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Tanaka et al.

[11] **3,817,384**

[45] **June 18, 1974**

[54] **PALM OIL RECIRCULATING SYSTEM FOR COLD-STRIP MILL**

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[73] Assignee: **Kawasaki Steel Corporation,** Kobe City, Japan

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[52] **U.S. Cl.** **210/177,** 210/168, 423/138

[51] **Int. Cl.** **B01d 35/18**

[58] **Field of Search** 210/177, 178, 168; 423/138, 558

[56] **References Cited**

UNITED STATES PATENTS

2,288,333 6/1942 Vinson ..... 210/177 X

2,786,529 3/1957 Parsons ..... 210/177 X

Primary Examiner—Granville Y. Custer, Jr.

Assistant Examiner—DeWalden W. Jones

[57] **ABSTRACT**

A system of recirculating lubricant palm oil in a cold-strip mill, including an iron remover for separating iron from used palm oil by using sulfuric acid and steam available in the mill, which steam provides heat and agitation for separating the iron as iron sulfates. The system also removes fatty acids in the used plam oil by saponifying them, so as to recirculate iron-free and fatty-acid-free palm oil to the cold-strip-mill.

7 Claims, 7 Drawing Figures

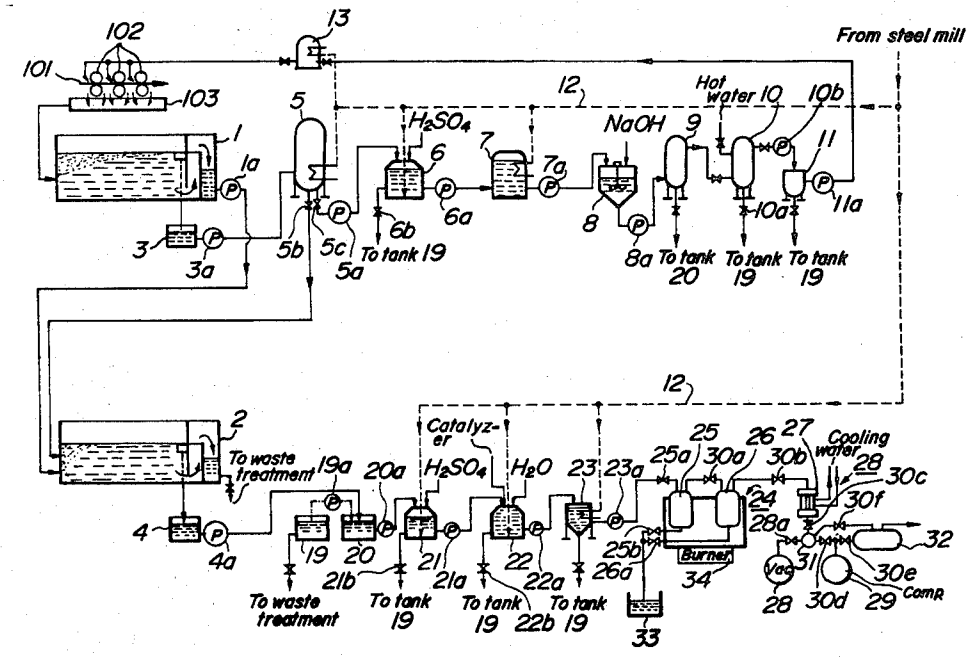


FIG_1

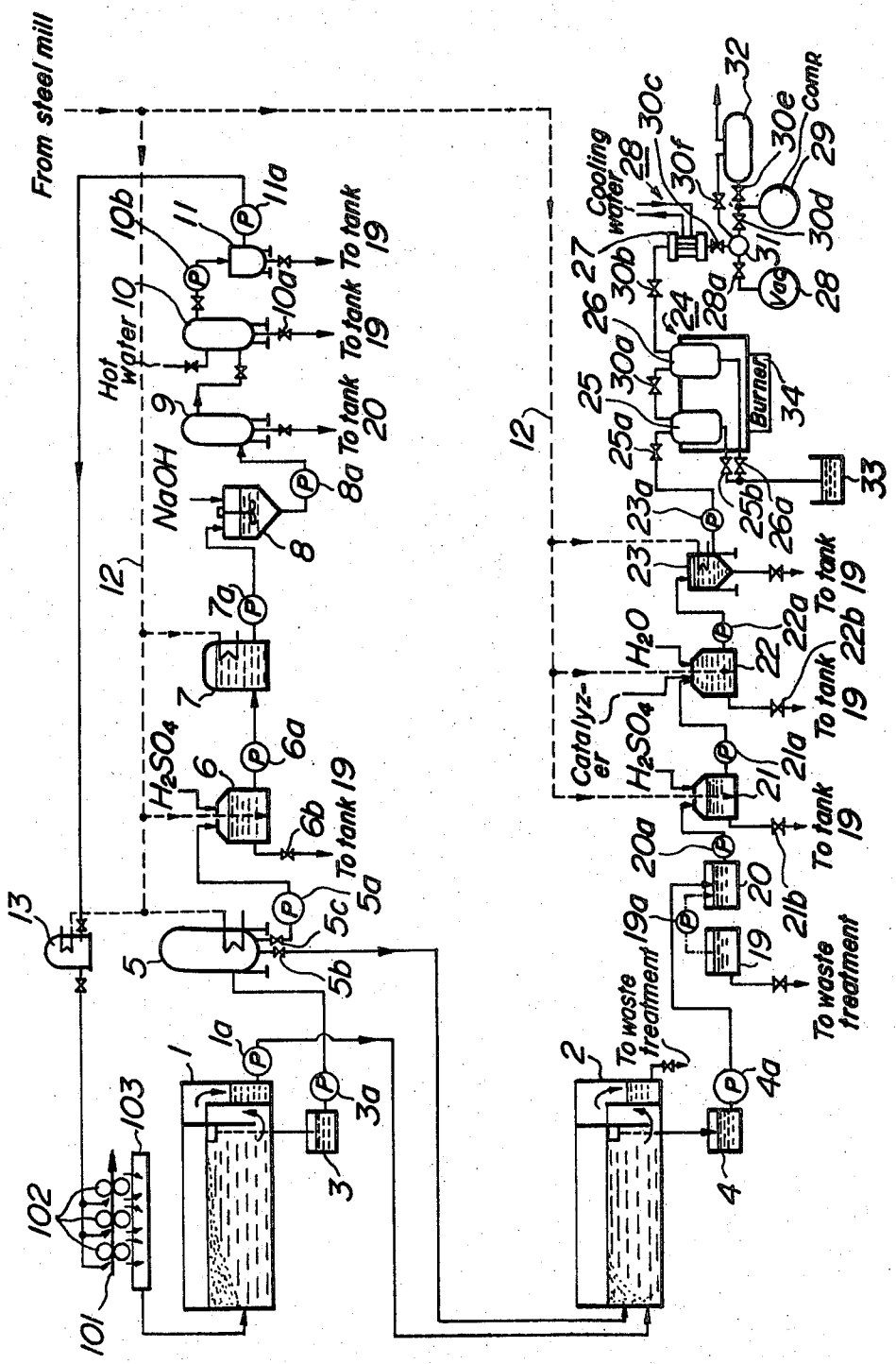

From steel mill
Hot water
NaOH
H_2SO_4
H_2O
Catalyzer
Cooling water
Burner
To tank 19
To tank 20
To waste treatment
Vac
Comp

FIG_2

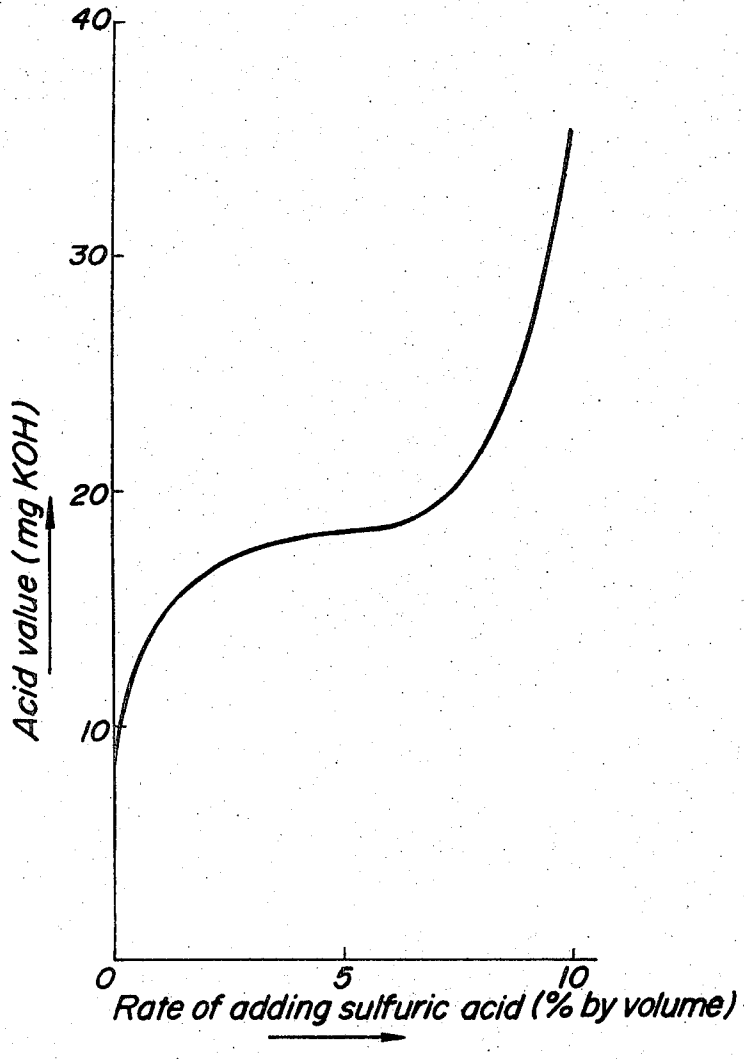

40
30
20
10
Acid value (mg KOH)
0
5
10
Rate of adding sulfuric acid (% by volume)

