COCO-NUT SHELL CHARCOAL.*

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1. Introduction.

Coco-nut shell charcoal is one of the best absorbents for gases, &c., which accounts for its well-known use in gas masks and also for certain industrial operations. Before it can be used for this purpose, however, it has to undergo a technical process known as "Activation". Coco-nut shell charcoal as prepared on the estate and as exported has very little absorbing power. Purchasers of such charcoal require it to reach certain standards of quality and in particular to be free from contaminants which make the activation process more difficult. The most likely common faults of locally produced charcoal are—

(i) Too much moisture.

(ii) Not sufficiently burned, which means loss to the manufacturer of activated charcoal, as the under-burned charcoal has to be carbonized or if used causes trouble in the activating plant.

(iii) Too much sand or earthy matter.

(iv) Containing salt through using brackish water in cooling off.

Purchasers usually buy on specifications controlling these faults and typical standards are given below.

It is the purpose of this article to describe the preparation of coco-nut shell charcoal by the ordinary simple method and to show how to avoid the above and other faults so as to produce charcoal up to the usual specifications. The writer has examined a large number of locally made samples and finds that with ordinary care there is no difficulty in producing a satisfactory product.

2. Charcoal Making.

The process of making charcoal is merely the burning of shells in a limited supply of air, so that they do not burn away to ash as in a copra fire-pit, but are carbonized. The only trick of the process is to get conditions right so that the shells are carbonized to just the right degree, i.e. burned enough but not too much.

Kiln.—The kiln in which the shells are burned may be anything from a simple hole in the ground to expensive steel and brickwork patent kilns. Actually patent kilns are not in use in Ceylon. On non-friable soils, a simple pit serves well enough, but it is obviously difficult in sandy soils to prevent the charcoal becoming mixed with sand unless a brick-lined pit be used.

The shape and size of the pit may vary. The diagram† shows types, actually in use, of various depths. Firebricks are preferable for the lining, but ordinary local bricks stand up for a considerable time and mud mortar is said to be more satisfactory than cement. As far as shape is concerned, circular pits narrower at the top than bottom such as *A*, or bottle-shaped such as *B*, are preferable, as the firing is more easily controlled.

The shells used should be dry, clean and free from adhering fibres of husk.

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* Reprint from *Coco-nut Industries*, Vol. 4, No. 2, p. 77, 1940.

† The diagram has been adopted from that given in F. C. Cooke's *Investigations on Coco-nuts and Coco-nut Products* (1932) with the omission of the simple unbricked pit and the addition of commercial type of pit (*a*) used on everal Ceylon estates.

Procedure.—In the pit of type *A* and *B* in the diagram a fire of shells is started at the bottom of the pit; more shells are added to this until these too are well alight; then more shells and so on until the pit is completely charged, the fire being allowed to burn up before each new addition. When the full charge is well burning the fire may be damped down by sprinking water. The glowing mass is then covered to exclude air, but space is allowed for the large volume of smoke to escape.

For covering, green fronds, damp turf and soil may serve. If old corrugated sheets are available, these are used as first coverings to prevent contamination with soil, which may be placed on top.

The time taken for charging will naturally vary with the size of the pit. Some operators prefer slow charging. By this method the first fire is started and the pit covered, *A* with its circular steel cover of $\frac{1}{4}$ in. mild steel fitted with handles or *B* with galvanized sheeting. Smothered carbonization is allowed to proceed for some time before the next addition of shells, after which carbonization is again controlled by replacing the cover and so on until the pit is full. This may take, with a pit of the dimensions of *B*, up to 6 or 7 days. This slow procedure, which does not require water cooling, is said to give better uniform well-burned charcoal than the more rapid procedure described above.

It is hardly possible to give precise directions for either procedure. Some practice is required to get exactly right conditions. If the combustion is too much smothered and carbonizaiton is incomplete, a mass of woody half-burned charcoal results. If, on the other hand, the burning is not smothered enough, there is a poor yield of charcoal and it is brittle and thin.

When the pit is full the slow burning proceeds while much acid smoke is given off. During this process, the pit (as described above) is covered except for sufficient space for a smoke outlet. It is not usually possible to open the pit until the third day. When the pit is opened the mass of charcoal may catch fire and it is sometimes therefore necessary to sprinkle with water to cool off.

C is a large pit which is filled with shells which are then fired by kerosene poured down the central bamboo. The author has not seen this in operation, but does not consider that it has any particular merit.

