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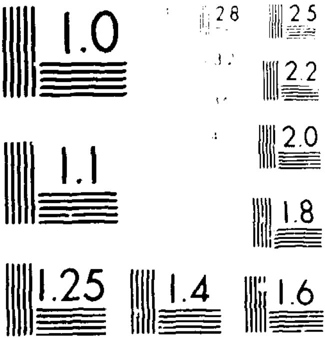
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UNITED NATIONS
INDUSTRIAL DEVELOPMENT ORGANIZATION

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ESTABLISHMENT OF A
COCONUT PROCESSING TECHNOLOGY CONSULTANCY SERVICE
UF/PAS/78/049

ASIAN AND PACIFIC COCONUT COMMUNITY

COCONUT PROCESSING TECHNOLOGY INFORMATION DOCUMENTS

PART 3 OF 7

"Coconut Oil Refining and Modification"*

Based on the work of T. K. G. Ranasinghe
in co-operation with representatives of the coconut processing industry
of the Asian and Pacific Coconut Community and individual international experts

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PREFACE

A valid criticism against the poor performance of many agricultural extension services in coconut producing countries is that the services do not have or know what to "extend". A similar analogy can be applied to a consultancy service on coconut processing technology.

"Registering" coconut processes applied in the APCC countries, may be a simple achievement and considered unimportant, when one views the deluge of impressively formulated and identified objectives and programmes pouring out of international agencies and institutions. The fact is, that the disappointments from two UN Development Decades, could be traced to the failure to execute the basic "Home Work" essential for achieving the ultimate objectives.

UNIDO, which concieved and supervised the execution of this project, rightfully owns the entire credit for an important programme of meaningful benefits to APCC and APCC member countries. UNIDO has provided APCC with a firm basis from which APCC must now build and develop an essential service to those countries and individuals reliant on the coconut for their economic survival.

Godofredo P Reyes Jr
Director

13 June 1980.-

INTRODUCTION

The United Nations Industrial Development Organisation, Vienna, funded and executed this project "Establishment of Coconut Processing Technology Consultancy Service" for the Asian and Pacific Coconut Community based in Jakarta. The project was initiated in 1978 and completed within 18 months.

Coconut Processes, commercial and household, applied in the APCC member countries were documented in individual technology sheets by Consultants for specialised areas and by the Project Manager/Coconut Processing Technologist. Each technology sheet carries a product code, based on the Customs Cooperation Council Nomenclature (CCCN) which has replaced the Brussels Tariff Nomenclature (BTN). This facilitates easy reference to determine import or export duties, freight rates, etc, as well as coding for library systems. Where there are co-products or by-products in a process, only the main product has been taken into consideration for coding.

The immediate objective of the project is to make the technology sheets available to all concerned as a "Consultancy Service" in the framework of technical cooperation among developing countries and others interested in improving the coconut processing discipline.

The technology documented is not only on major commercial processes but also on the hitherto, somewhat neglected, rural and household processes. These processes offer a large scope for further development with appropriate and suitably scaled technology, in order to bring about the commercialisation of new or improved products.

The development of the Coconut Processing Sector through technical cooperation in existing commercial processes and the improvement of rural and household products, could mean higher incomes and better living conditions for several hundred million people living in the coconut areas of the world.

ACKNOWLEDGEMENT

The kind assistance and co-operation rendered by the counterparts, the national collaborating agencies and the excellent services given by the APCC Secretariat are gratefully acknowledged.

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANISATION

AND ASIAN & PACIFIC COCONUT COMMUNITY

"Consultancy Service on Coconut Processing Technology"

(Project UF/RAS/78/049)

This document is one of VII parts: -

PART I	COCONUT HARVESTING AND COPRA MANUFACTURE
PART II	COCONUT OIL EXTRACTION
PART III	COCONUT OIL REFINING AND MODIFICATION
PART IV	DESICCATED COCONUT MANUFACTURE
PART V	DOMESTIC COCONUT FOOD PROCESSES
PART VI	COCONUT COIR FIBRE AND PRODUCTS
PART VII	COCONUT SHELL PRODUCTS AND OTHER PROCESSES

These Technology sheets have been prepared by :-

P.C. Catanaoan, UNIDO Consultant on oil extraction

H.B.W. Patterson, UNIDO Consultant on oil refining

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T.K.G. Ranasinghe, UNIDO Project Manager/Coconut Processing Technologist.

1979/1980

Consultancy Service on Coconut Processing Technology

UNIDO/APCC Project UF/RAS/78/049

PART III

COCONUT OIL REFINING AND MODIFICATION

List of Technology sheets

Product code: CCCN 15.071

Technology sheet no. III/I

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION

AND ASIAN & PACIFIC COCONUT COMMUNITY

"Consultancy Service on Coconut Processing Technology"

(Project UF/RAS/78/049)

1. Technology sheet for : BATCH NEUTRALIZATION/WASHING/DRYING/ BLEACHING.

The above steps are commonly understood to be included in "refining"; where deodorisation is included the oil is described as "refined and deodorised", or by some as "fully refined". American practice commonly takes deodorisation to be included in the description "refined". Where a crude oil with a fairly high FFA of several percent has been given a preliminary neutralization, washing, and drying and probably bleaching so as to bring the FFA well below 1%, it is sometimes referred to as "washed" oil, e.g. "washed cottonseed oil", max. FFA 0.3%.

2. Uses of Coconut Oil

Gives quick melting effect when used in margarine and confectionery of the temperate zones. Promotes quick lather in soap. A stable cooking oil. Used directly as hair oil and starting point for production of shampoos and chemical derivatives of the lauric acid group. A stable medium in which to pack active nickel catalyst for use in the hydrogenation of other oils. Can be hydrogenated or interesterified with hardened oils or the stearin fraction of other fractionated oils to give products for tropical use with the necessary steep dilatation curve, i.e. soft solids at 30-35°C completely melted at 36° - 38°C.

3. Country of origin: -

Coconut oil refining is now carried out in all the Asian member countries of the APCC. The technology has been obtained from plant manufacturers in various parts of the world. See section 7 for partial list of names and addresses.

4. Equipment: -

4.1 Description of Equipment

The batch operations of neutralising, washing, drying and bleaching are normally performed in sequence in the one vessel, a neutralizer/bleacher. This is a closed vessel to which vacuum maybe applied to assist the drying operation. In older factories the neutralizing and washing may be performed in an open cylindrical "pan" or "kettle" and then the oil pumped to a closed vessel for drying and bleaching. Where the drying/bleaching/filtering cycle is much shorter than the neutralizing/washing cycle it may be possible to have one bleacher serving two neutralizers, but this arrangement is no longer popular in modern plants.

At Fig. I is a sketch of a neutralizer/bleacher showing the important basic features. The cyclindrical vessel is closed by slightly curved dome at the top and by an inverted cone (apex angle 90^{o}) at the bottom. When filled with oil to the working level the depth in the straight walled section is approximately equal to the diameter of the vessel.

TABLE I

Working capacity (metric tons)	Diameter (metres)	Straight wall height (metres)
10	2	3
20	3	4.5
30	3.5	5

