STOVES FOR INSTITUTIONAL AND COMMERCIAL KITCHENS

Introduction

There are a large number of traditional, often staple, foods which require heating to make them safe and palatable to eat. Examples of such foods include rice, plantain (from green bananas), potato, cassava (also known as gari or tapioca), maize and sweet potato. Traditionally such foods were cooked on simple inefficient stoves, such as the three stone cooker, usually for single family groups. As long as the wood, straw and twigs which were used as fuel for cooking were in plentiful supply and much of the cooking done outdoors, allowing smoke to disperse over a wide area, there was no great incentive to introduce improved more efficient cooking methods. However, with more recent concern over access to fuel, deforestation, smoke production during inefficient cooking indoors, fires - sometimes fatal, caused by cooking, the length of time spent cooking and the fact that the food may lack nutrition or even cause harm due to smoke contamination and inadequate cooking, has prompted worldwide efforts to develop and disseminate improved cooking stoves and methods.

The main improvements which have been introduced have included changing the shape of the stove so that the cooking pot sits snugly within the body of the stove rather than on top of it, making the sides of the stove thicker for added strength and insulation and introduction of features such as a grate, baffles and a chimney for improved combustion of fuel. These improvements have made it necessary for the potters, metal workers and bricklayers who were making stoves to acquire and improve skills for their production.

The vast majority of improved cooking stoves, which are built today, are for domestic cooking, often used by single families or households. However, there are also schools, colleges, hospitals, prisons, factories and, perhaps, large temporary settlements such as refugee camps or sites of religious festivals where a large number of people may need feeding at any one time. Even in commercial centres and at roadsides, there are numerous snack bars, street stalls and cafes selling cooked food and serving a large number of people throughout the day. In such places the conventional domestic stove would not be suitable, even if several of them were used together - they would be just too small to meet the demand which is likely to be concentrated at particular times rather than regular.

Stoves to supply larger groups of people are known as institutional stoves. They are distinguished from domestic stoves mainly by their larger size and more sturdy construction. There are fewer types of institutional stove on the market than domestic stove because the market for institutional stoves is smaller and, because the development of a working stove design is often a very lengthy and detailed process.

Stove uses

Institutional stoves may be used for one or more of the following purposes, and should be designed accordingly:

- cooking or boiling
- heating water for tea, washing, or for heating systems
- as an oven for roasting or for baking bread or cakes
- frying on a hot plate

Different institutions will place different requirements on kitchens so the kitchen layout and design of stoves to use will vary to suit requirements.

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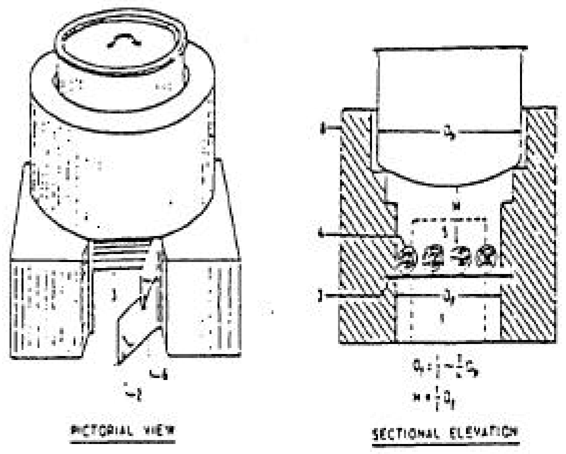

Figure 1: Community Chulha for Cooking Pots.

Stove size is dependant on pot capacity, which is dependent on the number of people served. The larger stoves are designed for 10 to 150 litre capacity and although stoves are made up to 300 litre capacity the cooking vessels then become very heavy to handle. Therefore, large institutions often prefer to use a larger number of smaller stoves. To supply 600 people, for example, 5 or 6 stoves could be used.

Fuels and efficiency

The impact on fuelwood use of institutional stoves in a particular country may be quite Significant. In 1986, for example, it was estimated that Kenya had 5,000 institutional kitchens using 10% of all the fuelwood used for cooking in the country. An average institutional stove would supply food and hot water to up to 300 people daily, which might require 50 to 70 tonnes of wood per month, and this might represent about *15%* of the total budget of running the institution. It should also be noted that much of the wood used to fire Institutional stoves often comes from trees which have been cut down. In contrast, domestic stoves, more often than not, are fired with branches, twigs and bushwood. This factor needs to be considered when looking at the potential environmental impact of the use of wood in institutional stoves.

