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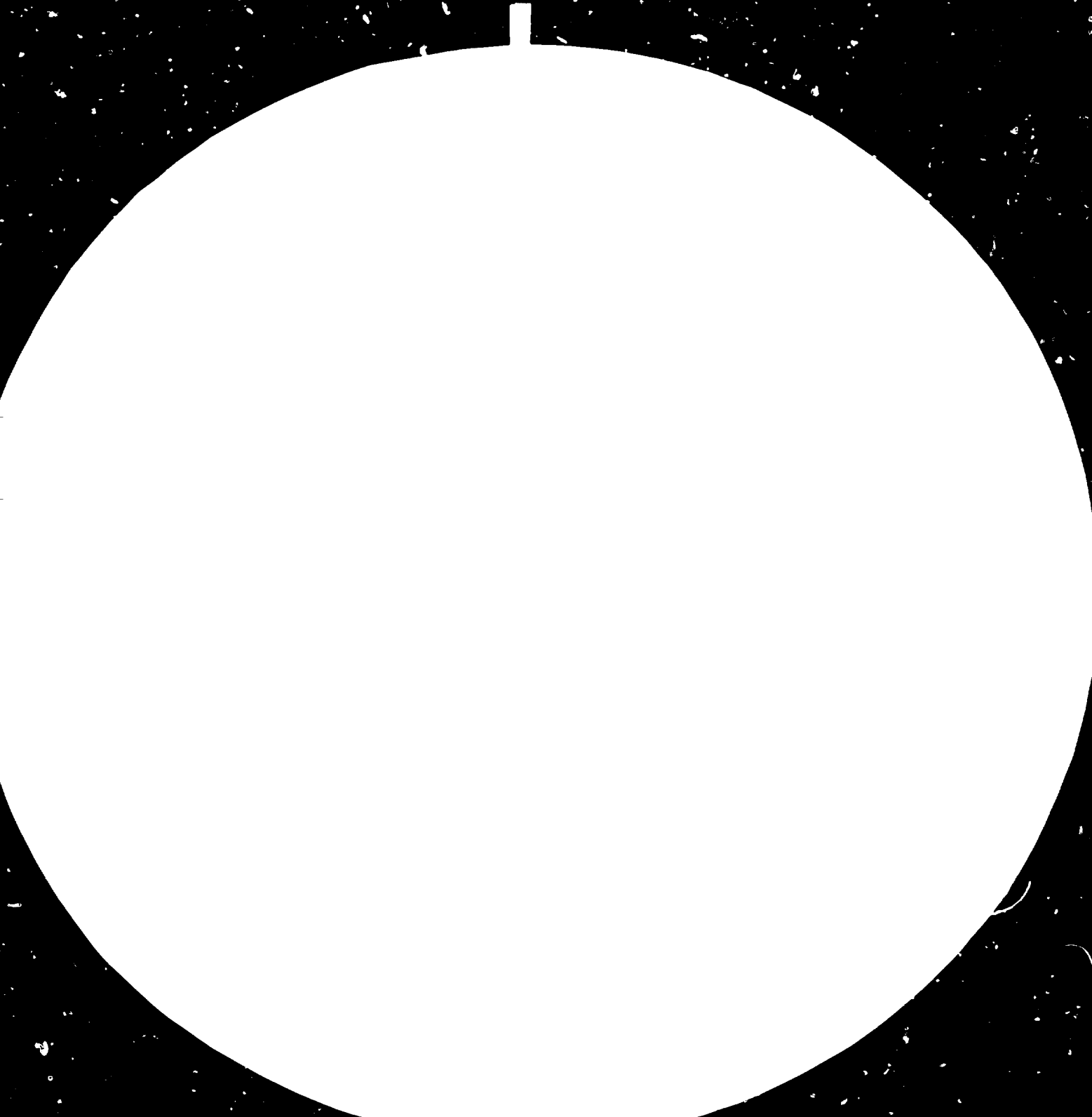

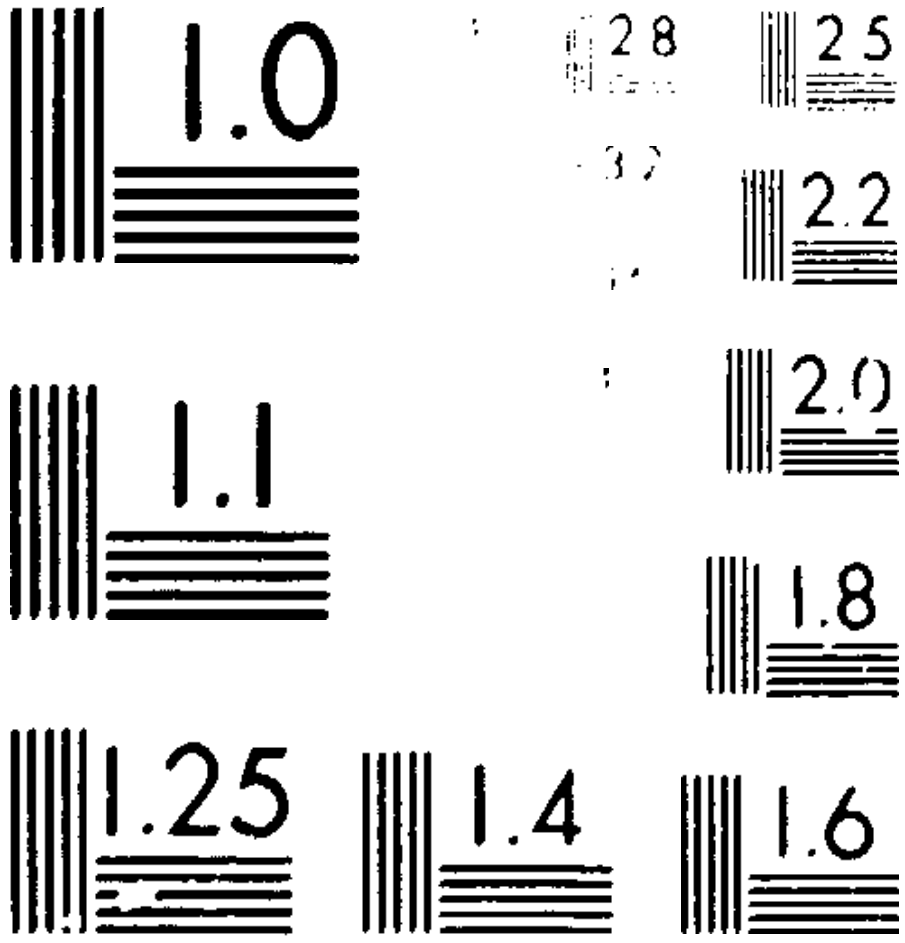
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4 September 1980
ENGLISH

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

ASIAN AND PACIFIC COCONUT COMMUNITY

COCONUT PROCESSING TECHNOLOGY INFORMATION DOCUMENTS

PART 7 OF 7

"Coconut Shell Products and other Processes"*

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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Mention of firm names and commercial products does not imply the endorsement of the United Nations Industrial Development Organization (UNIDO).

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Asian and Pacific Coconut Community

Jakarta — Indonesia

Our Ref :

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

P.M. Abaca, UNIDO Consultant on non traditional food

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

1979/1980

Consultancy Service on Coconut Processing Technology

UNIDO/APCC Project UF/RAS/78/049

PART VII

COCONUT SHELL PRODUCTS AND OTHER PROCESSES

List of Technology sheets

Product code : CCCN 44.02
Technology sheet no: VII / 1

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANISATION

AND ASIAN & PACIFIC COCONUT COMMUNITY

"Consultancy Service on Coconut Processing Technology"

(Project UP/RAS/78/049)

1. Technology sheet for : - MANUFACTURE OF COCONUT SHELL CHARCOAL USING PIT KILN (Cottage Industry)

2. Uses of finished product : -

2.1 Manufacture of Activated Carbon

2.2 Metallurgical uses as a reductant for smelting plants

2.3 Smokeless charcoal for Barbeques, Blacksmiths furnaces, Clothes irons in non electrified areas etc.

3. Country of Origin : - SRI LANKA

4. Equipment

4.1 Description of equipment: - See page 2 for drawing of pit kiln. The Pit Kiln comprises of a 6 feet diameter x 8 feet high cylindrical region excavated from the ground. The walls slope to avoid collapse. The slope is diverging upwards. The slope depends on the compactness of the soil. Kiln lining is usually ordinary bricks and mud mortar. On non-friable soil such as cabooky rock the lining is not required. A few discarded corrugated galvanized iron sheets are used as a cover for the kiln.

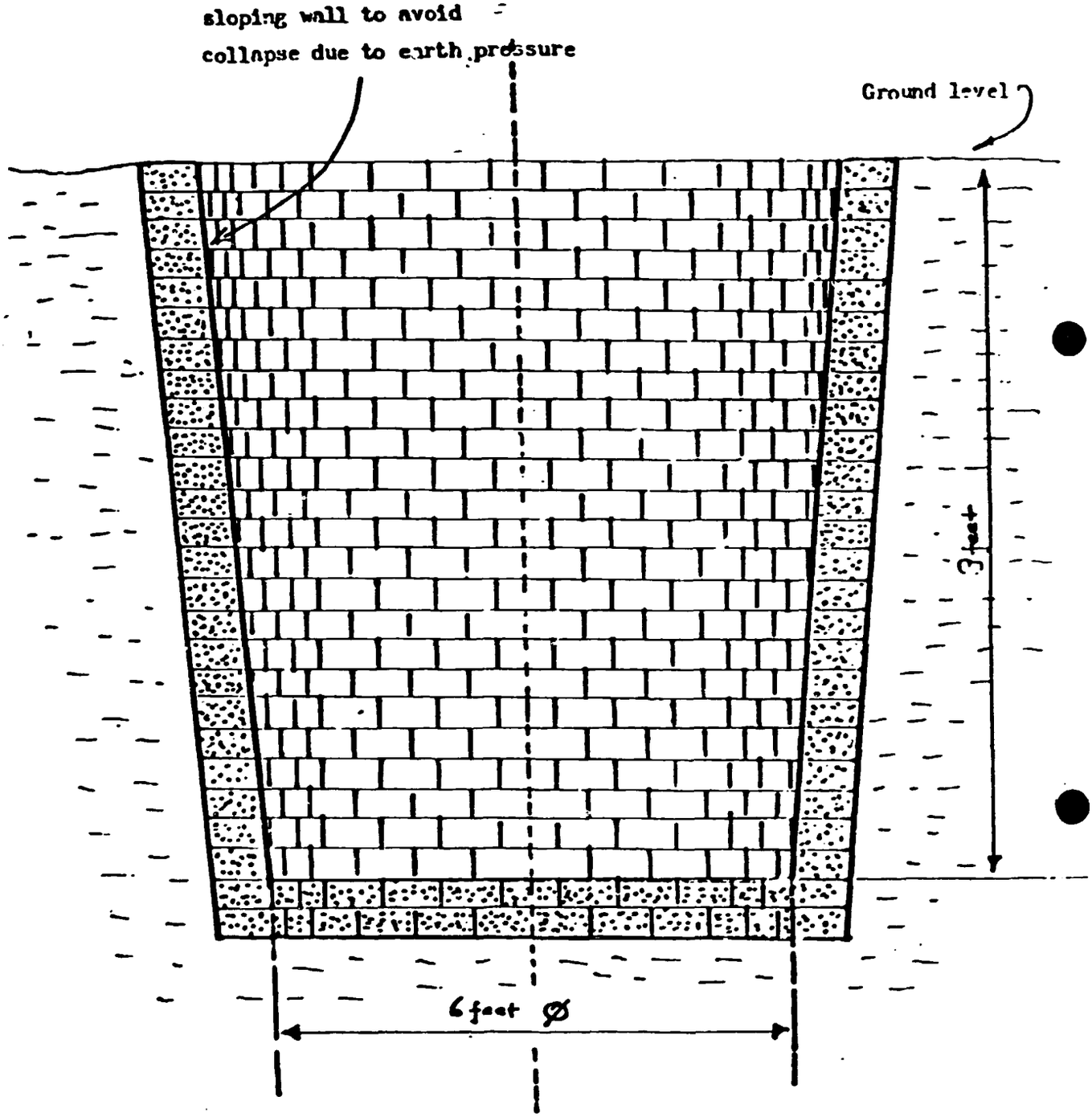
4.2 Materials for construction: -

Ordinary bricks 8" x 4" x 2" height	- 1800 Nos @ Rs 0.20	= Rs 360
Mud mortar (clay)	- 3 cubic metres	= no cost
Old corrugated G.I. sheets	- 10 Nos	= no cost

4.3 Cost of construction : -

	Rs	
Materials	360	
Labour for excavation	60	
Labour for laying bricks	100	
Total	Rs 520	(US$ 33.55)

1 US$ = Rs 15.50



Sectional Elevation

Note: With non-friable soil the brickliningis not required

SRI LANKA PIT KILN

4.4 Capacity

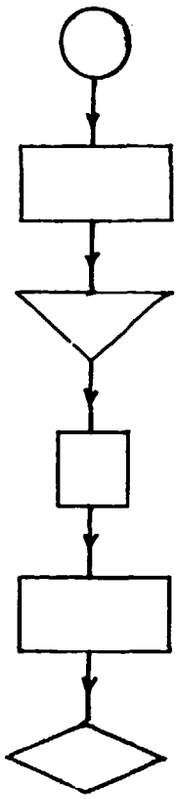
40,000 whole shells give 2 Tonne per batch every 3 days.

2 Tonne x 2 batches per week x 4 weeks per month =
16 Tonne per month.

Capacity per annum = 192 Tonne.

5. Process

5.1 Process Flow diagram : -



Raw shells (dry)

Carbonization in the pit

Shell Charcoal
(freshly burnt)

Exposure to air
for 2 weeks

Screening/Inspection/Bagging

Bagged Shell Charcoal

5.2 Description of Process : -

The raw material consists of fully matured coconut shells which are a by-product of the copra and desiccated coconut industry. The shells from the copra process are in halves while those from the desiccated coconut process are in pieces due to the "hatcheting" operation to break the shell. The shells should be free of fibrous material of the husk and be reasonably dry before carbonization.

The process requires optimum carbonization of raw shells in a limited supply of air so that there are neither unburnt shells nor excessive ash due to complete combustion. The pit is first charged with a few raw shells or charcoal and set fire. More shells are added to cover the flames. As these ignite, more shells are progressively added until the pit is full. If the firing is excessive at any stage, water is sprinkled in limited quantities to douse the fire. When carbonization (glowing mass) has reached the top of the kiln, further combustion is arrested by exclusion of air. For this purpose old G.I sheets or green fronds are used with damp earth on top. The G.I sheets help avoiding contamination with earthy matter. Provision is made for escape of gases and smoke through small openings. As the carbonization proceeds, thick white smoke escapes from these openings. When the smoke changes to a light blue colour, the carbonization is complete. The contents are allowed to cool up to the third day after which the charcoal is removed from the pit. Cycle time for one charge is three days.

