Parts of an Institutional Cook Stove
- Functions and principles for improved construction –

Institutional Stoves at GIZ / EnDev office in Liberia

Any kind of stove design starts from the fuel and the pot.
The following describes parts of an institutional brick stove for firewood, but many principles can be applied for other types of stoves, too.

1. Foundation

Function: protects the stove against moisture, stable ground for the construction

- Build in some plastic sheet/tarp, fold edges up to prevent water from flowing in, protect the plastic with sand from being damaged
- One layer of bricks or cement can be used as a foundation

Examples:

tarp and sand as protection

brick layer as foundation

2. Entrance for firewood

Function: provide space to push firewood into fire chamber, control the fire

- Should have the same size like the fire chamber
- Not smaller: would constrain users from using appropriate size and amount of firewood
- Not bigger: too much air would cool the fire down
- Visibility of fire should be possible

Examples:

entrance with “house shape”

entrance with rectangular shape

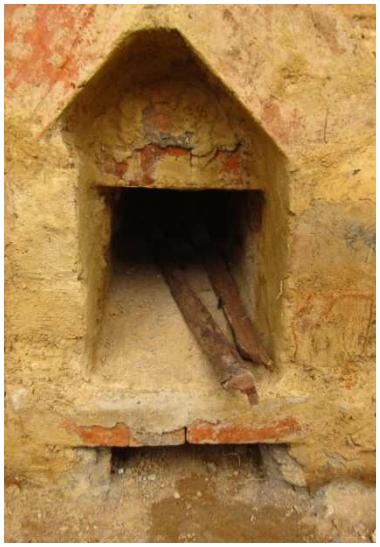
3. Grate for firewood

Function: barrier between moist bottom and firewood, makes airflow from beneath the firewood possible, prevents accumulation of coals

- Metal can be used even though it is exposed to heat, because it is easy to replace
- Bricks can be used too (see example)
- Build it in a way that embers fall through and don´t block the airflow
- Don´t make it level with where the firewood is pushed in but further down to have space for the ashes to burn off (ca. 2-5 cm is enough)

Examples:

Grate from JumboZama firechamber



Instead of a metal grate thin ceramic bricks were laid to create an entry for the firewood and a channel for the air inlet underneath

A metal grate from 10 mm steel rod was made to help embers from the tip of the firewood to burn down to ash. It sits below the level where the firewood enters so that airflow is not blocked by ashes.

Whole view of grate made from steel rod

4. Firechamber

Function: combustion of firewood, one of the most important parts of a stove

- Size should be calculated according to pot size (see table attached)
- Do not construct bigger than entrance for firewood: would not keep the fire hot
- Do not construct too low: does not give time and space to finish combustion
- The firechamber should not touch any other part of the stove (to minimize conduction of heat) but be insulated (preferably by air, which is the cheapest insulation material), like this, no heat is wasted and it goes directly to the pot and the outside of the stove stays cool and safe
- No use of metal that is prone to corrosion
- The location should be right in the center

Advantages of a portable, premanufactured firechamber, delinked from brick-structure:

- Allows shorter construction time in the field
- Quality control of one of the most important parts of a stove is easier at workshop
- The brick-structure of the stove stays flexible and can be adapted to the pots found in the field
- The firechamber can be replaced and makes the stove more durable
- The firechamber can be locally made or imported

Examples:

JumboZama firechamber (portable, imported)

Firechamber made out of fired specific cut ceramic tiles in an elbow shape, hold together by a metal wire (portable, locally made) bevelled bricks like in the sketch would hold better and be easier to construct

Firechamber built out of fired bricks in an elbow shape (not portable, locally made and constructed on site)

5. Pot rest

Function: support the pot and create a gap between the stove structure and the pot

