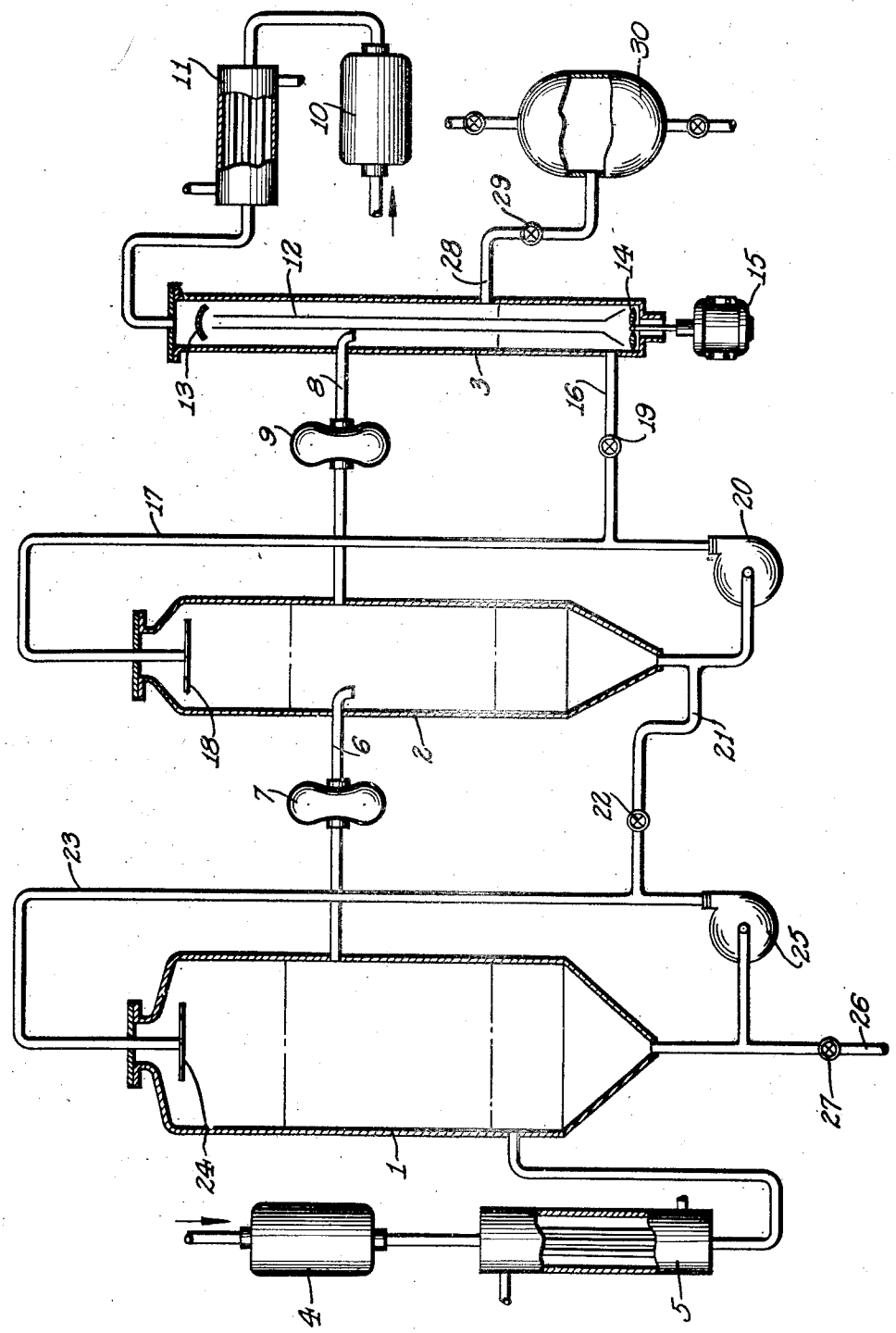
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HYDROLYSIS OF FATS AND OILS

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## HYDROLYSIS OF FATS AND OILS

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The present invention relates to the hydrolysis of glycerides of fatty acids such as fats, oils and greases and, more particularly, to the splitting of such glycerides into their fatty acid and glycerol components in the presence of water under conditions of high temperatures and pressures.