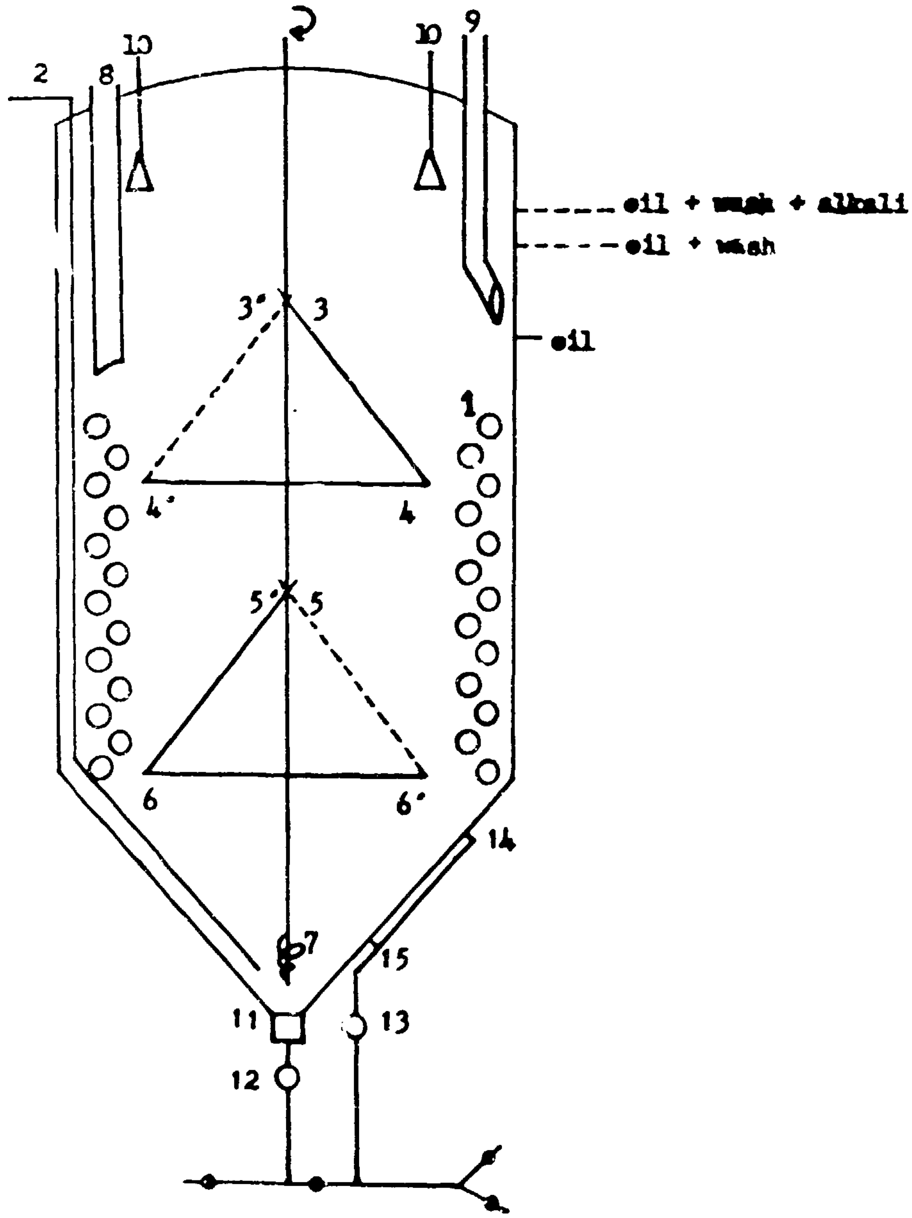
4.1.1. Heating / Cooling

A double helix of coil (1) 50–75 mm diam. (a few indicated in sketch) so as to afford up to 3 sq.m. coil surface per ton oil will enable the charge of oil to be heated at about 2^{o}C rise in temp. per minute if the steam pressure is 12 atms. If the coil length exceeds 800 times the diameter, it may have an advantage to design it in two lengths so as to reduce the risk of becoming waterlogged.

Fig. I

Batch Neutraliser Bleacher

(Not to Scale)



1. Heating/ Cooling coils
2. Open steam
3.3'; 4.4'; 5.5'; 6.6' Stirrer-arms
7. Helical stirrer
8. Bleaching earth/ carbon
9. Crude oil
10. Caustic soda/ water
11. Exit valve
12. 13. Sight glass
14. 15. Sampler

A pipe for the introduction of open steam (2) is often provided for use in certain types of final degumming operation but this is most unlikely to be needed for coconut oil.

4.1.2 Agitation

Two large stirring frames are fitted to the central shaft and are made from mild steel strips about 75 mm wide and a approximately 0.66 of the vessel diameter in length. The upper horizontal arm 3-3' is vertical to the plane of the paper in Fig. I (the point 3' lies below the plane of the paper) and the lower horizontal arm 4-4' lies in the plane of the paper as shown.

Viewed from above, rotation is clockwise. The arms incline forwards at 45^{o} to the vertical, so that as they move forwards they push downwards. Agitation is further assisted if the extreme end 3 of the upper arm is connected to the end 4 of the lower arm which is behind it (in clockwise rotation) by a curved 75 mm strip, shown as 3 - 4; like wise 3' - 4', all increasing downward push.

The stirrer indicated by arms 5-5' and 6-6' has all its arms inclined backwards at 45^{o} to the vertical, hence this time they push upwards; 5' is connected forwards to 6' and 5 forwards to 6 so these push up. A distance of at least 250 mm. separates 4'-4 from 5-5'. A small helical stirrer (7) is situated as shown 250 mm below 6-6' so as to disturb sediment collected near the outlet.

Two stirring speeds are sufficient, 40 and 20 rpm. The ratio of power to oil capacity is 1 HP per ton. A pipe (8) about 100 mm diam. is provided for the addition of earth when vacuum is applied inside the neutralizer and dips below the oil level so that clouds of earth are discouraged from flying into the vacuum connected in the dome. Even so the entrance to this vacuum pipe will need to be cleaned once or twice a year to keep it completely clear. Another pipe (9) about 75 diam. permits oil to be pumped into the neutralizer and directs the flow gently against the wall so as to minimize aeration due to splashing. At (10) are illustrated two of the several caustic soda solution or water wash addition points. A length of 20 mm diam. pipe terminates in a 10 mm diam. nozzle situated 120 mm above a horizontal splash plate. When liquid is pumped down the pipe it strikes the splash plate with such force that it is dispersed as a spray over the surface of the oil below. The distance between the plate and the highest level attained in the neutralizer by oil + alkali + wash should not be less than 300 mm. Each pipe (10) is connected to a ring pipe immediately above the dome and through which reagent liquids (caustic soda) or wash water are supplied. A small aperture is made on the top surface of the ring pipe immediately above the exit to the 20 mm pipe so that the latter and its nozzle may easily be cleaned at any time by insertion of a thin rod. This cleaning aperture is normally closed by a small screw plug, The number of spray points depends upon the size of the oil surface, but if their number is equal to the number of sq. meters in the surface and they are equally spaced on the ring about 2/3 of the radius of the vessel from the centre (Fig. I) this will be satisfactory.

At the bottom of the cone is a 75 mm bore valve (11) below which is a sight glass through which the flow of wash, emulsion, soap or oil may be observed when valve (11) is opened. A light of suitable power is placed behind the sight glass to make changes in the translucence of the liquor flow easily seen. As an advance warning system two 20 mm cocks at (14) and (15) enable sample flows to be fed to a smaller sight glass (13). The end of the soapstock/wash layer and the beginning of the oil can be detected in advance of the oil reaching the exit value (11). These cocks are manipulated by spindle rods easily reached by the refinery operator as he simultaneously controls the flow through valve (11). Provision should also be made for flushing through the entire sampling/inspection system with hot water to keep it clear

Below the neutralizer an arrangement of valves enables oil to be run in one direction and soapstock, emulsion or wash in the other. These last three may be further divided as indicated in Fig. I.

Not illustrated in Fig. I but located on the dome of the neutralizer are:

Vacuum connection
light glass) situated adjacent
sight glass) to one another to simplify
manhole) cleaning of first two
safety valve
bursting disc
vent pipe (75 mm diam.) to atmosphere.

Since the neutralizer/bleacher is required at times to work under vacuum it will have to be tested to an over pressure of at least 2 atms.

4.2 Material of construction. Mild steel.

4.3 Cost

10 tons capacity	20,000 US$
20 " "	32,000 "
30 " "	41,600 "

For installation on a prepared site add 20%.

4.4 Capacity

Physical or geometric capacity - as given
Working capacity - take 80% utilization throughout a working year of (say) 250 days - 300 days according to local custom.

5. <u>Process</u>

The oil should be well settled in a store tank to allow excess moisture and dirt to settle. Three weeks will achieve this effect, then water may be drained from the store tank and the oil withdrawn from a point 0.3 - 0.5m above the floor. Where a batch of oil is unusually dirty some refiners have the facility for passing it first through a filled filter containing residue from the bleaching process.

This displaces some good bleached oil in the filter back into process and exerts some cleaning effect on the crude oil. If this were to be a regular practice some additional filter capacity would have to be provided.

As has been stated earlier no specific degumming step is required for lauric oils including coconut oil.

5.1 Neutralisation/washing/drying

Description of Process

From a previous test the FFA% of the coconut oil, will be known; the batch size of oil to be neutralized will be known also. hence the litres of caustic soda solution to be added can be calculated and is usually obtained from a table of such data kept in the refinery. Coconut oil is not difficult to refine. For oil of low FFA%, say below 3%, caustic soda solution of 1 Normality may be used directly, but for oil of 3-6% FFA a stronger caustic soda, 3N, is often found preferable and just before it is added to the oil a quantity of hot water is mixed into the oil equal to twice the volume of 3N. caustic soda to be added.

This means when both water and caustic soda are allowed to settle a soapstock results which is reasonably dilute and in fact equivalent to what would be obtained from 1N caustic soda.

Procedure quoted here is for a batch of 30 metric tons. For parcels of different sizes the wash sizes should be altered, up or down, pro rata. Settling times however remain the same. Process time normally 6 to 7 hours.

5.2 Process steps. Neutralisation/washing/drying.

1. Charge the neutralizer with crude coconut oil and heat to 90°C - 95°C.

2. With lower speed stirring spray hot water into oil (equal to twice vol. 3N caustic soda)

3. Follow immediately with required 3N, caustic soda including 10% excess to achieve full neutralization - stirring at 20 rpm. Note 1.