FIG_3

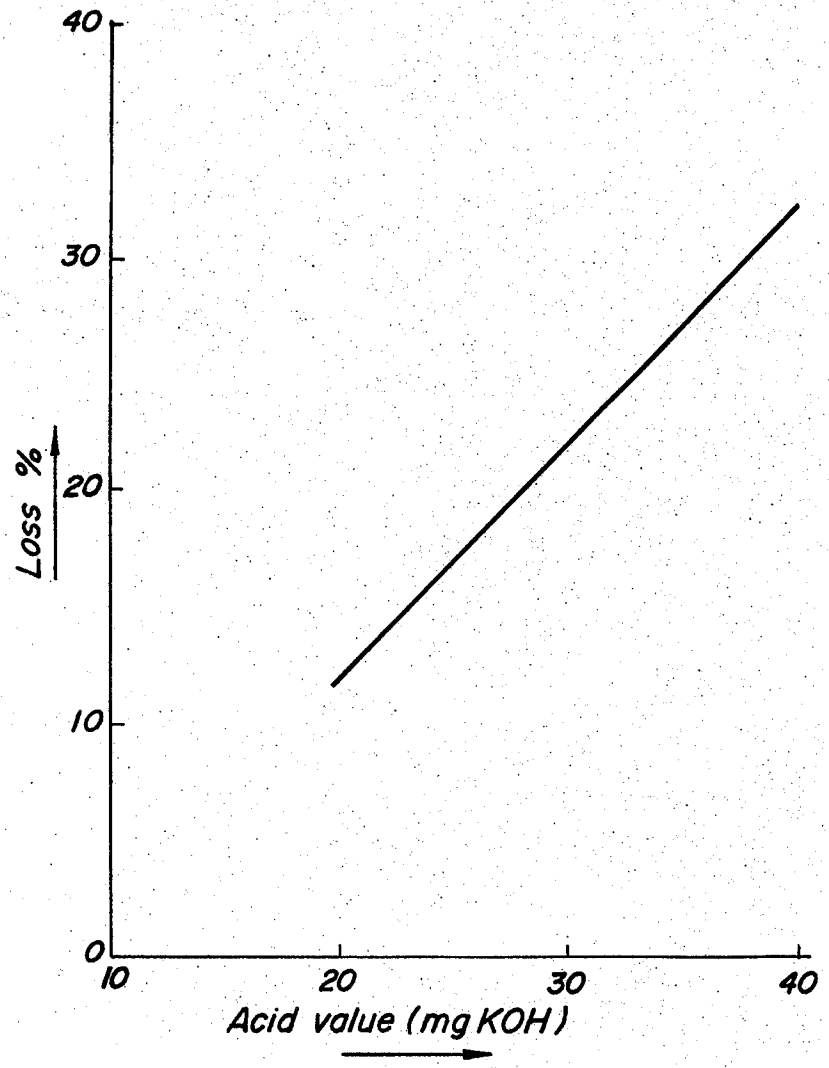


FIG_4

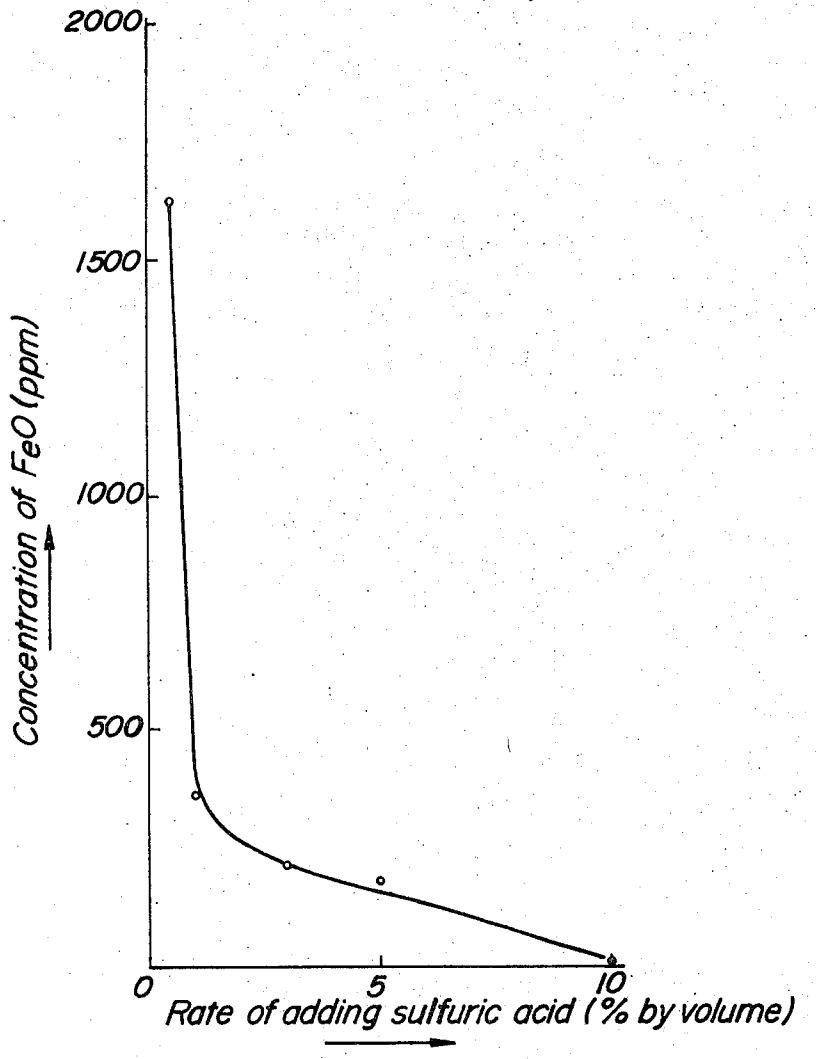

2000
1500
1000
500
0
5
10
Concentration of FeO (ppm)
Rate of adding sulfuric acid (% by volume)