For convenience of reference "fats and oils" will be used to refer to glycerides of any fatty acids, saturated or unsaturated, such as fats, oils or admixtures thereof in the pure form or in admixture with other materials. "Fatty material" will be used as generic to fats and oils or fatty acids and to refer to either or a mixture thereof in any proportion.

It is well known that fats and oils are composed principally of fatty acid glycerides which may be split or hydrolyzed into their fatty acid and glycerol components by the application of heat and pressure in the presence of water and, if desired, a suitable catalyst. Difficulty is experienced, however, in obtaining a high degree of splitting inasmuch as the hydrolysis reaction tends to reach an equilibrium in accordance with the mass action law. This may be offset to some extent, however, inasmuch as the equilibrium point can be raised within limits by certain techniques. In general, however, such a shifting of the equilibrium point as carried out heretofore is accompanied by undesirable effects upon the resulting products, or is disadvantageous in view of the necessity for the use of expensive equipment and the difficulty involved in carrying out the process in available equipment under optimum conditions of operation.

It is well known, for example, that a higher degree of hydrolysis may be accomplished by prolonging the splitting operation in the presence of an amount of water which is greatly in excess of that required theoretically for complete hydrolysis. It is apparent, however, that such a process is disadvantageous in view of the much greater amount of time involved, the requirement for equipment of much greater capacity, and the separation of glycerol in an undesirably dilute condition from which it is impractical to recover the glycerol economically.

Another common expedient utilized for shifting the equilibrium point is to remove one of the components, i. e., one of the products of the hydrolysis reaction, so that the reaction may proceed more nearly to completion. This has been accomplished heretofore by removing the glycerol water at intervals, or continuously, if desired, and replacing the same with fresh water. In the previous methods of carrying out this type of operation, however, it has been difficult to utilize preferred conditions of temperature and pressure efficiently. Moreover, the use of expensive high pressure and temperature equipment has been required to obtain a desired capacity for more economical operation, and even with the use of such equipment, optimum conditions of temperature and pressure ordinarily cannot be utilized.

The use of higher temperatures and pressures, it is believed, increases the solubility of the water in the fatty material and thus facilitates the reaction. The utilization of high temperatures and pressures when the object is to accomplish only a moderate degree of hydrolysis, primarily is to accelerate the splitting reaction and thus reduce the amount of time required for the operation. Higher pressures and temperatures may be utilized, also, to shift the equilibrium point and thus obtain a higher degree of hydrolysis, but this is not an important advantage when the object is to accomplish only a moderate degree of hydrolysis, particularly when compared to the much greater increase in splitting which may be obtained initially by removing the glycerol water and replacing it with fresh water. When the object is to obtain the highest degree of hydrolysis possible, however, the use of higher temperatures and pressures to increase the degree of hydrolysis is very desirable. Attempts to obtain a maximum degree of hydrolysis by the use of higher temperatures and pressures simultaneously with the replacement of the glycerol water with fresh water have been unsatisfactory heretofore in view of the expensive high pressure and temperature equipment required, the inefficiency inherent in such processes, and the inability to obtain optimum operating conditions and a desired capacity with even the best available equipment.

In processes of the type under discussion, because of the high unit cost of the stainless steel or other material used in making the apparatus and the large amount required in building apparatus that will withstand high pressures, the investment in apparatus cannot be ignored and must be considered with the thermal efficiency and the yield of the desired products. For example, it might be possible to design equipment that would give a high yield with high thermal efficiency, but the increased cost of such equipment could not be amortized over its life by the improvement in efficiency and yield. It is important in connection with processes of this general type, therefore, not to limit the considera-

tion to the operating conditions in the process in relation to the results obtained, but also to consider the apparatus that is required to attain those operating conditions.

It is an advantage of the present invention that a high degree of hydrolysis may be obtained by the efficient use of readily available equipment and that the operation may be carried out in a convenient and practical manner with a minimum use of expensive processing equipment under optimum conditions of operation. As a result, the all over efficiency, taking into account the yield, thermal efficiency and cost of equipment, of my process is very advantageous.

