Plant Oil Cooking Stove for Developing Countries

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1 Plant Oils as Cooking Fuel

In rural areas of tropical and subtropical countries wood is still the main energy source. Steadily rising firewood consumption for cooking purposes results in deforestation of large areas creating severe ecological, economical and sociological problems. Moreover, the emissions of the open fires are extremely harmful to the users. Therefore, utilization of alternative cooking energies is strongly recommended.

Plant oils are a new alternative cooking fuel resource securing a sustainable and independent cooking energy supply. Their utilization as cooking fuel can bring numerous benefits not only for urban but also for rural communities in developing countries.

A vast variety of oil plants originate in the Tropics and Subtropics. Many oil-bearing plants grow on low grade surfaces or in marginal locations, which are unsuitable for food crops while their oils are often toxic to human beings. Those plants are often cultivated on waste lands in order to prevent further erosion and to inhibit desertification. Energetic utilization of their oils will not compete with food production at all. Examples of those oil plants are the Physic nut tree (Jatropha Curcas L.), the castor oil plant varieties (Ricinus communis L.) and the babassú palm (Orbignya phalerata Mart.), among others. Some oil plants even grow in symbiosis with food plants and are used as shadow trees, for example.

Traditional methods for harvesting the fruits from the oil plants and extracting the oil already exist in many regions of tropical and subtropical countries. This local oil production strengthens decentralized structures providing employment and income opportunities for local population and ensuring sustainability. The presscake as a by-product of the oil processing can be used either as fodder or as high-quality fertilizer. Utilizing this new energy source will therefore directly increase the living standard of the population.

Next to this local fabrication of plant oils there are countries like Malaysia or India which already count with a large production of plant oils. In the Philippines, for example, many coconut trees are cut down today due to a reduced demand for the coconut oil. Those plants are not replanted which has serious ecological consequences. Utilization of coconut oil as cooking fuel, however, would give new incentives for replanting those trees.

In general, all plant oils liquid at ambient temperatures can be utilized as cooking fuel. They are bio-degradable and handling is both simple and free of danger. Moreover, burning of plant oils is carbon dioxide neutral.

2 Liquid Fuel Cooking Stoves

Liquid fuels can be burnt in wick and pressure stoves. Due to their high viscosity, plant oils can not be used in common wick stoves. Therefore, investigations have been focused on combustion in pressure stoves.

In those stoves pressure is induced in a tank through application of a pump. The liquid evaporates in a vaporizer and emits through a nozzle into a combustion area. The jet rebounds at a rebounding plate, mixes with ambient air and burns in a blue flame. The combustion area is surrounded by a flame holder. The power output is adjusted with a valve regulating the fuel flow. For ignition, a small amount of ethanol is incinerated in a pre-heating dish beneath the vaporizer.

Kerosene is the commonly used liquid cooking fuel in developing countries today. Since the gross calorific value per volume of plant oils is only 5 percent lower than the corresponding value for kerosene, the plant oils are suitable substitutes. Nevertheless, due to the differences in the chemical structures, plant oils show very distinct physical, chemical, and combustion properties like elevated vaporization and flash points as well as higher values of the carbon residue, among others.

3 Hohenheim Plant Oil Stove

At the Institute for Agricultural Engineering in the Tropics and Subtropics of Hohenheim University a plant oil pressure stove has been developed which is the first stove existing so far enabling continuous operation with various pure plant oils. In addition to plant oils as well as plant oil mixtures, the cooking stove can also be fueled with plant oil esters, kerosene, diesel fuel and gasoline.

The new plant oil stove can be easily introduced even in rural areas of developing countries since the operation of the plant oil cooking stove is similar to the known kerosene pressure stoves. Pre-heating is also done with the incineration of a small amount of ethanol in a dish. Likewise, the power is adjusted with a valve in the oil line. Regarding power output range and efficiency the plant oil stove is comparable to existing kerosene stoves.