FIG_5

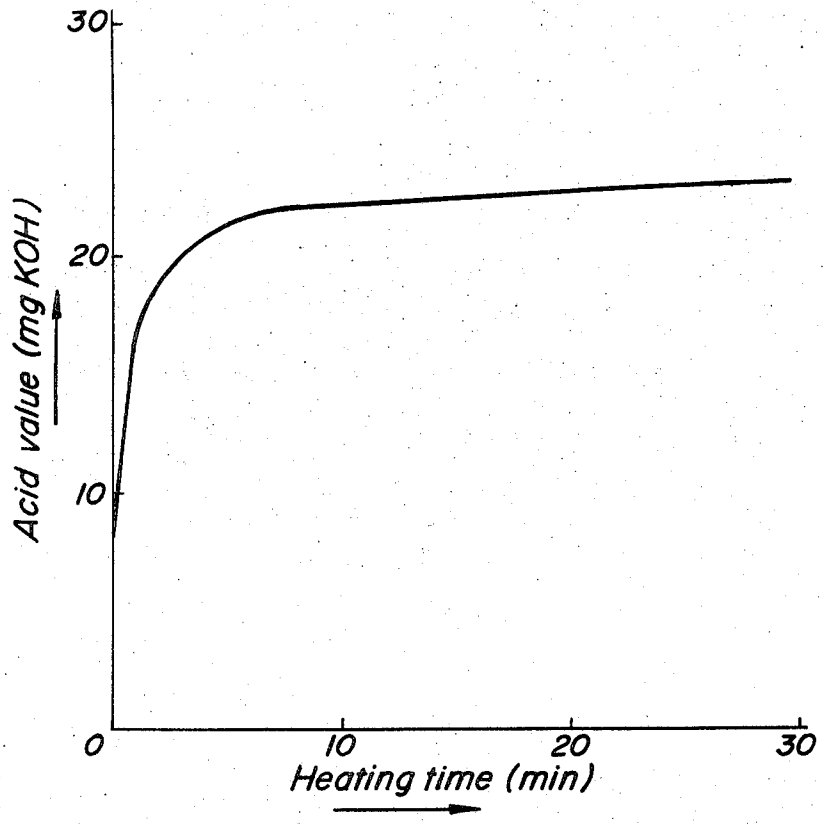


FIG_6

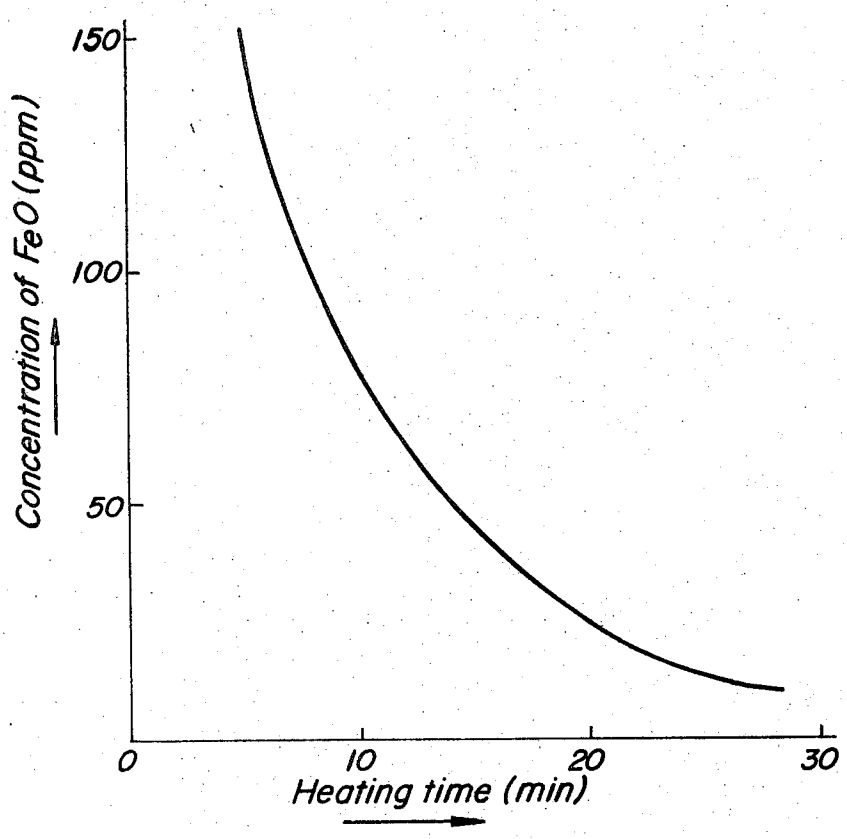
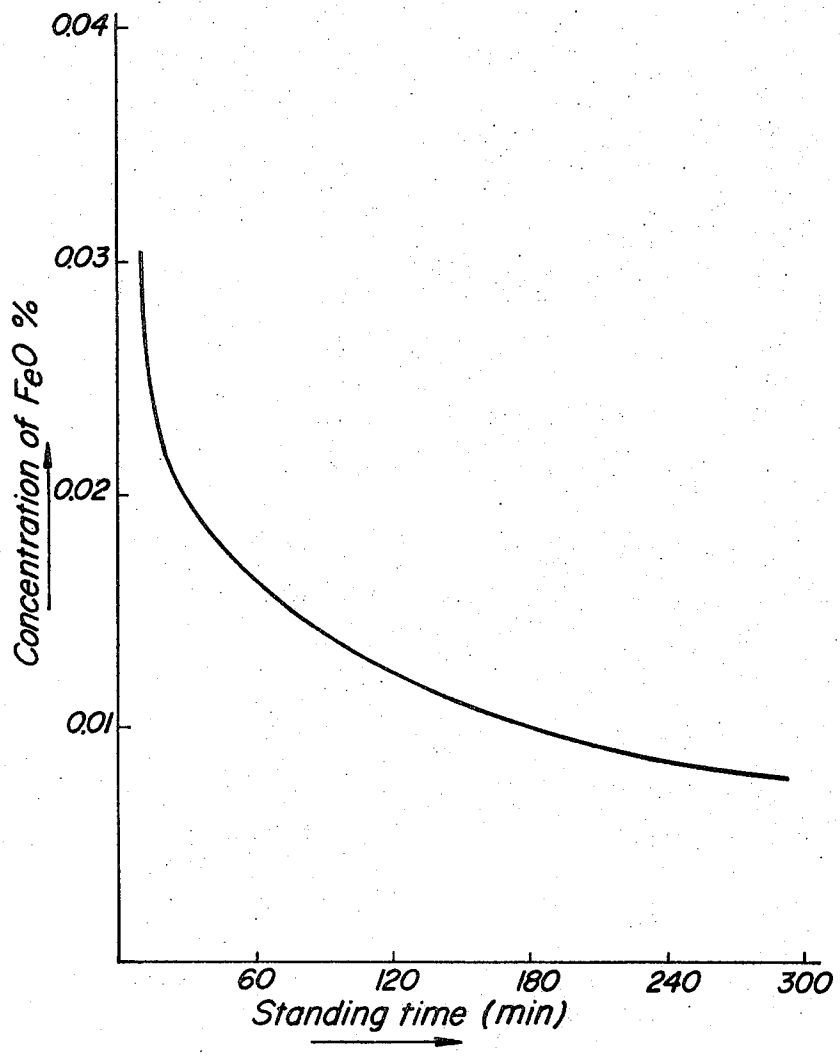

150
100
50
Concentration of FeO (ppm)
0
10
20
30
Heating time (min)

FIG. 7


0.04
0.03
0.02
0.01
Concentration of FeO %
60
120
180
240
300
Standing time (min)

PALM OIL RECIRCULATING SYSTEM FOR COLD-STRIP MILL

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to a system of recirculating palm oil in a cold-strip mill, and more particularly to a system for collecting waste palm oil and recovering reasonably pure palm oil for reuse in the cold-strip mill.

2. Description of the Prior Art

Palm oil has been used as a lubricant in cold-strip mill for making steel sheets, together with cooling water. The lubricating palm oil is collected together with cooling water in an oil cellar after being used, and the palm oil and water thus collected are discarded as waste despite the fact that they still contain a considerably large amount of useful ingredients. Since a sizeable amount of palm oil is used in a modern cold-strip mill, such discarding of palm oil may cause an environmental pollution problem.

To mitigate such difficulty, it has been proposed to regenerate or recover palm oil from the waste in the oil cellar. Because of the large amount of palm oil to be handled, the conventional palm oil recovering process has been costly. With one of known recovering processes, the mixture of the used palm oil and the cooling water from the oil cellar is brought to a skimming tank for standing there for the purpose of separation of the palm oil from the water. The palm oil thus separated in the skimming tank is further treated by a centrifugal separator for removing impurities therefrom. The palm oil from the centrifugal separator is used again in the cold-strip mill for lubrication. Such conventional palm oil recovering process has a number of shortcomings: namely, that the cooling water from the skimming tank contains a comparatively large amount of palm oil, and that the centrifugal separator cannot effectively remove impurities, such as iron particles, oxides of iron, and iron salts of fatty acid, so that such impurities cause plugging of palm oil injection nozzles at the cold-strip mill. The plugging of the nozzles inevitably results in degradation of steel sheets which are made by the cold-strip mill.

Therefore, an object of the present invention is to obviate the aforesaid difficulties of conventional palm oil recirculating process in a cold-strip mill, by providing an improved system for recovering reasonably pure palm oil for recirculation.