In accordance with the invention, the hydrolysis of fats and oils is carried out in a plurality of successive zones or stages which are so integrated that the resulting splitting of the fats and oils, which preferably is carried out in the plurality of zones or stages in different lengths of time and under different conditions of temperature and pressure, is effected efficiently and a maximum degree of hydrolysis is obtained.

The method of this invention comprises subjecting fats and oils to hydrolysis with water preferably at decreasing time intervals in a plurality of successive containers maintained under successively higher conditions of temperature and pressure. Water is supplied to the last of these containers preferably at a relatively high temperature and pressure. The pressure is sufficient to effect a maximum degree of hydrolysis in a short time interval in the last zone or stage of the operation and also to provide the pressure required to pump the water successively through earlier stages of the operation. The water also is heated initially to a temperature which preferably is sufficient to effect a maximum degree of hydrolysis in a short time interval in the last zone or stage of the operation, and also to raise the temperature of the fatty material as it passes through the successive stages of the splitting operation.

Notwithstanding the temperature and pressure gradients existing in successive stages of the operation, the method is carried out efficiently and conveniently inasmuch as it is necessary to apply heat to the water or fatty material only initially, i. e., in a single preheating step. The convenience and efficiency of such a process is readily apparent. Moreover, it is necessary to subject the water to pressure by pumping only prior to its introduction into the system and this may be carried out while the water is cold. This is an advantage because cold water may be pumped readily at very high pressures in contradistinction to the pumping of hot water which involves many problems primarily because of the difficulty in lubricating the pump at high temperatures. There is no such difficulty in pumping fats at high temperatures.

In view of the shorter time intervals required for maximum splitting in the later stages of the operation, it is possible to utilize vessels of smaller capacity in said later stages. It is an advantage of the method of this invention that the higher temperature and pressure condiions required to effect a high degree of hydrolysis and which also reduces the time interval required, may be applied in one or more small vessels in the final stages of the operation. This has a decided advantage because a small vessel may be made to withstand the high temperatures and pressures at much less cost than a large vessel. Also being small, there is much less area for radiation than in a large vessel; this is significant when operating at the high temperatures used in the last stage of the splitting because the loss by radiation varies as the fourth power of the absolute temperature. In view of the smaller vessels required in the final stage of hydrolysis, moreover, it is possible to utilize temperatures and pressures which are higher than those heretofore thought to be possible from a practical standpoint. The bulk of the splitting may take place in the earlier stages at lower temperatures and pressures in a larger vessel. This is not undesirable because a large vessel can be made to operate at lower pressures without involving great expenditure. Even though the vessel is large, the radiation loss is not a cause for concern because it is not a great factor at the lower temperatures.

In a system comprising three stages for example, it is preferred to utilize three autoclaves which may be operated at different temperatures and pressures. For example, the first autoclave may be operated at a moderate pressure of about 150 to 250 lbs. per square inch and a corresponding temperature; the second autoclave may be adapted to be operated at a pressure of about 350 to 450 lbs. per square inch and a corresponding temperature, and the third autoclave preferably is built to withstand a pressure of the order of 600 to 1000 lbs. per square inch and a corresponding temperature. Other pressure and temperature gradients may be utilized, however, and the foregoing is given merely by way of illustration. Since the speed of the reaction increases with an increase in temperature and pressure, the fatty material can be treated at a progressively faster rate in the second and third autoclaves. Accordingly, the second and third autoclaves may be made smaller with the advantages pointed out heretofore, and yet inasmuch as the time required for hydrolysis is decreased the amount of fat that can be treated in the smaller autoclaves in a given time is not reduced to below that which can be treated in the first autoclave and there is no reduction in the desired capacity of the process.

If, for example, the fat and water are permitted to remain in the first autoclave for 200 minutes, in the second autoclave for 50 minutes and in the last autoclave for 10 minutes, it would be possible to construct the last autoclave approximately one twentieth as large as the first autoclave.

