EUROPEAN PATENT SPECIFICATION

PROCESS FOR PREPARING BLOWN VEGETABLE OIL
VERFAHREN ZUR HERSTELLUNG VON GEBLASENEN PFLANZLICHEN ÖLEN
PROCEDE DE PREPARATION D'HUILE VEGETALE SOUFFLEE

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References cited:
EP-A- 0 405 601
US-A- 2 657 224
US-A- 4 609 500

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Description

[0001] The present invention relates to the refining of crude vegetable oils, and in particular the refining of crude soybean oil, to render the oil useful in industrial applications.

[0002] Refined vegetable oils and compounds and materials derived therefrom have a number of uses in industrial applications. For example, refined soy oil can be used as an ecological alternative to products derived from petroleum that are used in making urethane foams.

[0003] Crude oil that has been extracted from the oil-containing vegetable material is typically a dark colored turbid liquid that needs to be further refined to convert it to a useful oil product. There are a wide variety of known techniques for refining crude vegetable oils into useful vegetable oils. Because most of the refined vegetable oils are intended for human consumption, most of the conventional methods and equipment used in vegetable oil processing are directed to removing impurities that can contribute to unwanted flavor, color, odor, and other undesirable properties. Such impurities include phosphorus-containing contaminants such as hydratable and non-hydratable phospholipids, free fatty acids, color bodies and trace minerals. The typical known vegetable oil refining process involves several steps, such as degumming, neutralization (alkali refining), bleaching and deodorization. The degumming step typically involves adding water and usually other chemicals, such as phosphoric acid, to the crude oil, heating and agitating the mixture for a period of time (approximately 10-30 minutes) at temperatures of about 50-70°C, and then subsequently centrifuging the mixture to separate the water and oil. The degumming step can be repeated to further reduce the amount of phospholipids in the crude oil.

[0004] The degummed oil is then subjected to several additional refining steps to remove the other unwanted components such as free fatty acids, color bodies, and other impurities. In these refining steps, the free fatty acids are saponified, the oil is washed to remove the soaps, neutralized and further washed to remove excess chemicals and soaps. The oil is then bleached to remove color bodies and then finally deodorized. Since an alkali is used to saponify the free fatty acids, the process is known as alkali or chemical refining.

[0005] US Patent No: 2 657 224 discloses a refining technique generally of the kind described above. This patent describes a process in which a substantially slime-free oil phase separated from a mixture of the crude oil and water is first de-aerated and then fed as a stream and under pressure, to a mixing zone with a stream of a neutralizing agent for the free fatty acids in the oil, where they are intimately mixed under a super-atmospheric pressure. The resulting mixture is then passed into a centrifugal supporter and there separated into a soapstock phase and a refined oil phase. EP-A-0 405 601 discloses a process for deodorizing oils and fats.

[0006] The capital cost associated with equipment to practice these chemical refining steps is very high. For example, centrifuges and filtering equipment, which can be expensive to maintain, are typically used to separate the oil from the washing water. Chemical refining also involves many steps which are cumbersome and which inherently contribute to oil losses, since each of the refining steps produces a residue which carries with it a certain quantity of usable oil, thus decreasing the yield of the refined oil.

[0007] Because of the high cost of equipment, the high operating expense and the losses of product oil, there has been a desire in recent years to practice a process commonly referred to as physical refining. In a physical refining process, crude oil, which has been subjected to several pretreatment processing steps, is brought to an elevated temperature (250°C or more) in a vessel operated under vacuum. Steam is sparged into the oil during treatment. Temperature and retention time conditions are selected such that the free fatty acids and other impurities are volatilized and distilled off. The treated oil is then typically cooled and given a post bleach to further lighten the color of the oil.

[0008] Although physical refining offers the advantage of reduced capital and operating costs, it still requires the crude oil to be subjected to substantial pre-treating steps, including the addition of chemicals to remove at least some of the impurities in the crude oil. These substantial pretreating steps add to the cost of the physical refining process, making the fully refined oil resulting from the process nevertheless still economically undesirable for industrial applications.

