Charcoal - An Alternative Fuel

Dhammika de Silva

Wood and Cellulose Technology Section, Ceylon Institute of Scientific and Industrial Research (CISIR)

Independance from increasingly scarce and expensive fossil fuels has become a priority for Sri Lanka. This fact was brought to everyone's attention by the government decision to remove, at least partially, the subsidy on kerosene, diesel and fuel oil. The price rise that followed and the uncertainty of future price increases and availability has compelled many households and industries to look for alternatives. For the majority, the alternative has been firewood which is the most widely used renewable fuel. Unfortunately, the price of firewood has also risen hand in hand with kerosene and diesel prices, partly caused by the increased cost of transport. The general dearth of firewood, while also helping to push up the price means that firewood has to be transported over longer distances to reach the urban population. Therefore, with every increase in crude oil prices the cost of firewood (and of kerosene, diesel and fuel oil) will increase and we may very well be paying significantly more for these commodities by the end of 1981.

The time is opportune therefore to utilize a new type of locally renewable fuel in Sri Lanka. The new fuel is charcoal, expected to cost Rs. 2.00 per kilogram for wood charcoal and Rs. 2.50 per kilogram for coconut shell charcoal. Although it may be new to Sri Lanka, several countries in our region notably Thailand, Malaysia, Indonesia and several African countries have utilised charcoal for domestic cooking and industrial use for quite some time. The reason for their non-use in Sri Lanka is obscure but the low price of fossil fuels in the past would certainly have contributed towards suppressing their use.

Production of charcoal

Wood is converted to charcoal by heating to about 380° C in an inert atmosphere. The pit method has been the traditional method of carbonizing wood and coconut shells in Sri Lanka. This process is, however, inefficient and wasteful as only 15% (approximately) of the material is recovered as charcoal. The rest is consumed. The down draft type above ground level kiln provides for more efficient carbonization giving a yield of approximately 30% charcoal.

Wood charcoal has twice the heat value of wood, while coconut shell charcoal is slightly higher than that of wood charcoal.

Utilization of charcoal

Industrial use

Charcoal does not offer any direct advantage over firewood when used in an industrial type of furnace. In fact, due to the low efficiency of charcoal kilns it is less economical to use charcoal. It is only in situations where firewood has to be transported over long distances that charcoal has an advantage over firewood.

Domestic use

The advantages of charcoal for domestic use are many and varied :

* Clean burning — no smoke, no soot
* Double the heat value of wood
* Economical to transport
* Easy storage and handling
* Energy efficient in use.

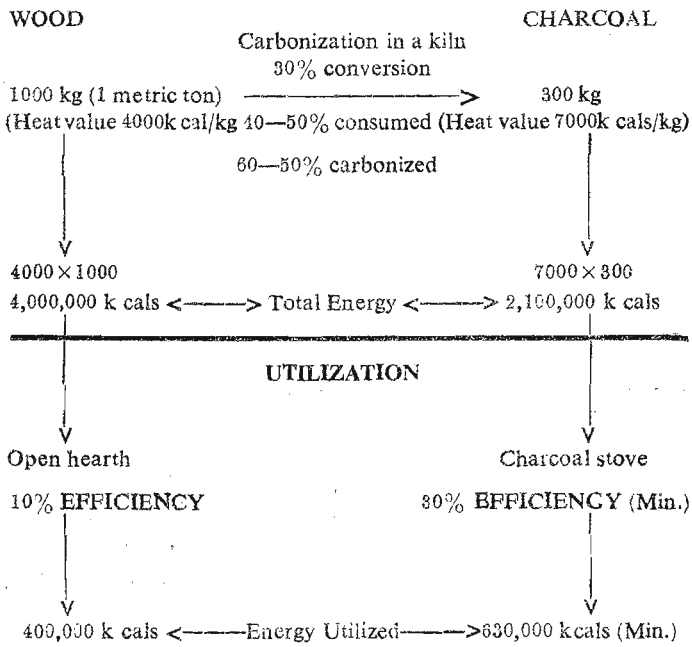
Clean burning — Compared to the firewood hearth or even the kerosene stove, the smokeless burning of charcoal is a definite advantage especially in an average urban house which lacks a kitchen with a chimney. Furthermore, apart from the fact that pots and pans will not need cleaning externally, use of a charcoal stove will improve the quality of life in a rural house. Usually smoke from the firewood hearth permeates throughout the house causing lung and eye diseases among rural women who are constantly exposed to large quantities of smoke.

Heat value — An extremely high heat is generated from charcoal producing a temperature of 550° C at the base of the cooking vessel. Cooking times will be equivalent to those with a kerosene stove or firewood hearth.

Transport — A major disadvantage of firewood is that it cannot be transported economically over long distances. The threshold distance for Sri Lanka is not known, but is thought to be about 80 km. With increases in the cost of diesel fuel, this distance will decrease. Once the wood is converted to charcoal, the threshold distance is automatically increased by a factor of two or more, making transport economical even up to 200 km. This situation applies to waste timber from the Mahaveli Development Zone. State Timber Corporation does not find it economical to transport this wood to urban centers at present firewood prices, but converted to charcoal it is a profitable proposition.

Storage — Charcoal will keep indefinitely without deteriorating, even in an exposed situation, in contrast to firewood which will be destroyed in a few years. Charcoal can also be packaged in bags of convenient sizes to facilitate handling.