The water preferably is pumped when cold at a pressure which it is desired to maintain in the third autoclave. Heat exchangers are provided between the pump and the autoclave for heating the water prior to admission to the autoclave to a high temperature such that upon contact with the cooler fat being introduced into the autoclave, the water will not be cooled below the temperature desired in the autoclave. The water from the third autoclave may be permitted to flow to the second autoclave by throttling to reduce the pressure to that maintained in the second autoclave. The water will not be super-heated at the lower pressure in the second autoclave because part of its latent heat will be used in raising the temperature of the fat that is pumped into the second autoclave from the first autoclave which is operating at a lower temperature. A like amount of water from the second autoclave is passed to the first autoclave, and a like amount removed from the first autoclave as glycerine water.

The path of the fats and oils, on the other hand, is in the reverse direction, i. e., it is

pumped to the first autoclave and from thence to the second and finally into the third autoclave. An equal amount of the fatty material is transferred from the first to the second autoclave from the second to the third, and from the third autoclave to an accumulator.

The process not only has the advantages enumerated heretofore, but retains the advantanges of counter-current operation, i. e., the last split which is the most difficult is accomplished with fresh water to facilitate the hydrolysis and the first split which is the easiest, utilizes the glycerine containing water which does not interfere greatly with the hydrolysis of this stage. It is preferred to operate the process intermittently, i. e., following a shift of the fatty material and water from autoclave to autoclave, all valves interconnecting the autoclaves are closed and there is a definite time interval during which the reaction is permitted to take place. This interval preferably is sufficiently long to permit a substantial equilibrium to be reached in each vessel, or at least as much as is efficient under operating conditions. The time interval will probably be governed largely by the conditions in the last autoclave and the type of product desired. Following such a time interval, the valves connecting the autoclaves are opened, whereupon fresh water is pumped into the third autoclave, fresh fat and oils are pumped into the first autoclave, and a transfer is made from the first to the second and the second to the third autoclaves. If desired, however, the operation may be carried out in a continuous manner.

In order that the invention may be more clearly understood, reference is made to the accompanying drawing which shows diagrammatically apparatus which may be utilized in carrying out the invention. The first autoclave 1 is of relatively large capacity and is adapted to be maintained under a pressure of, for example, 200 lbs. per square inch. The second autoclave 2 is of smaller capacity and is adapted to be operated at a pressure of about 400 lbs. per square inch. The third autoclave 3 is relatively small in capacity and is adapted to be operated at a pressure of about 600 to 1000 lbs. per square inch.

The relative size of the autoclaves will depend primarily on the rates of reaction in the several autoclaves. This in turn will depend, at least in part, on the temperatures and pressures that can be obtained in the manner described. The principles involved in relating these variables are merely a matter of design and readily apparent to those skilled in the art after a knowledge of the disclosure of the process set forth herein. In carrying out the invention, the relative capacities of the autoclaves may be varied over a wide range without departing from the scope of the invention. If desired, for example, satisfactory results may be obtained by utilizing a first autoclave having a capacity of the order of about four times that of the second autoclave and about twenty times that of the third autoclave. This example is given merely by way of illustration to assist in an understanding of the invention and is not intended to be construed as an express or implied limitation upon this particular feature of the invention.

Fat is pumped into the first autoclave by means of a pump 4 and is heated initially to the temperature prevailing in the first autoclave by means of a heat exchanger 5. The first autoclave and second autoclave are interconnected intermediate the ends by means of a conduit 6 which is provided with a pump 7 for transferring the fatty material and increasing the pressure thereon when it passes to the second autoclave. In similar manner, the second and third autoclaves are connected by means of a conduit 8 and oil pump 9.

The water is pumped by a water pump 10 through a heat exchanger 11 and is admitted adjacent the top of the third autoclave. The third autoclave may be provided with a stirring device, such as, for example, a tube 12 provided with a baffle 13, and a propeller 14 which is driven by an outside source of power 15. The water from the third autoclave is permitted to flow to the second autoclave by means of a conduit 16 and a second conduit 17 connected to a distributing device 18 situated at the top of the second autoclave. A valve 19 is provided in the conduit 16 for regulating the flow of water therethrough. If desired a pump 20 connected to the bottom of the second autoclave and the second conduit 17 may be provided for circulating water in the autoclave. In similar manner the water is permitted to flow from the second autoclave to the first autoclave by means of a conduit 21 provided with a valve 22 and a second conduit 23 connected to a distributing device 24 situated at the top of the first autoclave. A pump 25 may be provided as described in connection with the second autoclave for circulating the water in the first autoclave.