[0009] The present invention contemplates a physical refining process that eliminates the substantial pre-treatment steps and results in a partially refined vegetable oil that is useful in industrial applications. The intention is to limit or eliminate yield losses, and to eliminate the need for chemical pre-treatment of the crude oil.

[0010] According to the invention a method of partially refining a crude vegetable oil, such as soybean oil containing gums and other impurities, comprises the steps of:

(a) permitting the crude vegetable oil to settle over a period of time such that the oil becomes stratified into at least two distinct layers, with one layer comprising gums with a low oil content and a second layer comprising oil containing a fraction of the gums originally present in the oil;

(b) separating the oil layer from the gum layer and heating the oil layer to a first temperature which is
sufficient to evaporate moisture present in the oil;

(c) agitating the oil while it is being heated to said
first temperature;

(d) allowing the oil to cool to a second temperature
within the range 76-83°C (170-180°F);

(e) introducing air under pressure into the oil as it is
cooling to said second temperature;

(f) maintaining the oil within the temperature range
76-83°C 170-180°F for a time period sufficient to
achieve a desired viscosity;

(g) agitating the oil during step (f) and aerating the
oil during step (f) with air under pressure; and

(h) allowing the oil to cool to ambient temperature
without agitation or aeration to obtain a partially re-
finned vegetable oil.

[0011] In an alternative method of the invention a dif-
ferent degumming procedure is employed. The alterna-
tive degumming procedure comprises heating the crude
vegetable oil to a first temperature in the range 133-153°C (270-300°F) while agitating the oil. Once the
oil reaches the first temperature, the heat and agitation
are turned off and the oil is allowed to settle into layers,
wherein the bottom layer contains a substantial amount
of the phospholipid and free fatty acid impurities. The oil
is separated from the impurities and then subjected to
the same cooling and temperature maintenance steps
previously stated to obtain a partially refined oil having
a desired viscosity.

[0012] Some particular embodiments of the invention
are described in more detail below.

[0013] It has now been determined that a partially re-
finned vegetable oil suitable for use in industrial appli-
cations such as in making urethane foams can be obtained
from a physical refining process. It should be under-
stood that the refining process of the present invention is
performed on crude oil which has already been ex-
tacted from the oil-bearing vegetable matter, and is not
applied to the oil-bearing vegetable matter itself. Al-
though the process is applicable to a variety of crude
vegetable oils, its predominant commercial concern is
directed to soybean oil and will be particularly discussed
with reference to this oil.

[0014] The crude soybean oil obtained from extrac-
tion is put into a storage tank and allowed to settle for a
period of time sufficient to allow the fines and other in-
soluble impurities from the extraction process, as well
as the hydratable and non-hydratable phospholipids or
gums present in the crude oil, to settle to the bottom of
the tank. In general, this settling step takes about 20
days. During this time, the phosphorous content of the
crude oil decreases because the gums settle to the bot-
tom of the tank.

[0015] After settling, the crude oil is then pumped into
a blowing tank, taking care not to pump off the bottom
layer which contains the gums and other impurities.

[0016] The degummed crude oil is then heated in the
blowing tank to a temperature sufficient to cause the ex-
cess moisture present in the oil to bubble up through the
oil to the top of the tank. A sufficient heating temperature
is in the range 126-133°C (260-270°F) with 133°C
(270°F) being an optimum temperature. Temperatures
above 135°C (270°F) tend to cause darkening or scor-
ching of the oil, while temperatures below 126°C
(260°F) are not hot enough to efficiently cause the ex-
cess moisture to move through the oil.

[0017] As the oil is heated it is continuously agitated
to promote movement of the moisture through and out
of the oil. The equipment used to accomplish the heating
and agitation of the oil can be any heating and agitation
equipment known to those knowledgeable in soybean
processing. For example, it has been found useful in the
present process to equip the blowing tank with steam
coils positioned near the bottom of the tank to accom-
plish the heating of the oil and to equip the blowing tank
with an impeller to accomplish the agitation.

[0018] Once the temperature of the oil in the blowing
tank reaches about 133°C (270°F), the heat and agita-
tion are turned off, and the oil is then aerated by intro-
ducing air under pressure into the blowing tank. Al-
though a variety of aeration equipment could be used
to accomplish the aeration step, one useful design is to
equip the tank with perforated pipe that is placed near
the bottom of the blowing tank.

