystallised material is provided with a resting period during which it can equilibrate after having been discharged from the crystalliser (3) and before being crushed in step (c).

7. A process according to claim 2, **characterised in that** the period of time between crushing the said at least one solid block of crystallized material in step (c) and pumping the said paste to the filter press (7) in step (d) does not exceed 1 hour and is preferably less than 30 minutes.

8. A process according to any one of claims 1 to 7, **characterised in that** the crystalliser (3) is placed in a temperature controlled room.

9. A process according to any one of claims 1 to 8, **characterised in that** in step (b) the chamber (10) is emptied by opening the crystalliser (3).

10. A process according to any one of claims 1 to 9, **characterised in that** step (b) includes raising the temperature of the wall (11) of the cooling chamber (10).

11. A process according to any one of claims 1 to 10, **characterised in that** the product to be fractionated is selected from the group consisting of palm kernel oil, fatty acids and fatty acid methyl or ethyl esters.

12. An installation for the dry fractionation of lauric oils, fatty acids and fatty acid esters, comprising a crystallizer (3), a crusher (5), means for transporting solid blocks of crystallised material formed in the crystalliser (3) to the crusher (5), a filter press (7), and means for transporting the paste obtained in the crusher (5) to the filter press (7), **characterised in that** the said crystalliser (3) comprises at least one cooling chamber (10) that is provided with at least one wall (11) positioned vertically permitting heat transfer to form at least one solid block of crystallised material.

13. An installation according to claim 12, **characterised in that** the width of the cooling chamber (10) of the crystalliser (3) is from 1 to 10 cm.

14. An installation according to claim 12 or claim 13, **characterised in that** the width of the cooling chamber (10) of the crystalliser (3) is from 3 to 6 cm.

15. An installation according to any of claims 12 to 14, **characterised in that** the cooling chamber (10) is mounted in a hydraulic press and connected to a heat exchange medium supply system (16, 17).

16. An installation according to any of claims 12 to 15, **characterised in that** the cooling chamber (10) of the crystalliser (3) is provided with thermocouples (21) to measure the temperature of the product to be fractionated and / or of the heat exchange medium.

Patentansprüche

1. Verfahren für die Trockenfraktionierung von Laurinölen, Fettsäuren und Fettsäureestern, welche die folgenden Schritte aufweist:

   (a) Verfestigen des zu fraktionierenden Produkts in einem Kristallisator (3) zum Bilden eines festen Blocks kristallisierten Materials,
   (b) Ausgeben und Sammeln des festen Blocks, und
   (c) Zermahlen des festen Blocks zu einer pumpfähigen Paste;
   dadurch gekennzeichnet, dass der Kristallisator (3) mindestens eine Kühlkammer (10) aufweist, die mit mindestens einer Wand (11) bereitgestellt ist, die vertikal positioniert ist und eine Wärmeübertragung ermöglicht, um mindestens einen festen Block aus kristallisiertem Material zu bilden.

2. Verfahren nach Anspruch 1, das Weiterhin die folgenden Schritte aufweist:

(d) Pumpen der Paste in eine Filterpresse (7),
(e) Trennen der Paste in eine flüssige Fraktion (8) und eine Feststofffraktion (9) durch Filtration, und
(f) Sammeln beider Fraktionen (8) und (9).

3. Verfahren nach Anspruch 1 oder Anspruch 2, **dadurch gekennzeichnet, dass** es ein Vorkühlen und/oder Vorkristallisieren des zu fraktionierenden Produkts aufweist.

4. Verfahren nach Anspruch 3, **dadurch gekennzeichnet, dass** das zu fraktionierende Produkt in einem Ausmaß von höchstens 5 % vorkristallisiert ist.

5. Verfahren nach Anspruch 3, **dadurch gekennzeichnet, dass** das zu fraktionierende Produkt in einem Ausmaß von höchstens 2 % vorkristallisiert ist.

6. Verfahren nach einem der Ansprüche 1 bis 5, **dadurch gekennzeichnet, dass** der mindestens eine feste Block aus kristallisiertem Material mit einer Ruheperiode versehen ist, in der er äquilibrieren kann, nachdem er aus dem Kristallisator (3) ausgegeben wurde und bevor er in Schritt (c) zermahlen wird.