SUMMARY OF THE INVENTION

A mixture of lubricating palm oil and cooling water from a cold-strip mill is brought into a skimming tank for separating palm oil from the water. The palm oil thus separated at the skimming tank is chemically treated for removal of iron and iron oxides by adding sulfuric acid therein, decomposing iron salts of fatty acid for removal of iron by the sulfuric acid thus added, removing sulfates thus produced from the palm oil by using difference of specific gravities and difference of water solubility between the sulfates and palm oil. Fatty acids contained in the palm oil are saponified while adjusting acid value thereof by adding sodium hydroxide therein, and sodium salts of carboxylic acids thus formed are removed from the palm oil by using the difference of water solubility between the sodium salts and the palm oil so as to provide reasonably pure fatty acid.

Thus, according to a preferred embodiment of the present invention, there is provided a palm oil recirculation system for cold-strip mill using lubricant palm oil together with cooling water and having a skimming tank for physically separating used palm oil from water, characterized in that the system comprises an iron removing vessel, which receives the used palm oil from the skimming tank and to which sulfuric acid is forced together with steam from the cold-strip mill so as to separate iron in the used palm oil as water soluble iron sulfate, which iron removing vessel has a valve selectively discharging the iron sulfates dissolved therein, a saponifying vessel receiving the palm oil from the iron removing vessel and caustic soda so as to saponify excess fatty acid in the palm oil into foots, a foots separator removing the foots by using difference of specific gravities between the foots and palm oil, and a moisture remover removing moisture from the palm oil so as to ready the palm oil for reuse in the cold-strip mill.

BRIEF DESCRIPTION OF THE DRAWING

For a better understanding of the invention, reference is made to the accompanying drawing, in which:

FIG. 1 is a schematic diagram of a system for recirculating palm oil in cold-strip mill, according to the present invention;

FIG. 2 is a graph, showing the relation between acid value of the palm oil and the rate at which sulfuric acid is added therein;

FIG. 3 is a graph showing the relation between percent loss of the palm oil and acid value of separated palm oil;

FIG. 4 is a graph showing the relation between concentration of FeO in the palm oil after being treated by sulfuric acid and the rate at which sulfuric acid is added therein;

FIG. 5 is a graph showing the variation of acid value of the palm oil as it is heated;

FIG. 6 is a graph showing the variation of the FeO concentration of the palm oil as it is heated; and

FIG. 7 is a graph showing the manner in which the concentration of FeO in palm oil varies as it is left to stand.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to FIG. 1, when a steel sheet **101** is processed through roll stands **102** in a cold-strip mill, palm oil is injected to a cooperating pair of rolls in each stand **102** for lubrication. The lubricant palm oil is collected at an oil cellar **103**. Cooling water, which is injected to the roll stands **102**, is also collected at the oil cellar **103**, so that the liquid in the oil cellar **103** is a mixture of the used palm oil and the used cooling water. This mixture is brought to a skimming tank **1**, so that the comparatively light palm oil is collected at the top surface of fluid in the skimming tank **1**, which is then led to a scum pit **3** through a suitable conduit. Conventionally, the oil collected at the scum pit **3** is discarded or regenerated in a comparatively inefficient manner for reuse in the cold-strip mill. More particularly, when the palm oil from the scum pit **3** is directly discarded, it may cause environmental pollution, while the comparatively inefficient regeneration may cause plugging of the injection nozzles at the cold-strip mill.

The essential object of the present invention is to mitigate the aforesaid difficulties of conventional process. Furthermore, the present invention facilitates recirculation of the palm oil in the cold-strip mill.

After separating the used palm oil, the water from the skimming tank **1** has been discarded. Since this water still contains a certain amount of palm oil, it is preferable to further purify the water before discharging it to the outside of the mill. According to one of preferred embodiments of the present invention, this used water from the skimming tank **1** is also purified by removing residual palm oil and fatty acids therefrom.

According to the present invention, the used palm oil, as recollected at the scum pit **3** is brought to an iron removing vessel **6** for eliminating iron in the used palm oil. The iron in the used palm oil is in the form of small iron particles and in the form of chemical compounds, i.e., iron oxides and iron salt of fatty acid. The used palm oil from the scum pit **3** may be directly delivered to the vessel **6,** but the preferred embodiment, as illustrated in FIG. **1,** uses a settling tank **5** between the scum pit **3** and the vessel **6,** so as to separate solid iron particles and moisture in the tank **5.** A pump **3***a* is provided for facilitating the delivery of the used palm oil from the scum pit **3** to the settling tank **5.**

In the embodiment of FIG. **1,** the settling tank **5** acts to separate water from the used palm oil, based on the difference of specific gravities between them. More particularly, when the used palm oil is left to stand in the tank **5** for a certain period of time, the comparatively heavy water gather at the lower portion of the tank **5,** while the comparatively light palm oil gather at the upper portion thereof. A valve **5***b* is opened to selectively remove water from the tank **5,** for delivering the water to a second skimming tank **2** to be described hereinafter. Upon complete removal of the water, the valve **5***b* is closed and another valve **5***c* is opened and a pump **5***a* is actuated to deliver the used palm oil, whose moisture has been thus removed, to the settling tank **5.**

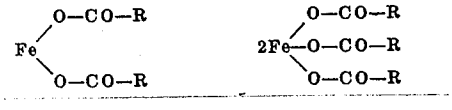
The used palm oil contains iron in the form of pure iron, iron oxides, and iron salts of fatty acid. The formation of iron salts of fatty acid will be briefly reviewed. A part of the palm oil is decomposed during the lubrication of hydrolysis, of which chemical reaction is given by the following equation (1).

$$\begin{array}{l} CH_2{-}O{-}CO{-}R_1 \\ CH{-}O{-}CO{-}R_2 \\ CH_2{-}O{-}CO{-}R_3 \end{array} + 3H_2O \rightarrow \begin{array}{l} CH_2{-}OH \\ CH{-}OH \\ CH_2{-}OH \end{array} + \begin{array}{l} R_1{-}COOH \\ R_2{-}COOH \\ R_3{-}COOH \end{array} \quad (1)$$

(palm oil fat) (water) (glycerine) (fatty acid)

Here, R_1, R_2, and R_3 are alkyl groups.

The fatty acid thus formed easily reacts with free iron which is dissolved in the palm oil during the lubrication, so as to form iron salts of fatty acid of the following structures.



