Results from Preliminary Experiments Conducted on Multi-level Primary Air Entry Gasifier Stove

Introduction

Unlike the traditional woodstoves demanding larger logs, gasifier stove is ideally suitable to burn fuels having smaller sizes. These fuels include wood chips, agricultural waste, forest residue, pellets and briquettes. Gasifier stove also gives you control over combustion rate, hence enabling you to economize your fuel. Furthermore, the stove has the capacity to realize clean combustion with fuels known to be smoky in conventional stoves as it relies on combusting smoke.

To enjoy the above mentioned and other incorporated benefits, we have developed a stove with the following basic design considerations:

1) Construction simplicity
2) Small number of components
3) Shorter in height to reduce heat loss

Construction of the stove

A ***natural draft*** gasifier stove with fuel size capacity of about 0.005m^3 was developed using mild steel sheet metal. The stove consisted of three concentric tubes of different sizes, perforated bottom disc to support fuel, and a hollow topping disc integrated with pot support. All parts of the stove were independent and can be assembled without temporary or permanent connectors. Overall dimension of the gasifier stove is 320cm height and a diameter of 19cm.

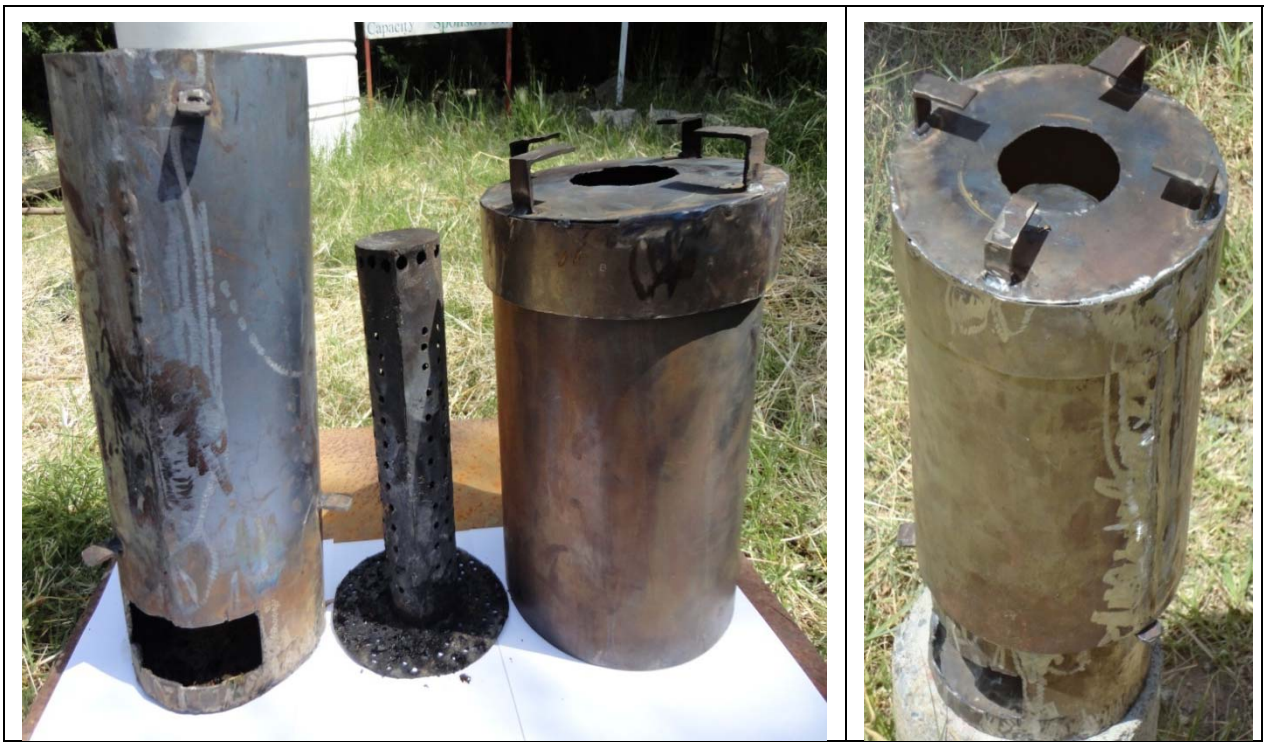

Figure 1: The three building blocks of the stove

Characteristic feature of the stove

The basic difference between previously developed Top Lit-UpDraft (TLUD) gasifier stoves and this stove is the inclusion of 'central column for air' in this stove. As it can be seen in Figure 1, the air column is drilled on the surface so as to let additional primary air radially into the fuel at different stages to compensate for air clotting that can occur when run with small sized fuel as you go up from along fuel column. This helps the flaming pyrolysis from being air starved due to interlocking of fuel particles. In addition to that, closely spaced holes of relatively larger size were made near the top of the central air column to supply more hot post-pyrolysis secondary air. The presence of two hot secondary air admission points is meant to supply enough air while keeping the stove short with reduced heat loss.

The Fuel