7. Verfahren nach Anspruch 2, **dadurch gekennzeichnet, dass** die Zeitperiode zwischen dem Zermahlen des mindestens einen festen Blocks aus kristallisiertem Material im Schritt (c) und dem Pumpen der Paste zu der Filterpresse (7) im Schritt (d) 1 Stunde nicht überschreitet und vorzugsweise kürzer als 30 Minuten ist.

8. Verfahren nach einem der Ansprüche 1 bis 7, **dadurch gekennzeichnet, dass** der Kristallisator (3) in einen temperaturkontrollierten Raum gestellt ist.

9. Verfahren nach einem der Ansprüche 1 bis 8, **dadurch gekennzeichnet, dass** in Schritt (b) die Kammer (10) durch Öffnen des Kristallisators (3) geleert wird.

10. Verfahren nach einem der Ansprüche 1 bis 9, **dadurch gekennzeichnet, dass** Schritt (b) das Erhöhen der Temperatur der Wand (11) der Kühlkammer (10) beinhaltet.

11. Verfahren nach einem der Ansprüche 1 bis 10, **dadurch gekennzeichnet, dass** das zu fraktionierende Produkt aus der Gruppe bestehend aus Palmkernöl, Fettsäuren und Fettsäuremethyl- oder -ethylestern ausgewählt ist.

12. Installation für die Trockenfraktionierung von Laurinölen, Fettsäuren und Fettsäureestern, umfassend einen Kristallisator (3), einen Brecher (5), Mittel zum Transportieren fester Blöcke aus kristallisiertem Material, die in dem Kristallisator (3) gebildet werden, zu dem Brecher (5), eine Filterpresse (7) und Mittel zum Transportieren der im Brecher (5) erhaltenen Paste zu der Filterpresse (7), **dadurch gekennzeichnet, dass** der Kristallisator (3) mindestens eine Kühlkammer (10) aufweist, die mit mindestens einer Wand (11) bereitgestellt ist, die vertikal positioniert ist und eine Wärmeübertragung ermöglicht, um mindestens einen festen Block aus kristallisiertem Material zu bilden.

13. Installation nach Anspruch 12, **dadurch gekennzeichnet, dass** die Breite der Kühlkammer (10) des Kristallisators (3) 1 bis 10 cm ist.

14. Installation nach Anspruch 12 oder Anspruch 13, **dadurch gekennzeichnet, dass** die Breite der Kühlkammer (10) des Kristallisators (3) 3 bis 6 cm ist.

15. Installation nach einem der Ansprüche 12 bis 14, **dadurch gekennzeichnet, dass** die Kühlkammer (10) in einer hydraulischen Presse montiert und an ein Wärmeaustauschmedium-Versorgungssystem (16, 17) angeschlossen ist.

16. Installation nach einem der Ansprüche 12 bis 15, **dadurch gekennzeichnet, dass** die Kühlkammer (10) des Kristallisators (3) mit Thermosonden (21) zur Messung der Temperatur des zu fraktionierenden Produkts und/oder des Wärmeaustauschmediums bereitgestellt ist.

Revendications

1. Processus pour le fractionnement à sec d'huiles lauriques, d'acides gras et d'esters d'acides gras, comprenant les étapes consistant à :

   (a) solidifier le produit à fractionner dans un cristallisoir (3) pour former un bloc solide de matière cristallisée,
   (b) décharger et recueillir ledit bloc solide, et
   (c) écraser ledit bloc solide en une pâte pouvant être pompée ;
   caractérisé en ce que ledit cristallisoir (3) comprend au moins une chambre de refroidissement (10) qui est munie d'au moins une paroi (11) positionnée verticalement et permettant un transfert de chaleur pour former au moins un bloc solide de matière cristallisée.

2. Processus selon la revendication 1, comprenant en outre les étapes consistant à :

   (d) pomper ladite pâte dans un filtre-presse (7),
   (e) séparer par filtration ladite pâte en une fraction liquide (8) et en une fraction solide (9), et
   (f) recueillir les deux fractions (8) et (9).

3. Processus selon la revendication 1 ou la revendication 2, **caractérisé en ce qu'**il comprend le pré-refroidissement et/ou la pré-cristallisation du produit à fractionner.

4. Processus selon la revendication 3, **caractérisé en ce que** le produit à fractionner est pré-cristallisé dans une mesure d'au plus 5 %.

