Abstract:

This invention relates to an improved stove operable on low alcohol concentration comprising a fuel tank provided with a pump and a pressure relief valve connected to an inlet port characterized in a burner unit fitted over a nozzle assembly, a condensate collection pan positioned above said burner surrounded by a jacket, which supplies adequate air for combustion of fuel, a flame regulating valve below the nozzle and pressure regulating valve adjacent to the tank.
An improved stove operable on low alcohol concentration

FIELD OF INVENTION

This invention relates to an improved stove operable on low alcohol concentration.

PRIOR ART

Most of the rural households in developing countries cook food on inefficient and biomass cookstoves that emit considerable amount of smoke. Besides creating environmental pollution, such stoves create health problems for a housewife. Further, such stoves are operable on biomass, which is not easily accessible and tedious to collect.

Though biogas has been used for cooking purposes since a considerable period, it suffers from drawbacks such as: input of large amount of cowdung; low production of gas; bulky equipment of gas producer, inability to be transported and hence has to be used very close to the gas producer and holder.
In rural areas of developing countries there is a substantial amount of illicit liquor production. The illicit alcohol production takes place in makeshift backyard and rudimentary distillation units which produce alcohol with 45-60% (w/w) ethanol/water concentration. At the same time the production of such low concentration ethanol can easily be done in the rural locations through a simple distillation unit consisting of a flash evaporation system. This simple system can also save the energy for distillation of ethanol.

Ethanol is highly inflammable with very low flash point (-15° C) and has been used in Brazil and South Africa as cooking fuel [Waldir A. Bizzo, et. al, "Safety issues for clean liquid and gaseous fuel for cooking in the scope of sustainable development". Energy for Sustainable Development, Vol. VIII, No. 3, September 2004]. However, generally it is used at 85% (v/v) and higher concentrations and is a dangerous fuel. Therefore, many fire deaths have been reported in its use at these concentrations.

**OBJECTS OF THE INVENTION**

An object of the invention is to propose an improved stove operable on low alcohol concentration.
Another object of the invention is to propose an improved stove operable on low alcohol concentration which is easily accessible.

Further object of the invention is to propose an improved stove operable on low alcohol concentration which is safe for use.

Still another object of the invention is to propose an improved stove operable on low alcohol concentration 50% (w/w) or higher concentration of ethanol/water mixture.

Yet another object of the invention is to propose a stove operable on low alcohol concentration in which the fuel can be produced from locally available biomass.

**STATEMENT OF INVENTION**

According to this invention there is provided an improved stove operable on low alcohol concentration comprising a fuel tank provided with a pump and a pressure relief valve connected to an inlet port characterized
in a burner unit fitted over a nozzle assembly, a condensate collection pan positioned above said burner surrounded by a jacket, for supply of combustible air, a flame regulating valve below the nozzle and pressure regulating valve adjacent to said tank.

**BRIEF DESCRIPTION OF THE ACCOMPANYING DRAWINGS**

Further objects and advantages of this invention will be more apparent from the ensuing description when read in conjunction with the accompanying drawings and wherein:

Fig. 1. shows: Isometric view of stove assembly.

Fig. 2. shows: Isometric view of different parts of the stove.

**DETAILED DESCRIPTION OF THE INVENTION WITH REFERENCE TO THE ACCOMPANYING DRAWINGS**

Reference may be made to figure 1 wherein the stove is provided with a fuel tank (2) having a pump (1) for pressurizing the tank. Satisfactory performance of the stove is obtained for tank pressures ranging from
about 50kPa-150 kPa, the capacity of which can be changed from a high of 2.45 kW to a low of 0.9 kW. Further, the tank is provided with a pressure relief valve (3) to shut down the stove. This is effective "off switch for the stove, though it can also be shut off with a flame regulating or needle valve (10). It enables easy regulation of the flame by regulating the fuel flow to burner, which has two settings one for simmer and other for high flame.

An outlet filter (4) is provided to filter the ethanol before it passes through the nozzle thus preventing any blockage that might occur due to suspended particles in the fuel mixture. It is made of mesh. Another filter (inlet) made of the same material is fixed at the inlet port beneath a tank cap (12) detachably provided over the inlet port. The cap houses the inlet filter.

