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Stove Camp 2010:
Observations on Design Principles for Charcoal Stoves

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Photo 2: Baseline Stove.


Photo 1: Improved Stove.

Main points mentioned at the end of the Stove Camp Workshop

1. **We need a <u>high turn down ratio.</u>**

To bring water and foods fast to the boil, we need high power in the heat-up phase. However, thereafter we commonly need low power for simmering. The stove therefore needs to offer the opportunity to turn down the power output drastically. Options:

a) Regulation of primary air supply (e.g. closing door)
b) The gap between pot and charcoal is increasing over cooking time (shape of char container provides more depth = increased gap to the char)

c) The amount of char available at the end of cooking is reducing (conical shape of char container = less char over time available)

2. **We need to <u>reduce heat losses to the bottom and to the side of the stove.</u>**

A char container radiates heat to all sides – not just to the pot. To reduce the amount of char used, it is important to reduce the heat losses to the other directions.
Options:

a) Bottom of stove: rebounding plate (with holes) in between primary air supply intake and charcoal container. Thus primary air is channeled through the heated rebounding plate, taking some heat back into the char container.
b) Side of the stove: double wall with air in between for insulation.

3. **We need to <u>maximise heat harvest from a given amount of charcoal.</u>**

Charcoal burning is mainly influenced by the amount of air available in the char container.
Options:

a) A vertical spacer in the center of the charcoal container (Lanny Henson's pig tail") seemed to increase the availability of air for charcoal combustion.
b) Additional draft (e.g. forced air) may increase heat generation per time unit. However, this may also increase CO emissions and reduce efficiency of char use.
c) Secondary air to burn off the CO in a gap between the charcoal and the pot may provide additional heat. However, for this to be beneficial it may not impact on the surface area available for direct radiation from the charcoal to the pot and should not cool down the air in the gap (well preheated secondary air).

4. **We need to <u>maximise heat transfer to the pot.</u>**

Generating as much heat as possible out of a given amount of charcoal is one step. But another important step is to make sure that most of this heat actually is transferred into the cooking pot.
Options:

a) "Sunken pot" concept seems to provide best results in terms of heat transfer (Henson stove). Unfortunately, in real life this might not be possible in many work environments.
b) Best heat transfer is NOT achieved if the pot rests on the char. Optimum is about 1inch away from the char, not closer than that. For Simmer, this could increase to 2-3 inches.
c) A skirt is highly important to shield the gap area between the pot and the char against the influence of wind. The gap between pot and skirt should be determined.

Christa's Summary in review of the stove camp

Observation and necessary action	Derived Design Principles
Charcoal radiates heat to all sides: as much can radiate towards the bottom of the stoves as can radiate upwards towards the pot. Action: Avoid loss of radiating and conducting heat from charcoal that is not directed towards the pot.	• Add space between the charcoal grate and other stove parts: Lift the charcoal grate slightly off the bottom of the stove and increase the space to the sides of the stove. • Limit the places where the hot grate can conduct heat to other stove parts. • Add a deflector plate between charcoal chamber and the stove bottom to radiate heat back upwards. • Insulate the stove bottom to prevent heat loss through the bottom. • Insulate sides of the stove. • Regain heat through air circulation (air cooling of stove) by passing air through heated stove parts thus preheating air entering the combustion system. This can be by passing primary air through the deflector plate below the grate and/or secondary air through a gap between double side walls of the stove.
Charcoal combusts in function of the available oxygen. Thus heat generation is a function of air supply to the charcoal grate. Action: get the right amount of air to the charcoal grate. To little will choke the combustion, too much will cool the flue gases.	If power of the stove is too low, increase air supply by • making more holes in the grate. • adding a 'Henson pig-tail' vertical air-pass through the charcoal bed. Do not pile the charcoal up too high, as this will restrict air flow through the charcoal bed (this is influenced as well by the shape and particle size of the charcoal chunks).
The combustion of charcoal goes from oxidizing C to CO, then in a subsequent step from CO to CO2. CO is a toxic gas and has still considerable energy value. Ensuring a complete combustion will increase energy output and reduce toxic emissions. Action: avoid CO emissions.	
Charcoal radiates heat but there	Avoid obstructions between the radiating

is also considerable convection of hot flue gases. Action: Optimize transfer of created heat into the pot.	charcoal bed and the bottom of the pot (increase the view factor of the charcoal seeing the pot).