Utilization of plant oils as fuel, however, prevents users from severe operating risks related to the easy inflammation of kerosene. The emissions of the plant oil stove are very much lower than the ones for open fires and within the same range of the emissions of pressure kerosene stoves. For example, the hydrocarbon emissions of the plant oil stove were measured to be 370 times lower than the emissions of an open fire with comparable power output. Likewise, the carbon monoxide and the nitrogen oxides emissions of the open fire are 120 times and 15 times higher than the according emissions of the plant oil stove, respectively.

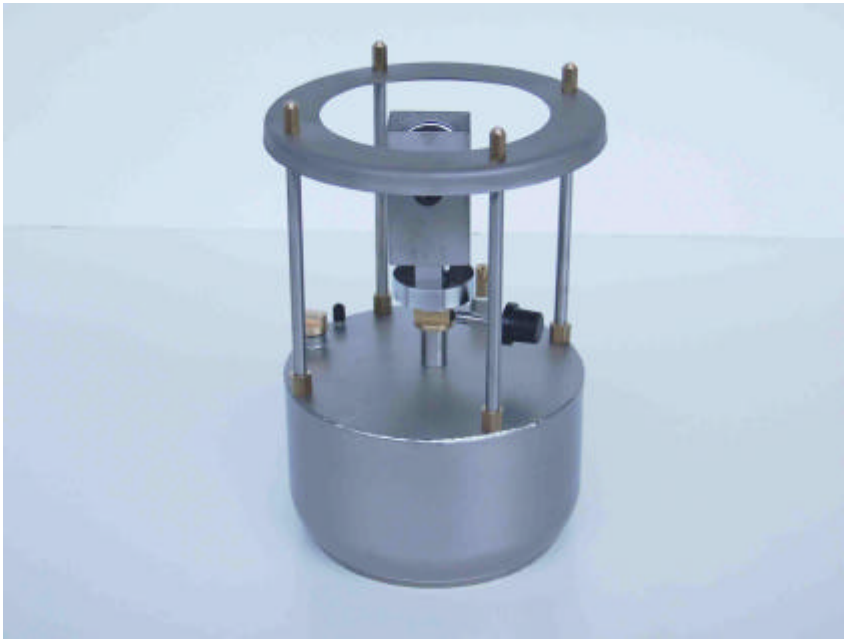
For the development of the plant oil stove, a completely new design of the burner was required in order to maintain a continuous vaporization as well as combustion. For example, the design of the vaporizer increased retention time of the plant oils in the cooker flame considerably taking into account the high flash points of those liquids. However, plant oil molecules start to dissociate at temperatures around boiling point leaving cracking products at the vaporizer walls. Therefore, the vaporizer can be released from the cooker frame and can be cleaned manually if necessary. For cleaning, a wire rope is pulled through the entire vaporizer tube. Nevertheless, the burner of the prototype already runs for more than 30 hours continuously on the test bench without cleaning.

In general, the new plant oil burner can be used independently of the stove’s tank design and pot support. Therefore, it can be adapted even for existing kerosene stove tanks. Nevertheless, common tank designs were analyzed and a new cooking stove prototype was designed. This

stove can be manufactured with simple means and materials at a very competitive price. The whole design is very robust and assures a stable placement of pots or woks during the cooking process.

The prototype is developed as a one-flame cooker. However, the burner of the plant oils stove can be also used in cooking stoves with multiple flames. Depending on the required cooking task, the burner can be built in different sizes with distinct power outputs.

Current research is carried out on the optimization of the stove parameters, like power range and efficiency. A first practical test of the cooking stove is planned in Guatemala. Later on, a field test of the plant oil cooking stove within a tropical or subtropical country will prepare the dissemination of this new technology.



4 Conclusions

A pressure cooking stove was developed which can be fueled by pure plant oils. Only a small amount of ethanol is needed for start-up. In addition, a new stove prototype was designed which can be built locally at competitive prices in developing countries.

Utilization of the plant oil cooking stove has numerous ecological, economical, and sociological benefits. Plant oils are a sustainable energy source ensuring sustainable cooking energy supply. Introduction of the new plant oil cooking stove can be readily acceptable to people in tropical and subtropical countries since its operation is similar to the well-known kerosene stoves.

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