[0019] The air is introduced into the oil at a sufficient
pressure and at a sufficient rate to cause the air to con-
tact and penetrate all the crude oil in the tank. An opti-
um air pressure for the introduced air is 8.3 x 10^5 N/
m^2 (120 p.s.i) an optimum rate is 0.85 m^3/min (30 cubic
feet per minute).

[0020] It is desirable to have a small amount of mois-
ture present in the oil, such as 0.03 to 0.05 % moisture.
During the heating and agitation step, too much mois-
ture can be evaporated from the oil such that the mois-
ture content drops below the range of 0.03-0.05 %. It is
then necessary to bring the moisture level up to the op-
timum range, and this can be accomplished by utilizing
humid air in the aeration step. The amount of humidity
is not critical; ambient air at ambient temperature typi-
cally contains sufficient humidity to raise and maintain
the moisture level of the oil at 0.05 %. If additional mois-
ture does not need to be added to the oil, i.e. the mois-
ture level is already at 0.05%, the air can be dried in a
dryer prior to being introduced into the blowing tank.

[0021] While the oil is being aerated, the heat is turned
off and the temperature of the oil is allowed to drop.
When the oil temperature reaches 76°C (170°F), the
amount of air introduced into the oil is increased to 3.7
m^3/min (130 ft^3/min) to insure thorough contact and pen-
etration of the air into the oil. The temperature of the oil
is then maintained within the range of 76-83°C (170-180°F) during the remainder of the aeration step. In order to maintain a temperature within this range, the heating coils may be turned on as needed to increase the temperature. Alternatively, if the temperature rises above 83°C (180°F), water can be introduced into the coils to lower the temperature to the desired range of 76-83°C (170-180°F).

[0022] Although the oil could be maintained at temperatures outside the 76-83°C (170-180°F) range, such temperatures are not optimum. At temperatures below 76°C (170°F), the viscosity of the oil is higher and the air does not disperse as well through the oil. If the oil is maintained at temperatures higher than 83°C (180°F) there is a danger that the oil will polymerize and darken in color.

[0023] During the aeration step it is desirable to agitate the oil to promote thorough mixing of the air with the oil. However, care must be taken to make sure that the oil does not reach temperatures over 133°C (270°F) because such temperatures can lead to scorching of the oil. Therefore, before air is introduced during the aeration step, the agitator is turned off, since the combination of agitation and aeration could lead to increases in the temperature of the oil above 133°C (270°F) due to natural friction. As the temperature of the oil drops during the aeration step, the agitator can be turned on intermittently to insure mixing of the air with the oil while minimizing the risk of increased temperatures. In general, an agitation time of 5 minutes every hour is sufficient. Once the oil temperature drops to 76°C (170°F) the agitation can be constant because the danger of the oil reaching too high of a temperature as a result of the frictional forces is minimal.

[0024] Aeration and agitation of the oil are continued until the oil reaches a desired viscosity. In general, the desired viscosity will depend upon the desired use for the partially refined oil. Viscosities ranging from 10800 kg·hr⁻¹·m⁻¹ - 14400 kg·hr⁻¹·m⁻¹ (30-40 poise) are typical desired viscosities. Once the oil reaches the desired viscosity, the aeration and agitation are stopped and the oil is allowed to cool. The oil tends to polymerize as it is cooling and thereby increase in viscosity. To prevent the oil from polymerizing, a blanket of nitrogen gas can be introduced into the blowing tank. The oil resulting from the process of the present invention has the following characteristics:

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Free Fatty Acid</td>
<td>3.8 to 2%</td>
</tr>
<tr>
<td>Moisture</td>
<td>0.05 to .006</td>
</tr>
<tr>
<td>Acid Value</td>
<td>1.4 to 3.6</td>
</tr>
<tr>
<td>Hydroxyl Value</td>
<td>50 to 125</td>
</tr>
<tr>
<td>Phosphorus</td>
<td>25 ppm to 110 ppm</td>
</tr>
<tr>
<td>Gardner Color</td>
<td>5</td>
</tr>
</tbody>
</table>

[0025] The oil resulting from the process of the present invention is a low cost oil suitable for use in industrial applications. Unlike prior art chemical and physical refining processes, the process of the present invention avoids the addition of chemicals to refine or pre-treat the crude oil, thereby eliminating expensive equipment such as centrifuges and eliminating additional processing steps.