4. Stop stirrer and allow soap to settle for 40 minutes.

5. Drop the soapstock but retain emulsion in neutralizer. Note 4.

6. Without stirring spray 3000 litres 0.1N. caustic soda onto the still oil.

7. Settle 30 mins.

8. Drop the wash, but retain emulsion. Note 4.

9. Without stirring spray 3000 litres hot water onto still oil.

10. Settle 30 mins. Note 2.

11. Drop the wash (Note 4); the emulsion layer should now be small and safe to retain to be dried in at the next step to minimize any loss. Equally well it may be management policy to drop the last emulsion layer to minimize the traces of soaps passed on. Note 3.

12. Apply vacuum and dry oil at 95°C. Normally the moisture content falls to 0.05% in 40 mns to 1 hour. As drying nears completion and very little moisture now passes up the vacuum pipe the latter becomes obviously cooler to the touch than at the beginning of drying.

Note 1. In no case should the addition of caustic soda be allowed to occur in under a duration of 10 minutes. This applies to all sizes of neutralizer and is designed to prevent a local excess of caustic soda building up at the top of the neutralizer and attacking oil rather than free fatty acid which is waiting to be brought up from the bottom of the neutralizer by the stirring action.

Note 2. If the desired level of FFA% (0.1% max) and soap % (0.06% max) has not been obtained steps 6,7 and 8 may be repeated and a further test done.

Note 3. The loss of all fatty matter from dry crude oil compared with the loss in free fatty acid is the refining factor. For coconut oil a factor of 1.5 is common. With careful work on good crude oil this may be reduced to about 1.3.

Note 4. Do not drop soapstock or washes so rapidly that a vortex can be seen in the sight glass sucking down good oil into the soapstock/wash.

5.3 Process steps. Bleaching (Decolourization)

The dry oil at 90–95°C is now bleached. When this is performed by the addition of adsorptive earth (Fullers Earth, Activated Earth, Activated Carbon) not only are some pigments removed from the oil but traces of remaining soap, gums and other impurities are removed at the same time, so that after efficient filtration a lighter completely clear product is obtained.
Process time 2.5 to 3 hours.

1. Vacuum is applied to the neutralizer and the stirrer started at top speed.

2. An amount of mildly activated earth equal to 0.3% the weight of the oil is made ready near a hopper at the other end of the bleaching earth line. The valve on the earth line (S) is opened and earth is sucked into the oil. In plants without an earth line the earth is added by hand through the man hole. If an activated carbon to adsorb any traces of heavy polycyclic aromatic hydrocarbons is to be used this will amount to 0.4%, and should be added 10 minutes after the earth. For purposes of decolourization activated carbon should not normally be needed, but if it is used for this purpose the best effect in relation to cost is obtained by restricting the amount of the carbon to 20% weight of earth, i.e. about 0.1% on weight of oil. If a cheaper neutral (or non-activated earth such as Fuller's Earth) earth is being used it will be desirable to increase the percentage addition of earth to 0.4-0.5%. The amount of earth added has to be judged by the refiner in relation to the quality of the crude oil used against the standard demanded for the final product. It is suggested here that often more earth is used as a matter of habit than is really necessary. Further, where two, three or more batches of oil/earth mixture are to be filtered on

the same filter prior to cleaning, then batches subsequent to the first may have their earth dose reduced by as much as 50%, because passage through the partly filled filter brings about an appreciable decolourizing effect in many cases. This is true for many oils. Such a reduction saves earth, oil lost in earth and increases filter utilization.

3. Allow 10 minutes for decolourizing contact, but if hydrocarbons are being adsorbed 45 mins. is recommended. If desired a sample may be taken from the vessel at this time to be filtered and the colour of the oil checked. Remember the colour of the oil from the plant filter is likely to be a little better than that of this sample.

4. Stop stirrer: break vacuum: commence filtering, slowly at first, then after 10-15 mins, at full rate. Especially on a clean filter this gradual start avoids "black run". During filtration (30 mins - 1 hour) a motion of the stirrer for about 15 seconds on two or three occasions is sufficient. It is desirable to keep hot bleached oil contact with air to a minimum. Modern continuous plants achieve this by the use of nitrogen and closed systems.

5. At the end of filtration blow line & filter clear of loose oil preferably with nitrogen, or with air if this does not cause heating of the filter cake. Because of cost, nitrogen blowing will have to be restricted to 2-3 minutes, whereas air may be used longer, always ensuring that it does not cause heating up of the filter cake by oxidation. Oil passed forward for deodorization must be free from bleaching earth and this is best ensured by following the main filter with a polishing filter of the "candle" or "bag" type rated to retain particles of 20 microns width. The unaided human eye can detect individual particles down to 40 microns.

6. <u>Quality</u>

REQUIREMENTS FOR COCONUT OIL OF DIFFERENT TYPES

CHARACTERISTICS	Grade I Refined & Deodourized	Grade II Refined	Grade III White Oil (Expelled)	Grade IV Industrial No. 1	Grade V Industrial No. 2
Free Fatty acid (as lauric) (in percent) Max.	0.10	0.10	1.0	6.0	10.0
Moisture and insoluble impurities, percent by weight Max.	0.10	0.10	0.25	0.5	0.5
Unsaponifiable matter, percent by weight Max.	0.50	0.50	0.50	0.8	1.0
Colour on a 1" cell on a Lovibond Scale expressed as Y+5R, not deeper than	2	2	4	11	30
Saponification Value, Min.	255	255	255	248	248
Iodine Value (Using Wijs)	7.5-9.5	7.5-9.5	7.5-9.5	7 - 11	7 - 11
Specific gravity at 30°C/30°C	0.915 to 0.920	0.915 to 0.920	0.915 to 0.920	0.915 to 0.920	0.915 to 0.920
Refractive index at 40°C	1.4480 to 1.4490	1.4480 to 1.4490	1.4480 to 1.4490	1.4480 to 1.4490	1.4480 to 1.4490
Mineral Acid Content	nil	nil	nil	nil	nil

It appears probable that the first three grades will finally be accepted for edible use, but three grades - rather than two - have been put forward for industrial use as follow:

	FFA% Max	Y + 5 R (1")
Grade IV	4	9
Grade V	6	12
Grade VI	10	30

6.1 Quality of bleached oil

Before bleaching a neutralized oil may have a colour of 7 Y 1.5R (1" Lovibond) and yield a bleached oil of 4 Y 1.2 R (5¼" Lovobond). Standards under discussion by APCC for final grades of oil are given at para 1.6.2 below.

6.2 Characteristics of Coconut Oil

Coconut oil contains around ninety percent of saturated fatty acids combined as various triglycerides in the oil. It melts at 25°C and so is liquid in the warm countries of origin laying within some 20° either side of the equator, but is solid in temperate regions. As FATTY ACID COMPOSITION TABLE below shows, it is very rich in the short chain fatty acids, C8–C12, and this largely explains both its short melting range or steep dilatation (solid fat index) curve and resistance to oxidation; these characteristics are enhanced when the oil is hydrogenated, thus saturating the small proportion of unsaturated fatty acids present in the original oil and raising the melting point to 33°C. As members of the lauric oil family, palm kernel, babassu and tucum oils exhibit similar behaviour. Apart from use as cooking oils in the tropics - often as fresh crude oil - the quick melting effect of lauric oils and hardened lauric oils led to their wide use in confectionery and margarines. Since the 1930's their position has been diminished on account of expense and by the advance of the technique of hydrogenation of other oils which has enabled the latter to replace them to an important extent.

TABLE II

TYPICAL FATTY ACID COMPOSITION OF COCONUT OIL

Fatty acid	Length of carbon atom chain	Number of double bonds	%
	C6	0	Trace
Caprylic	C8	0	8
Capric	C10	0	6
Lauric	C12	0	47
Myristic	C14	0	18
Palmitric	C16	0	9
Stearic	C18	0	2.5
Oleic	C18	1	7.0
Linoleic	C18	2	2.5

The Codex Alimentarius does not list coconut oil separately hence the provisions of the general statement CAC/RS19 - 1969 should be taken to apply.

In crude coconut oil about 1 ppm iron maybe found and sometimes a sulphur content of 4 ppm. Phosphatides and waxes are absent for all practical purposes, so a degumming step prior to neutralization is not necessary.