The charcoal is exposed to air in an open shed for 2 weeks to avoid spontaneous ignition and this is a requirement for shipment. The charcoal is sifted on a BSS $\frac{1}{4}$ " mesh sieve, inspected for removal of unburnt shells and contaminants. For sieving the charcoal, a very simple device is used. The wire mesh is fastened to a wooden frame which is held at 45^{0} by two legs at the higher side. The worker throws shovels of charcoal on to the screen. Sifted fine matter fall under the mesh whilst the good charcoal lumps roll down along the screen. The charcoal is bagged in polyethylene lined jute or coir net bags containing about 50 kg nett.

Note: - Construction of charcoal pit kilns has to be done atleast 400 yards away from desiccated coconut factories and any living quarters due to the smoke hazard.

5.3 Product flow diagram : -

3333 Kg raw shells (20,000 complete shells)

↓

1000 Kg charcoal Yield 30%

6. Quality of finished product : -

The export quality charcoal should be uniformly black in colour and free from dust and dirt due to husk and contaminants. There should not be unburnt pieces (brownish colour) nor over burnt pieces which are brittle. Broken edges should show a shiny black surface and a characteristic sharp fracture. When dropped on a cement floor, well carbonized charcoal lumps give a clear ring.

The following specifications are usually given by overseas buyers for lump charcoal and these values are maintained by charcoal produced by this method.

Volatile matter	-	15% max
Moisture content	-	8% max
Ash content	-	2% max
Fixed Carbon content	-	75% min (by difference)
Percentage through $\frac{1}{4}$ inch mesh	-	5% max.

7. Source of information

Visit to charcoal pit kilns in Sri Lanka.

Product code: CCCN 44.02

Technology sheet no: VII / 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 : - MANUFACTURE OF COCONUT SHELL CHARCOAL USING PIT KILN (Cottage Industry).

2. Uses of finished product : -

2.1 Manufacture of activated carbon.

2.2 Metallurgical use as reductant for smelting plants.

2.3 Smokeless charcoal for household purposes.

3. Country of origin : - PHILIPPINES

4. Equipment : -

4.1 Description of equipment : - See figure

The pit kiln measures 2 meters width x 3 meters length x 1 meter height. It is dug into the ground and lined with hollow cement blocks. A slight slope is maintained to avoid collapse of the walls. On non-friable soils, the brick lining is not required.

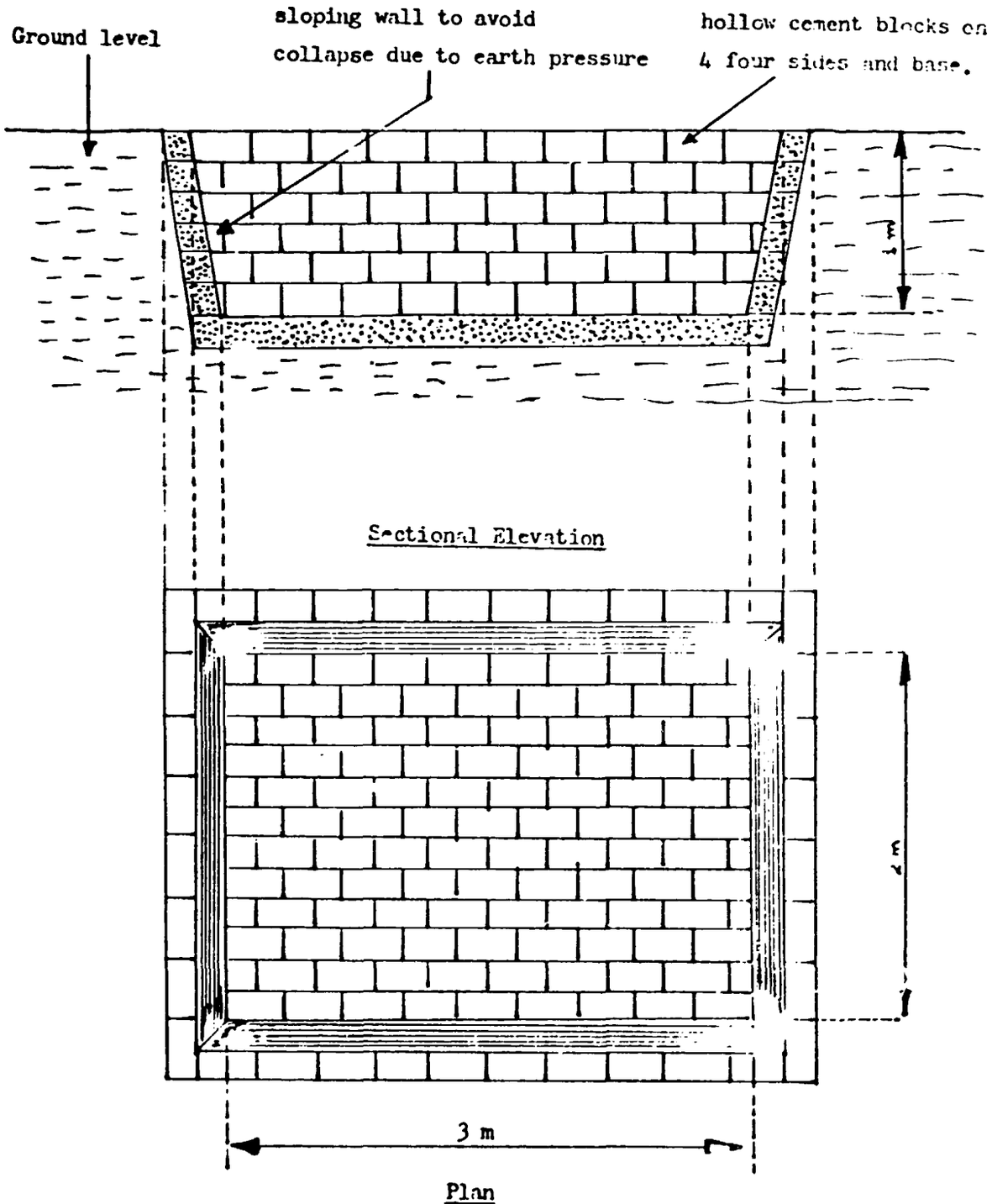
A few discarded corrugated galvanized iron sheets are used as a cover for the pit kiln.

4.2 Materials for construction : -

Hollow cement blocks 16" x 8" x 4" height 200 units a ₱ 1.80 = ₱ 360

Bags of cement 2 units a ₱30 = ₱ 60

Old corrugated G.I. Sheets - 6 units for covering = no cost.



Note : With non-friable ... the cement ... not required.

SIMPLE PIT KILN

(see section 4.1)

4.3 Cost of construction : -

Materials	₱ 420	
Labour for excavation	₱ 60	
Labour for laying bricks	₱ 220	
T o t a l	₱ 700	(US$ 95/-)

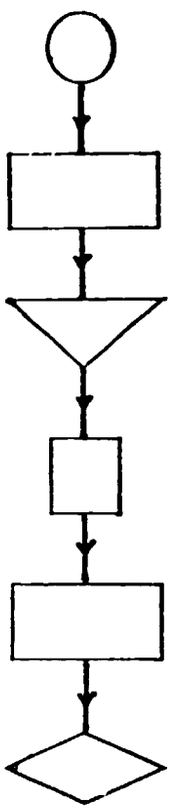
In areas with non friable soil, no lining is used. Then cost will be only that of excavation which is ₱ 60 (US$ 8/-)

4.4 Capacity : - 16,667 whole shells per batch of 600 kg charcoal.

Charcoal output = 600 kg per batch x 2 batches per week x 50 working weeks per year = 10 Tonne per year.

5. Process : -

5.1 Process flow diagram



Raw coconut shells

Carbonization in the pit

Shell charcoal

Exposure to air for 2 weeks

Screening/Inspection/[illegible]

Shell charcoal (bagged)

5.2 Description of process : -

The raw material is coconut shell halves which is a waste product of the copra processing industry. Clean, mature coconut shells are dried by exposure to the sun for one or two days.

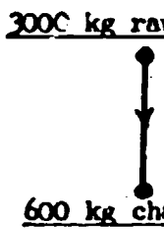
The manufacture of charcoal requires optimum carbonization of raw shells in a limited supply of air so that there is neither unburnt shell nor ash due to complete combustion.

Initially, a shovelful of coconut shells is put into the pit and ignited. When this is burning well, the pit is gradually filled with shells upto ground level. After several hours, the level of material goes down due to carbonization of material underneath. If flames appear from the top layers, water is sprinkled to put out the flame or else complete combustion would take place. Before carbonization of the top layers, more shells are added so that the level of material is about 18 inches above the ground level. After further time, more shells would get carbonized, bringing the level of fill to ground level. At this time the pit is covered with old corrugated galvanized iron sheets and then covered with earth. After a few more hours the carbonization is completed and then the pit begins to cool. The cooling takes two days, after which the covering is removed and the charcoal taken out.

The charcoal is stored in an open shed for two weeks as a pre-shipment requirement to avoid spontaneous ignition or explosions aboard the shipping vessels. There is usually contamination of the charcoal with earthy matter. This is removed by sifting on a BSS 8 wire mesh. This is a simple device with the mesh fastened to a wooden frame at an angle of 45° and held in position by two legs at the higher end. The sifting process removes any dust and ash as well.

The charcoal is bagged into second hand jute bags with an inner polyethylene liner. The net weight of each bag is about 50 Kg.

5.3 Product flow diagram



Note: - Above based on per tonne basis will read as: - 5000 kg coconut shells (27,780 whole shells) yields 1000 kg of charcoal.

The yield given in the Philippine coconut conversion table is 28% which is for the more efficient drum method.

6. Quality of finished product : -

Good quality coconut shell charcoal should be uniformly black in colour. The charcoal must be well carbonized without overburnt pieces. Broken edges show a shiny surface and charcacteristic sharp fracture. Gives a clear ring when dropped on a cement floor. The percentage fines Passing through BSS $\frac{1}{4}$ " mesh should not exceed 5%. The official specifications laid out for different grades of charcoal is as follows.

Grade	Volatile Matter	Moisture	Ash	Fixed Carbon
Metallurgical	20% max	10% max	3% max	80% min
Commercial A	20% max	10% max	3% max	75% min
Commercial B	20% max	10% max	3% max	65% min

The charcoal produced in the simple pit kiln is expected to conform to commercial grade B.

7. Source of information

Name of article : - Utilization of coconut shells.

Name of publication : - "Coconut Statistics" Semi annual 1977.

Published by : - United Coconut Association of the Philippines, Inc.
941, Josefa Llanes Escoda Street
Ermita
Manila
Philippines

T.K.G.R 1979.

Product code: [illegible]

Technology sheet no: VII / 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 : - MANUFACTURE OF COCONUT SHELL CHARCOAL USING SIMPLE DRUM KILN (Cottage Industry).

2. Uses of finished product : -

2.1 Manufacture of activated carbon.

2.2 Metallurgical use as a reductant in smelting plants.

2.3 Smokeless charcoal for household purposes.

3. Country of origin : - PHILIPPINES.

4. Equipment : -

4.1 Description of equipment: - See figure

A 55 gallon steel drum is used for this process. The lid is cut cleanly to obtain a hole of 16 inch diameter. A full lid of another drum is used as a cover. The bottom of the drum has seven ½ inch holes punched to allow air to flow into the drum. One hole at the centre and other six on per center diameter of about 12 inches. A second hand jute bag and adobe stone weight are required.

The useful life of a drum is 8 to 12 months during which time the drum will give about 200 burnings.

4.2 Materials for construction : - Not applicable.

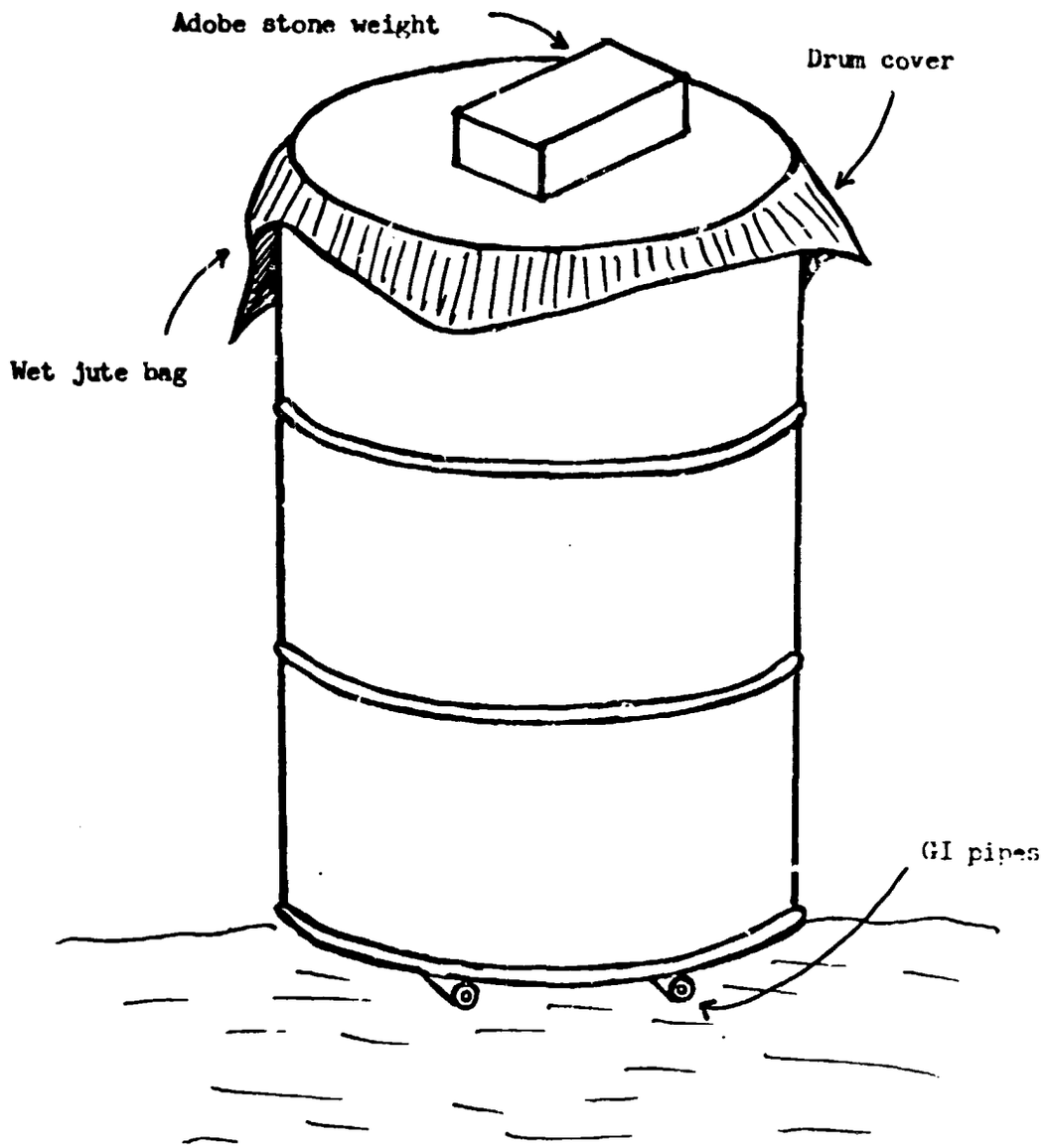
4.3 Cost of equipment : -

Cost of second hand 55 gallon steel drum is about

₱ 40 (US$ 5.39) 1 US$ = ₱ 7.42.

