Kenya Ceramic Jiko

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Kenya Ceramic Jinko, an improved cooking stove for Africa.

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Background

Traditional cooking methods in central Africa used a ceramic pot on an open fire or brick fireplace.

With the introduction of iron, metal cooking pots came into use (Figure 1). This was usually supported on stones or clay bricks, with a wood fire burning underneath.

With the flux of traders and colonists from Europe, surplus metal drums (oil, petrol) became available. These were cut open and flattened by village metal smiths. The sheet metal could be folded and riveted, and used for many purposes. Thus, simple stoves or jinkos were made from sheet metal (Figure 2). This is a simple cylinder with a perforated shelf half way up to support the fire. These were in almost universal use in Kenya for centuries. Heat escapes through the walls, making it very inefficient. The red-hot metal has a short lifetime.

The Need

Burning wood produces much smoke, which is a severe nuisance in a confined space such as a village hut. Many of the combustion products are toxic. Thus in some areas coke came into use. Wood is burned underground to exclude oxygen. The volatile constituents are driven off, and the solid carbon and the minerals are fused into a grey solid. This is then sold to villagers for use in their jinkos, with reduced smoke.

With ballooning populations, the forests are increasingly degraded by the demand for firewood. Collecting firewood is a major imposition on women. And the toxic fumes were still a problem.
Meanwhile, back in Europe, the value of ceramics was known. The classic Victorian fireplace had a ceramic block behind the fire. This provided insulation, reducing heat loss to the back. It also protected the metal from heat, prolonging its life.

Thus a group of aid workers searched for a more efficient jinko. They received funding from local and overseas sources. They applied the European ceramic technology by making a liner. This went through an evolution, but a typical product is shown in Figs 3-5.

The new design

The metal structure is made from old oil drums, flattened, cut using a template, re rolled, and riveted. It consists of two truncated cones, in an "hour glass" configuration. The lower cone has a hinged door.

A ceramic liner is made by local potters. Local clay is formed, using a mold. The bottom is perforated, and it is then fired. This is placed in the upper cone.

The completed unit cost US$15 at first, but after decades of refinement and competition the prices is now $1 to 4.

In use, the coke is placed in the upper chamber and lighted. Three hinged lugs can be folded inwards to support the cooking pot. A regulate air flow comes through the perforations in the liner. After the fire is established, the hinged door can be closed to further regulate air flow.

The lumps of coke cannot fall until they are reduced to fine ash, which then falls through the holes. When it accumulates, it can be removed through the door.

The metal is not exposed to red heat, and so has a reasonable life. There are handles on the sides and also on the door, to allow handling.

Thermodynamic Principles

Engineers might recognize many engineering principles incorporated in the Kenya Ceramic Jinko.

The firebox is insulated on all nonworking surfaces. Radiation and convection from the fire impinges on the walls. The ceramic, being a poor thermal conductor, rises to red heat, radiating according to blackbody theory (flux proportional to absolute temperature to the fourth power). It stabilizes at an equilibrium temperature, where the energy it radiates inwards, equals the energy it absorbs from the fire.

In other words, the wall looks like a mirror to thermal radiation. With less heat loss, the higher temperature allows more complete combustion.

The holes in the bottom retain the pieces of coke or wood. The carbon content is oxidized to carbon monoxide and carbon dioxide (this releases the heat energy). It burns eventually to a powdery ash (the mineral content of the coke), which then falls through to the lower section. This can be emptied with a scoop.

The air flow is limited by the hole size, and then further by closing the door. Thus the burning rate is limited and controlled by availability of oxygen (as in a slow combustion heater).
The best Western space heaters have an “afterburning chamber”, where new air is introduced to the gases away from the fuel. Thus the CO and other partial products have a second chance of further combustion to CO2, recovering more heat and being less toxic. Is this an opportunity for further improvement of the KCJ?

Performance

The KCJ reduces fuel use by 30-50%, with corresponding reduction in greenhouse gases. The average saving is $60 worth of coke or firewood per year. Women are spared some of the exertion of finding and collecting wood or coke. The fumes are much reduced, improving the confort of families.

In 1995, 700,000 were in use in Kenya, reaching 50% of households. Smaller numbers reached neighboring states.

References

- [http://www.solutions-site.org/kids/stories/KScat2_sol60.htm](http://www.solutions-site.org/kids/stories/KScat2_sol60.htm)