7. Partial list of equipment manufacturers
(In alphabetical order)

7.1 Alfa Laval AB
Department SFR
S- 14700 Tumba
Sweden

7.2 Costruzioni Meccaniche Bernardini SPA
2, Via della Petronella
Pomezia, Rome 00040
Italy

7.3 Fratelli Gianazza SPA
Vle Cardona 78/84
20025 Legnano
Italy

7.4 French Oil Mill Machinery Co.
Piqua, Ohio 45356
U.S.A.

7.5 H.L.S. Industrial Engineering Co.
P.O. Box. 193
Petah Tikwa
Israel

7.6 Lurgi
D-6000 Frankfurt am (main) 2
Gervius strasse 17/19 Postfach 119181
Federal Republic of Germany

7.7 Neumunz Inc.
Process Engineers
117 Fort Lee Road
Leonia N.J. 07063
U.S.A.

7.8 Pellerin - Zenith AB
Box. 721, S-251 07
Helsingberg
Sweden

7.9 Simon Rosedown Ltd
Cannon Street
Hull
England

7.10 Wurster & Sanger
22 W. Madison Street
Chicago, Illinois 60602
U.S.A.

Product code CCCN 15.071

Technology sheet No. III / 2

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANISATION

AND ASIAN & PACIFIC COCONUT COMMUNITY

"Consultancy Service on Coconut Processing Technology"

(Project UF/RAS/78/049)

1. Technology sheet for: CONTINUOUS CENTRIFUGAL NEUTRALIZATION - WASHING - DRYING - BLEACHING

The above steps are commonly understood to be included in "refining"; where deodorisation is included the oil is described as "refined and deodorised", or by some as "fully refined". American practice commonly takes deodorisation to be included in the description "refined". Where a crude oil with a fairly high FFA of several percent has been given a preliminary neutralization, washing, and drying and probably bleaching so as to bring the FFA well below 1%, it is sometimes referred to as "washed" oil, e.g. "washed cottonseed oil", max. FFA 0.3%.

2. Uses of Coconut Oil

Gives quick melting effect when used in margarine and confectionery of the temperate zones. Promote quick lather in soap. A stable cooking oil. Used directly as hair oil and starting point for production of shampoos and chemical derivatives of the lauric acid group. A stable medium in which to pack active nickel catalyst for use in the hydrogenation of other oils. Can be hydrogenated or interesterified with hardered oils or the stearin fraction of other fractionated oils to gives products for tropical use with the necessary steep dilatation curve, i.e. soft solids at 30-35°C completely melted at 36-38°C.

3. Country of origin: -

Coconut oil refining is now carried out in all the Asian member countries of the APCC. The technology has been obtained from plant manufacturers in various parts of the world. See section 7 for partial list of names and addresses.

4. Equipment

4.1 Description. Heat exchangers, pumps, knife and disc mixers, automatic caustic soda solution dosing equipment, centrifuges for separation of soapstock and later, wash water, cascade vacuum dryer, continuous earth dosing equipment, automatic 3 or 4 compartment continuous bleacher, oil cooler, filters (manual or automatic self cleaning as desired).

4.2 Material of construction. Substantial use is made of stainless steel in valves, dosing equipment, centrifuges and oil heaters the remainder being in mild steel.

4.3 Cost. Prices quoted here are for 1979; since oil can be refined in a 2 centrifuge system rather than the more common 3 or even 4 centrifuge system whose prices are quoted here, some reduction could be sought from the manufacturer.

Alfa-Laval (F.O.B Swedish port in million Swedish crowns): -

Ton/day	3 Stage Neut./wash	Dryer	Bleacher with AMA filter
50	1.05	0.07	1.1
100	1.25	0.073	1.2
150	1.50	0.075	1.4

1US$ = 4.12 S.Krona

French Oil Milling :-

For a 30 ton oil per day 4 centrifuge neutralization washing equipment (including degumming pretreatment) US$ (FAS US port) 147,343.

For dryer/bleacher plus one plate and frame press US$ (FAS US port) 71,402.

C.M. Bernardini :-

For a 50 metric ton oil per 24 hour day neutralizing, washing and drying equipment employing 3 Veronesi centrifuges. If Westfalia centrifuges are chosen the cost will be increased. Degumming and vacuum drying included. FOB Italian port, US$199,000. For continuous bleacher and two filterpresses to match above, FOB Italian port US$98,000.

4.4 Capacity. A very common size is one which is designed to cope with 30 tons oil throughout per 24 hours (Alfa-Laval, Westfalia, CMB), French Oil Milling 30 tons/24 hours; Veronesi, Sharples etc). The larger Alfa-Laval and Westfalia centrifuges will process over 6 tons oil per hour.

5. Process stages

1. Degumming addition of phosphoric acid is not needed.
2. Oil preheater. Note (1)
3. Caustic soda mixed with oil. Note (2)
4. Centrifugal separation of soapstock from oil
5. Oil pre heater
6. Wash water mixed with neutralized oil
7. Centrifugal separation of wash from oil
8. Oil dried in continuous cascade vacuum dryer. Note (4)
9. Oil pre-heater. Note (5)

10. Earth/carbon dosing equipment
11. Continuous bleacher
12. Oil/earth cooler
13. Filter.

Note (1) A common neutralization temp. is 85-95°C.

(2) For lower FFA % (say under 4%) some equipment manufacturers recommend a relatively weak caustic soda, say 2.26 N or 12°Be, and for FFA above 4% a stronger caustic soda of 6.75N or 28°Be.

Instruction sheets applied with equipment should be consulted.

Note (3) A temp. of 85-90°C with 10-15% water/oil addition recommended in Alfa-Laval system.

Note (4) Centrifugal refining systems commonly achieve lower FFA% than batch, say 0.05% V. 0.10% and lower soap %, say 0.02% or considerably less V. 0.05%. For best efficiency all water used should be less than 5° hardness (German) = 6.25° (UK).

Note (5) Bleaching temperature 90-95°C

Note (6) Earth addition is no greater than for the batch process; some refiners claim it may be slightly less. This has to be judged from experience.

6. Yield or Refining Factor and other economic considerations.

For many vegetable oils which refine by batch process with a refining factor of about 2 the centrifugal separation process achieves a reduction of around 0,2 in the factor, and it is this increased efficiency which helps pay for the bigger capital expenditure. In the case of coconut oil the batch refining factor is commonly already 1.4-1.5, with 1.3 a possibility on good oil with care. It is thus more difficult for the centrifugal refining of coconut oil to pay for itself as quickly as with other vegetable oils such as soyabean and groundnut oil. Centrifugal refining saves factory floor space and labour. The importance of these factors varies from country to country. Maintenance and the provision of spare parts must also be taken into account when deciding between adopting a continuous or a batch process.

7. Partial list of equipment manufacturers
(In alphabatical order)

7.1 Alfa Laval AB
Department SFR
S- 14700 Tumba
Sweden

7.2 Artisan Industries Inc.
Department M 2
73 Pond Street
Waltham Mass: 02154
U.S.A.

7.3 Costruzioni Meccaniche Bernardini SPA
2, Via della Petronella
Pomezia, Rome 00040
Italy

7.4 Fratelli Gianazza SPA
Vle Cardona 78/84
20025 Legnano
Italy

7.5 French Oil Mill Machinery Co.
Piqua, Ohio 45356
U.S.A.

7.6 H.L.S. Industrial Engineering Co.
P.O. Box. 193
Petah Tikua
Israel

7.7 Lurgi
D-6000 Frankfurt am (main) 2
Gervius strasse 17/19 Postfach 117181
Federal Republic of Germany

7.8 Neumunz Inc.
Process Engineers
117 Fort Lee Road
Leonia N.J. 07063
U.S.A

7.9 Pellerin - Zenith AB
Box. 721, S-251 07
Helsingberg
Sweden

7.10 Simon Rosedown Ltd
Cannon Street
Hull
England

7.11 Wurster & Sanger
22 W. Madison Street
Chicago, Illinois 60602
U.S.A.

Product code: CCCN 15.071
Technology sheet no. III / 3

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANISATION

AND ASIAN & PACIFIC COCONUT COMMUNITY

"Consultancy Service on Coconut Processing Technology"

(Project UF/RAS/78/049)

1. Technology sheet for : PHYSICAL REFINING

Free fatty acids being more volatile than the triglycerides from which they derive, can be separated from the latter by steam distillation. The removal of off-flavours also take place, so that the oil may be neutralized & deodorized at the same time. Thus steam is made to do the work of chemicals such as caustic soda which are used in batch and centrifugal refining plants. Where imported chemicals are costly this is a factor favouring physical refining; where they are cheap it may be that the increased capital expenditure on a physical refining plant is not justified unless the fact that it achieves very low refining factors combined with a rather high FFA% in the crude oil brings about immediate substantial savings. For example, if palm oil has an FFA% of 4 and on batch refining a refining factor of 2, a total of 8% is diverted to acid oil or soap. If the physical refining factor is only 1.2 a total of only 4.8% is diverted; the difference, 8 - 4.2 = 3.8%, provides the saving, more especially if the price margin between deodorized oil and acid oil or soap is fairly large.

2. Uses of refined oil. For margarine, cooking fats and oils.

3. Country of origin:

This technology can be obtained from various countries. See section 7 for partial list of names and addresses.