The potential for fuel saving is much greater in institutional kitchens than in domestic cooking if the owners are conscious of the cost of fuel and the amount used, and keep records of operating costs. Improved stoves of higher efficiency may be more expensive to buy but will repay their cost in the long term. As institutions buy fuel from outside contractors, rather than gather it for free themselves - as users of domestic stoves sometimes do, they have a strong incentive to keep down fuel costs by using efficient stoves.

The most commonly used fuel in large stoves is wood. Even where gas or electricity is available supplies can be unreliable and wood is often cheaper. Alternatively, a wood-burning stove may be held in reserve when using electricity, oil or gas burning stoves in case the fuel supply fails. Other forms of biomass or charcoal can also be used.

Fuel efficiencies between 25 to 40% can be achieved with institutional stoves compared with only 10-15% for traditional domestic stoves and 20 to 35% for improved domestic stoves. However, careless and wasteful use of stoves can reduce fuel efficiencies significantly. It is therefore essential that kitchen staff are properly instructed in correct operating procedures.

The efficient use of stoves has been extensively studied. Heat losses are considered to occur mainly by radiation from the stove, convection around the stove, convection through the chimney, heating up the stove body and the fuel (especially if the fuel is moist) before the heat can be utilised, and in removing ash from the grate which is still hot. In practical terms stove efficiency can be improved by:

- good insulation of the stove
- good stove design - to promote the required level of air flow through it
- use of pre-dried fuel, suitable size and feed rate of fuel (fuel pieces which are too large being particularly inefficient because they burn unevenly and may jam the door open).

- ensuring that the stove is not too large for the purpose (by minimising waste of food, regular cleaning and maintenance).

Stove design principles and the stove operating environment
The Bellerive Foundation, working in Kenya, recognised the need for institutions to be concerned about:

- catering hygiene
- working conditions in the kitchen
- cost reduction and efficiency improvement, for example by reducing food and fuel waste, especially given the high cost of charcoal.

There is a clearly recognised need for support to institutions to carry out the above improvements because of the environmental damage being done in Kenya by the consumption of wood for fuel. There is particularly a need to reduce the amount of charcoal being produced from indigenous trees.

With regard to the stoves themselves, Biomass Energy Services and Technology (BEST), considered the following criteria to be important:

- the kitchen should be free from smoke
- the pot, even with a capacity of 200 litres, should be easy to stir and remove
- the cost of the stove and its installation should be affordable.

Large stoves must be strong enough to take the weight of the water in the pot and be able to withstand hard and continuous use. They are normally made of bricks and clay and may have a steel envelope. A steel pot is normally used for cooking. Aluminium will not withstand the high temperatures which may arise from a direct flame, but an aluminium pot can be heated indirectly on a metal mesh heated by a flame. Stainless steel, although a lot more expensive, is easier to clean, so more hygienic, and will last longer, so could be more economic in the long run.

Every large stove should have a chimney with, optionally, a controllable damper to 'fine tune' the air flow to the fire which is usually regulated by opening the stove door to varying degrees. Fuel is normally burned on a grate at the bottom of the stove with voids in the grate to promote air flow through the stove and to facilitate cleaning out the ash. In an efficient stove the majority of air will flow through the grate rather than through the loading door or the sides of the stove.

If the pot heated by the stove is not designed to tip for emptying, it can, optionally, be fitted with a drain tap to facilitate emptying.

The stove itself should be well insulated to reduce heat wastage, prevent the kitchen getting uncomfortably warm to work in and to prevent burns when touching the stove.

The design of large stoves involves accurate calculations of grate size, primary and secondary air openings, chimney dimensions and flue control. Even when this is done, testing and modification are usually found necessary to get efficient and convenient operation and good fuel economy. If at all practical, smoke emissions must be measured to ensure safety for the operators and to minimise environmental damage. The design and installation of a large stove in an institutional kitchen should only be undertaken after consulting users of existing stove designs.

Stove designs
Several stove designs have been described in editions of Boiling Point (see end note). Boiling
Point is a newsletter on stoves and household energy which is published by Intermediate

Technology. Five designs are listed here.

Belier/ye Nouna Stove - This stove is designed to cook ugali, a Kenyan food, and it burns wood. It is made from bricks and clay and so is constructed on site. The stainless steel pots range from 50 to 100 litres capacity but are not tipping. It has a slightly higher efficiency than the Alfa-Laval, but is only slightly cheaper because of the stainless steel used. Surface temperatures are below 50°C.