[0026] In some production situations there may be a demand for the partially refined oil product that makes it impractical to utilize a lengthy settling period such as 20 days. In such situations, an alternative degumming procedure can be utilized in the present invention instead of using a settling period to remove the gums and other impurities.

[0027] In the alternative degumming procedure, the extracted crude oil is pumped directly into the blowing tank. Once in the blowing tank, the crude oil is heated with live steam introduced through the perforated pipes. An optimum steam pressure is 10.4 x 10⁵ N/m² (150 p.s.i.). The oil is heated to a temperature that is sufficient to reduce the viscosity of oil such that the phospholipids, free fatty acids and other impurities can settle out of the oil. In general a temperature in the range of 133-150°C (270-300°F) is a sufficient heating temperature, with 150°C (300°F) being preferred. Temperatures within this range provide an optimum oil viscosity and typically do not result in scorching or darkening of the oil because of the presence of all the impurities. As the crude oil is heated it is continuously agitated to insure thorough mixing of the steam and the oil.

[0028] Once the temperature reaches 150°C (300°F), the heat and agitation are turned off and the oil is allowed to settle in the tank. During settling, the phospholipids, free fatty acids and other impurities drop to the bottom of the blowing tank where they can be drained off. In general, it takes about five hours for the impurities to settle to the bottom of the tank.

[0029] After the phospholipids, free fatty acids and other impurities are drained off, the oil is then subjected to the same aeration step discussed previously in connection with the crude oil that is allowed to settle for 20 days. Again, the air is introduced at an air pressure of 8.3 x 10⁵ N/m² (120 p.s.i.), and at a rate of 0.85 m³/min (30 ft³/min). In order to insure that the moisture level in the oil is in the range of 0.03-0.05%, it may be necessary to use dried air rather than humid air in the aeration step.

[0030] When the temperature of the oil reaches 76°C (170°F), the amount of air introduced is increased to 2.85 m³/min (100 ft³/min) so that the air can thoroughly contact and penetrate the oil. The temperature of the oil is maintained within the range of 76-83°C (170-180°F) for the remainder of the aeration step.

[0031] As previously discussed, it is desirable to agitate the oil during the aeration step. Again, the oil is agitated intermittently as the temperature is allowed to drop from 150°C (300°F) to a temperature in the range of 76-83°C (170-180°F), and continuously agitated while the oil temperature is maintained within the range of 76-83°C (170-180°F).
Once the oil reaches a desired viscosity, the aeration and agitation are stopped and the oil is allowed to cool. The oil resulting from the process employing the alternative degumming procedure has the following characteristics:

<table>
<thead>
<tr>
<th>Free Fatty Acid</th>
<th>2.75 to 2%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moisture</td>
<td>.05 to .006</td>
</tr>
<tr>
<td>Acid Value</td>
<td>2 to 3.6</td>
</tr>
<tr>
<td>Hydroxyl Value</td>
<td>50 to 72</td>
</tr>
<tr>
<td>Phosphorus</td>
<td>5 ppm to 15 ppm</td>
</tr>
<tr>
<td>Gardner Color</td>
<td>5</td>
</tr>
</tbody>
</table>

Utilizing the alternative degumming procedure results in an oil having a lower phosphorus content because the steam used in the degumming procedure draws more phosphorus out of the oil than if the oil is degummed through settling alone.