4. Equipment:

4.1 Description

1. Pre treatment vessel
2. Filter
3. Store tank feeding refining unit
4. Heat exchanger

5. De-aerator
6. Physical refining unit.
   (Oil enters via a second heat exchanger situated in the bottom of the unit in modern designs).
7. Guard filter
8. Hot neutralized deodorized oil is pumped from internal heat exchanger to external heat exchanger (as at step 4).
9. Oil cooler.
10. Oil polishing filter. Pumps. Vacuum raising equipment.

4.2 Material of construction. Largely stainless steel

4.3 Cost

Alfa-Laval (FOB Swedish post in million Swedish crowns)

100 ton/day	3.0	S. Kr
150 ton/day	3.5	
200 ton/day	3.8	

1 US$ = 4.12 S. Kr

Girdler (USA) Gianazza (Italy) Feld and Hahn (Germany) French Oil Milling (USA) and numerous others.

4.4 Capacity. 50 - 200 tons/24 hr. day

5. Process Stages

1. Degumming by contact with 0.1% citric acid + 0.4 activated bleaching earth under vacuum at 95°C. A batch bleacher serves this purpose; in case of coconut oil the very low amount of gummy material in good crude oil may allow reduction of dose oil citric acid and earth. Note 1.

2. Remove earth by filtration; oil to filtered oil store.

3. Pump pre-treated oil via heat exchanger and deaerator to the physical refining unit (which may include a second heat exchanger in its base).

4. Oil is brought to temperature and sparged with steam to strip FFA and off-flavours.

5. Oil passes through internal heat exchanger, then external heat exchanger, cooler and polishing filter.

   Note 1. If even small amounts of non-fatty organic matter such as gum remain, these may cause darkening of the oil at the higher temps. of stripping of the free fatty acid in the middle stages of the physical refining column. Usually 5 trays, one above the other, through which the oil flows, achieve the necessary heating and then sparging. In the case of palm oil a temperature of 270°C is attained for a very few minutes, but this is also designed to heat bleach the carotene in the palm oil. This is not a consideration with coconut oil, hence the equipment supplier will say how high a temp. is to be employed to distill the more volatile free fatty acids of the coconut oil.

6. Refining factor - quality

Very low refining factors are to be expected on coconut oil of 1.1 - 1.2 so that plants which have physical refining units for palm oil processing can also employ then on coconut oil as the programme permits. It is sometimes the case that a shipment of palm oil is sub-standard in the sense that although it refines by the physical method to a bland light coloured oil of satisfactory low (under 0.1%) FFA, it nevertheless shows much poorer flavour stability. In such cases the oil is given a light caustic soda refining, bleaching and conventional deodourizing (ca. 180°C). To what extent this applies to coconut oil has to be discovered by the refiner and is an argument for not throwing out all batch refining units when a continuous system is installed.

7. Partial list of equipment manufactuerers

   (In alphabetical order)

7.1 Chemetron Process Equipment
P.O. Box. 35600
Louisville, Kentucky 40232
U.S.A.

7.2 Costruzioni Meccaniche Bernardini S.P.A
2, Via della Petronella
Pomezia, Rome 00040
Italy

7.3 E.M.I. Corporation
O' Hare Office Centre
3166 Des Plaines Ave.
Des. Plaines, Illinois
U.S.A.

7.4 Fratelli Gianazza SPA
Vle Cadorna 78/84
20025 Legnano
Italy

7.5 French Oil Mill Machinery Co.
Piqua, Ohio 45356
U.S.A.

7.6 Fried Krupp
Harburger Eisen - Und Bronzewerke
Hamburg 90
West Germany

Product code CCCN 15.07i
Technology sheet no. III / 4

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANISATION

AND ASIAN & PACIFIC COCONUT COMMUNITY

"Consultancy Service on Coconut Processing Technology"

(Project UF/RAS/78/049)

1. Technology sheet for : - **BATCH DEODORIZATION**

Deodorization of coconut oil is easily achieved whether in a batch or continuous system because as stated in the description of coconut oil at 1.6.2. the short chain fatty acids are sufficiently volatile to be easily steam stripped along with off flavours.

2. Uses of deodorized oil: margarine, cooking oils/fats.

3. Country of origin: -

This technology can be obtained from various countries
See section 7 for partial list of names and addresses.

4. Equipment : -

4.1 Description

The batch deodorizer is roughly comparable with the batch neutralizer in size, has a large free headspace above the oil of 40 - 45% total internal volume, to accommodate limited frothing and a rather more generous provision of heating/cooling coils equivalent to 5 sq.m. per ton oil which with high pressure steam of 10 - 15 atms. are capable of raising the oil temp. at 4°C per min. Sparger pipes with radial arms provide the flow of open steam both near the foot of the vessel and a little below the level of the oil when still. Hence violet agitation is certain.

A wide vacuum off-take pipe (the entrance shielded by a baffle) is situated at one side of the dome of the vessel and leads to a barometic condenser. A common arrangement is to have one primary ejector to produce a low vacuum quickly at the beginning, at least a further secondary stage to produce the higher vacuum during deodorisation and finally a booster steam compresser to enable the ejectors to maintain a higher vacuum (6 - 9 mm Hg) than they would otherwise be able to produce themselves.

4.2 Materials of construction.

Has frequently been made from mild steel, but it is here recommended the heating/cooling coils at least should be made from stainless steel at moderate extra cost, since this assists periodic cleaning and prolongs the life of the coils. Some refineries operate deodorizers whose whole interior is in stainless steel so that this is the only metal in direct contact with the oil at this stage.

4.3 Cost (including vacuum equipment).

	Cost
10 tons capacity	60,000 US$
20 " "	96,000 US$
30 " "	124,800 US$

4.4 Capacity

Physical or geometric capacity - as given.

Working capacity - take 80% utilization throughout a working year of (say) 250 days - 300 days according to local custom.

.5. Process steps

Total process time up to 8 hours.

1. Charge oil to deodorizer operating the primary ejecter simultaneously to build up vacuum.

2. Commence heating with closed steam and start secondary ejecter.

3. At about 80°C sparge with open steam
At about 100°C add one litre of citric acid soln. (50% w/w) per 5 tons of oil, i.e. 01% citric acid.
At about 160°C turn on booster steam compresser if provided.

4. At 180° - 185°C turn off closed coil steam.

5. Continue sparging with open steam until a bland taste is obtained on a sample. Note 1.

6. When a satisfactory flavour (i.e. virtually tasteless) is achieved reduce the open steam pressure by 50%, turn off booster compresser (if in use) and turn on cooling water in closed coils.

7. At 150°C add a further 0.01% citric acid (as before)

8. At about 80°C turn off open steam and secondary ejector; continue cooling to about 50°C, break vacuum and pump oil to store tank. Note 2.

Note 1. The time of steaming will depend upon how good a vacuum is provided by the equipment. This varies from one refinery to another but a vacuum of 6 - 15 mm Hg is usual. Also in some refineries the deodorisation temp. may be slightly lower then 180°C. In any case coconut oil is one of the easiest to deodorize. Within the above conditions of pressure and temperature about 11 cu. metres of open steam per Kg. oil will complete deodorisations of coconut oil within 3 hours steaming. It is a rough rule that the total weight of steam required for heating up the oil, creating the vacuum and stripping the free fatty acid amounts to 40 - 50% of the weight of the oil. Of this steam only about one twentieth is employed as the open steam for deodorisation.

Note 2. It is good practice to pass the deodorized oil through a small polishing filter before it is despatched or passed to the next process stage.

6. Quality : yield.

The deodorized oil should have an FFA under 0.1%, PV = nil and the colour will depend upon the effectiveness of the earlier neutralization/bleaching. A fatty matter loss of up to 0.3% is normal for the process.

7. Partial list of equipment manufacturers
(In alphabetical order)

7.1 Alfa Laval AB
Department SFR
S- 14700 Tumba
Sweden

7.2 Chemetron Process Equipment
P.O. Box. 356 00
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7.3 Costruzioni Meccaniche Bernardini S.P.A.
2, Via della Petronella
Pomezia, Rome 00040
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7.4 Fratelli Gianazza S.P.A.
Vle Cadorna 78/84
20025 Legnano
Italy

7.5 French Oil Mill Machinery Co
Piqua, Ohio 45356
U.S.A.

7.6 Fried Krupp
Harburger Eisen-Und Bronzewerke
Hamburg 90
West Germany

7.7 Wurster & Sanger
22 W . Madison Street
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U.S.A.

Product code CCCN 15.07 i
Technology sheet no. III / 5

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
AND ASIAN & PACIFIC COCONUT COMMUNITY
"Consultancy Service on Coconut Processing Technology"
(Project UF/RAS/78/049)

1. Technology sheet for : CONTINUOUS DEODOURIZATION

2. Uses of deodourized oils : Margarine, cooking fats and oils

3. Country of origin : This technology can be obtained from various countries. See section 7 for partial list of plant manufacturers.