Energy efficient in use — This is an important feature of charcoal in the context of fuel-wood availability in Sri Lanka. The crucial fact is that a well designed stove is essential to burn charcoal (it cannot be burnt, like firewood, in an open hearth) and even a simple stove such as the CISIR developed model, has an efficiency of about 30%. Considering the fact that an open hearth (to burn firewood) has an efficiency of only 10% to 15%, use of charcoal amounts to a big saving of scarce fuelwood resources. The situation is complicated by the fact that during conversion of wood to charcoal in a kiln, 40% to 50% of the wood is consumed. Nevertheless, as the flow chart below illustrates, use of charcoal nearly doubles the amount of utilizable energy.



Therefore theoretically fuel wood requirements of the country can be nearly halved by switching over to charcoal. A more practical figure would be a 25% reduction.

Majority of the rural folk, who obtain firewood at no direct cost, will continue to use firewood whatever the benefits of charcoal. Mention must be made of the Lorena type improved wood burning stoves, such as the one being popularized by the Industrial Development Board, that have efficiencies of 15% to 20%. However the popularity of these have not caught on, either in Sri Lanka or in other South and South East Asian countries, probably because its bulky, has to be constructed *in situ* and requires a moderate investment (about Rs. 50/- in Sri Lanka). The CISIR designed charcoal stove costs Rs. 20.00, it is portable and occupies an area of one square foot. This is currently being marketed by the State Timber Corporation. The CISIR also has designs of improved wood burning stoves suitable for owner construction.

The use of charcoal has its negative features too. The main drawback is that its ignition time (ie. starting-up time) is about 15 minutes. This eliminates using the charcoal stove for a quick cup of tea. Secondly, heat regulation is not possible in stoves of low price such as the present CISIR model. A test group of over 50 households that used the stove for 5 to 6 months, found that these defects could be generally overcome by planning the sequence of dishes to be cooked and by the experience and skill of the operator. Advanced models of the stove that offer waste heat utilization and heat regulation are under study at the CISIR. These will, naturally, cost more than Rs. 20.00.

Future prospects

Popularity of charcoal will ultimately depend on the cost of using charcoal relative to other common fuels. An experimental study (Tables I and II) has shown that for domestic use charcoal is more economical than kerosene even at the present subsidised price of kerosene while charcoal cannot compete with fuel oil for industrial use.

TABLE I

Comparison of cost to cook average* meal. (All prices — January 1981).

Fuel	Time	Fuel consumed	Unit price	Total cost Rs.	Saving by using charcoal	Remarks
Charcoal 6% moisture	2 hr	490 g	Rs. 2.35/kg	1.15	——	No heat regulation Slow ignition No smoke or soot Compact size.
Kerosene	2 hr	481 ml	Rs. 3.93/1**	1.89	(+) 39%	Heat control, soot
Firewood 10% moisture	2 hr	2.5 kg	Rs. 0.37/kg	0.93	(—) 23%	Heat control, smoke, soot Needs constant attention.

**Rice (900g) meat (250g) and 2 vegetables (250g each)

*Subsidised price. Subsidy Rs. 1.84/l approx.

The significant fact that emerges from this exercise is that coconut shell charcoal is also cheaper to use than kerosene. Although wood charcoal exports were stopped recently, coconut shell charcoal continues to be exported at a price that does not correspond to its value as a fuel. While one kilogram of coconut shell charcoal is exported at Rs. 2.50, kerosene with an equivalent heat content costs Sri Lanka Rs. 5.21. In actual utilization the cost of producing 10,000 k/cals from coconut shell charcoal and kerosene is Rs. 11.19 and Rs. 14.49* respectively.

The present drive to popularize charcoal as a fuel for domestic use is spearheaded by the State Timber Corporation. This organization has undertaken the giant task of carbonizing the waste wood from the Mahaveli zone and marketing the product, without simply leaving the wood on the land either to be submerged by water or reduced to dust as in the past irrigation schemes. The effort is all the more commendable because the exercise is not profit motivated but designed to alleviate the energy crisis in the country.

The question now is what happens when the Mahaveli charcoal, expected to suffice for 8 to 10 years, is exhausted? Future requirements will have to be supplied from fuelwood plantations. These plantations of fast growing eucalypts and other species will have to be established immediately so that they can be harvested, at maturity, in 8 to 10 years. In addition CISIR is carrying out research on carbonization of rice husk and straw. The carbonized material will be used as a base to produce charcoal pellets and briquettes. By-products such as methanol and low heat value pyrolytic oils will also be available from this process.

These developments will ensure a steady supply of charcoal in the future. However it remains to be seen whether people will accept charcoal as an alternative fuel and thereby ease the pressure on kerosene oil and firewood, the former to reduce drain of valuable foreign exchange and the latter to conserve the forest cover and safeguard our environment.

TABLE II

Theoretical cost of heat from different fuels (All prices—January 1981.)

Fuel	Wood charcoal 6% moisture	Coconut shell charcoal 6% moisture	Firewood 10% moisture	Kerosene	Furnace oil (viscosity 500 sec) sp. gr. = 0.96
Domestic Utilization					
Heat value (k cals/kg)	7000	8000	4000	11,380	—
Price (Rs.)	2.35 kg	2.75/kg	0.37/kg	5.77*/l	—
Burning efficiency	30 %	30 %	10 %	35 %	—
Cost of producing 10,000 k cals	Rs. 11.19	Rs. 11.45	Rs. 9.25	Rs. 14.49	—
Industrial Utilization					
Heat value (k cal/kg)	7000	8000	4000	—	10,800
Price (Rs.)	2.00 kg	2.50/kg	0.37/kg	—	4.44/l
Burning efficiency	66 %	66 %	66 %	—	75%
Cost of producing 10,000 k cals	Rs. 4.33	Rs. 4.74	Rs. 1.40	—	Rs. 5.72

*Without subsidy.