4.4 Capacity: - The capacity of each drum is 80 Kg of raw shell (or 445 whole shells) which gives a yield of 20 Kg charcoal (25 %). On the basis of 20 Kg per drum per burning x 5 burnings per week x 50 working weeks per year, Annual capacity per drum = 5 Tonnes.

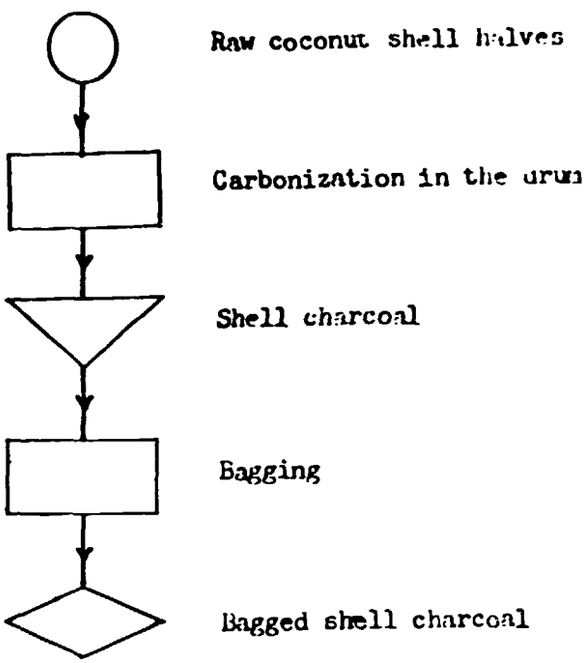
Note: - These drums are usually used in a battery of say 20 units which can be operated by one person.



SIMPLE DRUM METHOD

5. Process

5.1 Process flow diagram : -



5.2 Description of process: -

Coconut shell halves are a waste product from the copra manufacturing process. Clean, mature shells are dried in the sun for one or two days before carbonization.

The manufacture of charcoal requires optimum carbonization of raw shells in a limited supply of air so that there is neither unburnt shell nor ash due to complete combustion.

The steel drum is placed on top of two pieces of galvanized iron pipes or 3 stones to elevate the bottom of the drum. This facilitates entry of air through the holes at the bottom during carbonization.

To start the process, burn a shovelful of coconut shells on the cover of the drum. When the shells are burning fiercely, throw them into the drum. Throw in more shells just enough to put out the flames but not the fire. Continue to feed more shells making sure that the shells donot burn fiercely because a good slow burn gives the highest yield and the least ash. In about 4½ hours when the burning reaches the top, spread the wet jute bag on the top. Then place the lid in position and cover with sand or mud. The pipes under the drum are removed to stop entry of air. Take care to ensure that sand or mud does not contaminate the charcoal. For cooling, the drum it takes about 2½ hours. One man can operate about 20 drums in a working day.

5,3 Product flow diagram: -

80 Kg raw shells (444 whole shells)

↓

20 Kg shell charcoal Yield 25%.

Note: - The above based on a per tonne basis reads as: -
4000 Kg coconut shells (22,200 whole shells) yields 1000 Kg charcoal.

The yield given in the Philippine coconut conversion table is 28% which is for the more efficient 'improved' drum method.

6. Quality of finished product: -

Good quality coconut shells charcoal should be uniformly black in colour. The charcoal must be well carbonized without overburnt pieces. Broken edges show a shiny surface and characteristic sharp fracture. Gives a clear ring when dropped on a cement floor. The percentage fines passing through BSS $\frac{1}{4}$" mesh should not exceed 5%.

The official specifications laid out for different grades of charcoal is as follows: -

Grade	Volatile Matter	Moisture	Ash	Fixed Carbon
Metallurgical	20% max	10% max	3% max	80% min
Commercial A	20% max	10% max	3% max	75% min
Commercial B	20% max	10% max	3% max	65% min

The charcoal produced in the simple drum kiln conforms to commercial grades A or B depending on the skills in operation.

7. Source of information: -

Name of publication : - "How to make good quality charcoal"

Published by : - Information Staff
Philippine Coconut Authority
Diliman, Quezon City
Metromanila
Philippines.

T.K.G.R. 1979

Product code : CCCN 44.02
Technology sheet no: VII / 4

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANISATION

AND ASIAN & PACIFIC COCONUT COMMUNITY

"Consultancy Service on Coconut Processing Technology"

(Project UF/RAS/78/019)

1. Technology sheet for : - MANUFACTURE OF COCONUT SHELL CHARCOAL USING IMPROVED DRUM METHOD (Cottage Industry)

2. Uses of finished product : -

2.1 Manufacture of activated carbon

2.2 Metallurgical use as a reductant in smelting industry.

2.3 Smokeless charcoal for household purposes.

3. Country of origin : - PHILIPPINES

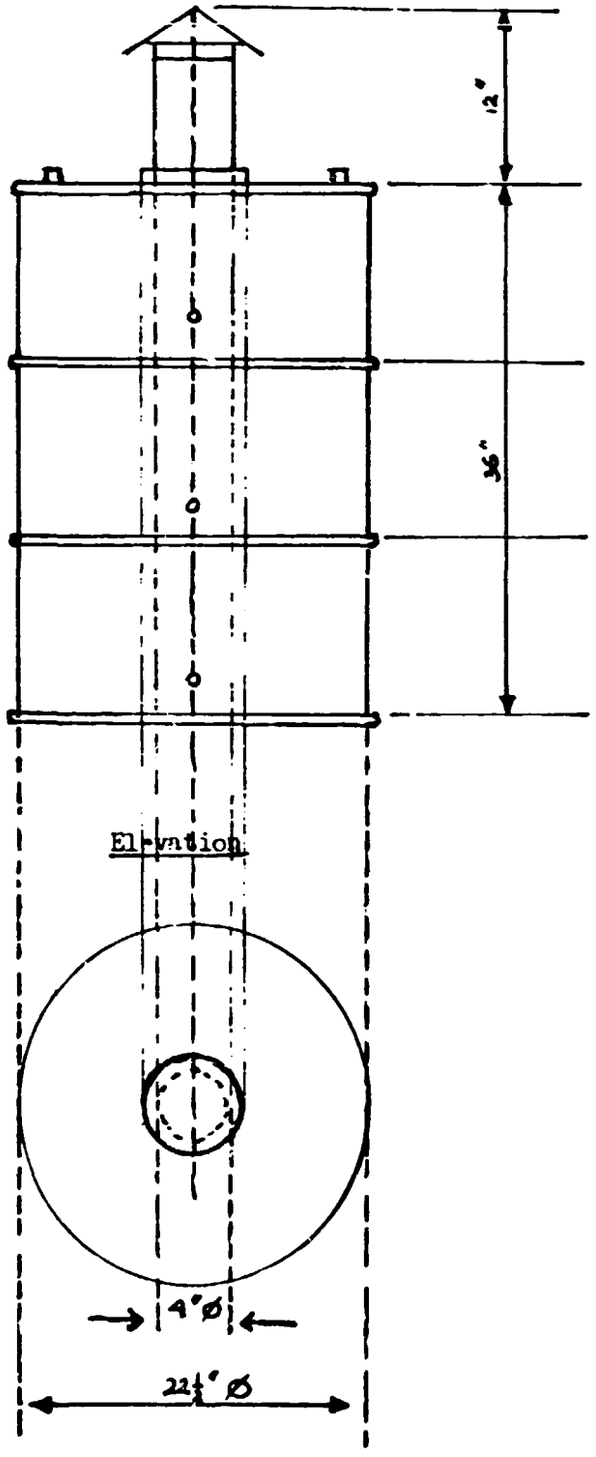
4. Equipment: -

4.1 Description of equipment: - See figure

In this method, a 55 gallon drum has holes on the side of the drum. This differs from the simple drum method where the perforations are at the bottom. There are three sets of four holes, each set being at a different level along the height of the drum, spaced at one foot distances as shown in the diagram.

For any given set, the four holes are equidistant along the circumference of the drum. Each hole is ½ inch (13 mm) diameter. The top of the drum has a 20 inch (510 mm) diameter hole cut out. A plate of 22 inch (560 mm) diameter obtained from a separate drum is used as a lid after incorporating a chimney. The chimney is 4 inches (100 mm) diameter x 1 foot height, fabricated of 26 gauge galvanized iron sheet. The chimney has a flanged base and a cap. The lid has a 4 inch hole in the centre where the chimney is placed. The base of the chimney is welded to the plate lid with three lugs.

The useful life of one drum is 8 to 12 months during which time the drum will give about 200 burnings.



IMPROVED DRUM KILN

4.2 Materials for construction: - Not applicable.

4.3 Cost of equipment: -

Cost of second hand 55 gallon steel drum is about ₱ 40
Cost of making 12 Nos holes, cutting lid, and fabricating chimney: - ₱ 25 (estimated)
Total cost per drum = ₱ 65 (US$ 8.76) - estimated

1 US$ = ₱ 7.42

4.4 Capacity

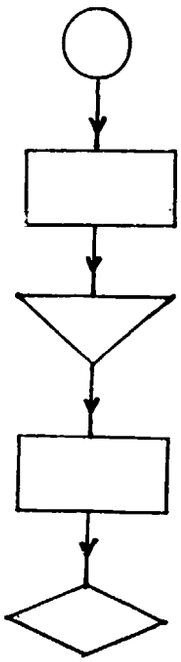
The capacity of each drum is about 80 kg of raw shell (445 whole shells) which gives 22.4 kg charcoal at 28% yield.
22.4 kg x 5 burnings per week x 50 working weeks per year,

The annual capacity per drum = 5.6 Tonne.

Note: - These drums are usually used in a battery of 20 drums which can be operated by one man.

5. Process : -

5.1 Process flow diagram : .



Raw coconut shell halves

Carbonization in the drum

Shell charcoal

Bagging

Bagged shell charcoal

5.2 Description of process : -

Coconut shell halves are a waste product from the copra manufacturing process. Clean, mature shells are dried in the sun for one or two days before carbonization.

The manufacture of charcoal requires optimum carbonization of raw shells in a limited supply of air so that there is neither unburnt shell nor ash due to complete combustion.

The steel drum is charged with raw shells after placing temporarily, a 4 inch diameter wooden pole along the axis of the drum. The wooden pole is then removed, leaving a hollow space which allows the flow of smoke during carbonization.

To start carbonization, a piece of burning rag is dropped to the bottom of the drum through the hollow space. When the fire is well underway, the cover with the chimney is placed into position and the two upper sets of holes are covered with clay. Carbonization which starts from the bottom progresses as it goes up as well as radially from the hollow space. When carbonization is complete in a particular zone, a persistant glow can be seen right round in all the four holes of a set. When the bottom most set of holes indicate this situation, the middle set of holes is opened and the bottom set closed with clay. The stoppage of air flowing into the bottom region avoids over-carbonization in that region.

The progressive carbonization results in reduction in volume of contents and therefore more shells are added from the top. When the middle region is carbonized well, the top set of holes is opened while the middle set is now closed. A further addition of raw shells is done to fill the volume reduction to maximise capacity per burning. When the top region is well carbonized, the top set of holes is also sealed with clay, resulting in complete stoppage of air inflow to the drum.

The proper sealing of all holes is very important to ensure a good yield and avoidance of over-carbonization. The burning process takes about 4 hours and another 2½ hours for cooling.

These drums are used in a set of about 20 drums which can be easily handled by one operator.

5.3 Product flow diagram: -

80 Kg raw shells (444 whole shells)

↓

22.4 Kg shell charcoal (yield 28%)

Note: The above expressed on a per tonne charcoal basis would read 3570 Kg coconut shells (19,820 whole shells) will yield 1000 kg charcoal.

The yield of 28% is as per Philippine Coconut conversion table.

6. Quality of finished product: -

Good quality coconut shell charcoal should be uniformly black in colour. The charcoal must be well carbonized without unburnt pieces. Broken edges show a shiny surface and characteristic sharp fracture. Gives a clear ring when dropped on a cement floor. The percentage fines passing through BSS $\frac{1}{4}$" mesh should not exceed 5%.

The official specifications laid out for different grades of charcoal is as follows: -

Grade	Volatile matter	Moisture	Ash	Fixed Carbon
Metallurgical	20% max	10% max	3% max	80% min
Commercial A	20% max	10% max	3% max	75% min
Commercial B	20% max	10% max	3% max	65% min

The charcoal produced in the improved drum kiln conforms to commercial grade A.

7. Source of basic information : -

Name of article : - "Utilization of coconut shell".

Name of publication : - Coconut Statistics, Semi annual 1977.

Published by : - United Coconut Association of the Philippines, Inc.
941, Josefa Llanes Escoda Street
Ermita
Manila
Philippines.

T.K.G.R 1979.

Product code : CCCN 44.02
Technology sheet no: VII / 5

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 : - MANUFACTURE OF COCONUT SHELL CHARCOAL USING THE "PHILCOA" KILN (Small scale industry).