4. Equipment : -

4.1 Description

This is basically similar to the physical refining unit except free fatty acid and gums have already been removed from the neutralized bleached oil hence the demand for steam is less and the operating temperature recommended may be in the 180-240°C region. There is no pretreatment equipment.

4.2 Materials of construction

Most parts in direct contact with oil will be of stainless steel.

4.3 Cost

French Oil Milling (FAS American post) US$ 134,718
Alfa-Laval (FOB Swedish post - million Swedish Krona)

100 tons/day	2.0	1US$ = 4.12 S. Kr.
150 tons/day	2.2	Girdler Corporation (USA)
200 tons/day	2.4	are also well known
		suppliers of these

4.4 Capacity. From 30 tons/day upwards

5. Process stages

5.1 Pump preheated oil via heat exchanger and de areator to the physical refining unit (which may include a second heat exchanger in its base)

5.2 Oil is brought to temperature and sparged with steam to strip FFA and off-flavours.

5.3 Oil passes though internal heat exchanger, then external heat exchanger, cooler and polishing filter.

6. Quality

The deodourized oil should have an FFA under 0.1%, PV = nil and the colour will depend upon the effectiveness of the earlier neutralization/bleaching.

7. Partial list of equipment manufacturers
(In alphabetical order)

7.1 Alfa Laval AB
Department SFR
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7.2 Chemetron Process Equipment
P.O. Box. 356 00
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7.3 Costruzioni Meccaniche Bernardini S.P.A.
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7.4 Fratelli Gianazza S.P.A.
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7.5 French Oil Mill Machinery Co.
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U.S.A.

7.6 Fried Krupp
Harburger Eisen - Und Bronzewerke
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7.7 Wurster & Sanger
22 W. Madison Street
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Product code CCCN 15.13 a
Technology sheet no III / 6

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANISATION

AND ASIAN & PACIFIC COCONUT COMMUNITY

"Consultancy Service on Coconut Processing Technology"

(Project UF/RAS/78/049)

1. Technology sheet for : BATCH HYDROGENATION

2. Use of finished product : Hardened Coconut Oil

Hydrogenation of coconut oil elevates the melting point from about 25°C to 33°C. Since in the hydrogenated product there is a higher proportion of solid triglycerides at temperatures up to 33° C than is the case for the unhardened oil, an appreciably firmer harder material results which nevertheless melts quite sharply as 33°C is approached. These characteristics are most useful in the formulation of confectionery and margarine where a product is required which is solid at ambient temperatures but which melts completely in the mouth (36.8°C) and hence leaves no residual fatty sensation. Resistance to atmospheric oxidation and the onset of rancidity is enhanced by hydrogenation.

3. Country of origin

This technology can be obtained from plant manufacturers in various countries. See section 7 for partial list of names and addresses of equipment manufacturers.

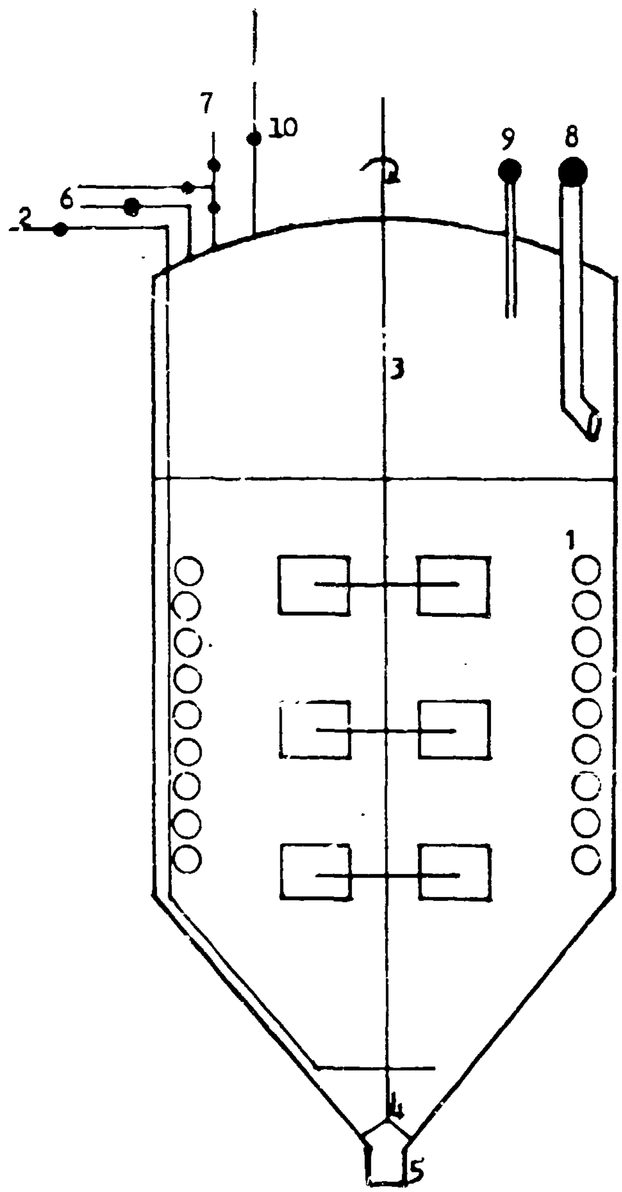
4. Equipment

4.1 Description

Where hydrogen of a high standard of purity is available (say 99.5% pure on a dry basis) the so called "dead end" process is much to be preferred. This consists simply of stirring

Fig.II

HYDROGENATION VESSEL



1. Heating/Cooling coil
2. Hydrogen
3. Stirrer
4. Footstool
5. Exit valve
6. Hydrogen (Top gas)
7. Vacuum
8. Soft oil
9. Catalyst
10. Vent to atmosphere

hydrogen and oil together in a closed vessel and feeding in more hydrogen as some is absorbed into chemical combination with the oil. When the oil can combine with no more hydrogen it is described as "saturated" or "fully hardened". For a full description see "The Hydrogenation of Vegetable Oils and the Production of Vegetable Ghee", ID/124, UN Publication Sales No. E 74.11.B.7 (1974).

Other systems of hydrogenation circulate the hydrogen repeatedly through the oil removing much of the condensible impurity after each pass, but eventually when inert impurities such as methane and nitrogen have reached the 20 - 30% v/v level the hydrogen handling system has to be purged to atmosphere to avoid the hydrogenation reaction from becoming unacceptably slow. For this reason only a typical "dead end" hydrogenation vessel is shown at Fig. II. This figure is purely diagrammatic and not to scale.

The headspace above the oil occupies 30% of the volume of the vessel. Oil is heated/cooled by the closed coils (1). The critical feature is the cooling when oils with a large rapid uptake of hydrogen are being hydrogenated, since if the iodine value falls say 2 points in one minute, the oil temperature could rise 3°C and the cooling system must be capable of controlling this. With coconut oil there is no such problem as the IV drop is limited to 11. Hydrogen at about 3 atmospheric pressure is fed via line (2) to a circular sparging ring at the foot of the vessel whose small holes point downwards so that powdered catalyst cannot lodge in them.

The agitation system is that of the typical Rushton stirrer. A number of vertical vanes are mounted on a flat ciruclar disc rotated at high speed on a shaft, i.e. turbine stirrer. In small vessels (5 tons) there may be only two agitation discs, but for 10 tons and above three are normal. Gas bubbles from the sparger ring are smashed to very small ones on the underside of the lower turbine and ejected to the wall where they rise and are sucked to the underside of the middle turbine, again ejected and then sucked under the top turbine which is close enough to the oil surface (20 cm from horizontal plate to level of oil at working temperature) to create a vortex. Hence very little hydrogen escapes to the headspace but such as does is drawn back by the vortex. The bottom of the stirring shaft is secured by a footstool of specially hard metal (4). Four or five baffle plates (not shown in Fig. II about 150 mm wide and running the depth of the straight vessel wall section immersed in the oil are provided to increase turbulence and hence mixing of the gas. A "top gas" connection is provided at (6) for occasions when it is desired to hydrogenate slowly and under tight control by absorption from the gas space rather than by rapid turbine dispersion. This "top gas" connection is also used when the vessel is being emptied and therefore hydrogen should not be admitted from the sparger ring lest additional unwanted hydrogenation take place.

The vacuum connection at (7) is controlled by two valves in series one above the other with a small branch between them bearing a third valve. When the vessel is under hydrogen pressure the branch valve is open and the other two firmly closed. In this way hydrogen cannot be wasted by being drawn into the vacuum system because of valve failure. The vacuum in a hardening plant should be provided by a steam ejector system for safety reasons . Soft-oil and catalyst slurry connections are at (8) and (9). Hardened oil and catalyst are pumped from exit valve (5) to a filter.