The stove comprises a burner unit (5), which fits over the nozzle. The unit allows 50% ethanol/water mixture to combust by first evaporating the mixture evenly followed by combustion. The burner is designed so that the water in the ethanol converts into steam. The resulting flame is
yellowish-red in colour with no smell. The CO emission near the stove are well within the acceptable range. It has a small container which acts like a preheater for starting the stove. A condensate collection pan (6) is provided over the unit to collect liquid, which is again evaporated without affecting function of the burner. This part is necessary since, when a utensil is placed on the stove, water vapor coming from the combusting fuel mixture would condense on the bottom surface of the utensil and drip onto the burner. The amount of this condensate at times is sufficient to cool the burner below 100°C required for evaporation of the fuel mixture. This would result in the collection of the un-evaporated fuel mixture in the fuel pan at the bottom of the burner, which would eventually cause major operating problems. With the condensation pan in place, the liquid is collected and again evaporated without affecting the burner's function.

Further, the stove is provided with a jacket (9), constituting a channel for induction of vertical air flow for mixing with the fuel vapor in the combustion area just outside the burner. It provides an adequate supply of air for complete combustion of fuel and also keeps the levels of carbon
monoxide low in its vicinity. Further, it also acts as a shield to prevent radiation losses.

A main frame (8) of the unit is provided to support a utensil support (7) resting on the jacket. These components are assembled by welding. They provide the structural support for stove operation.

A pressure regulating valve (PRV)(II) is provided adjacent to the flame regulating valve and connected to the filter (4) which is diaphragm type.

It allows flow of fuel mixture at a fixed pressure and hence flowrate.

The pressure regulating valve is used so that the flame strength could be independent of the pressure in the tank. Fig. 2 shows a view of the tank, nozzle, outlet filter, FRV and PRV assembly without the burner, jacket or frame in place.

**WORKING PRINCIPLE**

With the pressurization of the 50% ethanol-water fuel mixture in the tank, the flow of fuel is initiated by opening the FRV. It first flows
through the PRV where its flow is regulated, then through the outlet filter (where all the suspended particles are removed) and finally out of the nozzle. Thereafter, the fuel mixture is vaporized on coming into contact with the preheated burner surface. The combustion takes place just outside the burner where the mixing of air and fuel takes place. The air for combustion is supplied through natural updraft provided by the jacket. The stove is made operational with the help of a small amount (5-10ml) of ethanol in the preheater which heats the burner and hence helps in evaporating the mixture. Subsequently, the heat of the flame heats the burner.

Table 1. Test results of low concentration ethanol stove, which may be taken as an example

<table>
<thead>
<tr>
<th>1. Dimensions of stove</th>
<th>42.5 cm(L) X 20 cm (W) X 22.7 cm (H)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2. Weight of stove</td>
<td>4.3 Kg</td>
</tr>
<tr>
<td>3. Fuel tank capacity</td>
<td>2.61</td>
</tr>
<tr>
<td>4. Material of stove</td>
<td>Stainless Steel</td>
</tr>
<tr>
<td>5. Capacity of stove (for 50% w/w mixture)</td>
<td>2.45 kW for maximum capacity (max) 0.9 kW for minimum capacity (min)</td>
</tr>
<tr>
<td>6. Fuel consumption (ethanol)</td>
<td>0.33 Kg/hr (max) 0.125 Kg/hr (min)</td>
</tr>
<tr>
<td>7. Efficiency of stove (50% w/w mixture)</td>
<td>~ 45% (max) ~ 43% (min)</td>
</tr>
<tr>
<td>8. Water boiling time (1 liter of water) (50% w/w mixture)</td>
<td>5 minutes (max) 13.5 minutes (min)</td>
</tr>
<tr>
<td>9. Carbon monoxide emissions</td>
<td>&lt; 5 ppm</td>
</tr>
<tr>
<td>10. Estimated cost (in mass production)</td>
<td>Rs. 1000/- 1500/- (~25 US dollars)</td>
</tr>
</tbody>
</table>
The stove runs effectively on any ethanol/water concentration of 50% and above. Fig. 3 shows the effect of varying ethanol concentrations on burner capacity for the maximum setting.