The fuel considered were those ones which are considere to burn by traditional stoves, even to the extreme treated as waste. This widens the fuel domain for our society who rely up on wood logs and charcoal as the only source of energy found at vicinity. Wood chip, handmade briquettes of sawdust and, a machine pressed briquette of sawdust, and briquette form coffee husk were used the feedstock used for testing the gasifier stove.

i. ***Wood chip***: it was collected from the remainees of construction reinforcement that can not be used for the same task again. Burning of wood chip in traditional stoves is difficult as the combusiton is spontaneous resulting in high fuel consumption rate.

ii. ***Coffee husk briquette***: As Ethopia is one of world's largest coffee exporters, the resulting coffee husk disposed as waste. Briquetting is now a days introduced as disposal mechanism to make the handling easier. It is this briquette that has been tested for house hold energy supply in the stove. The briquettes were made using a motor driven press machine.

iii. ***Sawdust-cow dung briquette***: Several wood workshops are well engaged in making furnitures for wide range of customers from residential houses to business and academic institutions. The saw dust from these shops either piled in disposal site or freely given to individuals to use it along with wood in wood stove, which is unefficient. Cow dung on the other hand, one of the smoky fuels for the non-previllaged to get firewood. Cow dung is here used as binder to make briquettes out of saw sawdust better control over combustion can be achieved.

(a) Wood chips (b) Cofffee husk briquette (c) Saw dust-cow dung briquette

Figure 2: Fuels considered in the pleniminary test

Operational characteristics of the stove

Ones the stove fed with enough fuel, either kerosene or easily catching wood chips should be used for faster starting. Putting chimney on top also assists fire catching. The same starting method having been used for the preliminary tests made with all the three types of biomass feedstock, the gasifier stove operated continuously without smoke until the fuel tank remained with charcoal of respective fuel. The startup time for the waste wood and sawdust-cowdung briquette has been shorter compared to the coffee husk briquette, presumed to be resulted from difference in density. After successful start up firing, about 0.5kg of coffee husk briquette and 0.3kg of sawdust-cowdung briquettes burnt gently non-stop for about 90 and 60 minutes respectively. Ash formation was also observed to be lower for briquettes compared to wood chips.