Not shown in Fig.II are

Manhole)
Sight-glass) Adjacent
Light-glass)
Safety valve
Bursting disc

Sampling point: temperature probes.

If the heating coil is made in an upper and lower section, the division being just above the level of the middle turbine, half sized changes of oil may be hardened as a matter of routine.

4.2 Material of Construction Mild steel

4.3 Cost

10 tons capacity	105,000 US $
20 " "	168,000 "
30 " "	218,000 "

4.4 Capacity

Physical or geometric capacity - as given.
Working capacity. Three charges per day at 80% utilisation throughout a working year of (say) 250-300 days according to local custom.

5. Process Steps

Total process time under 8 hours.

(1) Apply vacuum and commence filling vessel with correct amount of oil. Residual hydrogen in the vessel from the previous process cycle will be safely drawn off by the steam ejector. The alternative would be to purge the vessel with nitrogen first of all.

(2) Catalyst slurry may also be added at the same time and the bulk of this must be included in the final total bulk to cover top turbine.

(3) Commence heating vessel; leave vacuum open - this helps dry oil still further.

(4) At 120°C close vacuum (open branch safety valve on (7) Fig.II)

(5) Admit hydrogen to sparger via valve (2)

(6) Observe pressure in vessel rise to atmospheric

(7) Open vent to atmosphere valve for 30 seconds so as to purge gas space above oil.

(8) Close vent to atmosphere valve

(9) Start turbines: observe rise in pressure in hardening vessel to 3 atms. or whatever other working pressure has been decided.

(10) Check refractive index of oil at intervals of about 10-15 minutes, but more frequently as end point is approached.

(11) Control temp. of vessel to 180 ± 5°C closing steam inlet and opening cooling water. Coconut, palm kernel and palm oil generate a comparatively small amount of heat, even when fully hardened; therefore it is a matter of very slight use of cooling water, if any, once temperature of hydrogenation has been reached. If the hydrogenation is complete before 180°C is reached this is unimportant in the case of coconut oil.

(12) When the end point is attained, the turbine stirrer should be stopped and, if desired, a sample tested for IV, slip mp °C as may be required. This test takes up process time during which the vessel is waiting to be filtered, hence if the test can be anticipated, or the refractive index accepted as sufficient evidence the end point has been reached, this will improve utilisation of the vessel.

(13) Cool the vessel to 90°C open the top gas valve (6), open exit valve (5) and pump the hardened oil to the filter and on to the hardened oil store. Commence filteration gradually to avoid "black run".

(14) When the vessel is empty close exit valve (5) and top gas valve (6) and blow through filter line and filter with nitrogen from a small connection just below (5).

6. Quality : Yield

Hardened Coconut Oil 33°C mp.

The amount of catalyst required is between 0.1-0.2% nickel on weight of oil charge. There may be only 25% nickel in the catalyst flakes as supplied by the manufacturer; this means weight of flakes to be added is 0.4-0.8% on weight of oil. When catalyst is being reused the amount of nickel in the filter from several charges can be calculated. When this cake is slurried in oil and kept agitated to prevent the nickel from settling out a certain depth may be dispensed from the slurry container as representing so many pounds nickel. Catalyst can be used several times before becoming so poisoned as to be almost inactive. The wastage rate should represent 10-20 re-uses. As the nickel ages the dose of recovered catalyst to the hardening vessel may be stepped up with a view to maintaining the hydrogenation time fairly constant at 1-2 hours on gas. The IV drop during hydrogenation will be about 9 which making a small (5%) allowance for loss represents 9 cu. metres hydrogen per metric ton oil.

The characteristics of the product will be: -

Slip melting point 32 - 34°C

Solid Fat Index (SFI)	44-50 or Dilatation	1100-1250	at	20°C
	5-4	125-175	at	30°C
	2-4	50-100	at	35°C
	0-1	0-25	at	40°C

As against unhardened coconut oil: -

SFI	33-37	D 825-925	at	20°C
	1-3	30-70	at	30°C
	up to 2	up to 50	at	40°C

Final IV under 2

If hardening is stopped at IV above 2 the characteristics of solid will obviously be intermediate between the fully hardened and the unhardened coconut oils shown above.
Unaccounted for process loss above 0.2%

7. <u>Partial list of plant manufacturers</u>
(In alphabetical order)

7.1 Alfa Laval AB
Department SFR
S- 14700 Tumba
Sweden

7.2 Costruzioni Meccaniche Bernardini S.P.A.
2, Via della Petronella
Pomezia, Rome 00040
Italy.

7.3 French Oil Mill Machinery Co.
Piqua, Ohio 45356
U.S.A.

7.4 Harshaw Chemical Co. (For Nickel Catalysts)
Catalyst Department
23800 Mercantile Road
Beachwood. Ohio 44122
U.S.A,

7.5 H.L.S. Industrial Engineering Co.
P.O. Box. 193
Petah Tikua
Israel

7.6 Lurgi
D- 6000 Frankfurt am (main) 2
Gervinus strasse 17/19
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Federal Republic of Germany

7.7 Wurster & Sanger
22 W. Madison Street
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U.S.A.

Product code CCCN 15.13 a
Technology sheet no. III/7

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANISATION

AND ASIAN & PACIFIC COCONUT COMMUNITY

"Consultancy Service on Coconut Processing Technology"

(Project UF/RAS/78/049)

1. Name of Process : CONTINUOUS HYDROGENATION

2. Uses of hardened oils : Margarine, cooking fats/oils, soap etc.

3. Country of origin : The technology can be obtained from plant manufacturers in various countries. See section 7 for partial list of names and addresses.

4. Equipment : Details of the equipment can be had from the manufacturers.

5. Process :

Few continuous edible oil hydrogenation plants are operated because where a number of hardened oils are required in the production the flexibility of the batch hydrogenator becomes the dominant factor. However, if the only product required is fully hardened coconut oil there is a good case for considering a continuous system. Two very helpful features are the small IV drop, hence the low requirement for hydrogen of around 10 cu. metres per ton, and no risk of overshooting the end point since zero IV would be excellent. It would have to be established that the required residence time in the system was not too long because the elimination of the last two or three units of IV is somewhat slower than average in any hydrogenation reaction. Buss of Switzerland produces small continuous units but information on cost is not to hand at the time of writing.

6. Quality : Hardened coconut oil 33°C melting point.

7. Partial list of plant manufacturers: -
(In alphabetical order)

7.1 Alfa Laval AB
Department SFR
S- 14700 Tumba
Sweden

7.2 Costruzioni Meccaniche Bernardini S.P.A.
2, Via della Petronella
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Italy

7.3 French Oil Mill Machinery Co.
Piqua, Ohio 45356
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7.4 Harshaw Chemical Co. (For Nickel Catalysts)
Catalyst Department
23800 Mercantile Road
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7.5 H.L.S. Industrial Engineering Co.
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Petah Tikva
Isreal

7.6 Lurgi
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U.S.A.

Product code CCCN 15.13 a

Technology sheet no. III / 8

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANISATION

AND ASIAN & PACIFIC COCONUT COMMUNITY

"Consultancy Service on Coconut Processing Technology"

(Project UF/RAS/78/049)

1. Technology sheet for : BATCH INTERESTERIFICATION

Not only can physical mixtures be made with coconut oil and other oils and fats but in the presence of a catalyst such as sodium methylate the fatty acids of the several triglycerides in the mixed oils redistribute themselves very quickly to attain a truly random distribution over all types of triglycerides present, including some not present in the original unreacted mixture. This change affects the physical texture but not the chemical stability.

2. Use of interesterified oils. To improve physical texture of edible oils & fats products.

3. Country of origin. This technology can be obtained from plant manufacturers in various countries.

4. Equipment

4.1 Description. Although specialised plants for interestification exist the process can be carried out in the batch neutralizer/bleacher described earlier (1.4.1). The oil or oils to be modified should have their FFA less than 0.1% and moisture under 0.05% as both of these cause a wasteful increase in the catalyst required.

5. Process steps (10 ton charge)

.1 The neutralised oil or neutralised oil mixture if not already known to be dry is dried under vacuum at 100 - 110°C for 1 hour.

.2 Add catalyst directly through the manhole of the neutralizer/bleacher into the oil with slow stirring. 0.2% catalyst is almost certain to suffice for most well dried oils; experience will show if this can be reduced by half in favourable cases.

3. An obvious colour change should take place in the oil and be complete within 10 minutes if the reaction has taken place.