2. Uses of finished product : -

2.1 Manufacture of activated carbon.

2.2 Metallurgical use as a reductant in smelting industry.

2.3 Smokeless charcoal for household purposes.

3. Country of origin : - PHILIPPINES

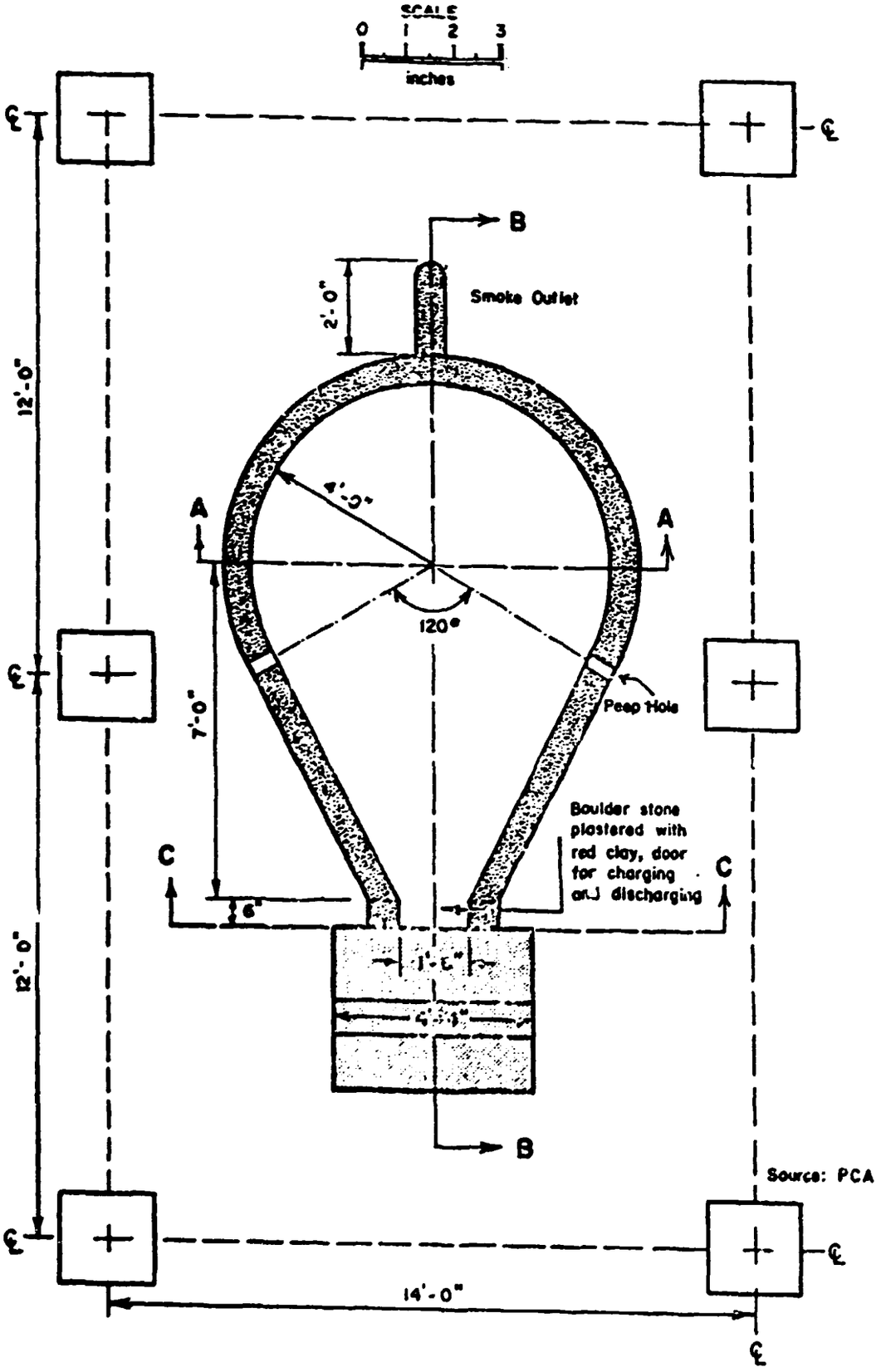
4. Equipment: -

4.1 Description of equipment : - See diagrams on pages 2,3 and 4.

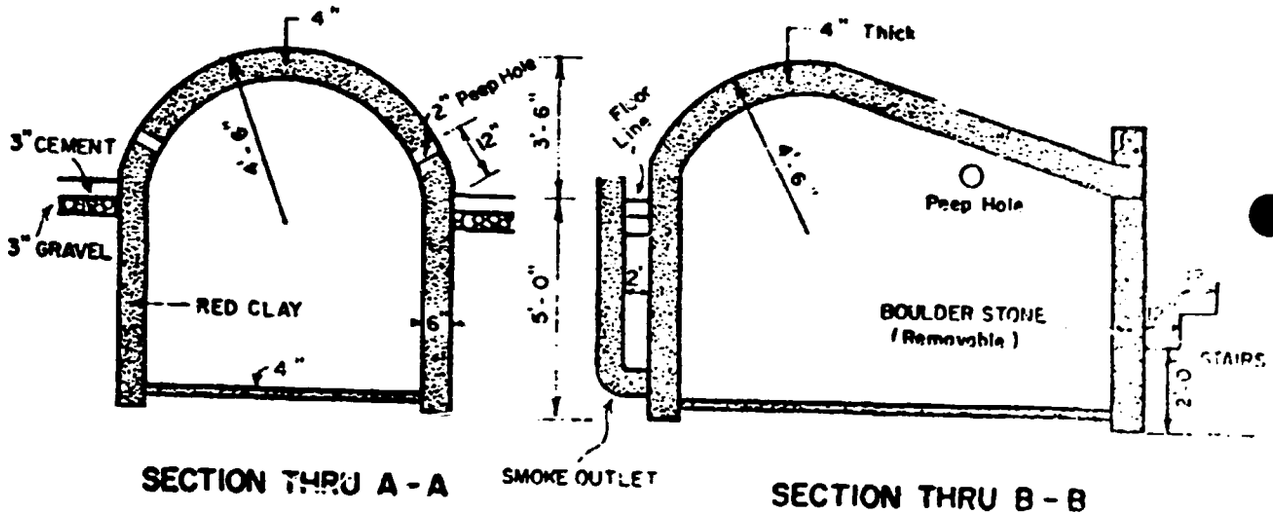
The "Philcoa" kiln has a 4 inch concrete floor located 5 feet below the ground level. It has vertical walls and a complex curved arch covering, all of which are constructed out of fire bricks and clay mortar. The entire kiln is protected by a suitable structure to keep out rain and water. The door for charging and discharging is kept closed with adobe stones during carbonization.

4.2 Materials for construction : -

The following bill of materials is for the "Philcoa" kiln complete with the roof and structure. The prices are those applicable for 1979.



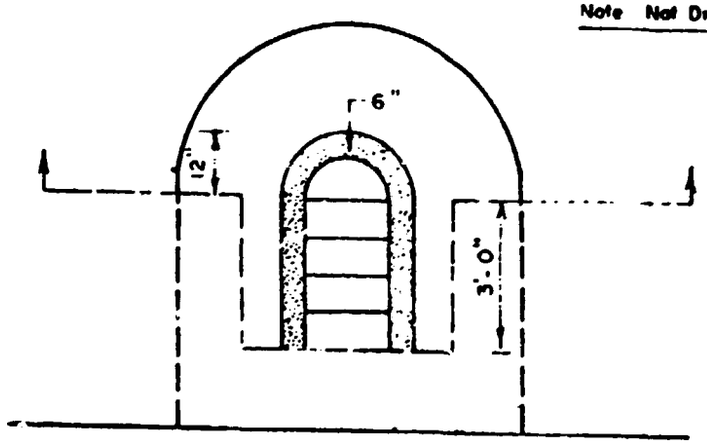
LAYOUT PLAN OF PHILCOA KILN



SECTION THRU A - A

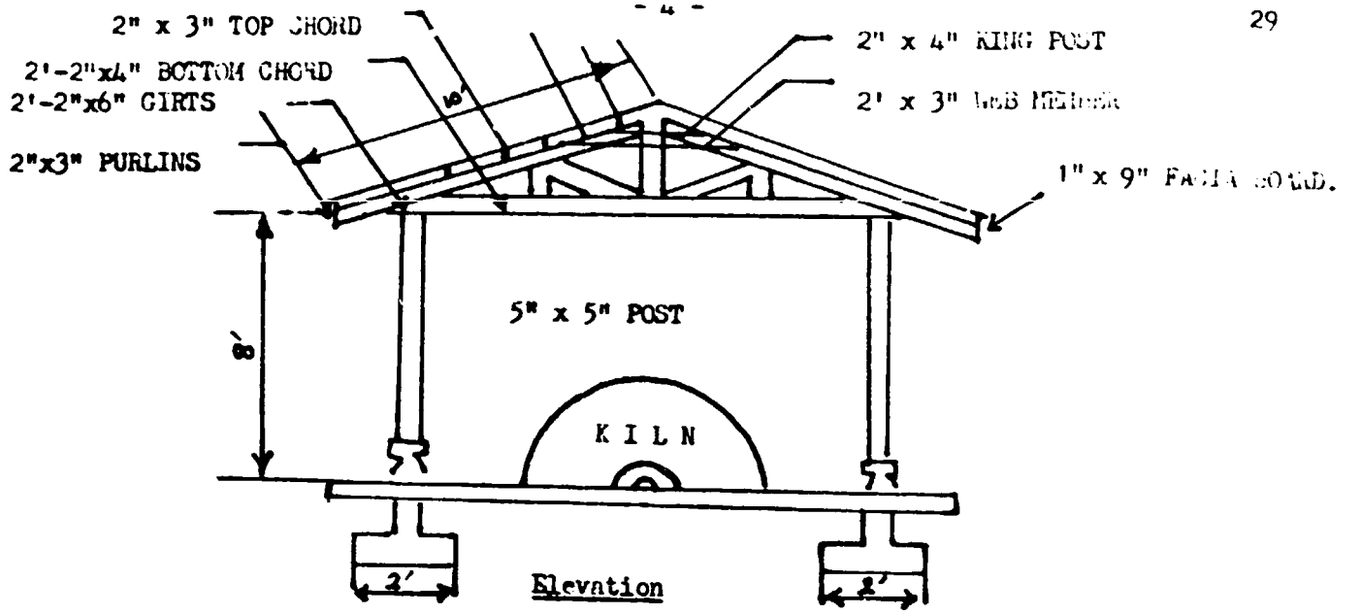
SECTION THRU B - B

Note Not Drawn To Scale

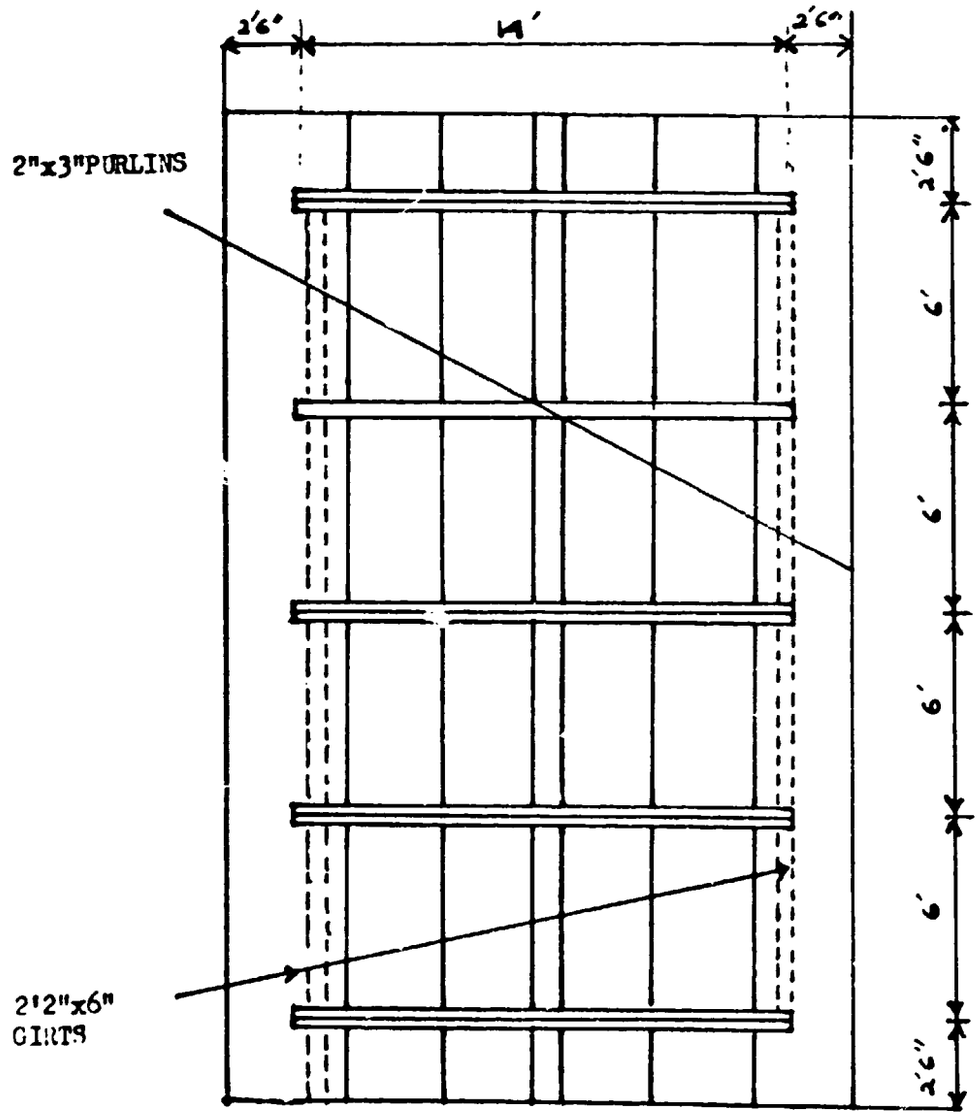


SECTION THRU C - C

Source: PCA



Elevation



Plan of roof frame

Scale $\frac{3}{16}$" = 1 foot

ROOF FOR PHILCOA KILN

				₱
Posts	- 6 Pcs.	5" x 5" x 8'	Apitong S4S	450
Girts	- 8 Pcs.	2" x 6" x 12'	Apitong S4S	432
Bottom Chord	- 10 Pcs.	2" x 4" x 16'	Apitong S4S	480
Top Chord	- 10 Pcs	2" x 5" x 10'	Apitong S4S	480
King Post & C.P.	- 7 Pcs.	2" x 4" x 10'	Apitong S4S	375
Web Members	- 5 Pcs.	2" x 3" x 10'	Apitong S4S	112
Purlins & Blocks	- 16 Pcs.	2" x 3" x 16'	Apitong S4S	576
Facia Board	- 4 Pcs.	1" x 8" x 10'	Apitong S4S	120
Facia Board	- 4 Pcs.	1" x 8" x 16'	Apitong S4S	192
Cleats	- 2 Pcs.	2" x 2" x 12'	Apitong S4S	36
Form Lumber	- 6 Pcs.	1/2" x 6" x 8'	Apitong Rough	54
Form Lumber	- 6 Pcs.	1" x 2" x 8'	Apitong Rough	36
Bolts w/Nuts & Washers	- 12 Pcs.	1/2"ϕ x 6"		30
Bolts w/Nuts & Washers	- 12 Pcs.	5/8"ϕ x 8"		36
W.I. Straps	- 12 Pcs.	3/16" x 1¼" x 22"		72
G.I. Sheets	- 25 Pcs.	32" x 10' ## 26 Corr.		1,750
G.I. Sheets	- 2 Pcs.	36" x 10' ## 26 Plain.		130
Nails	- 2 kg	2" C.W.	Nails	16
Nails	- 3 kg	3" C.W.	Nails	24
Nails	- 4 kg	4" C.W.	Nails	32
Nails	- 3.5 kg	2 1/2" roofing	Nails	28
Lead Washers	- 4 kg			40
G.I. Pipes	- 2 Pcs.	4" ϕ x 5' S.H.		300
	- 1 Pc.	4" ϕ x Elbow 45°		30
Cement	- 34 bags	(94 ##)		1,020
Sand	- 3 Cu.M.			195
Gravel	- 3.5 Cu.M.			262
Boulder Stone No. of pieces and sizes to fit the doors (say 50 pcs)				150
Red Clay equivalent to Los Banos Clay	- 1 Cu.M.			40
Fire Bricks	- 10,000 Pcs. 2" x 4" x 8" at ₱ 3			30,000
			Sub total	₱ 37,498
			Contingencies	2,502
			Cost of Materials	₱ 40,000

4.3 Cost of equipment : - (1979 prices)

Cost of material	₱ 40,000	
Cost of labour	₱ 5,000	
Total cost	₱ 45,000	(US$ 6000)

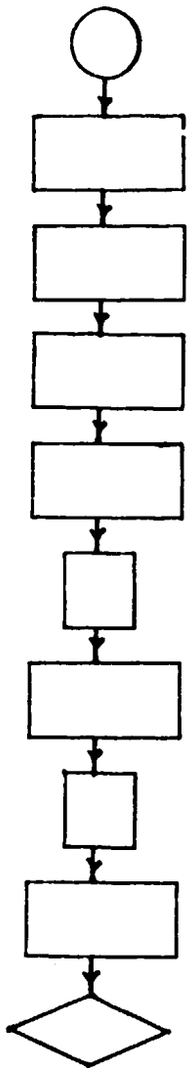
4.4 Capacity : -

The kiln can be charged with 7000 shells per burning with a cycle time of 3 days.