- Should be very durable and resistant
- Should not obstruct air flow or flames
- In the case of the separate firechamber, one of the pot rests should be directly opposite the entrance where the firewood gets pushed in: this way it functions as a damper that absorbs the shock and pressure from the firewood and prevents the firechamber from getting dislocated or uncentered
- The other potrests should be in a good triangle. 3 pot rests are preferable as this provides maximum stability of the pot
- Should not be out of metal, prone to corrosion
- The height of the pot rest should be in a way that the pot sits slightly above the flames. This is the hottest point of the fire

Examples:

Pot rest made out of fired bricks in a round stove construction

Pot rest made out of fired bricks, located at plastered "bowl" for pot

6. Pot-Stove fit

Function: essential for maximum heat transfer

- The stove has to be designed around the pot
- As much surface of the pot as possible should be in touch with the hot gases
- The pot should “sink” into the stove as much as possible: it protects the pot from the wind that can cool the pot and maximizes the surface of the pot where the pot can be heated through the contact with the hot flue gases
- The limit to sink the pot in are the pot-handles: it must still be easy and safe for the user to remove the pot, so a space of aprox. 8 cm has to be left so that the handles of the pot can still be grabbed
- If the heat transfer is good the food will start to boil from all sides. This shortens the cooking time and also minimizes the danger of food getting burnt on the pot bottom

Stove-pot fit without chimney

- The pot sits “in the chimney”, so it is part of the flow-path of the hot flue gases
- This means, without a separate chimney, the entire surface of the pot is exposed to the hot flue gases, which maximizes heat transfer and speed of cooking
- The distance between pot and stove should not be too tight: this would obstruct air flow. Normally a gap of 10 mm is sufficient for a pot of 100 liters.
- The distance between pot and stove should not be too wide: the hot gases would not be forced directly against the pot
- A metal ring around the pot with 10 mm distance holders at the widest point of the pot is needed (in the case of the slightly conical Liberian pot the widest part is on top)
- The metal ring gets fitted with the little metal stubs of 10 mm steel rod inside (at least 6) to prevent the pot from sitting flush against the metal ring and obstruct flow. While the horizontal parts of the ring can be covered by plaster for protection, it is important that the vertical stubs towards the pot stick out above the plaster to create the 10 mm gap

Examples:

Pot sits “in chimney”, the 10 mm distance holders of the metal ring, define the space between stove and pot

Close view of the metal ring with distance holders, sitting on top of the round structure of the stove, covered by plaster for heat protection

Stove-pot fit with chimney

- Tight seal for pot to prevent flue gases to escape around the pot
- The flow path of the air/flue gases has to be sealed so that the hot gases don´t escape before but are directed to the chimney
- The entry into the chimney should be at the highest point to maximise the area of the pot that can be in touch with the hot flue gases to maximise heat transfer
- Solutions to seal the pot can be a metal ring from steel rod that is inbuilt in the stove structure at the widest point of the pot that sits inside (leaving the space to grab the handles) or a external, separate long bag filled with wet sand that can be wrapped around the pot to seal the gap between pot and stove

Examples:

A metal ring from 10 mm steel rod is built into the top of the stove on the highest point to seal the flow path for the air and directing it to the chimney

Entrance of the chimney is at the highest point to maximize the area where the pot is in touch with the hot gases

7. Brick structure

Function: accommodate the pot, windbreak to shield the fire

- Has to be wide enough to accommodate the pot
- Can be made out of fired bricks, cement blocks or unfired earth blocks
- Wall should be stable enough to support the weight of the full pot
- Wall should not be too thick to make stove ergonomic and to avoid that cook has to bend over too much

Round construction

- Should be perfectly round
- Make first a metal ring that fits about 8cm below the top edge of the pot (so that handles still can be grabbed). This round structure can be used as a guide for each course of bricks laid. It should always fit perfectly inside the ring of bricks

Square construction

- Easier to build when larger blocks are used
- A solution needs to be found for the pot-stove fit (without chimney: a solution to fix the metal ring with the distance holders, i.e. some extra slabs for the corners / with chimney: a solution to create a perfect airflow around the pot)

