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Research Application Summary

Performance of a natural draft briquette-gas stove for domestic use

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Abstract

Biomass as a source of energy supplies close to 68% of the total energy demand in Kenya. The stoves used to burn these biomass fuels are characterized by high inefficiencies and high emissions posing environmental risks to the Kenyan forest cover as well as health status to the users due to indoor air pollution. This project aimed to mitigate these two major problems by developing a gasification stove to use briquettes mostly derived from organic waste. The stove integrated the design features of the Modified Inverted Downdraft Gasification Experiment (MIDGE), the Vesto stove by Crispin and the Stanley & Venter stove designs. The performance of the stove was tested using the standard water boiling test. The efficiency of the stove was found to be 31%. The cost of this stove, when mass produced would be USD 8, and is recommended for household use.

Key words: Biomass, energy, stove efficiency, water boiling test

Résumé

La biomasse comme source d'approvisionnement en énergie de près de 68% de la demande totale d'énergie au Kenya. Les poêles utilisés pour brûler ces combustibles de la biomasse sont caractérisés par une grande inefficacité et les émissions qui présentent des risques élevés de l'environnement de la forêt kenyane couvrent, ainsi que l'état de santé, pour les utilisateurs en raison de la pollution de l'air intérieur. Ce projet vise à atténuer ces deux problèmes majeurs par le développement d'un poêle de gazéification à l'utilisation de briquettes pour la plupart issus de déchets organiques. Le poêle a intégré les caractéristiques de conception de la mise à jour inversé descendante Expérience de gazéification (cécidomyie), le poêle Vesto par Crispin et le Stanley & Venter dessins poêle. La performance du poêle a été testée en utilisant l'eau d'ébullition standard de test. L'efficacité du poêle a été trouvée à 31%. Le coût de ce poêle, lorsque la masse produite serait de USD 8, et est recommandé pour une utilisation domestique.

Mots clés: La biomasse, l'énergie, l'efficacité du poêle, test de l'eau bouillante

Background

Biomass source of energy supplies up to of 68% of the total energy demand in Kenya (Republic of Kenya, 2004). It is estimated that Kenya has a fuel wood supply of 15.5 million metric tons per year yet the total demand is approximated to be 32 million metric tons (Republic of Kenya, 2004). The deficit of over 16.4 million metric tonnes is met through stock depletion and use of agricultural residue. Close to 90% of the rural households use firewood for cooking, while 80% of semi-urban households use the same as a source of energy for their cooking. The average annual per capita consumption of fuel wood was approximately 741 kg and 691 kg for rural and urban households, respectively by 2002 (Theuri, 2004). Close to 84% of firewood is obtained mainly from agro forestry or on-farm source, 8% from trust lands and 8% from gazetted forests (Theuri, 2004). Approximately 79% of households obtain all their firewood free, 17 % of the households regularly purchase it while 7% supplement their free collection by purchasing some firewood. Firewood is mainly used for cooking and space heating.

By 2002, use of charcoal in Kenya was about 47% at the national level representing 82% and 34% of urban and rural households, respectively. Per capita consumption was 156 kg in urban areas and 152 kg in rural areas. The survey further shows that the amount of charcoal produced each year in Kenya is 1.6 million tons mostly produced in inefficient earth-mound kilns, whose efficiency rarely goes above 20%. This implies that close to 8 million tons of wood goes into making of charcoal yearly (Theuri, 2004). Search and utilization of biomass energy source is associated with much of environmental degradation and side effects. The utilization of this type of energy, and increase in demand for wood for other uses, has led to forest degradation thus contributing to the reduction of the overall forest cover in Kenya. The use of biomass fuel has reduced the forest cover in Kenya from 10% by 1963, down to less than 1.7% currently.

The globe has been warming due to the release of greenhouse gases into the atmosphere. These greenhouse gases originate mostly from the use of energy. Among the greenhouse gases is CO_2 which is released when non-renewable biomass fuels are burnt. As biomass is the principal fuel for cook stoves in the developing world, these stoves produce up to 800,000 tons of soot every year. These particles have been documented to absorb solar energy and contribute to global warming. It is projected by 2050, cooking in Africa will contribute to approximately 7 billion tons of emissions every year, which is

about 6% of all emissions from the continent. There is therefore need for more efficient cooking stoves that use less biomass and release less soot into the atmosphere. In this study we developed a gasification stove and tested its efficiency when using orgnic waste derived briquettes.

Study Description

In designing the stove, an average amount of energy needed for an average family cooking an average meal was established. The average kitchen performance test while cooking with charcoal on a common KCJ with an average cooking efficiency is adopted. From this common kitchen performance test, it is noted that an average family in Kenya of six people uses one kg of charcoal to cook an average meal of ugali and kale. Four types of briquettes were used for the test, and included wood, paper, leaves and sawdust briquettes.

The performance testing of the stove was done using the standard water boiling test (Bailis *et al.,* 2005), where the efficiency of the stove was determined in three phases:

i) In the first phase, the stove was started at room temperature and using a pre-weighed bundle of briquettes to boil a measured quantity of water in a standard pot.
ii) In the second phase, water was boiled beginning with a hot stove in order to identify differences in performance between a stove when it is cold and when it is hot.
iii) Lastly, boiling of a measured amount of water and then, using pre-weighed briquettes, simmering the water at just below boiling for a measured period of time (45 minutes) was conducted.

The overall efficiency of the stove was computed from the average of the three efficiencies, which indicates the amount of useful energy used in the evaporation of water to the energy given out from the burn of the briquettes.

Research Application

The performance of the gasification stove was also the same for all the four types of briquettes. The combustion efficiency was highest for sawdust briquettes, followed by leaf, wood and paper briquettes recarding percentage efficiencies of 34.1, 32.1, 32.0 and 31.1%, respectively. Power generated from these various briquettes was also about the same. It was highest for paper (1.71%) followed by wood and leaf briquettes (1.67% each) and least in sawdust briquettes (1.66%).

The briquette technology developed by the legacy foundation and disseminated by various groups and organization here in Kenya, offers an alternative source of fuel to biomass fuel. Therefore a briquette gasification stove will be more appropriate in burning these fuel briquettes in reducing indoor air pollution associated with burning of biomass sources of fuel. This stove is cheaper and easy to fabricate by the informal sector, compared to other gasification stove designs that are existing. The overall benefit of the project is expected to reduce the pressure on biomass fuel use in Kenya, reduce the amount of money a family spends on buying wood and charcoal, and also reduce health hazards associated with use of biomass fuel for cooking.

Recommendation

It is therefore recommended that this stove along side the briquette technology be disseminated widely in Kenya. The briquette technology is likely going to receive a boost because one of the reasons for slow dissemination has been lack of an appropriate stove to burn the fuel briquettes (Terra Nuova, 2007).

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