The yield per cycle is 350 kg.
0.35 Tonne per cycle x 2 cycles per week x 50 working weeks per year gives an annual capacity of 35 Tonne.

5. Process : -

5.1 Process flow diagram : -



Raw coconut shell halves

Pre charging and charging kiln

Firing and sealing door

Carbonization for 36 hours.

Total sealing of kiln

Cooling for 36 hours

Discharging charcoal after 3 day cycle.

Exposure to air for 2 weeks

Bagging

Bagged coconut shell charcoal

5.2 Description of process : -

The source of raw material is the waste product of the copra making process where coconut shell halves are obtained. Clean and mature coconut shells are dried for 1 or 2 days in the sun before charging the kiln.

The principle of carbonization involves burning raw shells in a limited supply of air such that shell are neither completely burnt nor left underburnt.

The kiln is precharged with inflammable material such as sundried ricestraw mixed with rice hull or dried coconut leaves. Thereafter it is charged fully with coconut shells.

The inflammable material is fired and when properly burning, the door is closed with adobe stones and sealed with clay. The time of closing the door is noted. Continuously check for leaking smoke from cracks etc on the brickwork and seal all places except the two peep holes. Carbonization will progress gradually and be completed in about 36 hours.

Thirty six hours after closing the door, the peep holes are observed for quality of smoke coming out. If the smoke has changed from thick white colour to a clear smoke, the carbonization is complete. At this stage all the peep holes are covered and sealed with clay. The kiln is left for another 36 hours for cooling. The total cycle time is 3 days.

When the external surface of the kiln has returned to normal temperature, the peep holes and the adobe stone door are opened and then the charcoal discharged.

The charcoal is exposed to air for 2 weeks as a pre-shipment requirement. It is then bagged in polylined jute bags containing approximately 50 Kg nett.

5.3 Product flow diagram : -

1260 kg raw shells (7000 whole shells)

350 kg shell charcoal (yield 28%)

The above on the basis of per tonne charcoal reads: - 3600 kg shells (20,000 whole shells) yield 1000 kg charcoal.

The above yield of 28% is as per Philippine Coconut conversion table.

6. Quality of finished product : -

Good quality coconut shell charcoal should be uniformly black in colour. The charcoal must be well carbonized without unburnt pieces. Broken edges show a shiny surface and characteristic sharp fracture. Gives a clear ring when dropped on a cement floor. The percentage passing through a BSS $\frac{1}{4}$" mesh should not exceed 5%.

The official specifications laid out for different grades of charcoal is as follows: -

Grade	Volatile matter	Moisture	Ash	Fixed Carbon
Metallurgical	20% max	10% max	3% max	80% min
Commercial A	20% max	10% max	3% max	75% min
Commercial B	20% max	10% max	3% max	65% min

The charcoal produced in the "Philcoa" kiln conforms to commercial grade A.

7. Source of basic information: -

Name of article : - "Utilization of coconut shell"
Name of publication : - Coconut Statistics, Semi annual 1977.
Published by : - United Coconut Association of the Philippines, Inc.
941, Josefa Llanes Escoda Street
Ermita
Manila
Philippines.

T.K.G.R. 1979.

Product code : CCCN 14.05 c

Technology sheet no: VII / 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 : - COCONUT SHELL FLOUR USING GRAVITY CONVEYING SYSTEM (Small scale industry).

2. Uses of finished product : -

2.1 Filler and extender for phenolic thermosetting plastics

2.2 Filler for phenolic glues used in plywood manufacture

2.3 Filler for mosquito incence coils

2.4 Filler for flux coating of electric welding rods.

3. Country of origin : - PHILIPPINES.

4. Equipment: -

4.1 Description of equipment : - See figure A, page 2 for layout of plant.

4.1.1 Bucket Elevator for coconut shell halves.

4.1.2 Magnetic Separator - This separates iron particles mixed with the shells.

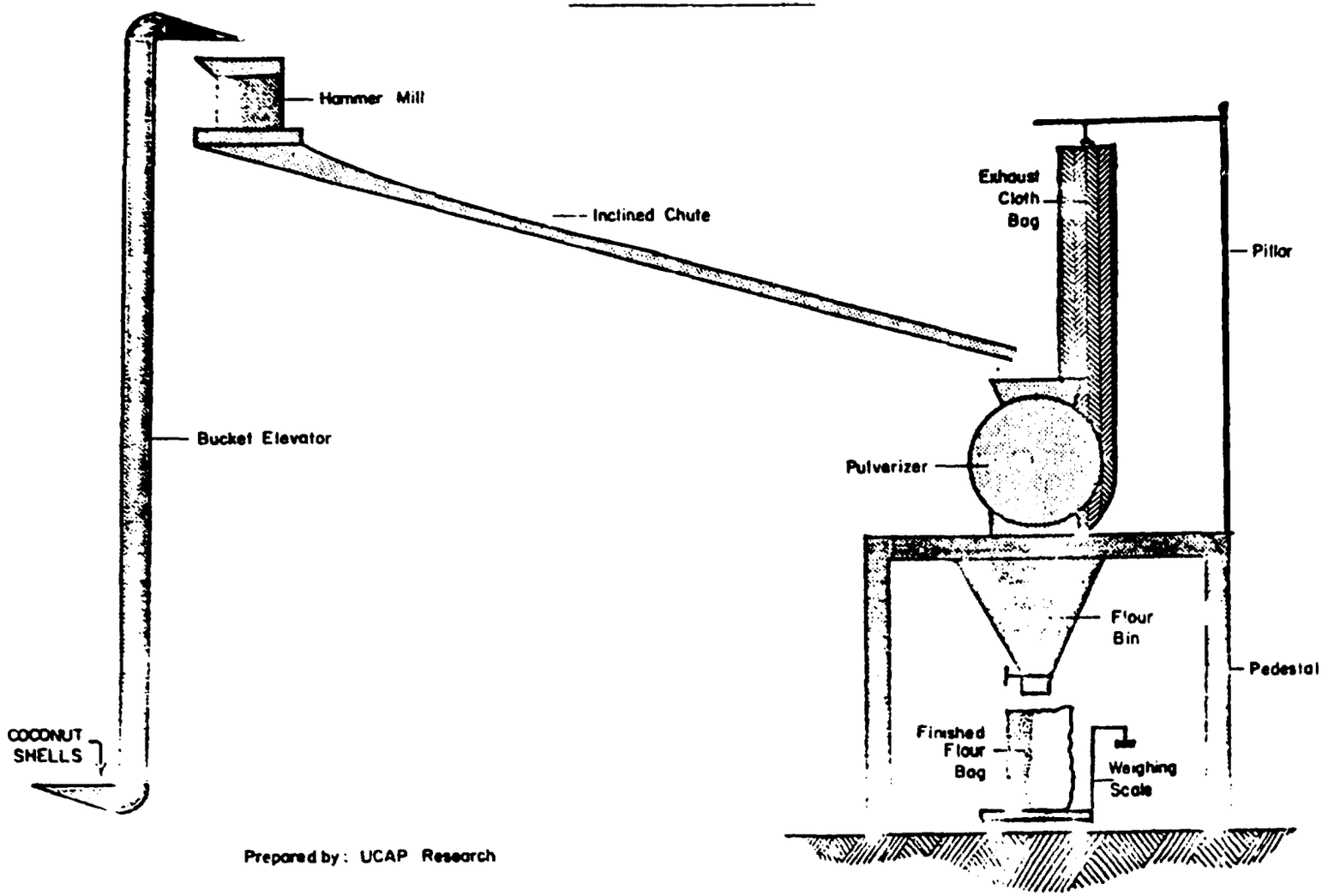
4.1.3 Hammer mill (Pre Crusher) This is a hammer type disintegrator to reduce coconut shell halves down to 5 or 6 mm square.

4.1.4 Inclined chute - This conveys by gravity, the crushed material to the pulverizer.

Figure A

TYPICAL LAYOUT OF COCONUT SHELL FLOUR PLANT

(GRAVITY CONVEYOR SYSTEM)



Prepared by: UCAP Research

4.1.5 Pulverizer — This reduces the granules from 5 or 6 mm down to less than BSS 100 by using a 100 mesh screen at the base outlet. The pulverizer comprises basically of a rotor and stator arrangement to cause size reduction of the coconut shell granules through attrition (rubbing). Since the coconut shell itself is abrasive, there is usually rapid wastage of the rotor and stator. The Pulverizer is mounted on a mild steel platform to facilitate fixing a collection bin below it. The pulverizer has a separate outlet connected to an exhaust cloth bag to trap the dust. The dust returns to the flour bin for bagging along with the other particles which have been pulverized.

4.1.6 Collection bin with valve - This is fabricated of mild steel sheet.

4.1.7 Platform weighing machine - for weighing bags up to 50 Kg (110 pounds) net weight.

4.2 Materials for construction : -

The equipment listed under section 4.1 requires various foundations, steel platforms, chutes and piping etc. Electrical installations are required for the machinery. Details of these items are not available.

As regards buildings, the manufacturing area will require a floor space of 25 feet width and 50 feet length. The height to be 20 feet. Storage space required is 25 feet width and 30 feet length with stacking height of 10 feet for the finished material. The raw material is stored in the open.

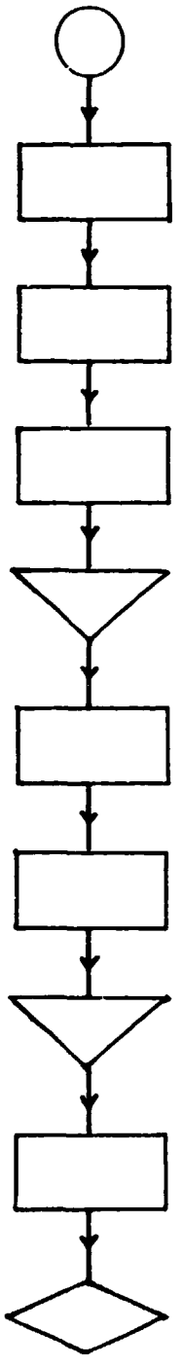
4.3 Cost of construction : - Information not available.

4.4 Capacity : -

250 Kg/hour x 8 hours/day x 250 days/year = 500 Tonne/year.

5. Process: -

5.1 Process flow diagram.



Coconut shell halves

Convey vertically up with bucket elevator

Remove iron particles with magnetic separater

Disintegrate with hammer mill

Coconut shell granules (5 or 6 mm)

Gravity conveying through inclined chute

Pulverizing

Coconut shell flour with dust (- 100 #)

Collecting into bags and weighing

Bagged shell flour (-100 #)

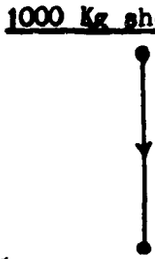
5.2 Description of process : -

Coconut shell halves are a by-product of the copra making process. Clean, dry, mature coconut shell halves are fed into the bucket elevator and conveyed upto the feeding point of the hammer mill. To ensure only good shells are used, the bad ones are weeded out and those with husk matter are cleaned manually. At the top of the elevator and before entering the mill, an electro-magnetic separater traps any iron particles that may be mixed with the coconut shells. These iron particles if not removed will damage the hammer mill and pulverizers.

Inside the hammer mill, the shell halves are disintegrated into granules of 5 or 6 mm square by impact. The disintegrated material flows under gravity down an inclined chute for feeding the pulverizer. Inside the pulverizer, the granules are reduced in size by the rotor-stator arrangement through attrition (rubbing). The pulverizer has a screen of BSS 100 at the outlet so that oversize particles will be subjected to further pulverizing. The pulverized particles drop down into the flour bin. Very light particles move upwards into the exhaust cloth bag where it is trapped and then fall down into the same flour bin.

The flour in the bin is collected into bags of 75 to 100 lbs, by weighing. The bags comprise of 5 ply Kraft paper. The mouth of the bags is stitched by machine.

5.3 Product flow diagram : -



*Estimated.

6. Quality of finished product : -

The finished product has particles less than BSS 100 going down in size to fine particles as dust. Therefore the product is not of close grading and consequently not of desired quality for some applications given in section 2.

7. Source of basic information : -

Name of article : - "Utilization of coconut shell"

Name of publication : - Coconut Statistics, Semi annual 1977.

Published by : - United Coconut Association of the Philippines, Inc.
941 Josefa Llanes Escoda Street
Ermita
Manila
Philippines

8. Notation : - +100 # Bigger than (retained on) BSS 100 mesh.
-100 # Smaller than (passing through) BSS 100 mesh.

T.K.G.R 1979.

Product code : CCCN 14.05 c

Technology sheet no: VII / 7

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 : - COCONUT SHELL FLOUR USING PNEUMATIC CONVEYING AND CYCLONE SYSTEM (Small to medium scale industry).

2. Uses of finished product : -

2.1 Filler and extender for phenolic thermosetting plastics

2.2 Filler for phenolic glues used in plywood

2.3 Filler for mosquito incence coils.

2.4 Filler for flux coating of electric welding rods.

3. Country of origin : - PHILIPPINES

4. Equipment: -

4.1 Description of equipment : - See figure B, page 2 for layout.

4.1.1 Raw material bin : - For loading coconut shell halves.

4.1.2 Inclined conveyor : - For elevating and feeding coconut shells to the hammer mill.

4.1.3 Magnetic separator : - For separating iron particles mixed with shells.

4.1.4 Hammer mill (Precrusher). This is a hammer type disintegrator to reduce coconut shell halves down to 5 or 6 mm square. The hammer mill is connected to a dust extractor.