In places with a high water table it may be necessary to use an above-ground kiln, such as *D* in diagram. This kiln is charged with shells, which are fired. When the shells are burning well, the fire hole is blocked, and air regulated by air holes at the top.

Sorting and Bagging.—The good pieces of charcoal are sorted out from the bulk; any unburned shells or under-burned pieces are put aside and used in starting the burning of the next charge.

Since accidents have occurred both on land and sea through stocks or cargoes of charcoal becoming ignited, it is now made a condition of shipment that charcoal shall be exposed freely to the air for at least 14 days before packing or bagging. It is packed in stout gunny bags holding a hundredweight (twelve to the shipping ton).

The crude charcoal contains sufficient acidic products to cause deterioration of bags on prolonged storage. This indicates that bulk storage is preferable in cases where immediate shipment is not possible. Such storage would have to be in dry godowns or warehouses. This extra handling may also cause the production of a large percentage of small pieces and dust.

3. Yield.

The weight of charcoal obtained should be just under 30 per cent. of the weight of the original shells. The weight of shells varies considerably, and in fact goes parallel with the out-turn of copra. The weight of a 1,000 shells may vary from as low as 280 lb. to as much as 400 lb. but is nearly always about a quarter of the weight of the husked nuts. Thus after a drought, when nuts are small and out-turns of copra are poor, shells will also be thin and light.

The following is a rough guide to what may be expected:—

Out-turn of copra.	Weight of 1,000 shells.	Number of shells to a ton.	Number of shells to make a ton of charcoal.
	lb.		
1,000	437½	5,120	17,650
1,100	400	5,600	19,300
1,200	365	6,140	21,200
1,300	337	6,650	23,000
1,400	312½	7,170	24,700

Twenty thousand whole shells to a ton of charcoal is a usual working average. The heaviest and thickest shells give the best charcoal.

4. Quality.

Good charcoal should be uniformly black in colour, and free from dirt due to husk. Broken edges should show a shiny black surface, and a characteristic sharp fracture. When dropped on a stone floor good pieces give a clear ring; badly burned pieces give a dull sound. Over-burned pieces are very thin and brittle; they are not favoured for inclusion in samples for export, as they easily go to dust.

Other faults of bad charcoal have been enumerated above, and buyers' specifications are based on avoiding these. Individual firms have slightly different specifications, but the following are nearly always required:—

(i) *Size.*—It is usually stipulated that not more than 5 per cent. shall pass a ¼ in. mesh sieve. Some firms have more stingent specifications indicating what percentage shall pass or be retained on a series of graduated sieves.

(ii) *Ash Content.*—A limit of 2 per cent. is usually imposed. An ash content of over 2 per cent. almost always indicates contamination with sand or soil. Clean good charcoal averages about 1.8 per cent. of ash, which is largely potash salts derived from the shells themselves. A tolerance of only 0.2 per cent., or 2 parts per thousand, is thus allowed for sand, &c., from outside. The necessity for care in seeing that no sand or soil is allowed to contaminate the charcoal is thus obvious.

Chloride Content.—One firm imposes a limit for chloride of 1.0 mg. per gm. A figure over this indicates the presence of salt, as when salt or brackish water is used for damping the fires and in cooling off. This should never be used, but only fresh water.

(iii) *Moisture.*—Different firms have different specifications for limit allowed for moisture. Five per cent. is usual, though some allow up to 10 per cent. It is not uncommon for unscrupulous local makers to damp the charcoal too much, so as to increase its weight for sale. This is easily detected and is bad business in the long run, as a prejudice is created in the buyers' minds against the particular seller practising it.

(iv.) *Volatile Matter.*—This is an arbitrary figure, and different firms have different standards. A usual limit is 15 per cent., that is, the sample when heated under certain fixed standard conditions shall not lose more than 15 per cent. of its weight. A content of volatile matter over this limit indicates under-burning, which is a fairly common fault.

5. Costs..

The price of charcoal and of shells fluctuates considerably, and it would be of little value to quote prices in this article.

In purchasing shells for charcoal making, care must be taken to have some idea of their out-turn or to buy on weight rather than by the number. As mentioned above, it may require anything from 17 to 24,000 shells to make a ton of charcoal, according to the out-turns of the nuts. Just as much care is, in fact, necessary, as in buying nuts for copra or desiccated coco-nuts, as charcoal out-turns vary in the same manner as copra and desiccated coco-nuts out-turns.