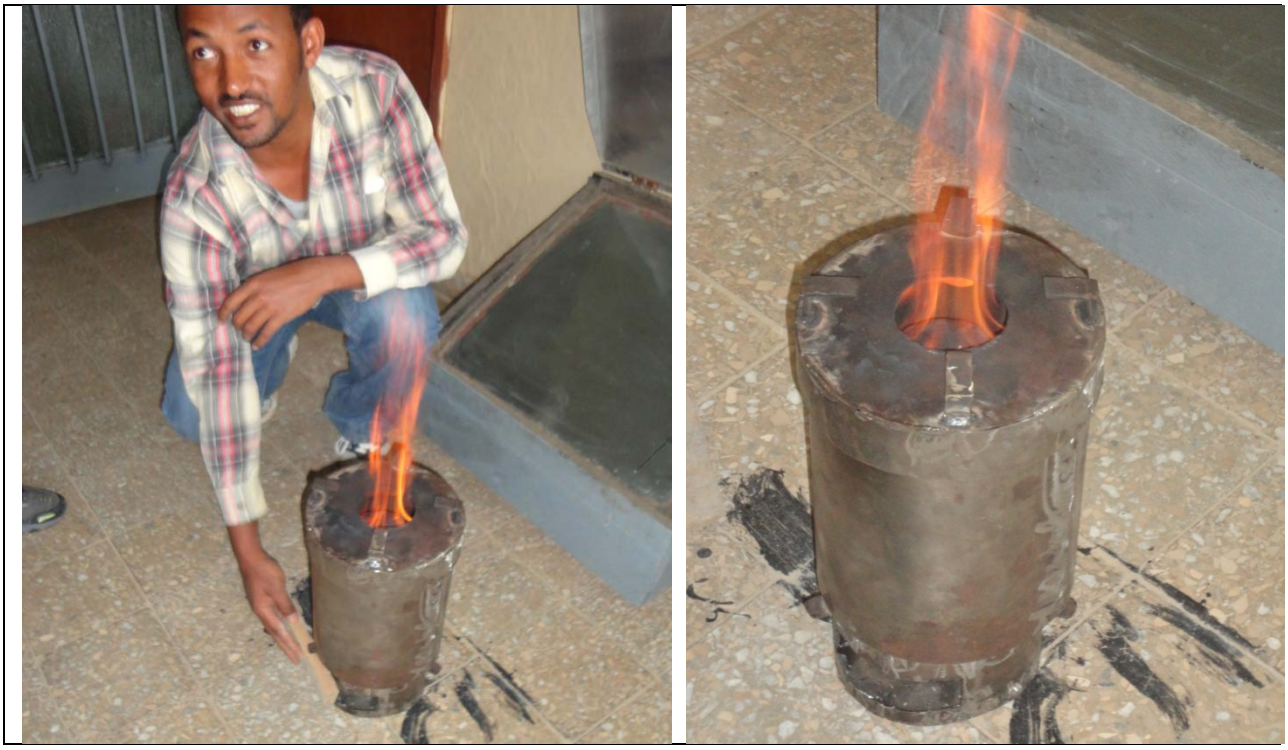

Figure 3: The stove under operation

Furthermore, the stove can be scaled up to institutional size and made to suite different sized fuels as per customer requirement by making minor design alterations.

The fact that the stove runs on processed fuel also gives a new business opportunity for people engaged in preparing the fuel in addition to manufacturers of the stove itself.

Pyrolisis products

Creation of flame does not continue till the fuel gets in to ashes; rather, it terminates when the whole amount of fuel in fuel chamber is carbonized (changed in to charcoal). Hence, this charcoal was removed from the stove as the stove doesn't efficiently combust it. Friability of charcoal was dependent on the density of the feedstock. Figure 4 shown below illustrates the appearance of the charcoal eventually obtained from stove test.

(a) Carbonized Wood chips

(b) Carbonized coffee husk briquette

(c) Carbonized sawdust-cow dung briquette

Figure 4: Pyrolysis products of the stove (charcoal)

The produced char can be used in charcoal stoves either as it is or as briquette made preceding milling process. This enhances higher conversion efficiency of the feedstock to end use.

Future plans

- Conduct more detailed experiments on the stove with different fuel
- Distribute about twenty stoves to selected households and get feedback
- Construct institutional size stove and test at practical conditions

Implementation of the gasifier stove is beyond energy production

1) Utilizes waste as energy source
2) Creates business opportunity to community members with low income

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