The glycerol water is removed from the bottom of the first autoclave through a conduit 26 provided with a valve 27. If desired, the glycerol water so removed may be utilized to preheat the water pumped to the first autoclave. The provision of suitable heat exchangers for carrying out such a preheating is conventional and is not shown in the drawing. The fatty acid product is removed from the third autoclave through a conduit 28 provided with a valve 29 to an accumulator 30 from which it may be removed as desired.

The relative proportion of fat and water introduced into the system may vary but I prefer to use a volume of water that is about 40 to 75% of the volume of the fat.

In utilizing the apparatus above described, the operation is carried out for a short period of time in order that an equilibrium may be reached. After this short interval of time, it is desired to accomplish a split of the fatty material of the order of 60 to 75% about in the first autoclave, while in the second autoclave the degree of splitting desired may be about 75 to 90% and in the third autoclave a desired high degree of hydrolysis of the order of 90 to 97% may be accomplished.

The high degree of splitting of the fatty material which is carried out in the third autoclave may be accomplished, for example, in approximately 10 to 20 minutes. Accordingly, it is preferred under such conditions of operation to shift the water and fatty materials from autoclave to autoclave at time intervals of the order of about 10 to 20 minutes when the apparatus is operated intermittently. It will be apparent that longer or shorter time intervals would be effective depending upon the time interval required to effect the desired degree of hydrolysis which in turn may be regulated by varying the pressure and temperature conditions utilized.

The temperature conditions referred to above in connection with the operation of the autoclaves are described in their relationship with the pressures utilized. Hydrolysis is accomplished most effectively when the water and fatty material are

in a liquid phase, i. e., in liquid contact. A liquid emulsification is desirable also to prevent thermal decomposition of the fatty materials at high temperatures. The temperatures utilized assist in effecting the high pressures required, but it will be apparent that the temperature should be maintained at least slightly below the temperature of saturated steam at the pressure prevailing in the autoclaves. The preferred temperature ranges may be derived from any standard tables of saturated steam temperatures and pressures. For example, at 200 ibs., 400 lbs. and 600 lbs. per sq. inch, the maximum desired temperatures would be about 388° F., 448° F., and 488° F., respectively.

It is preferred to construct the autoclaves, conduits and other apparatus of metal which does not have a deleterious effect upon the hot fatty materials. The use of such metals in the treatment of fatty materials is conventional. Among the alloys which may be utilized are the nickel chromium steels.

It will be apparent that any number of autoclaves may be utilized in series. While two may be employed utilizing the principles of my invention, three is the preferable minimum. Four or more may be employed depending on the relation of the cost of the equipment to the advantages gained. A wide range of temperatures and pressures may be utilized in each autoclave. The time intervals utilized and the degree of splitting obtained in each autoclave also may be varied over wide ranges depending upon the results desired. Inasmuch as the invention herein described may be susceptible to many variations by one skilled in the art, as discussed above, all such variations are intended to be included within the scope of the invention

I claim:

1. A method of hydrolyzing fat and oil in a plurality of successive hydrolyzing zones comprising supplying fat and oil under pressure to the first of said zones, supplying water at an elevated temperature and at a higher pressure to the last of said zones, transferring fatty material to each succeeding zone from the preceding zone under increasing pressures, transferring water to each preceding zone from the succeeding zone under decreasing pressures, withdrawing water and glycerol from the first zone, and withdrawing fatty acid from the last zone.

2. A method of hydrolyzing fat and oil in a plurality of successive hydrolyzing zones comprising the steps of supplying fat and oil under pressure to the first of said zones, supplying water at an elevated temperature and at a higher pressure to the last of said zones, transferring fatty material to each succeeding zone from the preceding zone under increasing pressures, transferring water to each preceding zone from the succeeding zone under decreasing pressures, withdrawing water and glycerol from the first zone, and withdrawing fatty acid from the last zone, said steps being carried out at predetermined intermittent intervals.