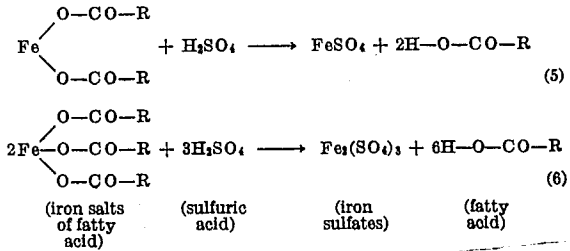
According to the present invention, the iron contained in the used palm oil in the aforesaid forms of free iron, iron oxides, and iron salts of fatty acid is turned into water soluble iron sulfates by adding sulfuric acid therein while heating it. To this end, the used palm oil from the scum pit **3,** or through the settling tank **5,** is delivered into the iron removing vessel **6,** where the used palm oil is mixed with sulfuric acid and heated and agitated by steam from the cold-strip mill. It is a very important factor of the present invention that the heat energy which is necessary for effecting the aforesaid chemical reaction of converting the iron in the used palm oil to the water soluble iron sulfates is provided by steam which is readily available in the cold-strip mill. A steam piping **12** delivers such steam. Accordingly, the system of the present invention does not require any separate heat source, but existing steam source in a cold-strip mill can be used for ensuring the completion of the chemical reaction of the iron sulfates formation. Furthermore, with the present invention, the steam is simply blown into a reaction vessel for the iron removing operation. Whereby, both heating and agitation of the used palm oil can be simultaneously effected by such simple blowing of the steam.

The chemical reaction for producing the iron sulfates from the free iron, iron oxides, and iron salts of fatty acid are as follows.

$$Fe + H_2SO_4 \rightarrow FeSO_4 + H_2 \quad (2)$$

$$FeO + H_2SO_4 \rightarrow FeSO_4 + H_2O \quad (3)$$

$$Fe_2O_3 + 3H_2SO_4 \rightarrow Fe_2(SO_4)_3 + 3H_2O \quad (4)$$



(iron salts of fatty acid) (sulfuric acid) (iron sulfates) (fatty acid)

The iron sulfates thus formed are separated from the palm oil by standing the mixture of the palm oil and the sulfuric acid in the vessel **6,** so as to allow the water in the mixture to be accumulated in the lower part of the vessel **6** due to the difference of specific gravities between the palm oil and water. The water carries the iron sulfates as dissolved therein. Then, a valve **6***b* is opened, so as to deliver only the water to a discharge drain tank **19** to be described hereinafter. It is apparent that the iron sulfates are transferred to a water tank **19** together with the water. Upon removal of the water, the valve **6***b* is closed, and the iron-free palm oil is delivered to a saponifying tank **8** by a pump **6***a*, either directly or through a buffer tank **7.**

To ensure satisfactory reactions in the iron removing vessel **6,** various conditions must be properly selected; namely, the rate of adding sulfuric acid in the used palm oil, the reaction temperature in the vessel, heating time, and the duration of standing the liquid in the vessel. The inventors have carefully studied those conditions.

a. Rate of adding sulfuric acid, and reaction temperature

To find out the proper rate of adding sulfuric acid in the used palm oil, the inventors have carried out tests. Concentrated sulfuric acid with a concentration of about 98% was added in specimens of the used palm oil which consisted of 44% to 60% of palm oil and 40% to 56% of moisture and sludge. The used palm oil with the sulfuric acid was heated at 95° to 100°C for 20 minutes and left to stand for 4 hours. FIG. **2** shows the relation between the rate of adding sulfuric acid by volume and the acid value of the iron-free palm oil to be delivered out of the iron removing vessel **6.** The acid value is expressed in terms of mg of potassium hydroxide which is necessary for neutralizing free fatty acid in the iron-free palm oil. When this acid value is too high, the useful part of the palm oil is excessively decomposed into fatty acids, so that the ultimate yield of the palm oil is impaired, because once the palm oil is decomposed into fatty acids it cannot be regenerated easily. The relation between the yield of the palm oil and the acid value at the output of the iron removing tank **6** is shown in FIG. **3.** The acid value in the abscissa of FIG. **3** corresponds to the aforesaid acid value of the iron-free palm oil. The loss, as shown in the ordinate of FIG. **3,** is as follows.

$$\text{Loss} = X - X_1/X \times 100 \quad (7)$$

Here,

X: concentration of pure palm oil in the input to the iron removing vessel 6 (g/lit.)

X_1: that part of the concentration X which is ultimately delivered from a moisture remover **11** to a palm oil tank **13.**

More particularly, when the acid value of the iron-free palm oil from the vessel **6** is about 20 mg KOH, the loss is about 11%, namely, about 89% of palm oil in the input to the vessel **6** can be recovered and returned to the palm oil tank **13.** The inventors have found out that, to minimize the loss of palm oil for improving the yield of the regenerated palm oil, the rate of adding the concentrated sulfuric acid is preferably less than 5% by volume. The present invention is not restricted to such rate of adding sulfuric acid, because the properties and conditions of the input palm oil to the iron removing vessel **6** varies greatly, depending on how the palm oil is used in the cold-strip mill.

If the aforesaid concentrated sulfuric acid is used, it is preferable to add more than 1% by volume of the concentrated sulfuric acid in the used palm oil, because, for the purpose of iron oxide removal, less than 1% by volume of sulfuric acid is not so effective, as shown in FIG. **4.** However, the present invention is not restricted by such minimum rate of adding sulfuric acid.

The inventors' tests also indicated that the preferable temperature in the iron removing vessel **6** is between 95° and 100°C. The removal of iron is, however, possible even outside of such temperature range.

b. Heating time

Tests were made by adding 3% by volume of sulfuric acid into specimens taken from the input to the iron removing vessel **6,** heating the mixtures thus prepared for different periods of time, leaving them to stand for 4 hours, and separating the iron-free palm oil from the water in the aforesaid manner. FIGS. **5** and **6** show the result of the tests; namely, FIG. **5** illustrates the relation between the heating time and the acid value of the output iron-free palm oil from the vessel **6,** while FIG. **6** illustrates the relation between the heating time and the concentration of FeO in the iron-free palm oil.

As can be seen from FIGS. **5** and **6,** in the case of the subject example, the preferable heating time is between **10** minutes to **20** minutes. Such numerical example, however, does not restrict the scope of the present invention.

c. Standing time

Specimens of the used palm oil were allowed to stand for different time periods, after being added with 3% by volume of sulfuric acid therein and being heated and agitated at 95° to 100°C for 20 minutes. After separating iron-carrying water from the palm oil in the aforesaid manner, the concentrations of FeO in the specimens were measured. The result is shown in FIG. **7.** In this case, the standing time of 4 hours was sufficient for substantially removing FeO from the palm oil.