6. By-products.

Brief mention may be made of the nature of the products lost in the smoke—some 70 per cent. of the weight of the shells. If, instead of being burned in pits, shells are fired in ovens or retorts heated from outside, and the vapours given off condensed, there are obtained from 100 lb. shells, besides about 34 lb. charcoal left in the retort, some 40 lb. of a crude acid, known as pyroligneous acid, and about 5 lb. of tar. The pyroligneous acid contains 10 to 12 per cent. of acetic acid, and from the tar can be obtained carbolic acid and creosote. The working-up of these products are technical operations not suitable for small-scale working.

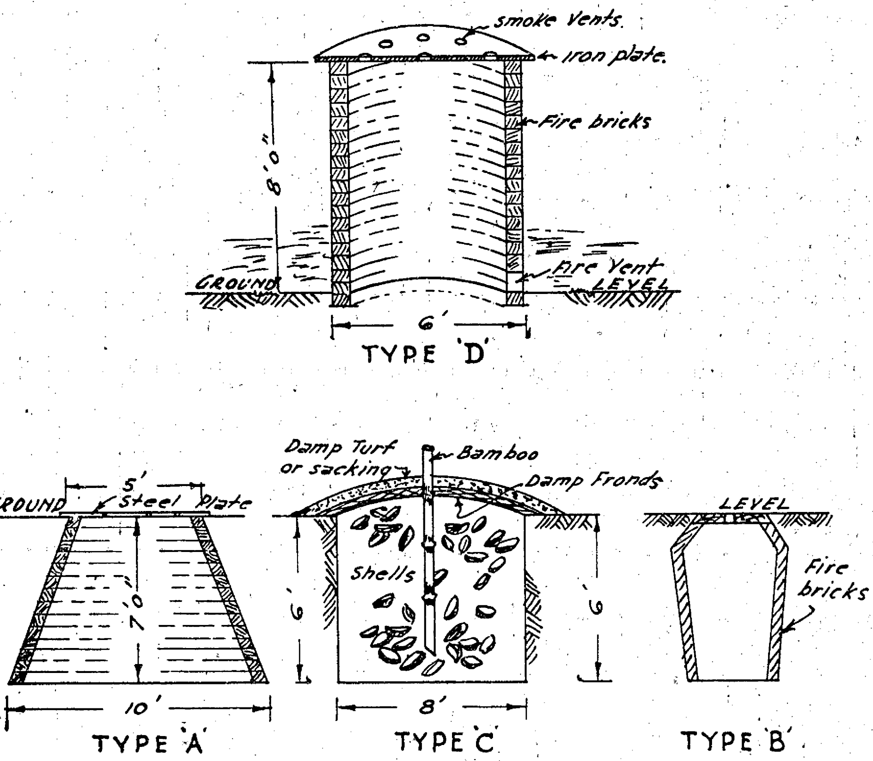
7. Conclusion.

It appears likely that the demand for charcoal will be maintained at a good level whilst war conditions continue.

Where copra is dried in ordinary Ceylon kilns, however, not more than 300 shells are left over for charcoal making from every 1,000 nuts cured. This will doubtless give an impetus to the use of other types of kiln burning butt-ends, &c.,

and also, where practicable, to sun-drying. In very dry weather it is possible to effect considerable economy of shells by reducing the number of kiln firings and increasing the number of sun-dryings.

TYPES OF CHARCOAL KILNS.



CHEMICAL NOTES.

A recent enquiry led to the antiscorbutic value of the juice of the common New Guinea "moolie" or lime being determined. The average figure for the analyses of the juice of five moolies from different sources was 28 milligrams of ascorbic acid (vitamin C) per 100 cubic centimetres, which is in good agreement with figures obtained for limes in temperate climates.

Approximately 2.5 milligrams of ascorbic acid per day will protect a baby from scurvy, and in case the diet of the baby does not contain this amount it is customary to supplement it with orange juice. It has been found that Australian orange juice may contain from 29 to 74 milligrams of ascorbic acid per 100 cubic centimetres, so that, three teaspoons of moolie juice are equal, in antiscorbutic value, to one teaspoon of good Australian orange juice or three teaspoons of juice from a poor orange.

The addition of sugar to the moolie juice does not lower its antiscorbutic value.