Examples:
A stove can have many different forms and shapes:

8. Chimney

Function: guide the smoke away from the user and the space where the user operates

→ The heat gets drawn quickly into the chimney; this is why stoves with a chimney are generally less efficient

Recommendation:
Without chimney: for well ventilated kitchens or simple shelters at schools
With chimney: for existing enclosed kitchens

- Build the entry into the chimney at the highest point of the stove to maximize the area of the pot that can be in touch with the hot gases to maximize heat transfer
- A long chimney creates more draft and draws the hot gases away from the pot: make it as short as possible and as long as necessary to remove the gases through the wall or the roof
- try to create a cleaning trap for the chimney to allow cleaning without removing it
- can be made out of bricks or metal (put insulation at the lower part of a metal chimney for safety)

Examples:

Entrance of the chimney is at the highest point to maximize the area where the pot is in touch with the hot gases

Metal chimney, insulated with bricks at lower part

Brick chimney

9. Parts for user convenience

Function: a stove will only be used when it is convenient to use

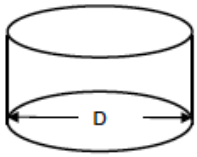
- Wall of the stove should not be too thick to make stove ergonomic and to avoid that cook has to bend over too much
- If the stove is high, some steps should be added on the sides for the cook to be able to reach the pot comfortably. Sometimes two steps are needed on either side of the stove so that two people can carry the pot and set it inside the stove. If needed a platform has to be created so that the user can operate the stove in a comfortable position
- Construct some space to place kitchen materials
- Produce a hook to scrape ashes and grab the grate for the firewood
- Construct a sandbox to extinguish firewood after cooking and reuse it. This will preserve and save firewood and greatly reduce the smoke from the smoldering embers
- Make the stove safe: insulate all lower parts to prevent hot surfaces

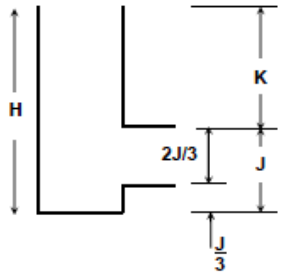
10. Construction material

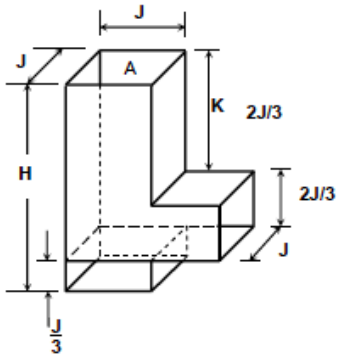
- Keep number of parts low and tool up where possible for speed and ease of production
- Maximize the use of locally available materials and adjust the design of the stoves to the easily available material and size of be it ceramic fired bricks, unfired earth bricks or cement blocks
- Minimise the use of metal, it is likely to corrode and costly
- Make important features like the pot rest out of durable ceramic / bricks
- If metal is used, it should be as much as possible covered in plaster, or be a part that is easy to replace (like a firewood grate)

Acknowledgement
This manual was compiled by Ylva Kuerten based on the Institutional Stove workshop held by Christa Roth, Food and Fuel consultant, at GIZ/EnDev Liberia in August 2017

Appendix: Relationship between Saucepan / Pot Diameter and Combustion Chamber







The rocket elbow combustion chamber

Notation	Pot Capacity (L)	J (cm)	K = 1.5 X J (cm)	H = K + J (cm)	Chamber Area (cm^2)	Chamber Sizing (cm)
	20-40	15	23	38	225	15 x 15
	41-60	16	24	40	256	16 x 16
	61-80	18	27	45	324	18 x 18
1	81-100	20	30	50	400	20 x 20
2	101-150	21	32	53	441	21 x 21
3	151-200	22	33	55	484	22 x 22
4	201-230	23	35	58	529	23 x 23
5	231-300	24	36	60	576	24 x 24