Judging from the foregoing equations (1) to (6), the iron-free palm oil from the iron removing vessel **6** contains a considerably large amount of fatty acids. Therefore, it is necessary to remove the fatty acid therefrom, so as to provide fairly pure palm oil which is suitable for lubrication in the cold-strip mill. The inventors have found out that the removal of the fatty acids can be advantageously effected by saponifying them by addition of sodium hydroxide therein. In the embodiment, as illustrated in FIG. **1,** the iron free palm oil from the vessel **6** is once accumulated in a buffer tank **7,** and then forwarded to a saponifying vessel **8** by a pump **7***a*. The buffer tank **7** is just for temporary storage, and not essential in the present invention. The chemical reaction in the saponifying vessel **8** is as follows.

$$\underset{\text{(fatty acid)}}{H-O-CO-R} + \underset{\text{(sodium hydroxide)}}{NaOH} \rightarrow \underset{\text{(sodium salt of carboxylic acid)}}{Na-O-CO-R} + H_2O \quad (8)$$

The rate of adding sodium hydroxide depends on the concentration of fatty acid in the iron-free palm oil. Excess sodium hydroxide spoils the palm oil itself, so that due care must be taken not to excessively add sodium hydroxide. In an embodiment of the present invention, the inventors have found out that the addition of sodium hydroxide in the iron-free palm oil at a rate of 10% and stirring the mixture thus formed at 60°C proved to be satisfactory. This rate of sodium hydroxide coincides with the amount of it which is theoretically required for the saponification of the fatty acid in the iron-free palm oil.

The saponified palm oil from the vessel **8** contains sodium salt of carboxylic acid, which is generally referred to as foots. To refine the saponified palm oil, the output from the vessel **8** is forwarded to a foots separator **10** by a pump **8***a*, either directly or through another settling tank **9.** The output from the foots separator **10** is forced to a moisture remover **11.** The settling tank **9** partly removes the foots from the palm oil before forwarding it to the moisture remover **11,** but such settling tank is not essential in the present invention.

In the foots separator **10,** the foots, i.e. sodium salts of carboxylic acid, are dissolved in hot water which is separately forced therein. The hot water carrying the foots is selectively discharged to the drain water tank **19** through a valve **10***a*. After draining the hot water, the palm oil is forwarded to the moisture remover **11**

by another pump **10***b*. The moisture remover **11** is, for instance a centrifugal separator or a kind of ion exchanger or any other suitable moisture removing device, so that moisture in the palm oil is removed.

The output palm oil from the moisture remover **11** is delivered to an oil tank **13,** from which the palm oil is dispatched to injection nozzles for lubricating the roll stands **102** for rolling steel sheets **101.** Thus, the recirculation of the palm oil is completed. With the system according to the present invention, iron contained in the used palm oil, which is inevitable as long as it is used for lubricating the iron rolling process at the rolling stands **102,** is almost completely removed before reusing it. Whereby, the risk of hardening of the palm oil and plugging of palm oil injection nozzles can be completely eliminated. In the embodiment of FIG. **1,** steam heaters are provided in the settling tank **5,** the buffer tank **7,** and the palm oil tank **13,** for keeping the viscosity of the palm oil in a preferable range.

According to another embodiment, fatty acids contained in the used palm oil is recovered, so as to produce marketable fatty acids. By recovering fatty acids, the risk of environmental pollution by the fatty acids contained in the waste water is diminished. At the same time, the economy of the palm oil recirculating system for the cold-strip mill is noticeably improved by the by-products which are marketable.

Referring to FIG. **1,** the residual water from the skimming tank **1** is re-skimmed in another skimming tank **2.** The skimming tank **2** also receives palm oil containing water from the settling tank **5,** in case such settling tank is used. The palm oil in the skimming tank **2** is collected by using the difference of specific gravities between the water and the palm oil. The palm oil is collected in another scum pit **4,** while the water from the skimming tank **2** is forwarded to a waste treating unit. Since the palm oil from the cold-strip mill is skimmed in two stages, the risk of environmental pollution is greatly diminished.

The reused palm oil is forwarded from the scum pit **4** to the discharge oil tank **20** by a pump **4***a* and further forwarded to a reaction vessel **21.** Residual palm oil and residual saponified fatty acids in the drain water tank **19** are also forwarded to the reaction vessel **21** through the tank **20.** The reaction vessel **21** also receives sulfuric acid and steam, so as to effect iron separation according to the equations (2) to (6) and decomposition of sodium salts of carboxylic acid of equation (8) into fatty acids. The iron is selectively removed from the reaction vessel **21** by selectively opening and closing a valve **21***b*, in the same manner as the valve **6***b* of the iron removing vessel **6.** The output from the vessel **21** is forwarded into a decomposing vessel **22** by a pump **21***a*. Steam and water are forced into the decomposing vessel **22,** so as to carry out the decomposition of the used or soiled palm oil into fatty acid, according to the equation (1). To accelerate the decomposition or hydrolysis, a small amount of sulfuric acid or other suitable catalyzer may be added in the vessel **22.** Moisture in the decomposing vessel **22** is removed by selectively actuating the valve **22***b*. After removing the water, the mixture of glycerine and fatty acid is forwarded to a temporary storage tank **23** by a pump **22***a*, and further transferred to a distilling unit **24.** After loading a preheating oven **25** of the unit **24** to a proper level, a valve **25***a* is closed.

The distilling unit **24** includes a burner **34,** which heats up the preheating oven **25,** wherein the mixture of the glycerine and fatty acids is heated, as pointed out above. The preheated mixture is transferred to a distillation still **26** of the unit **24** and a valve **30***a* is closed. After the contents of the still **26** is heated, a vacuum pressure is applied thereto from a vacuum pump **28** through a valve **28***a*, a fatty acid receiver **31,** a valve **30***c*, a condenser **27,** and another valve **30***b*. Thereby, fatty acid in the distillation still is suddenly evaporated and pulled toward the condenser **27,** where cooling water from piping **28** acts to condensate the fatty acid. Whereby, liquefied fatty acid is collected in the receiver **31.** After a certain amount of the fatty acid is accumulated in the receiver **31,** the valves **28***a* and **30***c* are closed while opening valves **30***d* and **30***f*, and a pneumatic pressure is applied to the receiver **31** from a compressor **29,** so as to transfer the fatty acid to a tank **32.** To deliver the fatty acid from the tank **32,** the valves **30***d* and **30***f* are closed and the valve **30***e* is opened for applying the pneumatic pressure to the tank **32.** The residual glycerine from the preheating tank **25** and the distillation still **26** is drained to a glycerine tank **33,** by properly operating valves **25***b* and **26***a*.