3. A method of hydrolyzing fat and oil in a plurality of successive hydrolyzing zones comprising supplying fat and oil under pressure to the first of said zones, supplying water at an elevated temperature and at a higher pressure to the last of said zones, transferring fatty material to each succeeding zone from the preceding zone under increasing pressures and temperatures, transferring water to each preceding zone from the succeeding zone under decreasing pressures and temperatures, withdrawing water and glycerol from the first zone, and withdrawing fatty acid from the last zone.

4. A method of hydrolyzing fat and oil in a plurality of successive zones comprising supplying fat and oil at a pressure of the order of about 150 to 250 lbs. per sq. inch and at an elevated temperature below that of saturated steam at the said pressure to the first of said zones, supplying water at a pressure of not less than about 500 lbs. per sq. inch to the last of said zones, and at a temperature such that the water in said zone is below that of saturated steam at the said pressure, transferring fatty material to each succeeding zone from the preceding zone under increasing pressures, transferring water to each preceding zone from the succeeding zone under decreasing pressures, withdrawing water and glycerol from the first zone, and withdrawing fatty acid from the last zone.

5. A method of hydrolyzing fat and oil in a plurality of successive vessels comprising forcing fat and oil under pressure into the first of said vessels, heating the fat and oil at least prior to admitting it into the first vessel, forcing water at a higher pressure into the last of said vessels, heating the water at least prior to admitting it into the third vessel to a temperature exceeding that to which the fat and oil is heated, forcing fatty material into each succeeding vessel from the preceding vessel under increasing pressures, permitting water and resulting glycerol to flow from the succeeding vessel into each preceding vessel under decreasing pressures, withdrawing water and glycerol from the first vessel, and withdrawing fatty acids from the last vessel.

6. A method of hydrolyzing fat and oil in a plurality of successive vessels comprising forcing hot fat and oil under pressure into the first of said vessels, forcing water at a higher temperature and pressure into the last of said vessels, forcing fatty material into each succeeding vessel from the preceding vessel under increasing pressures, permitting water and resulting glycerol to flow from the succeeding vessel into each preceding vessel under decreasing pressures, withdrawing water and glycerol from the first vessel, and withdrawing fatty acids from the last vessel.

7. A method of hydrolyzing fat and oil in a plurality of successively smaller vessels connected in series comprising forcing hot fat and oil under pressure into the first of said vessels, forcing water at a higher temperature and pressure into the last of said vessels, forcing fatty material into each succeeding smaller vessel from the preceding larger vessel under increasing pressures, permitting water and resulting glycerol to flow from the succeeding smaller vessel into each preceding larger vessel under decreasing pressures, withdrawing water and glycerol from the first vessel, and withdrawing fatty acids from the last vessel.

8. A method of hydrolyzing fat and oil in a plurality of successively smaller vessels connected in series comprising forcing hot fat and oil under pressure into the first of said vessels maintained at a pressure of the order of 150 to 250 lbs. per sq. inch and an elevated temperature below that at which water in a vapor phase would be formed, forcing water at a higher temperature and pressure into the last of said vessels maintained at a pressure of the order of at least 500 lbs. per sq. inch and a temperature below that at which water in a vapor phase would be formed, forcing fatty material into each succeeding vessel from the preceding vessels under increasing pressures, permitting water and resulting glycerol to flow from

the succeeding vessel into each preceding vessel under decreasing pressures, withdrawing water and glycerol from the first vessel, and withdrawing fatty acid from the last vessel.

9. A method of hydrolyzing fat and oil in a plurality of successively smaller vessels connected in series comprising the steps of forcing hot fat and oil under pressure into the first of said vessels, forcing water at a higher temperature and pressure into the last of said vessels, forcing fatty material into each succeeding smaller vessel from the preceding larger vessel under increasing pressures and temperatures, permitting water and resulting glycerol to flow from the succeeding vessel into each preceding larger vessel under decreasing pressures and temperatures, withdrawing water and glycerol from the first vessel, and withdrawing fatty acid from the last vessel, said steps being carried out at a rate such that a high degree of hydrolysis is obtained in the last vessel.

