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INNOVATIVE BIOMASS GREEN STOVE

Environmental Science

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ABSTRACT

In the rural areas of developing countries and many deprived urban areas, biomass fuel- wood, crop residues (stalks and husks), and animal dung –is the principal source of energy. Fuels, which must be purchased, such as kerosene oil, electricity, and gas, are often beyond the financial means of most members of rural and low- income urban communities even if these are available. Thus, biomass will continue to be used for a significant period to come (WHO 1992). According to the international energy agency in 2012, globally, around 2.6 billion people 40 percent of the world's population-still rely on traditional biomass (wood, crop residues, dung, etc.) to meet household cooking requirements. Also, nearly 1.3 billion people remain without access to electricity and 2.6 billion still do not have access to clean cooking account for two- thirds of those without electricity and just three countries- India, China, and Bangladesh-which account for more than half of those without clean cooking facilities.

INTRODUCTION

With increasing health ailments due to indoor air pollution, there is wide - need for environment – friendly cook stoves. Recently, an improved wood –burning cook stove with a thermal efficiency of 28.3 percent has uses wood pellets, and twigs as fuel and its power output rating is 2.5 KWH. One of the striking features of this cook stove is its economical price.

HEALTH IMPACTS

In 2009, UN Women watch found that women and girls on an average spend 20or more hours per week trudging through dangerous and isolated areas in order to collect fuel for their cooking needs. It is recognized that exposure to air pollutants fund in an indoor environment plays a significant role on human health.[1] Biomass fuel emissions constitute a health hazard with effects that vary in type and severity depending upon the locality, probably the type of fuel used, and the population at risk (WHO 1984). Indoor smoke from solid duels is the tenth leading cause of avoidable deaths worldwide. It is the second most important environmental cause of disease after contaminated diseases (WHO 2012)

A 2012 WHO study found that every year 4.3 million people die prematurely from illness attributable to the household air pollution (see table 1) caused by the inefficient use of solid fuels.

Among these deaths:

- Twelve per cent is die to pneumonia
- Thirty four per cent die from stoke,
- Almost 26 per cent die from chronic obstructive pulmonary disease (COPD), and
- Six per cent is from lung cancer.

It is also estimated by WHO that three to four lakh people die of indoor air pollution in India every year. This is a major public health issue (WHO 2009).

TABLE – 1HEALTH EFFECTS OF POLLUTANTS PRODUCED BY INCOMPLETE COMBUSTION OF SOLID FUELS

Pollutants	Associated health effects
Carbon monoxide(CO)	• Binds to hemoglobin thereby interfering with transportation of oxygen • Causes headache • Causes nausea • Causes dizziness • Leads to low weight at birth • Result in increase in preinstall deaths
Particulate matter	• Causes irritation and oxidative stress producing lung and airway inflammation, hyper- responsiveness, and in the long run, exposures to airway remodeling and emphysema. • Causes reduced mucociliary clearance and macrophage response • Is carcinogenic
Nitrogen oxide(NO_2)	• Causes irritation, affecting the mucosa of eyes, nose, throat, and respiratory tract • Increases susceptibility to infections because of increased bronchial reactivity, longer-term exposure
Sulphur dioxide (SO_2)	Causes irritation, affecting the mucosa of eyes, nose, throat, and respiratory tract
Lower molecular weight PAHs (1,3 butadiene, benzene, styrene, and formaldehyde)	Is carcinogenic

ENERGY OUTLOOK AND POSSIBLE SOLUTIONS

A number of potential solutions to the fuel crisis exit, varying according to region and climate. Among these solution are improved biomass cook-stoves, which use biomass fuel in a more cost-effective and health-effective way; biogas plants on an individual or village scale; improved ventilation in housing units; and improved kitchen design (WHO 1992). Over the past decade, clean cook stoves and fuel sector have evolved dramatically and are now poised to offer significant life-saving and life-changing benefits to the poor on a global scale.

Reliable and affordable access to energy is a critical input required to fuel development. The world over, this realization is gaining momentum as demonstrated by various global initiatives. Energy, poverty, and affordability have been assessed and made part of the critical agenda for Asia and Africa by the world energy council. The United Nations' 'sustainable energy for all' initiative works toward the goal of achieving sustainable energy for all by the year 2030.

Figure 1: A Woman Using Traditional Chullha

PORTABLE COOK STOVES

At present, a large number of metallic wood stoves exist. Among these designs, one similar design, a multi-fuel portable stove has been developed recently. The portable stoves are used for cooking which reduces fuel consumption and pollution. A variety of solid fuels such as wood, twig, leaf, dung cake, agricultural waste, taw coal, briquettes, etc., can be burnt in these stoves at high thermal efficiency, irrespective of different physical and chemical characteristics. [5]The fuel saving is 50 per cent more than the traditional cook stoves.