Claims

1. A method of partially refining crude vegetable oil containing gums and other impurities comprising the steps of:

   (a) permitting the crude vegetable oil to settle over a period of time such that the oil becomes stratified into at least two distinct layers, with one layer comprising gums with a low oil content and a second layer comprising oil containing a fraction of the gums originally present in the oil;

   (b) separating the oil layer from the gum layer and heating the oil layer to a first temperature which is sufficient to evaporate moisture present in the oil;

   (c) agitating the oil while it is being heated to said first temperature;

   (d) allowing the oil to cool to a second temperature within the range 76-83°C (170-180°F);

   (e) introducing air under pressure into the oil as it is cooling to said second temperature;

   (f) maintaining the oil within the temperature range 76-83°C (170-180°F) for a time period sufficient to achieve a desired viscosity;

   (g) agitating the oil during step (f) and aerating the oil during step (f) with air under pressure; and

   (h) allowing the oil to cool to ambient temperature without agitation or aeration to obtain a partially refined vegetable oil.

2. A method in accordance with Claim 1, wherein the first temperature is in the range 126-133°C (260-270°F).

3. A method in accordance with Claim 1 or Claim 2 wherein the air used to aerate the oil during step (f) is at a pressure of 8.3 x 10^5 N/m² (120 p.s.i.).

4. A method in accordance with Claim 3 wherein the air used to aerate the oil during step (f) is introduced at a rate of 3.7 m³/min (130 ft³/min).

5. A method of partially refining crude vegetable oil containing gums and other impurities comprising the step of:

   (a) heating the crude vegetable oil to a first temperature of 150°C (300°F);

   (b) agitating the vegetable oil while it is being heated to said first temperature;

   (c) permitting the heated crude vegetable oil to cool and to settle over a period of time such that the oil becomes stratified into at least two distinct layers, with one layer comprising gums with a low oil content and second layer comprising oil containing a fraction of the gums originally present in the oil;

   (d) separating the gum layer from the oil layer and allowing the oil to cool to a second temperature within the range 76-83°C (170-180°F);

   (e) introducing air under pressure into the oil as it is cooling to said second temperature;

   (f) maintaining the oil within the temperature range 76-83°C (170-180°F) for a time period sufficient to achieve a desired viscosity;

   (g) agitating the oil during step (f) and aerating the oil during step (f) with air under pressure; and

   (h) allowing the oil to cool to ambient temperature without agitation and aeration to obtain a partially refined oil.

6. A method in accordance with any preceding Claim wherein the vegetable oil is agitated constantly as it is being heated to said first temperature.

7. A method in accordance with any preceding Claim wherein the heating in step (a) is accomplished by
introducing steam under pressure into the crude vegetable oil.

8. A method in accordance with any preceding Claim wherein the air introduced in step (e) is introduced at a pressure of \(8.3 \times 10^5\) N/m\(^2\) (120 p.s.i.).

9. A method in accordance with Claim 8 wherein the air introduced in step (e) is introduced at a rate of 0.85 m\(^3\)/min (30 ft\(^3\)/min).

10. A method in accordance with any preceding Claim wherein the oil is intermittently agitated as it is cooling to said second temperature.

11. A method in accordance with any preceding Claim wherein the oil is constantly agitated while it is being maintained within the temperature range 76-83°C (170-180°F).

12. A method in accordance with any preceding Claim wherein the air used to aerate the oil during step (f) is introduced at a rate of 2.85 m\(^3\)/min (100 ft\(^3\)/min).

Patentansprüche

1. Verfahren zum teilweisen Veredeln rohen Pflanzenöls, das Gummen und andere Verunreinigungen enthält, umfassend die folgenden Schritte:

   (a) Absetzenlassen des rohen Pflanzenöls über eine Zeitspanne, sodass das Öl zumindest zwei getrennte Schichten ausbildet, wobei eine Schicht Gummen mit einem niedrigen Ölgehalt umfasst, und eine zweite Schicht Öl umfasst, das eine Fraktion der Gummen, die ursprünglich in dem Öl anwesend waren, enthält;

   (b) Trennen der Ölschicht von der Gummi- schicht und Erhitzen der Ölschicht auf eine erste Temperatur, die ausreicht, um im Öl vorhandene Feuchtigkeit zu verdunsten;

   (c) Rühren des Öls, während es auf die erste Temperatur erhitzt wird;

   (d) Zulassen, dass sich das Öl auf eine zweite Temperatur im Bereich 76-83°C (170-180°F) abkühlt;

   (e) Einbringen von Luft unter Druck in das Öl, während es auf die zweite Temperatur abkühlt;

   (f) Halten des Öls innerhalb des Temperaturberei- chs von 76-83°C (170-180°F) für eine Zeitspanne, die ausreicht, um eine gewünschte Viskosität zu erreichen;

   (g) Rühren des Öls während des Schrittes (f) und Belüften des Öls während des Schrittes (f) mit unter Druck befindlicher Luft;

   (h) Zulassen, dass das Öl sich auf die Umg- bungstemperatur abkühlt ohne Rühren oder Belüften, um ein teilweise veredeltes Pflanzenöl zu erhalten.