The use of the line for producing the by-product of fatty acids results in the following advantages.

1. The discharge water from the skimming tank **1** is further cleansed for preventing environmental pollution.
2. The construction and operation of the reaction vessel **21** is similar to those of the iron removing vessel **6,** so that the entire system can be constructed and operated in an economical fashion.
3. Fatty acids produced in the palm oil regenerating process can be effectively utilized, e.g., for production of grease and soap.

The palm oil which is regenerated from the used palm oil in a cold-strip mill by a system according to the present invention is of high quality, which is comparable with that of fresh palm oil. Physical and chemical properties of an example of the regenerated palm oil, which is prepared by the system according to the present invention, is shown in Table 1, in comparison with the corresponding properties of fresh palm oil.

TABLE 1

Item	Fresh palm oil	Regenerated palm oil
Acid value (mg KOH)	10±5	max 15
Saponification value (mg KOH)	200±5	min 180
Iodine value (g I)	50±10	50±10
FeO (% by weight)	—	max 0.05
Demulsification* (20 seconds)	—	5'00''~8'00''
Moisture (% by weight)	max 0.5	max 0.5
Unsaponifiable matter (% by weight)	max 3.0	max 3.0
Viscosity (C.St. at 50°C)	28±4	28±4
Melting point (°C)	38±5	38±5

* Demulsification was determined by the method of JIS K 2517.

The specimen of the regenerated palm oil of Table 1 also proved to be substantially free from fatty acids, which had been a cause of troubles in reusing the lubricant palm oil in the cold-strip mill. Thus, the system of the present invention provides an economical way of recirculating palm oil in a cold-strip mill, while dimin-

ishing the risk of environmental pollution due to direct disposal of used palm oil.

Furthermore, with the present invention, it is also possible to include an optional means for recollecting fatty acid in parallel with the regeneration of the lubricating palm oil. The fatty acid thus recollected is of such quality that they are marketable for the production of grease and soap. Consequently, the construction cost and running cost of the overall system for the regeneration and recirculation of the lubricating palm oil can be minimized.

Although the present invention has been described by referring to a preferred embodiment, it is possible to modify the illustrated embodiment of the system, without departing from the scope of the present invention. For instance, the process which is embodied in the illustrated example of recirculating palm oil in a cold-strip mill can be also applied to recirculation of palm oil in other kind of plant wherein the palm oil is used as a lubricant together with cooling water. In the latter case, the palm oil may partly react with a metal with which the palm oil contacts during the lubrication. The present invention provides a system for separating the metal from the used palm oil containing the compound between the palm oil and such metal by using a suitable acid while heating and agitating the acid-palm oil mixture. In the case of application to a cold-strip mill of steel, the metal is iron and the acid is sulfuric acid.

We claim:

1. A palm oil recirculating system in a plant using lubricant palm oil together with cooling water and having a skimming tank for physically separating used palm oil from water, characterized in that the system comprises a metal removing vessel, which receives the used palm oil from the skimming tank and to which an acid is forced while heating and agitating the metal removing vessel so as to separate metal in the used palm oil as water soluble metal sulfate, which metal removing vessel has a valve selectively discharging water carrying the metal sulfates dissolved therein, a saponifying vessel receiving the palm oil from the metal removing vessel and caustic soda so as to saponify excess fatty acid in the palm oil into foots, a foots separator removing the foots by using difference of water solubilities between the foots and palm oil, and a moisture remover removing moisture from the palm oil so as to ready the palm oil for reuse in the plant.

2. A palm oil recirculating system for cold-strip mill using lubricant palm oil together with cooling water and having a skimming tank for physically separating used palm oil from water, characterized in that the system comprises an iron removing vessel, which receives the used palm oil from the skimming tank and to which sulfuric acid is forced together with steam from the cold-strip mill so as to separate iron in the used palm oil as water soluble iron sulfate, which iron removing vessel has a valve selectively discharging water carrying the iron sulfates dissolved therein, a saponifying vessel receiving the palm oil from the iron removing vessel and caustic soda so as to saponify excess fatty acid in the palm oil into foots, a foots separator removing the foots by using difference of hot water solubilities between the foots and palm oil, and a moisture remover removing moisture from the palm oil so as to ready the palm oil for reuse in the cold-strip mill.

3. A palm oil recirculating system according to claim **2**, characterized in that the system further includes a reaction vessel which receives sulfuric acid, steam from the mill, and discharge waters from the skimming tank, the iron removing vessel, the foots separator, and the moisture remover so as to separate iron from the discharge waters as water soluble iron sulfates while heating and agitating the waters by the steam, which reaction vessel also decomposes the saponified fatty acids in the discharge waters by the sulfuric acid, which reaction vessel has a valve selectively discharging iron-containing water therefrom, a decomposing vessel which receives the output from the reaction vessel and fresh water for decomposing residual palm oil in the output from the reaction vessel into glycerine and fatty acids, said decomposing vessel having a valve selectively discharging water therefrom, and a distilling unit which distills the fatty acids from the glycerine.

4. A palm oil recirculating system according to claim **2**, characterized in that a settling tank is disposed between the skimming tank and the iron removing vessel, so as to remove water from the used palm oil before delivering it to the iron removing vessel.

5. A palm oil recirculating system according to claim **2**, characterized in that another settling tank is disposed between the saponifying vessel and the foots separator, so as to remove water from the output from the saponifying vessel before delivering it to the foots separator, based on the difference of water solubilities between the foots and palm oil.

6. A palm oil recirculating system according to claim **2**, characterized in that a temporary storage tank is disposed between the iron removing vessel and the saponifying vessel, so as to continuously feed the iron-free palm oil from the temporary storage tank to the saponifying vessel.

7. A palm oil recirculating system according to claim **3**, characterized in that another skimming tank is provided between the first skimming tank and the reaction vessel, so as to further recollect palm oil from the discharge water of the first skimming tank.

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