Other stoves suitable for institutional use developed by the Bellerive Foundation include **:-**

- **Mama** - a two pot metal stove which stands clear of the ground on a three legged frame. It has a chimney and comes in two sizes - 12 litres (2 x 6 litre pots) and 25 litres (2 x 12.5 litres).
- **Hoteli** - a mild steel stove of 50 litre capacity designed for small catering establishments. The pot is encased in a single skin steel cylinder.
- **Institutional** - a sturdier adaptation of the Hoteli stove, it has 100 or 200 litre capacity. It contains a twin shell of galvanised steel cylinders, with glass wool insulation in between. The pot is stainless steel. The stove was originally built with a brick and clay lining, but from 1992 onwards this was replaced with a second steel cylinder for durability and ease of installation.

Note that the Bellerive foundation no longer make stoves for sale on the commercial market. In Kenya private sales of Bellerive stoves are arranged by Penroche Development Services. Very similar stoves are produced by Uganda Fabricators in Uganda and B&S International in Tanzania, while a Kenyan company - Rural Technology Enterprises make adapted Bellerive stoves as well as a range of barbecue equipment and metal stoves. Contact addresses of these companies are given at the end of this brief.

BEST - The casing is made from stainless steel. The stove has refractory and insulating linings and contains a firebrick firebox with a steel grate. The pot capacity is 200 litres.

DUMA stove - This stove was developed by the Centre for Agricultural Mechanisation and Rural Technology (CAMARTEC) in Tanzania. The company designs and builds stoves to order based on a customer questionnaire followed by a survey, a design specification and a quotation. Sizes range from 30 to more than 50 litres. The stoves are square and made of brick and steel.

REDI - The stove consists of two concentric sheet steel cylinders, one considerably larger than the other, with a gap between them. This gap is filled with sand for improved insulation and covered by a metal cap. The pot rests in the hollow cavity formed by the inner cylinder, in which the firebox is also situated. The stove has been designed to facilitate fabrication in a small-scale workshop.

There are also many other different types and designs of locally made stoves in the 10 to 50 litre size range.

Case Study

A stove is usually a costly item to purchase for an institutional or commercial kitchen, so it is important to buy one which is efficient and which requires little maintenance during its lifetime, if properly used. It should be noted that as well as the stoves listed above, and probably a number of other designs from around the world, there are also numerous types of stoves with significant deficiencies or problems. Often these types of stoves are cheaper than other types, but not always so. If possible, the buyer should visit other institutional kitchens to find out the experiences these kitchens have had with particular types of stoves. If a stoves extension centre or project operates in the area they might also be able to advise.

The following account of the development of institutional stoves in East Africa illustrates why the stove buyer should be wary and ask questions before buying a particular type of stove.

Following the early work of the Bellerive Foundation in Kenya a number of other organisations and private workshops began to make similar institutional stoves for sale, some of them at considerably lower cost. Studies indicated that some of the stoves on the market had serious design and operational faults among which included

- an outer lining of mild steel, which corrodes easily
- an outer lining of only 1 mm, instead of 3 mm, with holes appearing in the lining after less than one year
- gross over-charging for basic materials such as bricks
- pots which are of aluminium or mild steel and which corrode faster and are harder to keep clean
- chimneys which do not have any access points for cleaning; chimneys should be supported from floor level to get a brush inside to remove soot, otherwise the whole structure needs to be dismantled; alternatively, as with Bellerive stoves and some other types, there is a removable cap on the chimney bend to allow access
- chimneys which are so thin that holes appear in a matter of months
- fireboxes which lack strength and resistance to heat; cast iron grates are best, but many grates are just the hub of an old lorry wheel and quickly wear out
- no cleaning tools are provided
- very expensive maintenance charges for basic work such as chimney cleaning, repairs and painting.

References and Further reading

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- *Stove Images*, Beatrix Westhoff & Dorsi Germann, Brandes & Apsel Verlag GmbH, Frankfurt am Main, Germany, 1995.

Articles about institutional, commercial or small industry special purpose stoves have been published in *Boiling Point*, ITDG's stove journal, in particular in edition numbers - 5,8,9,10,13,15,16,18,20,22,23,26,29 & 34.

Useful Addresses

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