2. Verfahren nach Anspruch 1, wobei die erste Temperatur im Bereich von 126-133°C (260-270°F) ist.

3. Verfahren nach Anspruch 1 oder 2, wobei die Luft, die verwendet wird, um das Öl im Schritt (f) zu be- lüften, unter einem Druck von \(8.3 \times 10^5\) N/m\(^2\) (120 p.s.i.) steht.

4. Verfahren nach Anspruch 3, wobei die Luft, die verwendet wird, um das Öl während des Schrittes (f) zu belüften, mit einer Geschwindigkeit von 3,7 m\(^3\)/min (130 ft\(^3\)/min) eingebracht wird.

5. Verfahren zum teilweisen Veredeln rohen Pflanzen- öls, das Gummen und andere Verunreinigungen enthält, umfassend die folgenden Schritte:

   (a) Erhitzen des rohen Pflanzenöls auf eine erste Temperatur von 150°C (300°F);

   (b) Rühren des Pflanzenöls, während es auf die erste Temperatur erhitzt wird;

   (c) Abkühlen und absetzen lassen des erhitzen- ten rohen Pflanzenöls über eine Zeitspanne, so- dass das Öl zumindest zwei getrennte Schichten ausbildet, wobei eine Schicht Gummen mit einem niedrigen Ölgehalt umfasst und eine zweite Schicht Öl umfasst, die eine Fraktion der Gummen, die ursprünglich in dem Öl anwe- send waren, enthält;

   (d) Abtrennen der Gummischicht von der Öl- schicht und Zulassen, dass sich das Öl auf eine zweite Temperatur im Bereich von 76-83°C (170-180°F) abkühlt;

   (e) Einbringen von Luft und Druck in das Öl, während es auf die zweite Temperatur abkühlt;

   (f) Halten des Öls innerhalb des Temperaturbe- reichs von 76-83°C (170-180°F) für eine Zeitspanne, die ausreicht, um eine gewünschte Viskosität zu erreichen;

6. Verfahren nach einem der voranstehenden Ansprü- che, wobei das Pflanzenöl ständig gerührt wird, während es auf die erste Temperatur erhitzt wird.

7. Verfahren nach einem der voranstehenden Ansprü- che, wobei das Erhitzen in Schritt (a) durch Einbrin- gen von Dampf unter Druck in das rohe Pflanzenöl erreicht wird.
8. Verfahren nach einem der voranstehenden Ansprüche, wobei die Luft in Schritt (e) bei einem Druck von $8,3 \times 10^5 \text{ N/m}^2$ (120 p.s.i.) eingebracht wird.

9. Verfahren nach Anspruch 8, wobei die Luft, die in Schritt (e) eingebracht wird, mit einer Geschwindigkeit von $0,85 \text{m}^3/\text{min}$ (30 ft$^3$/min) eingebracht wird.

10. Verfahren nach einem der voranstehenden Ansprüche, wobei das Öl periodisch gerührt wird, während es sich auf die zweite Temperatur abkühlt.


12. Verfahren nach einem der voranstehenden Ansprüche, wobei die Luft, die verwendet wird, um das Öl während Schritt (f) zu belüften, mit einer Geschwindigkeit von $2,85 \text{m}^3/\text{min}$ (100 ft$^3$/min) eingebracht wird.