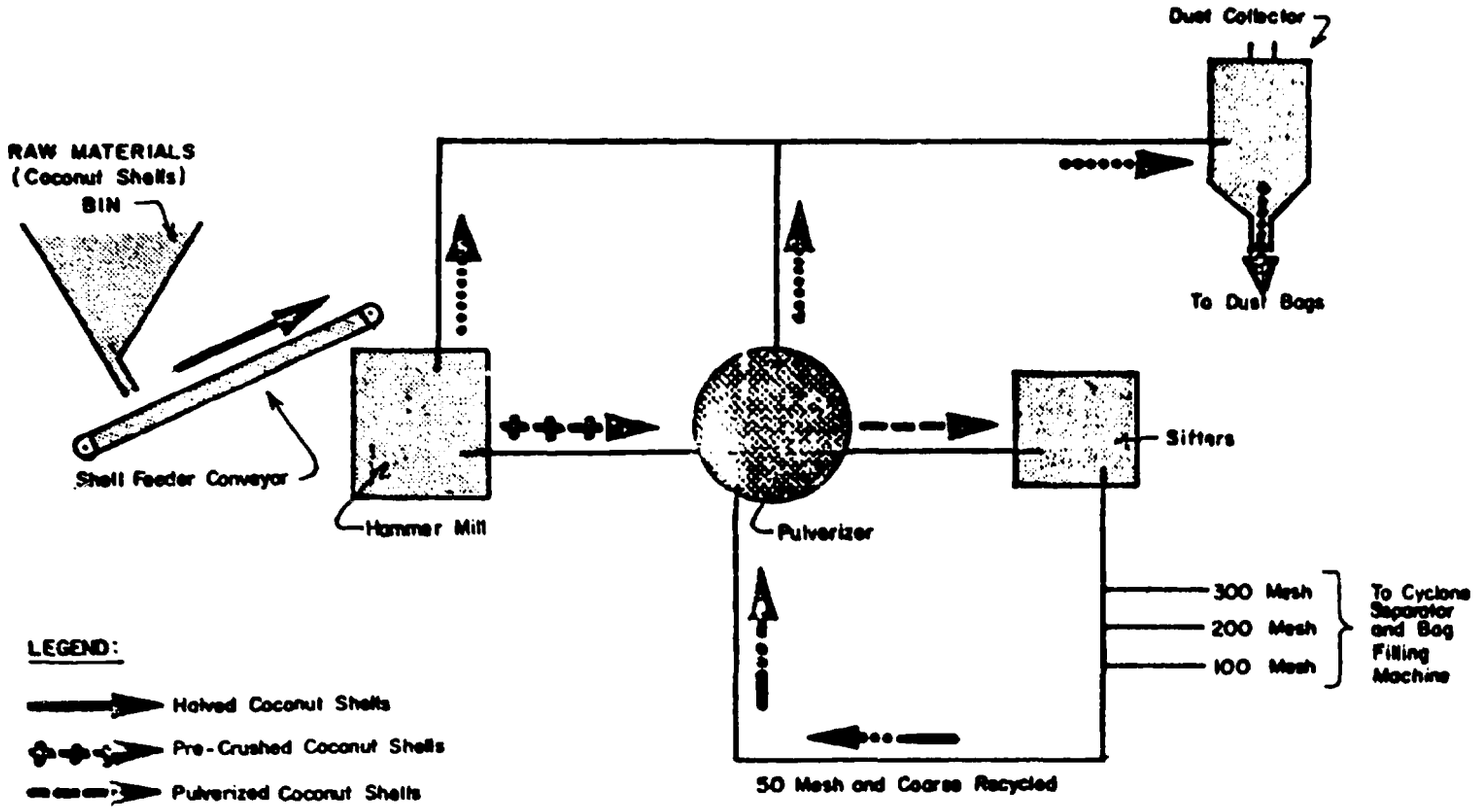
4.1.5 Conveyor : - For the disintegrated material to the pulverizer.

4.1.6 Pulverizer : - This reduces the granules from 5 or 6 mm down to below BSS 50.

Figure 8

SCHEMATIC LAYOUT OF A COCO-SHELL FLOUR PLANT

(PNEUMATIC FEEDING SYSTEM)



LEGEND:

- Halved Coconut Shells
- Pre-Crushed Coconut Shells
- Pulverized Coconut Shells
- Dust
- Recycled Coarse Particles

Source: Borden Chemical Company (Phils.) Inc.

Prepared by: UCAP Research

RECOVERY: Coconut Shell Flour 80 %
Dust 20 %

DUST ANALYSIS:

400 Mesh 95 %
Fibrous Materials 5 %

The pulverizer comprises basically of a rotor and stator arrangement for size reduction of the granules by means of attrition (rubbing). Since the coconut shell itself is abrasive, there is usually rapid wastage of the rotor and stator. As shown in the schematic layout, the output of the pulverizer is conveyed to charge the sifter. The dust from the pulverizer is removed by connecting onto the dust extractor.

4.1.7 Conveyor : - For flour from pulverizer to sifters.

4.1.8 Sifters : - Have two wire mesh screens, whose sizes are usually BSS 50 and BSS 100. Several sifters work in parallel.

4.1.9 Cyclone separator system. The material smaller than BSS 100 passing through the sifters is fed to the cyclone. The cyclone separates -100 +200 #, -200 +300 # and -300 +400 #

4.1.10 Bag filling machine For filling bags upto 50 Kg and stitching.

4.1.11 Dust collector/extractor From the collection bin, the dust is bagged as a separate grade of shell flour.

4.2 Materials for construction: -

The equipment listed under section 4.1 requires various foundations, steel platforms, piping for the dust extractor and the cyclones etc. Electrical installations are required for the machinery.

Building requirements for the industry will be as follows. Manufacturing area 25 feet width x 50 feet length x 20 feet height. Storage space for finished material is 20 feet width x 30 feet length with stacking height of 10 feet. The raw material is stored in the open.

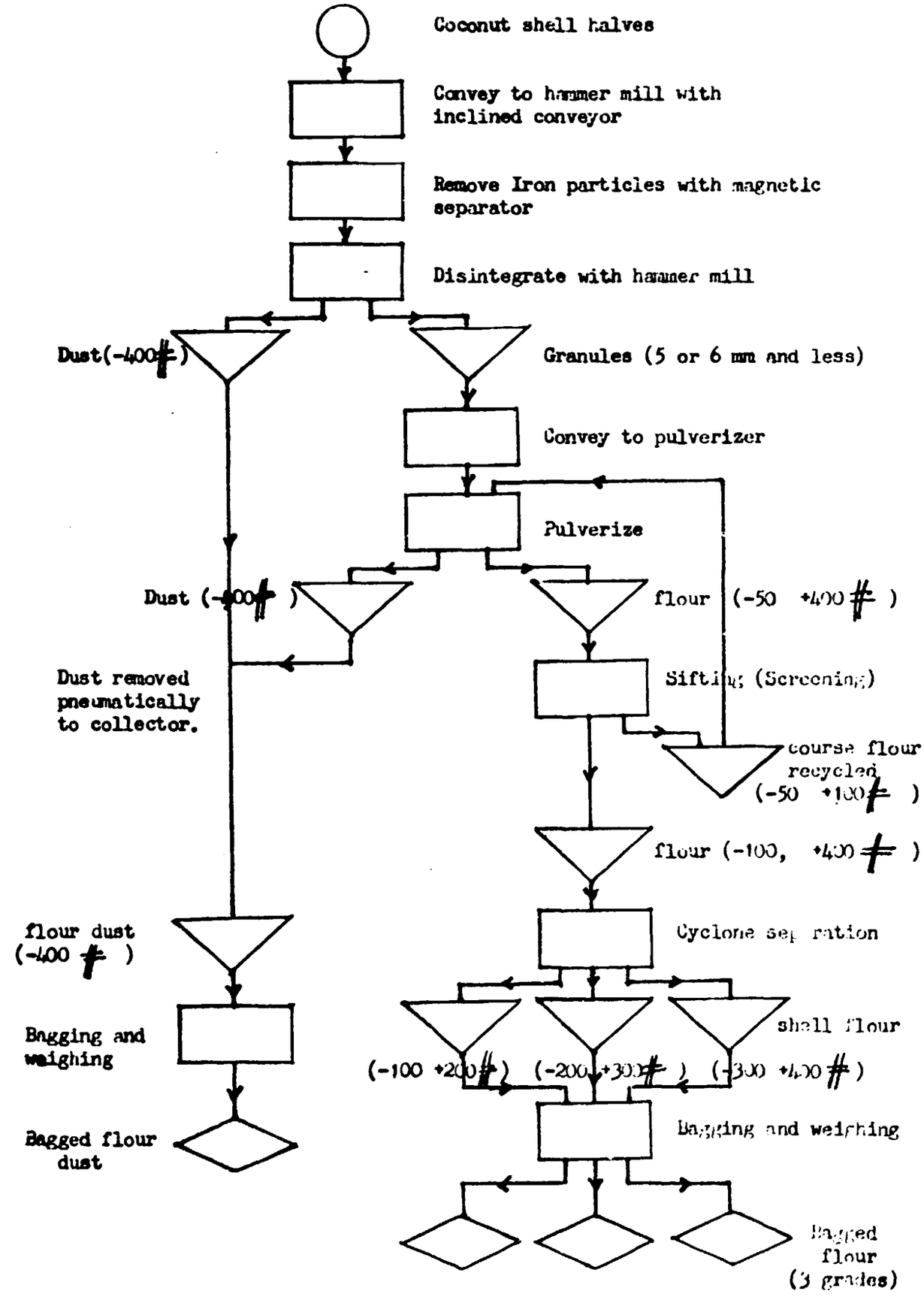
4.3 Cost of equipment and construction: - Information not available.

4.4 Capacity: -

250 Kg/hour x 8. hours/day x 250 days/year = 500 Tonne/year.

5. Process: -

5.1 Process flow diagram: -



5.2 Description of process: -

Coconut shell halves are a by-product of the copra manufacturing process. Bad shells are weeded off. Shells with husk matter are cleaned manually.

Clean, dry, mature coconut shell halves are loaded into the raw material bin from which they are discharged at a steady rate onto an inclined conveyor. At the top of the conveyor and before entering the hammer mill, an electro-magnetic separater removes all iron particles mixed with the coconut shells. The iron particles if not removed; will cause extensive damage to the hammer mill and the pulverizer.

The hammer mill disintegrates the shell halves into granules of 5 or 6 mm by impact. The disintegrated material is conveyed to the pulveriser. Dust is removed by means of an extractor.

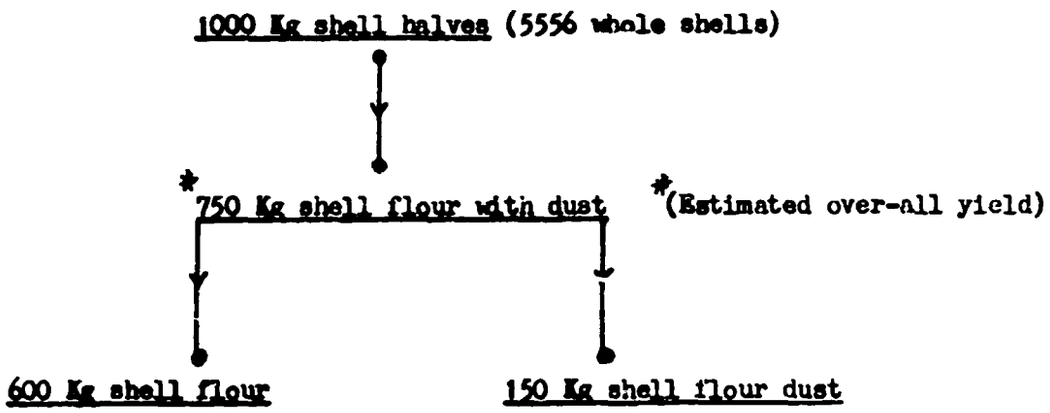
Inside the pulverizer, the granules are reduced in size by the rotor and stator arrangement through attrition (rubbing). The pulverizer has a screen of BSS 50 at the outlet so that oversize particles will be subjected to further pulverizing. The dust particles are removed from the pulverizer by the dust extractor. The pulverized flour is conveyed to the sifters which usually work parallel. The sifters usually have two decks for wire mesh screens. The upper deck is fitted with BSS 50 wire mesh and the lower with BSS 100 wire mesh. Material retained on the top deck and bottom deck is fed back to the pulverizer. Material smaller than BSS 100 is fed to the cyclone system.

The cyclone system separates the flour to closely graded sizes as follows: - -100 +200#, -200 +300#, -300 +400#. These sizes are weighed and bagged into 5 ply kraft paper bags containing 75 to 100 pounds nett. The mouth is stitched by machine.

The dust (-400#) collected from the disintegrator and the pulveriser, is separately weighed and bagged into 5 ply kraft paper bags and sold as a special grade.

The efficient collection of dust is a necessity to avoid a hazardous situation. If dust is allowed to freely contaminate the air, a very combustible mixture is formed when the concentration reaches 8% dust in air.

5.3 Product flow diagram: -



6. Quality of finished product: -

The quality specifications of the 3 grades of shell flour

- 100 + 200 #
- 200 + 300 #
- 300 + 400 #

are not available.

As can be expected, each grade will have bulk of the material passing through the larger screen size and the bulk retaining on the small screen.

The coconut shell flour -400# has 95% passing through BSS 400 mesh. The 5% retained represents fibrous material present in the raw coconut shell.

7. Source of information: -

Name of article : - "Utilisation of coconut shell"

Name of publication : - "Coconut Statistics" Semi annual 1977.

Published by : - United Coconut Association of the Philippine, Inc.
941 Josefa Llanes Escoda Street,
Ermita
Manila
Philippines.

8. Notation : -

+ 100 # = Bigger than (retained on) BSS 100 mesh

- 100 # = Smaller than (passing through) BSS 100 mesh

- 100 + 200 # = Particle size range specified as bulk passing through BSS 100 mesh and bulk retained on BSS 200 mesh.

T.K.G.R 1979.

Product code : CCCN 14.05 c
Technology sheet no: VII / 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 :- COCONUT SHELL FLOUR USING PNEUMATIC CONVEYING AND CYCLONE SYSTEM (Small to medium scale industry).

2. Uses of finished product : -

2.1 Filler and extender for phenolic thermosetting plastics.

2.2 Filler for phenolic glues used in the manufacture of plywood and polyester laminated sheets.

3. Country of origin : - SRI LANKA

4. Equipment : -

4.1 Description of equipment : -

4.1.1 Inclined conveyor : - To elevate shells up to disintegrator

4.1.2 Disintegrator : - This equipment reduces the coconut shell pieces into granules. The output of the disintegrator is conveyed pneumatically to the first cyclone separator (A).

4.1.3 First Cyclone Separator (A)

This generally sucks out all particles smaller than BSS 100 and conveys to the second cyclone separator (B). Particles bigger than BSS 100 fall down into the common hopper feeding the pulverizers.

4.1.4 Pulverizer

There are three pulverizers working in parallel, fed from a common hopper.

The pulverizers are of the same design and "Original Pallman" Type PP6. The pulverizers grind the granules down to around BSS 50 and less by the use of screens at the outlet. The Pulverizer comprises basically of a rotor and stator arrangement for size reduction of the granules through attrition (rubbing). Since the coconut shell flour is abrasive, there is usually rapid wastage of the rotor and stator. The output from the three pulverizers is fed back into the same cyclone separator (A). by pneumatic means.