4. Cool to 95°C

5. Spray 1150 litres hot water onto oil to destroy catalyst.

6. Settle 30 mins, then draw off wash, retaining emulsion in neutralizer.

7. Spray 1150 litres 0.1 N. caustic soda onto still oil.

8. Settle 30 mins. Test if FFA& + soap % together are less then 0.15%. (If not repeat (7) and (8)).

9. Draw off wash: retain emulsion if desired.

10. Dry as for other oils.

11. Bleach with 0.4 - 1.0% activated or mildly activated earth for 10 min at 90-95°C, adding activated carbon if this is considered necessary 10 min after earth addition. Note. 1

12. After contact time for carbon break vacuum and filter.

Note 1. The amount and type of earth will have to be judged according to the class of oils being processed.

The above steps will require 6 to 7 hours.

6. Quality

A vegetable oil stearin of slightly over 50°C melting point can be reduced to around 37°C mp by interesterification with 40% coconut oil and to under 30°C mp with 80% coconut oil.

7. Partial list of plant manufacturers

(In alphabetical order)

7.1 Alfa Laval AB
Department SFR
S- 14700 Tumba
Sweden

7.2 Costruzioni Meccaniche Bernardini S.P.A.
2, Via della Petronella
Pomezia, Rome 00040
Italy

7.3 French Oil Mill Machinery Co.
Piqua, Ohio 45356
U.S.A.

7.4 H.L.S. Industrial Engineering Co.
P.O. Box. 193
Petah Tikwa
Israel.

7.5 Lurgi

D- 6000 Frankfurt am (main) 2
Gervinus strasse 17/19
Postfach 119181
Federal Republic of Germany

7.6 Wurster & Sanger
22 W. Madison Street
Chicago, Illinois 60602
U.S.A.

Product code CCCN 15.13 a

Technology sheet no. III/9

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANISATION

AND ASIAN & PACIFIC COCONUT COMMUNITY

"Consultancy Service on Coconut Processing Technology"

(Project UF/RAS/78/049)

1. Technology sheet for : CONTINUOUS INTERESTERIFICATION

2. Use of interesterification oils : To improve physical texture of edible oils and fats products.

3. Country of origin :

The technology can be obtained from plant manufacturers in various countries. See section 7 for partial list of names and addresses.

4. Equipment :

Details of equipment can be obtained from plant manufacturers.

5. Process.

Sodium metal is extruded under pressure into a stream of neutralized oil that flows along a pipe into a mixing vessel which imposes a delay until the reacted mixture is next pumped forward to be quenched and washed with water in a final vessel. This is a private design. For the present, batch operated interesterification would be appropriate for APCC members.

6. Quality :

A vegetable oil stearin of slightly over 50°C melting point can be reduced to around 37°C m.p. by interesterification with 40% coconut oil and to under 30°C m.p. with 80% coconut oil.

7. Partial list of plant manufacturers : -

(In alphabetical order)

7.1 Alfa Laval AB
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7.5 Lurgi
D- 6000 Frankfurt am (main) 2
Gervinus strasse 17/19
Postfach 119181
Federal Republic of Germany

7.6 Wurster & Sanger
22 W. Madison Street
Chicago., Illinois 60602
U.S.A.

Product code CCCN 15.071

Technology sheet no. III / 10

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANISATION

AND ASIAN & PACIFIC COCONUT COMMUNITY

"Consultancy Service on Coconut Processing Technology"

(Project UF/RAS/78/049)

1. Technology sheet for : RECOVERY OF OIL FROM BLEACHING EARTH CAKE BY THOMSON PROCESS

2. Use of Thomson Recovered Oil. Return to crude oil or reprocess for edible or technical end use

5. Process. If hot water at 95°C is pumped through filters containing oily cake approximately 65% of the oil is displaced by water. This oil is led to a settling tank from the foot of which the separated water may be drawn for immediate re-use, if desired, in washing the same filter cake. For the best effect the pressure of wash water should be a little above the final pressure achieved when filtering the oil and a flow rate of 0.5 - 1.0 ton water/sq. metre of filter/hour should be maintained. The proportion of water passed through the filter should be between 5 and 20 times the weight of the cake. Normally 10 times is quite adequate. This may be achieved by the same water being circulated several times after settling in transit. The time of the operation is normally less than 40 min. The Thomson washed cake should be blown with air and then steamed to a moisture content of about 25% for ease of disposal. The majority of the oil recovered comes out in the first few minutes of washing; later less oil flows and grows much deeper in colour.

6. Quality. There is no fixed quality standard but if desired the first oil can be segregated for edible use (after refining) and the following darker oil for soapmaking or other technical outlets.

H.B.W.P. 1979

Product code CCCN 15.071

Technology sheet no. III / 11

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANISATION

AND ASIAN & PACIFIC COCONUT COMMUNITY

"Consultancy Service on Coconut Processing Technology"

(Project UF/RAS/78/049)

1 Technology sheet for : - RECOVERY OF OIL FROM BLEACHING EARTH CAKE AND SPENT NICKEL CATALYST CAKE USING SOLVENT

2 Use of recovered oil : - After reprocessing - for edible or technical use.

.5 Process comment : - If a solvent extraction plant is being operated on the same site the above cakes can be extracted (separately) by dropping them into a mixing vessel with same solvent; then filtering the extracted solid on a closed filter. The miscella is then evaporated in the usual way. Quality and yield of recovered oil is much better than for the cheap Thomson process, but it is NOT suggested a solvent recovery plant be built for this purpose, merely that an existing one be used intermittently as a minor part of its programme. If there is no solvent plant on site, but one exists in the area, an arrangement with the owner could be made. Whereas there is only about 20-25% nickel in fatty spent catalyst, once the fat is removed the nickel rises to 50% and is therefore a much more attractive proposition for acid extraction to form nickel sulphate. Such defatted cake there fore commands a higher price. The value of the oil recovered usually pays the process cost of the extraction or may yield a profit. A defatted bleaching earth cake is a much more easily discarded effluent than one containing fat.

Product code CCCN 15.10 a
Technology sheet no III / 12

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANISATION

AND ASIAN & PACIFIC COCONUT COMMUNITY

"Consultancy Service on Coconut Processing Technology"

(Project UF/RAS/78/049)

1. Technology sheet for : BATCH SOAP SPLITTING

When the soapstock is drawn off a neutralizer of coconut oil it may be diverted directly to the soapmaking department of the factory if there is one. If not, it is unlikely that transport of what may be 70-80% water to a distant user will be economic. The addition of sulphuric acid to the soapstock converts the soap to free fatty acid and the 30% of the fatty matter present as neutral oil remains with it, both forming the so called acid oil. When settled the acid oil can reach 98% fatty matter and this represents a better economic proposition as regards movement.

2. Use of acid oil : Soapmaking; production of oleochemicals

3. Country of origin : This technology can be obtained from manufacturers of neutralization equipment.

4. Equipment

4.1 Description

The most elementary form of soap splitting plant consists of a group of vats made from pitch pine, teak or other acid resistant materials, each one fitted with an acid resistant open steam oil. Acid addition points and acid water withdrawal points are provided.

5. Process

As the soapstock is pumped from the neutralizer it is directed to one of these vats and the addition of sulphuric acid (78%) commences at a rate which is just insufficient to split all the soap until the end, when 5% excess acid is added, and the vat boiled gently with open steam from an acid resistant open coil. The amount of acid required is easily calculated from the volume of caustic soda used to refine the batch of oil. The vat is settled then the acidic water run off. It should have a ph of about 3 and not lower than 2.3, as this implies waste of acid by a negligent operator. The acid water may be neutralised with a little of some future soapstock/wash before being discarded. Acid oil is best stored in a tank whose lower portion, at least, has been made acid resistant.

6. Quality of acid oil

Fatty matter not below 98%; mineral acid more than trace; other requirements to be specified by purchaser.

Product code CCCN 15.10 a

Technology sheet no. III / 13

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANISATION

AND ASIAN & PACIFIC COCONUT COMMUNITY

"Consultancy Service on Coconut Processing Technology"

(Project UF/RAS/78/049)

1. Technology sheet for : CONTINUOUS SOAP SPLITTING

2. Use of acid oil : Soap making, production of oleochemicals.

3. Country of origin :

This technology can be obtained from manufacturers of neutralisation plant in various countries.

4. Equipment

4.1 Description

An acid resistant stainless steel chamber in which soap-stock and sulphuric acid are vigorously mixed with a continuous automatic control of the excess acid being used. A centrifugal separation of acid oil from acid water is an optional extra which would probably be employed in a sophisticated plant.

4.2 Material of construction

Stainless steel

4.3 Cost

Alfa-Laval (FOB Swedish post, million Swedish Krona)

	Without separator	With separator
700 kg acid oil/hour	0.75	0.975
1400 " "	0.75	1.15

4.4 Capacity

From 700 kg. acid oil/hour upwards.

5. Process comment

As more physical refining plants are taken into use, soap splitting will not be needed. For the present, direct use of soapstock where possible, or batch splitting where not, appears adequate for APCC members.