10. A method of hydrolyzing fat and oil in a plurality of successive vessels comprising forcing hot fat and oil under pressure into the first of said vessels, forcing water at a higher temperature and pressure into the last of said vessels, forcing fatty material into each succeeding vessel from the preceding vessels under increasing pressures, permitting water and resulting glycerol to flow from the succeeding vessel into each preceding vessel under decreasing pressures, agitating the fatty material and water in at least one of said vessels, withdrawing water and glycerol from the first vessel, and withdrawing fatty acid from the last vessel.

11. A method of hydrolyzing fat and oil in a plurality of successively smaller vessels connected in series comprising the steps of pumping fat and oil and admitting it while hot under pressure into the first of said vessels maintained at a pressure of the order of 150 to 250 lbs. per sq. inch and at an elevated temperature but below that at which water in a vapor phase would be formed, pumping water and admitting it at a higher temperature and pressure into the last of said vessels maintained at a pressure of the order of at least 500 lbs. per sq. inch and a temperature below that at which water in a vapor phase would be formed in said vessel, pumping fatty material into each succeeding vessel from the preceding vessels under increasing pressures, permitting water and resulting glycerol to flow from the succeeding vessel into each preceding vessel under decreasing pressures, withdrawing water and glycerol from the first vessel, and withdrawing fatty acids from the last vessel, said steps being carried out intermittently at time intervals of the order of 10 to 30 minutes.

12. A method of hydrolyzing fat and oil in a series of three vessels comprising pumping fat and oil and introducing it while hot under pressure into the first of said vessels, pumping water and introducing it at a higher temperature and pressure into the third of said vessels, pumping fatty material from the first to the second vessel and from the second to the third vessel, transferring water and resulting glycerol from the third vessel to the second vessel and from the second vessel to the first vessel, withdrawing fatty acid from the third vessel, and withdrawing water and glycerol from the first vessel.

13. A method of hydrolyzing fat and oil in a series of three vessels comprising the steps of pumping fat and oil under pressure into the first of said vessels, heating said fat and oil to an elevated temperature at least prior to admitting it to the first vessel, pumping water at a higher pressure into the third of said vessels, heating said water at least prior to admitting it to the third vessel to a temperature higher than that to which the fat and oil are heated, pumping fatty material from the first to the second vessel and from the second to the third vessel, transferring water and resulting glycerol from the third vessel to the second vessel and from the second vessel to the first vessel, withdrawing fatty acid from the third vessel, and withdrawing water and glycerol from the first vessel, said steps being carried out at a rate such that at least 60%, 75% and 90% hydrolysis of the fat and oil is accomplished in the first, second and third vessels, respectively.

14. A method of hydrolyzing fat and oil in a series of three vessels of successively smaller capacity such that the capacity of the first vessel is substantially four times that of the second vessel and substantially twenty times that of the third vessel comprising the steps of pumping fat and oil and introducing it under pressure and at an elevated temperature into the first of said vessels, pumping water and introducing it at a higher temperature and pressure into the third of said vessels, pumping fatty material from the first to the second vessel and from the second to the third vessel under increasing pressures, transferring water and resulting glycerol from the third vessel to the second vessel and from the second vessel to the first vessel under decreasing pressures, withdrawing fatty acid from the third vessel and withdrawing water and glycerol from the first vessel, said steps being carried out at a rate such that at least 70%, 85% and 95% hydrolysis of the fat and oil is accomplished in the first, second and third vessels, respectively.

15. A method of hydrolyzing fat and oil in a series of three vessels comprising the steps of pumping the fatty material under pressure into the first of said vessels, preheating the fatty material at least prior to admitting it to said first vessel, pumping water and preheating it to a relatively high temperature before admitting it into the third of said vessels, pumping fatty material from the first to the second vessel and from the second to the third vessel, transferring water and resulting glycerol from the third vessel to the second vessel and from the second vessel to the first vessel withdrawing fatty acid from the third vessel, and withdrawing water and glycerol from the first vessel, said pumping being carried out at a pressure such that the first vessel will be operated at a pressure of about 150 to 250 lbs. per sq. inch, the second vessel at a pressure of about 350 to 450 lbs. per square inch and the third vessel at a pressure of about 600 to 1000 lbs. per square inch, and said preheating being carried out at a temperature such that the temperature maintained in the autoclaves will approach but be below that at which a water vapor phase is formed.

