CLEANCOOK Stoves vs. Gel Fuel Stoves

Ethanol

Ethanol is produced through the fermentation and distillation of sugars (derived from molasses, sugarcane, sweet sorghum, etc.) or starch crops (cassava, maize, etc.). The liquid ethanol can be burned directly in specialized stoves like the CLEANCOOK, Chinabest, Sterno, Bluewave, and Britelyt.

Ethanol Gel Fuel

Gel fuel is produced by mixing denatured ethanol with a thickening agent (cellulose) and water through a very simple technical process. Gel fuel has a much higher viscosity and is easier to handle.

CLEANCOOK Stove

The CLEANCOOK Stove is powered with liquid ethanol and the fuel tanks hold the ethanol in a special adsorptive fiber so that it cannot spill out. The tanks are not pressurized. The burner flame is easily adjusted or extinguished by means of a simple lever.

Figure 1: CLEANCOOK stove

Gel Fuel Stove

One type of gel fuel stove, the D&S stove in Malawi, comprises a simple can structure with a regulator that sits in a basic metal frame. Fuel is poured into the can through the middle of the regulator and it is lit with matches. The stove is turned off by placing a lid over the regulator. Most gel fuel stoves are built on the same principles.

Figure 2: D&S gel fuel stove in Malawai

Emissions Performance

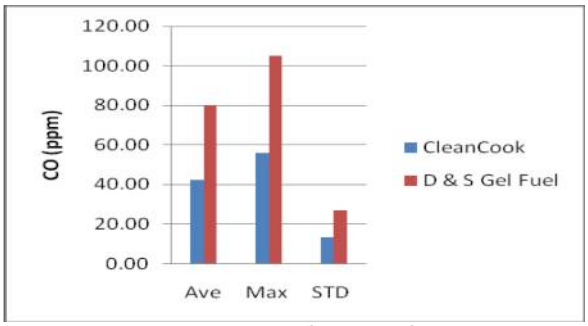

Figure 3: Average CO data [Lakew, 2007]

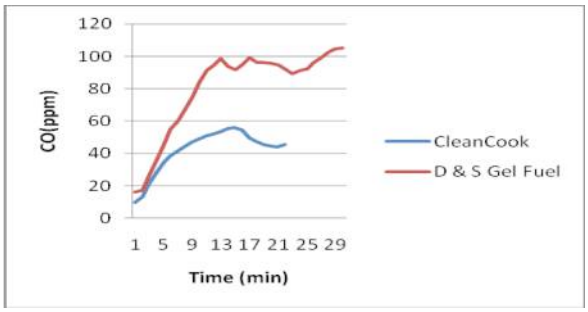

Figure 4: CO data [Lakew, 2007]

As shown in the above test figures, the emissions from the gel fuel stove are roughly double those from the ethanol stove, and they become increasingly more polluting with higher power. These pollutant levels are likely caused by the gelling agent, which, although it makes the fuel safer to use, leads to less complete burning, producing poisonous carbon monoxide rather than carbon dioxide, which is safe.

Specific Fuel Consumption

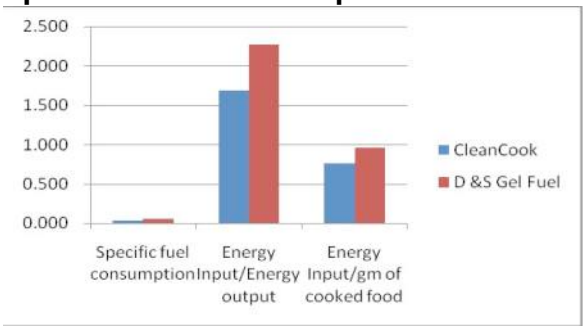

Figure 5; Fuel consumption data [Laekew, 2007]

Table 1: Water boiling test – 5liters [Aprovecho, 2008]

Standard Measures	Kerosene	CLEANCOOK
Fuel to Cook 5L (g)	223	317
CO to Cook 5L (g)	8	5.3
PM to Cook 5L (mg)	10	4
Energy to Cook 5L (kJ)	9704	6766
Time to Boil(min)	42	32

Efficiency and Economic Impact

From Table 2, it can be seen that the gel fuel stove is 34% less energy efficient than the CLEANCOOK. The cost of useful energy using the CLEANCOOK is nearly three times less. Energy output from liquid ethanol fuel is ~50% greater.

Table 2: Cooking costs – comparison on a useful energy basis at October 2007 [Hilawi,2007]

	CLEANCOOK	D&S
Energy of fuel (MJ/L)	24.8	16.4
Stove efficiency	59%	44%
Stove Price (USD)	46*	17
Useful energy cost (USD/MJ)	0.089	0.242
Energy cost (USD/MJ)	0.085	0.253

*Cost likely to decrease when locally manufactured

The CLEANCOOK stove costs around three times more than the D&S, but per year it costs less. Liquid ethanol is 32% less expensive.

CookSafe, Sungel, & CLEANCOOK Performance

The results of water boiling tests performed in Cape Town University show that most gel fuels burn with higher emissions and less efficiency than the liquid CLEANCOOK stove, particularly at higher power levels [Lloyd, 2006].

Table 3 shows that the CLEANCOOK stove is the most efficient, with the highest net power and lowest CO/CO2 ratio.

Table 3: – Boiling 2 ½ liters water [Lloyd, 2006]

Stove	Net kW	Time (mins)	Efficiency, %	CO /CO_2
Sungel	0.109	39.00	13.1	0.13
CookSafe	0.730	12.00	57.9	0.052
CLEANCOOK	0.998	9.62	65.3	0.03

Figure 6: CookSafe gel fuel Stove and a bottle of fuel

The tests undertaken by the Aprovecho research center shows that the CLEANCOOK stove is under the CO/CO_2 < 2% standard deemed acceptable. At higher power, the CO/CO_2 ratio is 0.016 (1.6%) and under low power, the CO/CO_2 ratio is 0.012 (1.2%).

Figure 7: One burner CLEANCOOK stove

Safety Evaluation

The CLEANCOOK stove was evaluated for safety based on the protocol developed by Nathan Johnson of Iowa State University. The CLEANCOOK stove was deemed very safe. Access to the fuel canister is only through the bottom of the stove, preventing any dangers associated with refilling from the top and the associated risk of burns. Refilling can only be done with the canister completely removed and it does not generally remain hot enough to be dangerous [Aprovecho, 2009].

Consumer Appraisals

Completed extensive pilot studies for 850 CLEANCOOK stoves in Ethiopia and in a pilot in Nigeria demonstrated stove efficiency, safety, and user-friendliness. Thousands of stove test days have been logged without a single accident

Conclusions

Gel fuel does not represent an economically viable alternative to paraffin in Malawi. Gel fuel has been reported to be 2.5 to 208 times as expensive as paraffin to achieve the same cooking performance. [Evaluation of Gelfuel experience in Malawi, Oct 2006]. Based on data from this assessment, most gel fuel stoves suffer from having incomplete and inefficient combustion, with the associated problem of not generating enough heat for cooking effectively.

By comparison, the CLEANCOOK has been shown to be clean, affordable, safe, and easy to use.