5. Processus selon la revendication 3, **caractérisé en ce que** le produit à fractionner est pré-cristallisé dans une mesure d'au plus 2 %.

6. Processus selon l'une quelconque des revendications 1 à 5, **caractérisé en ce que** ledit au moins un bloc solide de matière cristallisée bénéficie d'une période de repos pendant laquelle il peut s'équilibrer après avoir été déchargé du cristallisoir (3) et avant d'être écrasé dans l'étape (c).

7. Processus selon la revendication 2, **caractérisé en ce que** la période de temps entre l'écrasement dudit bloc solide de matière cristallisée dans l'étape (c) et le pompage de ladite pâte dans le filtre-presse (7) dans l'étape (d) ne dépasse pas 1 heure et est de préférence inférieure à 30 minutes.

8. Processus selon l'une quelconque des revendications précédentes 1 à 7, **caractérisé en ce que** le cristallisoir (3) est placé dans une chambre à température maîtrisée.

9. Processus selon l'une quelconque des revendications 1 à 8, **caractérisé en ce que,** dans l'étape (b), la chambre (10) est vidée en ouvrant le cristallisoir (3).

10. Processus selon l'une quelconque des revendications 1 à 9, **caractérisé en ce que** l'étape (b) comprend l'élévation de la température de la paroi (11) de la chambre de refroidissement (10).

11. Processus selon l'une quelconque des revendications 1 à 10, **caractérisé en ce que** le produit à fractionner est sélectionné à partir du groupe constitué par l'huile de palmiste, les acides gras, et les esters d'éthyle ou de méthyle d'acides gras.

12. Installation pour le fractionnement à sec d'huiles lauriques, d'acides gras et d'esters d'acides gras, comprenant un cristallisoir (3), un broyeur (5), un moyen pour transporter les blocs solides de matière cristallisée formés dans le cristallisoir (3) jusqu'au broyeur (5), un filtre-presse (7), et un moyen pour transporter la pâte obtenue dans le broyeur (5) jusqu'au filtre-presse (7), **caractérisée en ce que** ledit cristallisoir (3) comprend au moins une chambre de refroidissement (10) qui est munie d'au moins une paroi (11) positionnée verticalement permettant au transfert de chaleur de former au moins un bloc solide de matière cristallisée.

13. Installation selon la revendication 12, **caractérisée en ce que** la largeur de la chambre de refroidissement (10) du cristallisoir (3) est de 1 à 10 cm.

14. Installation selon la revendication 12 ou la revendication 13, **caractérisée en ce que** la largeur de la chambre de refroidissement (10) du cristallisoir (3) est de 3 à 6 cm.

15. Installation selon l'une quelconque des revendications 12 à 14, **caractérisée en ce que** la chambre de refroidissement (10) est montée dans une presse hydraulique et est reliée à un système d'alimentation en milieu d'échange de chaleur (16, 17).

16. Installation selon l'une quelconque des revendications 12 à 15, **caractérisée en ce que** la chambre de refroidissement (10) du cristallisoir (3) est munie de thermocouples (21) pour mesurer la température du produit à fractionner et/ou du milieu d'échange de chaleur.