4.1.5 Second cyclone Separator (B)

This cyclone separates and sucks out dust (-300 μ) and sends through the blower inlet into the dust collecting bags. Particles which are bigger, fall down the cyclone through a delivery pipe line. This pipe divides into 6 smaller pipes, each feeding a sifter.

4.1.6 Sifters

There are six sifters working in parallel. They are similar, and of the simple reciprocating type, mounted on leaf spring blades. The motion is derived by an eccentric on a shaft powered by an electric motor. Each sifter has two wire mesh screens, Usually BSS 80 - is used on the top deck and BSS 100 on the second deck.

4.1.7 Blower

This of the centrifugal type. The axial inlet is connected to cyclone B. The outlet is connected to the dust collector.

4.1.8 Dust collector — This compfises of two rows (sets) of filters fitted to the outlet of the blower after division into two pipe lines. Each set comprises of 21 filter bags.

4.2 Materials for construction : -

The equipment listed under section 4.1 requires various foundations, steel platforms, piping for the pneumatic conveying and cyclone systems. Electrical installations are required for the machinery. Details of these requirements are not available.

Building requirements for the industry will be as follows. The manufacturing area comprises of a multifloor building of about 40 feet width x 50 feet length x 30 feet height which is capable of withstanding vibration. At the ground floor there are four separate rooms utilised as follows : -

1. Pulverizers (3 units)
2. Bagging and weighing flour
3. Blower room
4. Dust collector system

A separate section adjascent to the main building has the disintegrator installed. On the first floor (above Pulverizers and bagging section), the six sifters are installed with output delivery chutes going down to the bagging section. The Dust collector system has no first floor above it. A mezzanine floor/platform above the first floor holds the common feed hopper for the sifters. The top floor has the two cyclones installed. This floor has no roof.

4.3 Cost of construction : -

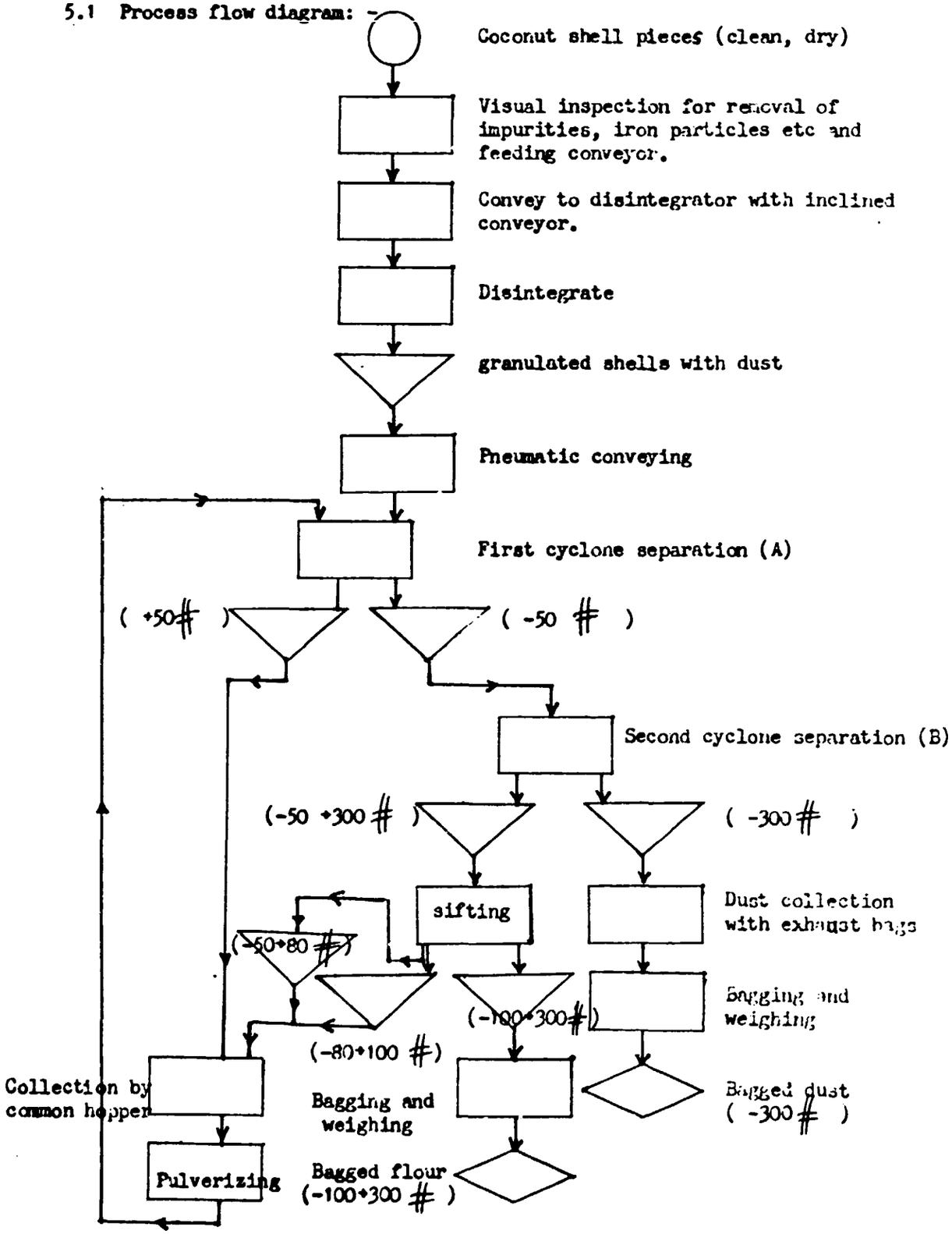
No cost details available for equipment, installation and building construction.

4.4 Capacity : -

Information not available.

5. Process : -

5.1 Process flow diagram: -



5.2 Description of process : -

Coconut shell pieces are a by-product of the desiccated coconut industry. Unlike in the copra manufacturing process which gives coconut shell halves as a by product, the "hatcheting" operation in the desiccated coconut manufacture results in the removal of the coconut shell in pieces to facilitate recovery of the kernel without breakage in the ball shape

Clean, dry mature coconut shell pieces are visually inspected for removal of impurities and iron pieces and loaded onto the inclined conveyor. The shell pieces are broken down to granules by the disintegrator through impact and thereafter pneumatically conveyed upto the first cyclone separator at the top floor of the building.

Inside the first cyclone, all particles smaller than about BSS 50 is sucked away to feed the second cyclone. All particles bigger than about BSS 50 fall down under gravity along a chute to fill the common hopper of the pulverizers.

Three pulverizers working in parallel reduce these granules to below BSS 50 and smaller particles. The outlet of each pulverizer has a piping system to pneumatically convey the material for recycling into the first cyclone. The first cyclone therefore has four feed lines, the fourth being from the disintegrator.

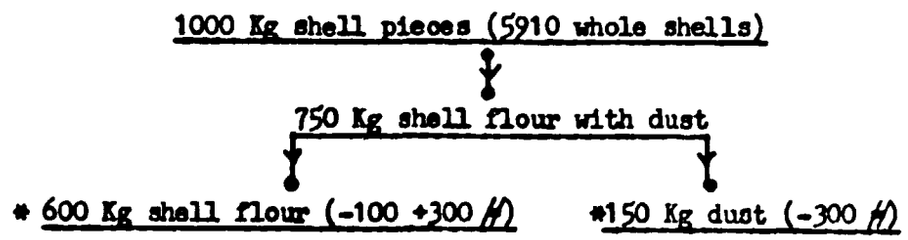
The second cyclone which is bigger, is installed in tandem with the first cyclone on the top floor. This is fed with material below BSS 50. Here, the dust (-300 #) is carried over out of the cyclone and pneumatically conveyed into the dust collector system. All particles bigges than BSS 300 are trapped and made to fall under gravity along a chute which branches into six smaller pipes to feed the sifters.

The sifting system comprises of six identical units working in parallel. The sifters are of the simple reciprocating type, mounted on leaf spring blades. The motion is derived by an accentric on a shaft powered by an electric motor. Each sifter has an upper and lower deck holding wire mesh screens. The upper is usually BSS 80 and the lower BSS 100. The purpose of the sifters is to separate +100 # from -100 # .

This is done in two stages by using a mesh BSS 80 on the top deck which facilitates early removal of particles very much oversize of BSS 100. The material that is retained on the top deck is -50 +80 #. Therefore the bottom deck is not overloaded with too much material and thus ensures more accurate grading by avoiding carryover of -100 #. What is retained on the bottom deck is -80 +100 # . The material retained on both decks is oversize and therefore collected and sent down together in one chute under gravity into the common hopper of the pulverisers for recycling. The material passing through the bottom deck is -100 +300 # and is weighed and bagged as 80 pounds nett into 5 ply kraft paper bags. The mouth is stitched by machine.

The dust (-300 #) particles from the second cyclone enters the dust collectors through the blower. The filters are installed in two sets, each having 21 bags. The two sets are fed by means of two pipes which have branched off the main line from the blower outlet. The air breathes out of the filters. The lower neck of each filter bag is fastened onto the top rim of an empty 45 gallon steel drum into which the trapped material collects. This dust (-300 #) is then weighed and bagged into 5 ply kraft paper bags and the mouth stitched by machine. The entire dust collection system is inside a fully enclosed room to avoid extra fine particles contaminating the surrounding atmosphere.

5.3 Product flow diagram



* Estimated relative yields for flour and dust.

6. Quality of finished product :-

The quality specifications of finished product are not available. In a broad sense the two grades have particle size as follows.

Shell flour (-100 +300 #) : - Bulk of flour passes through BSS 100 mesh and bulk retained on BSS 300 mesh.

Shell flour dust (-300 #) : - Bulk passing through BSS 300 mesh.

7. Source of information :

Observations during field visit to a coconut shell flour manufacturing industry in Sri Lanka.

8. Notation : -

+ 100 # Bigger than (retained on) BSS 100 mesh.

- 100 # Smaller than (passing through) BSS 100 mesh.

- 100 + 300 # Particle size range specified as passing through BSS 100 mesh and retained on BSS 300 mesh.

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Product code : CCCN 34.01
Technology sheet no: VII / 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 : - SOAP MAKING BY THE COLD PROCESS FROM CRUDE COCONUT OIL (Cottage Industry).

2. Uses of finished product : - Soap as bars, cakes etc for cleansing and laundry purposes in the rural areas and for low income people in the urbanized areas.

3. Country of origin : - SRI LANKA

4. Equipment and raw materials: -

4.1 Description of Equipment

4.1.1 Vessel for mixing the caustic soda lye. An enamel jug can be used for this purpose. Aluminium vessels must not be used.

4.1.2 Vessel (called soap pan) and wooden paddle for mixing the oil and lye together. The size of this will depend upon the capacity per batch.
The smallest type of unit will have a set of 1 gallon (4.5 litre) kerosene tin cans with the lid removed. Each tin can has a capacity of about 10 lb of raw material.

Larger scale operation will use cast iron pans of say 31 inches (787 mm) diameter and 24 inches (610 mm) deep. This holds about 500 lb of raw material.

4.1.3 Frame or box for cooling the soap. Simple wooden frames with removable sides are easiest to deal with. This enables the slab of soap to be easily removed after cooling.

Alternatively a wooden box of say 12 x 14 x 8 inches deep (305 x 355 x 203 mm) with removable sides can be used. This holds about 50 pounds of soap.

4.1.4 Weiging scale for oil and caustic soda.

4.1.5 Additional equipment such as a device for cutting the soap into bars and a stamping machine are optional. A hydrometer can be used for checking the strength of the caustic soda solution.

4.2 Cost of Equipment

The simplest operation with say 5 cans of 1 gallon each (50 lb capacity per batch) and other equipment may cost about Rs300/= (or US$20) (1US$ = Rs15/50).

The bigger scale operation with one cast iron pan and other optional equipment may cost about Rs 5000/= (or US$ 320).

4.3 Capacity

The simplest operation will have a capacity of about 50 lbs per batch (22.7 Kg) every two days).

The bigger scale operation with one cast iron pan has a capacity of 500 lbs per batch (227 Kg) every two days.

4.4 Raw materials

4.4.1 Coconut oil - Crude but filtered coconut oil of FFA not exceeding 2%. In Sri Lanka, filtered chekku coconut oil or freshly made mill oil is of adequate quality.

4.4.2 Hard oils such as tallow or Mee oil. Whilst coconut oil alone can be used, it is advantages for technical and economic reasons to use a moderate blend with other oils such as tallow, Mee oil etc.

4.4.3 Rosin (Grade II) is often used to improve odour of the soap.

4.4.4 Colouring and Perfuming

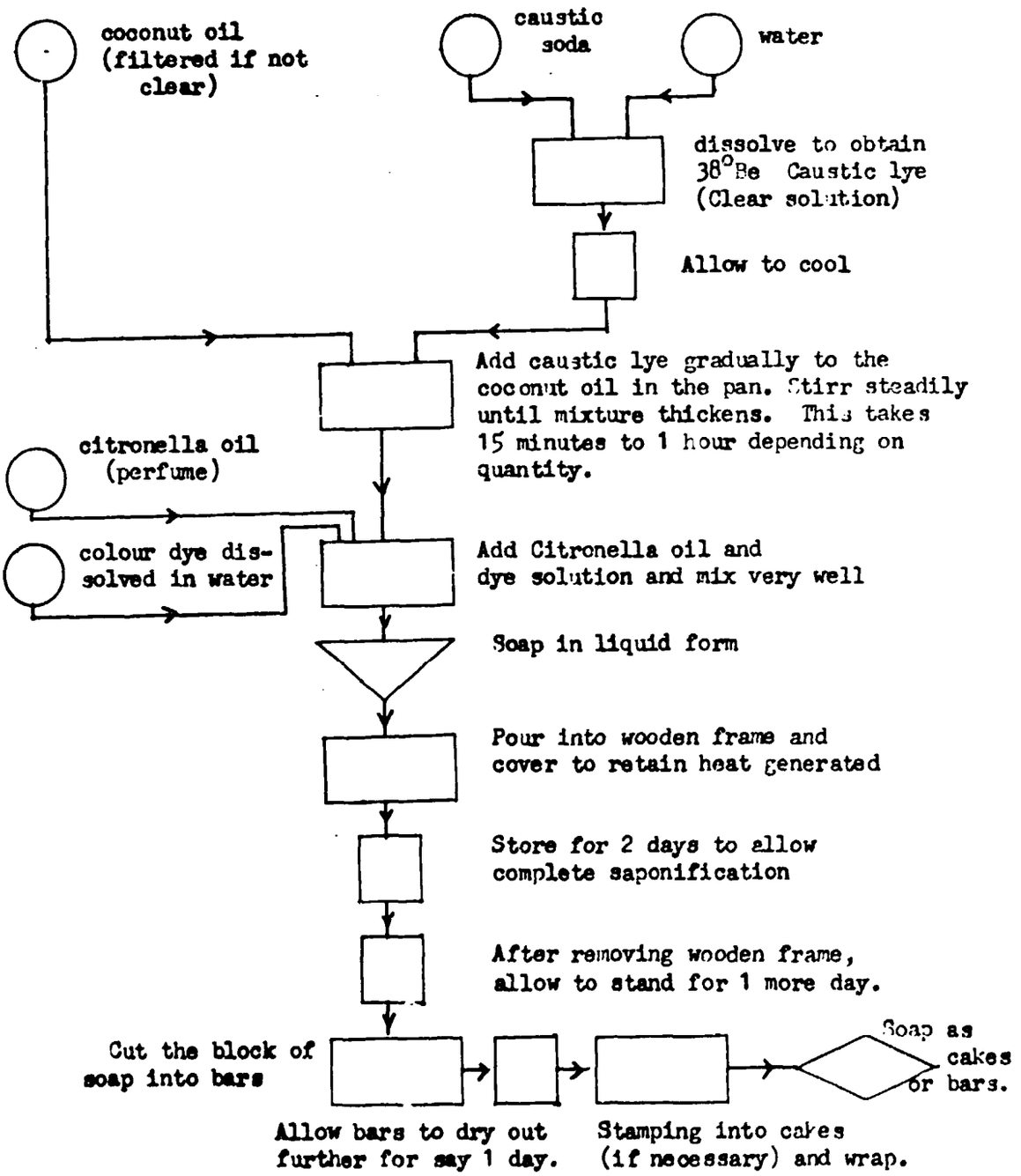
Colouring dyes suitable for soap is easily available with retail chemists in the cities. For perfuming, citronella oil is usually used.