FIELD TESTING OF STOVES

After the development and lab testing these stoves have been field-tested. Thus women farm laborers who do the cooking on wood stoves were asked to prepare their meals on this stove. They used their existing utensils and cooked their regular fare. The testing was done in a small room (4.5 m x 3.1 m and 3-m ceiling) which had one window and a door to simulate their actual dwellings. These women cooked regular food, which included rice, lentil soup, chapatti (wheat flat bread) and vegetables. They appreciated the silent stove and specially the ability to control the flame.

On an average the stove consumed about 3.6 to 4.5 kWh (thermal) of energy in cooking this food. This is much less than 5-6 kWh, normally used in wood cookstoves cooking the same amount of food. The CO
levels, measured by hand held electronic CO meter, were between 3-10 ppm near the cook. Table 2, gives the details of testing and comparison of ethanol stove with kerosene and LPG stoves.

The following advantages ensue from the stove of the present invention:

• It is easy to light and operate.

• There is no smell and smoke and hence it is better than the woodstove, as the eyes don't burn and gives no headache.

• It is better than the kerosene stove as it is completely silent and there is an absence of kerosene smell once extinguished.

• It is safer than a kerosene stove as it requires less similar pumping.

• It is a LPG stove since it has flame control.
Table 2. Summary of cooking tests

<table>
<thead>
<tr>
<th>No.</th>
<th>Item</th>
<th>LPG</th>
<th>Kerosene</th>
<th>Alcohol Stove</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Total no. of Field Tests</td>
<td>2</td>
<td>6</td>
<td>67</td>
</tr>
<tr>
<td>2</td>
<td>Total no. of women</td>
<td>2</td>
<td>4</td>
<td>16</td>
</tr>
<tr>
<td>3.</td>
<td>Average amount of fuel used per meal, kg</td>
<td>0.21</td>
<td>0.27</td>
<td>0.48</td>
</tr>
<tr>
<td>4.</td>
<td>Avg. Food and water cooked, kg</td>
<td>5.23</td>
<td>5.12</td>
<td>5.98</td>
</tr>
<tr>
<td>5.</td>
<td>Avg. Time required, minutes</td>
<td>126</td>
<td>125</td>
<td>135</td>
</tr>
<tr>
<td>6.</td>
<td>Avg. Specific Energy required kW-hr/kg</td>
<td>0.52</td>
<td>0.63</td>
<td>0.60</td>
</tr>
<tr>
<td>7.</td>
<td>CO values (near the cook), ppm</td>
<td>0 to 2</td>
<td>8 to 10</td>
<td>6 to 8</td>
</tr>
<tr>
<td>8.</td>
<td>Cost of cooking. Rs/kg</td>
<td>0.89</td>
<td>1.60</td>
<td>1.62</td>
</tr>
</tbody>
</table>

- The above data is for meals cooked without the use of pressure cooker. There is 20 to 30% savings in the specific energy required per meal using a pressure cooker.
• Cost of cooking is reduced.

It is to be noted that the present invention is susceptible to modifications, adaptations and changes by those skilled in the art. Such variant embodiments employing the concepts and features of this invention are intended to be within the scope of the present invention, which is further set forth under the following claims:-
WE CLAIM:

1. An improved stove operable on low alcohol concentration comprising a fuel tank provided with a pump and a pressure relief valve connected to an inlet port characterized in a burner unit fitted over a nozzle assembly, a condensate collection pan positioned above said burner surrounded by a jacket, which supplies adequate air for combustion of fuel, a flame regulating valve below the *nozzle* and pressure regulating valve adjacent to the tank.

2. An improved stove operable on low alcohol concentration as claimed in claim 1 wherein the stove is provided with an outlet filter to filter the ethanol to avoid clogging of the *nozzle*.

3. An improved stove operable on low alcohol concentration as claimed in claim 1 or 2 wherein the inlet port houses an inlet filter.
4. An improved stove operable on low alcohol concentration as claimed in any of the preceding claims comprising a frame supporting utensil support resting on the jacket.

5. An improved stove operable on low alcohol concentration substantially as herein described and illustrated with reference to accompanying drawings.
Fig. 1