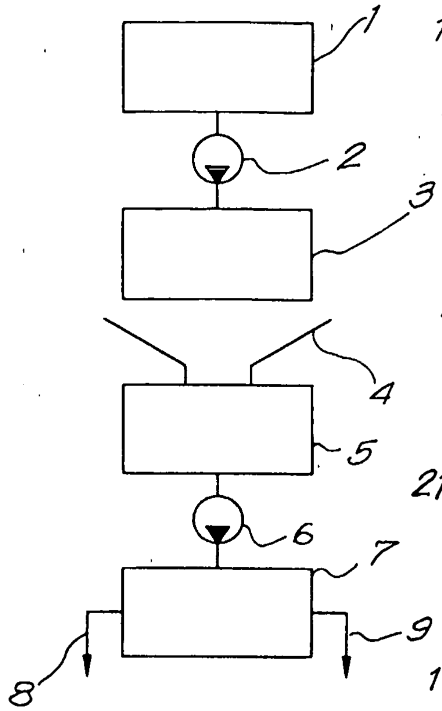

Fig.1

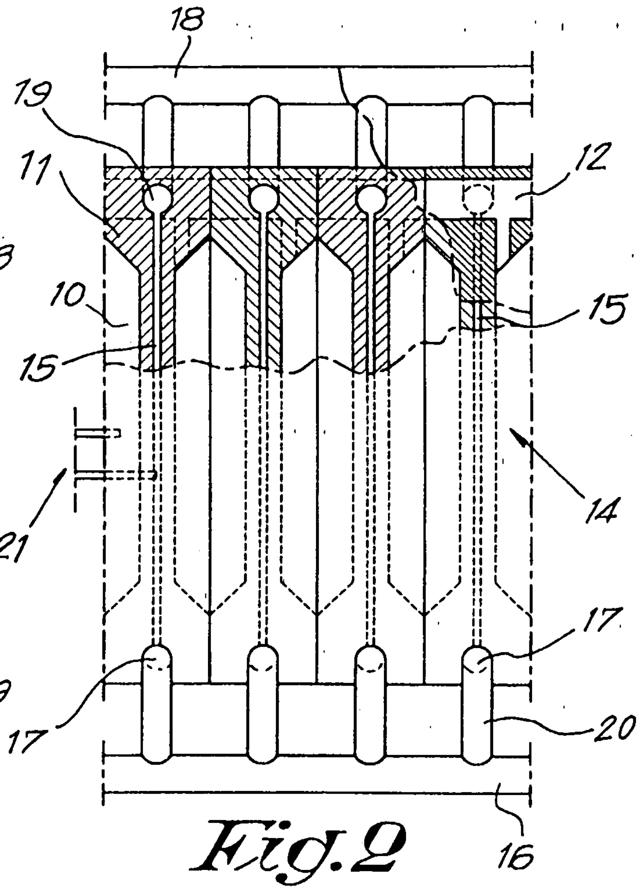

Fig.2

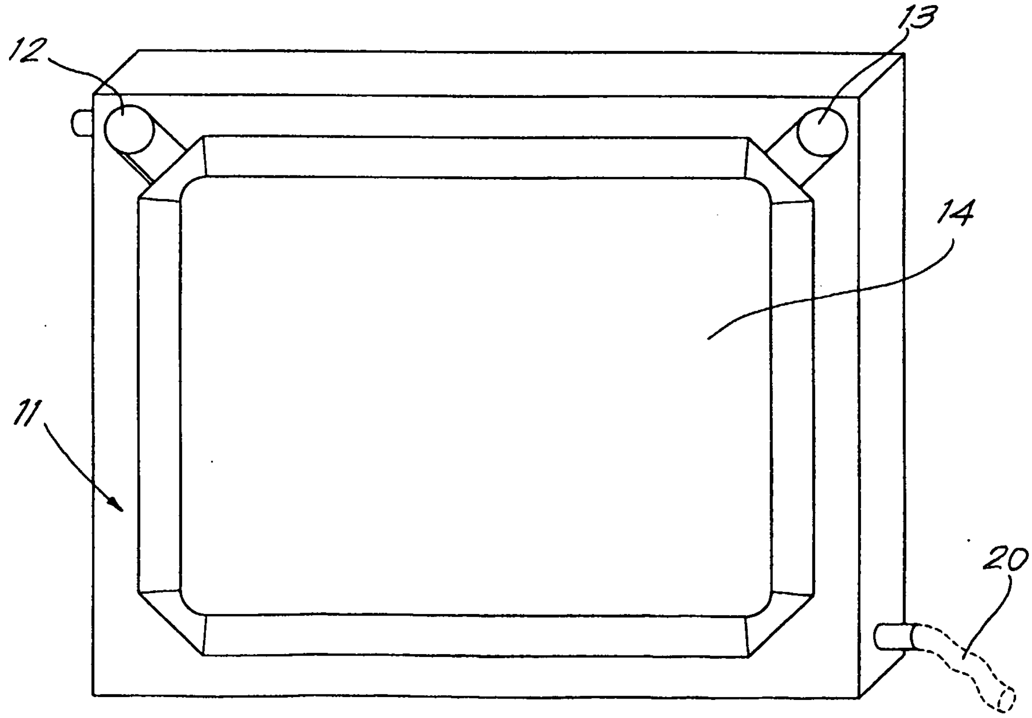

Fig.3

REFERENCES CITED IN THE DESCRIPTION

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