4.4.5 Caustic soda which is available in drums of 1, 3 or 5 cwt (Approximately, 50, 150 & 250 Kg drums) Caustic soda can be purchased in smaller quantities from retail chemists. This is very caustic and must not be allowed to come into contact with skin. This should always be stored in closed tins.

5. Process

5.1 Process flow diagram

This is presented for the case of the simplest formulae given in section 5.2.6 where coconut oil alone (without other fatty oils) is used with colouring and perfuming.



5.2 Description of process : -

5.2.1 The "cold process"

The making of soap as a cottage industry is best carried out by the cold process, since this is essentially very simple and does not require elaborate and expensive plant. It is fortunate moreover, that coconut oil which is the raw material most readily available in the coconut areas, is the fat most suitable for the "Cold Process". Most other fats & oils being difficult to convert to soap without boiling.

5.2.2 Raw materials

The essential ingredients for making soap are fat (or fatty oil), caustic soda and water. Although reasonably good soap can be made using coconut oil without any other fatty oils, improved soap can be made by using mixtures of coconut oil and small proportions of tallow, Mee oil etc and or rosin.

Special precautions should be taken to store caustic soda in closed tins and in handling. Caustic soda must not be allowed to come into contact with the skin as it is very irritating and if it does it should be washed with vinegar at once. For the same reason, it is most undersirable to have any unchanged caustic soda in the finished soap, which would be damaging to clothes washed with it. Caustic soda must be kept in closed tins and stored in a dry place. When exposed, it deteriorates, getting wet by absorbing moisture in the air and being converted gradually into ordinary washing soda, which will not make soap by the cold process.

5.2.3 "Saponification"

The formation of soap from a fat or oil and caustic soda is known as saponification. All fats and fatty oils undergo saponification with caustic soda, though some require boiling. Coconut oil is readily saponified by stirring in the cold with a strong solution of 'lye' or caustic soda, and thus

is the basis of the "Cold Process". In saponification, besides soap there is also formed glycerine. The process can be represented by the equation:-

Fat (or fatty oil) + caustic soda = soap + glycerine

In large scale soap manufacture by the "Boiling Process" the soap is separated from the glycerine by addition of salt, which causes the soap to rise to the surface whilst the "spent lye" with the glycerine remains at the bottom of the vessel. In the cold process, no attempt is made to separate glycerine, which remains in the finished soap. The glycerine left in the soap is a useful constituent as it is good for the skin.

It will be obvious that since all the materials used remain in the finished soap in one form or another, the quality of the soap depends upon the quality of the raw materials. Therefore oils should be clear (filtered if necessary). Tallow if used should be freshly rendered and melting clear. Rosin if used must be of pale colour. Grade II rosin is suitable. The caustic lye should be clear. All oils should have low FFA (2% max). If the acid content is high, "bunching" takes place. This is the formation of separate grains in the mix which gives a bad uneven appearance to the soap.

Soap made from coconut oil alone lathers freely, so much so that it can be used with sea-water. So called "Marine Soaps" are made from coconut oil for this reason. The lather is not a lasting one and coconut oil soaps have the disadvantage of wasting away quickly and so are not economical in use.

Harder fats such as tallow, Mee oil, etc. correct this. Therefore, whilst it is essential that a large proportion of the fat charge should be coconut oil (for ease of working the cold process), a moderate percentage of hard fat is useful.

A certain proportion of rosin is often used. Although this is not a fat it does form a sort of soap with caustic soda. It's use in moderate amount improves the odour of the soap and to some extent checks any tendency to rancidity. It is less frequently used in 'cold process' soaps than in boiled soaps as

certain precautions have to be observed.

5.2.4 Preparation of caustic lye

The lye used for the saponification in the cold process is a strong one, usually over 30 per cent. by weight. The following formulae are based on a 38°Beaume lye, except when stated.

Study of this question is complicated by the fact that at least three scales are in use for measuring the density of lye, viz. Twaddell's (mostly in England) and Beaume's (mostly continental) and the ordinary scientific scale of densities, which should be preferred.

The following table shows the comparison of the various scales with the corresponding lye strengths :-

Density	Degrees Twaddell	Degrees Beaume	lb. caustic soda per 100 lb solution	lb. per 100 gallons
1.20	40	24	18.2	218.5
1.22	44	26	20.2	246
1.24	48	27.9	22.1	274
1.26	52	29.7	24.0	303
1.28	56	31.5	28.8	330
1.30	60	33.3	27.5	358
1.32	64	35	29.2	386
1.34	68	36.6	30.8	414
1.36	72	38.2	32.5	442
1.38	76	39.8	34.1	470
1.40	80	41.2	35.6	498.5

The table will be found useful since it covers most of the strengths used in 'Cold Process' soap making, and it has been calculated for use at tropical temperatures of about 80°F. Any hydrometer can thus be used.

A 38° Beaume lye (or a 71.15° Twaddell) has a density of 1.358 approximately and contains 32.3 lb. of caustic soda in 100 lb. of solution

To make up this lye, 4 lb. 14 oz. of caustic soda are dissolved in a gallon of water (it may be mentioned again that the caustic soda and the lye should not get on the skin. If it does, wash it off with vinegar at once). The solution gets hot and must be allowed to cool before use.

When the solution is cool, its strength should be tested with the hydrometer. It will probably be found a little strong, and a little water must then be added until the hydrometer reads correctly, i.e. 1.358, or 38° Beaume or 71.15° Twaddell.

If the solution is not clear it must be allowed to settle and the clear liquor carefully poured off for use. During cooling and settling (if necessary) the solution should be covered away from the air.

5.2.5 Proportions of various fats to caustic lye

Proportions of Fat to Lye:- Different fats and oils require different amounts of caustic soda for complete saponification. Thus to convert 100 lb. of coconut oil into soap (plus glycerine) 18.3 lb of caustic soda are required. If less is used, the resulting soap will contain unchanged oil; if more, the soap will contain unchanged caustic soda. The approximate figures for other oils likely to be available locally are : -

Oil (100 lb) require	lb. caustic soda	or	lb 38°Be Lye
Coconut oil ...	18.2 lb.		56.5 lb
Coconut (Parings) oil	17.1 "		53 "
Tallow ...	13.9 "		43 "
Mee oil	13.8 "		42.75 "
Ground nut oil	13.5 "		41.75 "
Castor oil	13.2 "		41 "
Rosin ...	12.5 "		38.75 "

From these figures it is easy to calculate by proportions the caustic soda or lye required for any mixture of the above oils, fats or rosin.

In practice it is customary to use about 5 or 6 per cent, less than the weight of lye actually required according to the theoretical requirements given by the above table. The reason for this is that it is practically impossible to get absolutely complete 100 per cent saponification by the cold process and it is better to have a soap with a little unchanged fat in it than run the risk of having unchanged caustic soda. So, using coconut oil alone, for 100 lb. instead of 56½ lb of 38° Be lye, between 50 and 54 lb are used.

When starting for the first time without experience to work the cold process it is advisable to use even less caustic soda.

The beginner moreover would be advised to start on a simple coconut oil soap. The saponification in this case goes well at the ordinary tropical temperature of 80° to 90°F. With larger proportions of tallow it is necessary to work with the oil mixture slightly warmed, say 100° to 105°F.

5.2.6 Formulae of blended fats to lye

The following formulae are arranged roughly in order of complexity, starting from a simple coconut oil soap.

(a) Coconut oil ... 100 lb.
Caustic lye 38° Be 50 " (6 gallons 6½ pints)
With practice the lye can be increased to 53 lb.

(b) Coconut oil ... 91 lb
Mee oil ... 9 "
Caustic lye 38° Be 52 " (7 gallons 1½ pints)
With experience the lye can be increased up to 53 lb.

(c) Coconut oil ... 80 lb.
Mee oil ... 20 "
Caustic lye 38° Be 53 " (7 gallons 1½ pints)

The following formulae give full quantity of lye, for experienced workers.

(d)	Coconut oil ...	75 lb.
	Castor oil ...	15 "
	Groundnut oil ..	10 "
	Caustic lye 38° Be	51 " (6 gallons 7½ pints)
(e)	Coconut oil ...	60 lb.
	Mee oil ...	20 "
	Groundnut oil ..	20 "
	Caustic lye 38° Be	50 " (6 gallons 6⅔ pints)
(f)	Coconut oil ...	50 lb.
	Tallow ...	50 "
	Caustic lye 38° Be	49 " (6 gallons 5¼ pints)

An example with rosin, which should be tried when practice has been obtained with oils alone :-

(g)	Mee oil ...	50 lb.
	Coconut oil ...	40 "
	Rosin ...	10 "
	Caustic lye 38° Be	47½ " (6½ gallons)

If a balance or scale is not available, it is useful to note that a gallon of coconut oil or groundnut oil weighs 9 lb. 3 oz. and a gallon of castor oil 9 lb. 10 oz. A balance will however be necessary when tallow or rosin is used.

5.2.7 Method of working

The oil charge is placed in the oil pan. When coconut oil alone or coconut with liquid oils such as castor are used, melting or heating is not necessary at tropical temperatures. Tallow, rosin, and sometimes Mee oil and parings oil require melting until the whole mixture is liquid and homogeneous. Special care must be exercised with rosin. It should be finely powdered and then warmed with the oil until completely dissolved. After melting, the mixture must be allowed to cool. The saponification must not be started when oils are still hot. Coconut oil alone is worked quite cold; mixtures (b), (c) and (d) at about 90°F and (e) and (f) at 100°F (just warm to the hand). A thermometer is useful but not absolutely necessary.

The cooled lye (prepared as above) is added very gradually to the oil in the pan, and well stirred-in with a wooden paddle. Good, steady (but not violent) stirring is necessary, the object

being to get the lye well in contact with the oil. As mixing proceeds the mixture thickens to the consistence of treacle and stirring is continued until the mixture seems smooth and homogeneous and is firm enough for a mark made on the surface to remain for a short time. This point is better recognized as a result of experience than from any written description. According to the quantity of material worked the mixing and stirring may take from 15 minutes to an hour. Half hour is usually enough for a small batch of say 20 lb.

If the saponification is commenced with oil or lye or both too warm, good mixing is impossible and a layer of oil may even separate on top, and a good soap cannot be obtained.

At this stage the whole mix is poured off into the frames. Saponification goes on in the frame for a day or more, the temperature rising to about 180°F. It is desirable to conserve the heat developed so as to promote as complete saponification as possible. Wooden frames lose heat less quickly than metal and further, the frames are covered with planks and sacks to prevent loss of heat.

After two days the process is complete and on the third day the soap can be removed, by taking down the collapsible sides of the frame. (For easy removal it is sometimes the practice to line the frame with paper). It is best to allow the block of soap to stand for a day before cutting into bars. The bars themselves are allowed to dry out further before stamping.

5.2.8 Colouring and Perfuming

For perfuming, the most easily available material locally is citronella oil and this is satisfactory enough when used with discretion. 12 ozs. is sufficient for 100 lb. of soap.

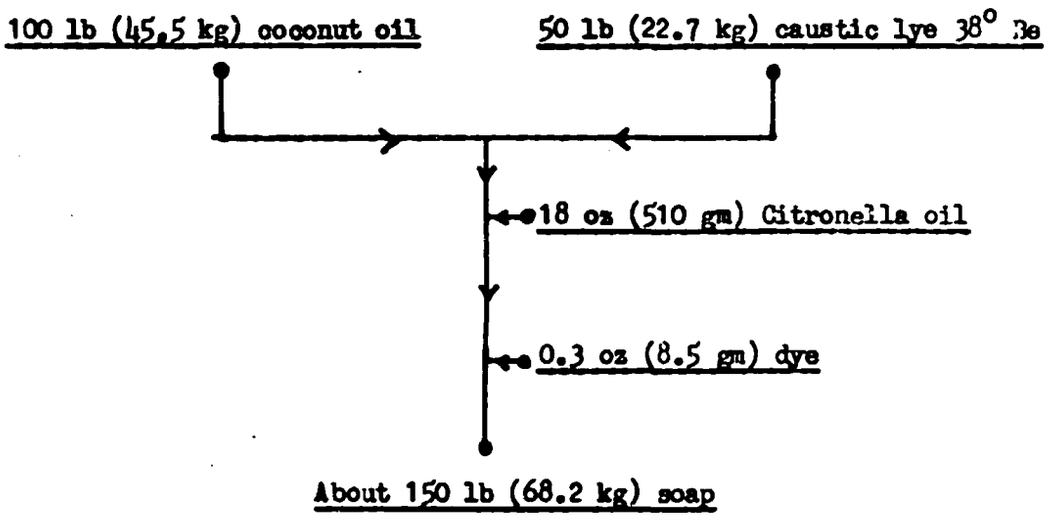
Suitable soap dyes can be purchased from chemists in the cities. It is a common fault that too much colour is used or that it is not evenly mixed. Very small quantities of dyes are required to give a good colour, 1 or 2 oz. being enough for 1,000 lb. of soap. The dye-stuff is prepared by dissolving 1 oz. in 50 oz.

of water; 1 oz. of this solution is then enough for 50 lb of soap.

The dye-stuff solution and the perfume oils are stirred in just before the soap is ready for framing. It is obvious that good mixing is essential as the contents would be rather viscous at this stage.

5.3 Product flow diagram

The product flow diagram is given for the simplest process comprising of 100 lbs of coconut oil (Formulae 'a' in section 5.2.6) with colouring and perfuming.



6. Quality of finished product

The precautions described in the procedure outlined ensures production of a soap of adequate quality. There are many refinements possible by blending with various fatty oils etc to give improved qualities.

7. Source of information

Leaflet No. 10 (1968)
Coconut Research Board
Lunuwila, Sri Lanka.-

T. K. G. R. 1979