Revidications

1. Procédé de raffinage partiel d'une huile végétale brute contenant des gommes et d'autres impuretés, comprenant les étapes consistant à :

(a) laisser l'huile végétale brute au repos pendant une durée telle que l'huile se stratifie en au moins deux couches distinctes, une couche comprenant les gommes avec une faible teneur en huile et une seconde couche comprenant l'huile contenant une fraction des gommes initialement présentes dans l'huile ;

(b) séparer la couche d'huile de la couche de gommes et chauffer couche d'huile à une première température qui est suffisante pour évaporer l'humidité présente dans l'huile ;

(c) agiter l'huile pendant son chauffage à ladite première température ;

(d) laisser l'huile refroidir à une seconde température dans la plage allant de 76 à 83 °C (170 à 180 °F) ;

(e) introduire de l'air sous pression dans l'huile pendant son refroidissement à ladite seconde température ;

(f) maintenir l'huile dans la plage de température allant de 76 à 83 °C (170 à 180 °F) pendant une durée suffisante pour obtenir une viscosité désirée ;

(g) agiter l'huile pendant l'étape (f) et aérer l'huile pendant l'étape (f) avec de l'air sous pression ; et

2. Procédé selon la revendication 1, dans lequel la première température est dans la plage allant de 126 à 133 °C (260 à 270 °F).

3. Procédé selon la revendication 1 ou la revendication 2, dans lequel l'air utilisé pour aérer l'huile pendant l'étape (f) est à une pression de $8,3 \times 10^5 \text{ Pa}$ (120 psi).

4. Procédé selon la revendication 3, dans lequel l'air utilisé pour aérer l'huile pendant l'étape (f) est introduit à un débit de $3,7 \text{m}^3/\text{min}$ (130 pieds$^3$/min).

5. Procédé de raffinage partiel d'une huile végétale brute contenant des gommes et d'autres impuretés, comprenant les étapes consistent à :

(a) chauffer l'huile végétale brute à une première température de 150 °C (300 °F) ;

(b) agiter l'huile végétale pendant son chauffage à ladite première température ;

(c) laisser l'huile végétale brute chaude refroidir et au repos pendant une durée telle que l'huile se stratifie en au moins deux couches distinctes, une couche comprenant les gommes avec une faible teneur en huile et une seconde couche comprenant l'huile contenant un fraction des gommes initialement présentes dans l'huile ;

(d) séparer la couche des gommes de la couche d'huile et laisser l'huile refroidir à une seconde température dans la plage allant de 76 à 83 °C (170 à 180 °F) ;

(e) introduire de l'air sous pression dans l'huile pendant son refroidissement à ladite seconde température ;

(f) maintenir l'huile dans la plage de température allant de 76 à 83 °C (170 à 180 °F) pendant une durée suffisante pour obtenir une viscosité désirée ;

(g) agiter l'huile pendant l'étape (f) et aérer l'huile pendant l'étape (f) avec de l'air sous pression ; et
(h) laisser l'huile refroidir à température ambiante sans agitation ni aération pour obtenir une huile partiellement raffinée.

6. Procédé selon l'une quelconque des revendications précédentes, dans lequel l'huile végétale est agitée de manière constante pendant son chauffage à ladite première température.

7. Procédé selon l'une quelconque des revendications précédentes, dans lequel le chauffage de l'étape (a) est réalisé par l'introduction d'une vapeur sous pression dans l'huile végétale brute.

8. Procédé selon l'une quelconque des revendications précédentes, dans lequel l'air introduit dans l'étape (e) est introduit à une pression de $8,3 \times 10^5$ Pa (120 psi).

9. Procédé selon la revendication 8, dans lequel l'air introduit dans l'étape (e) est introduit à un débit de $0,85 \ m^3/\min$ (30 pieds$^3$/min).

10. Procédé selon l'une quelconque des revendications précédentes, dans lequel l'huile est agitée de manière intermittente pendant son refroidissement à ladite seconde température.

11. Procédé selon l'une quelconque des revendications précédentes, dans lequel l'huile est agitée de manière constante pendant son maintien dans la gamme de température allant de 76 à 83 °C (170-180 °F).

12. Procédé selon l'une quelconque des revendications précédentes, dans lequel l'air utilisé pour aérer l'huile pendant l'étape (f) est introduit à un débit de $2,85 \ m^3/\min$ (100 pieds$^3$/min).