16. A method of hydrolyzing fat and oil in a series of three vessels of successively smaller capacity comprising the steps of pumping the fat and oil under pressure into the first of said vessels, heating the fat and oil at least prior to admitting it to the first vessel, pumping water into the third of said vessels, heating the water at least prior to admitting it to the third vessel, pumping fatty material from the first to the second vessel and from the second to the third vessel, transferring water and resulting glycerol from

the third vessel to the second vessel and from the second vessel to the first vessel, withdrawing fatty acid from the third vessel, and withdrawing water and glycerol from the first vessel, said pumping being carried out at a pressure such that the first vessel will be operated at a pressure of about 200 lbs. per square inch, the second vessel at a pressure of about 400 lbs. per square inch and the third vessel at a pressure of about 600–1000 lbs. per square inch, and said preheating being carried out at a temperature such that the temperature maintained in the autoclaves will be below that at which a water vapor phase is formed, said steps being carried out at a rate such that at least 70%, 85% and 95% hydrolysis of the fatty material is accomplished in the first, second and third vessels, respectively.

17. A method of hydrolyzing fat and oil in a series of three vessels of successively smaller capacity such that the capacity of the first vessel is substantially four times that of the second vessel and substantially twenty times that of the third vessel, comprising the steps of pumping fat and oil into the first of said vessels, heating the fat and oil at least prior to admitting it to the first vessel, pumping the water into the third of said vessels, heating the water at least prior to admitting it to the third vessel, pumping fatty material including resulting fatty acids from the first to the second vessel and from the second to the third vessel, transferring water and resulting glycerol from the third vessel to the second vessel and from the second vessel to the first vessel agitating the fatty material and water in said vessels, withdrawing fatty acid from the third vessel, and withdrawing water and glycerol from the first vessel, said pumping being carried out at a pressure such that the first vessel will be operated at a pressure of about 200 lbs. per square inch, the second vessel at a pressure of about 400 lbs. per square inch and the third vessel at a pressure of about 600–1000 lbs. per square inch, and said preheating being carried out at a temperature such that the temperature maintained in the autoclaves will be below that at which a water vapor phase is formed.

18. A method of hydrolyzing fat and oil in a series of three vessels of successively smaller capacity such that the capacity of the first vessel is substantially four times that of the second vessel and substantially twenty times that of the third vessel, comprising the steps of pumping the fat and oil into the first of said vessels, heating the fat and oil at least prior to admitting it to the first vessel, pumping the water into the third of said vessels, heating the water at least prior to admitting it to the third vessel, pumping fatty material including resulting fatty acids from the first to the second vessel and from the second to the third vessel, transferring water and resulting glycerol from the third vessel to the second vessel and from the second vessel to the first vessel, withdrawing fatty acid from the third vessel, and withdrawing water and glycerol from the first vessel, said pumping being carried out at a pressure such that the first vessel will be operated at a pressure of about 200 lbs. per square inch, the second vessel at a pressure of about 400 lbs. per square inch and the third vessel at a pressure of about 600–1000 lbs. per square inch, and said preheating being carried out at a temperature such that the temperature maintained in the autoclaves will be below that at which a water vapor phase is formed, said steps being carried out intermittently at time intervals such that at least 70%, 85% and 95% hydrolysis of the fatty material is accomplished in the first, second and third vessels respectively.

19. A method of hydrolyzing fatty material in a system comprising three autoclaves of successively smaller capacity, comprising the steps of introducing water and resulting glycerol from the second autoclave and preheated fatty material to the first autoclave at a resulting temperature of the order of 388° F. and a pressure of the order of 200 lbs. per square inch, transferring water and resulting glycerol from the third autoclave and fatty material from the first autoclave to the second autoclave at a resulting temperature of the order of 448° F. and a pressure of the order of 400 lbs. per square inch, introducing fatty material from the second autoclave and preheated water to the third autoclave at a resulting temperature of about 488° F. and a pressure of the order of 600–800 lbs. per square inch, withdrawing glycerol and water from the first autoclave, and withdrawing fatty acid from the third autoclave, said steps being carried out at intervals such that at least 70%, 85% and 95% hydrolysis of the fatty material is accomplished in the first, second, and third autoclaves, respectively.

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