For complete combustion of the fuels with low excess air, the fixed carbon and volatile parts of fuels burn separately in the corrugated grate and the perforated combustion chamber of the stove with the help of preheated primary and secondary air streams. The ash scraper helps to remove ash intermittently during burning. Otherwise, ash is discharged from the stove automatically. The design facilitates clean high temperature flame.[2]

THE PRESENT DESIGN

In the new stove, primary air enters throughout the perforated lower circumferential wall of the combustion chamber. The lower perforated portion of the combustion chamber is formed by two rows of air entry holes and is surrounded by a bottom-opened cylindrical cover. Stacked wooden sticks in combustion chamber get air from surroundings. A rectangular fuel feed opening is located just above the perforated wall. There is a sliding cover plate with the fuel feed opening above the wooden sticks, to prevent the entry of cold air during combustion. A fuel rest plate also exists at the bottom of the perforated wall on which the wooden sticks are placed. These sticks remain inclined when placed on the fuel rest plate. For the arrangement, primary air is available throughout the surrounding of the burning wooden sticks for better mixing during combustion.[3] Thus, the wooden sticks burn well rather than if they were placed horizontally. Both primary and secondary air enters from the annular air space provided in between the combustion chamber and the surrounded bottom opened large cylindrical cover at the lower portion of the stove. The secondary air stream then enters the smaller diameter portion of the stove. This air is preheated in annular air passage surrounding the combustion chamber wall and mixed with effluent gas through upper perforated wall in which two rows of air entry holes are there.[4] One row is located above the fuel feed opening and the other row is aligned with upper level of the opening. The primary air is preheated when it comes in contact with the perforated lower circumferential wall of the combustion chamber enclosed by the large cylindrical cover. The secondary air also initially heated in the same region.

Figure 2: Multi-Fuel Portable Stove

In the new stove, as primary air enters through the perforated wall located above the fuel rest plate, not through conventional grate at bottom, the deposited ash is unable to block the air passage. The deposited ash also helps to preheat this primary air. In the stove, ash removal is possible after a long interval, practically after completion of cooking. To facilitate ash deposition on fuel rest plate, the primary air entry holes are cut, keeping a reasonable gap from fuel rest plate. [6]The ash removal process is very simple in the stove. One end of the fuel rest plate is hinged with the lower part of combustion chamber wall and the other end is arranged with a hinged lock clip fitted with outer wall of the stove. By opening the lock clip, one end of the rest plate is dropped down to clear the ash from the stove. The provision of an ash chamber below the grate is thus eliminated in this design. This design also avoids implementation of the complicated shaker grate system of present day's metallic wood stoves.

Figure 3: Front View of the Stove

Figure 4: Inside View of the Stove

MERITS OF THE NEWLY DESIGNED COOK STOVE

The new cook stove has the following merits:

- It has high thermal efficiency along with reduced smoke emission.
- For better mixing with wood fuel during combustion, the primary air in the stove is supplied throughout the perforated circumferential wall at the lower part of combustion chamber.
- In addition to the typical preheating system of secondary air, which while passing through the

Annular air passage surrounding the combustion chamber wall, the primary air is also preheated as it comes in contact with the perforated lower circumferential wall of the combustion chamber.

- The primary air is allowed to enter through the perforated wall located above the fuel rest plate, in spite of the conventional grate at the bottom. It helps to prevent the blockage of air passage for Primary air entry by ash deposited on fuel rest plate.
- Ash removal is very easy; it can be done by just opening the holding clip of the fuel rest plate.
- Sliding cover plate of fuel feed opening prevents the entry of the external cold air inside the combustion chamber.

CONCLUSION

According to the 2011 India census, 62.5 per cent of rural households use firewood as the primary fuel for cooking, 12.3 per cent use crop residue as the primary cooking fuel, and 10.9 per cent use cattle dung. On the whole, about 66 per cent of India's total population used traditional biomass for cooking purposes in 2011 (IEA). The Unnat Chullah Abhiyan programme and NBMMP of the MNRE will contribute in providing enormous benefits in tackling the problems of indoor air pollution. Both the programme may be evaluated at the end of the 12th five-Year Plan period separately on these important outcome parameters as far as the indoor air pollution and addressing the associated problems are concerned-reduction in biomass fuel consumption, reduction in emissions of carbon dioxide and other greenhouse gases, mitigation in terms of health hazards, socio-economic developments, and livelihood concerns.

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