International Journal of Engineering Science Invention Research & Development; Vol. III, Issue VII, January 2017
www.ijesird.com, e-ISSN: 2349-6185

SMOKELESS KITCHENS IN RURAL INDIA- AN OVERVIEW

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Abstract: **To overcome the problems of over consumption of the firewood, and the fear of global warming, several stoves were designed time to time with better efficiencies and design. In this present scenario, there is a demand of an efficient stove design, which would not only reduce exposure to harmful smoke particles, but also use less fuel, saving both time and effort. The new smokeless stoves generally work well but require material and fabrication techniques unavailable in these areas where it is actually needed. A number of smokeless stoves are designed in India to decrease smoke production and increase fuel efficiency. These new stoves are in use and further work is going on to improve the efficiency. This article summarizes some of the well known projects.**

Keywords: **Biomass, Smokeless kitchen, stove, three-pan, two-pan**

I. INTRODUCTION

Innovation is the key to growth in country's economy. But it is dependent on resources like money, technology and skilled labour. These resources are easily available in the urban area. Most of the rural innovations remain unnoticed because they do not get support of promotion or their use is confined to limited rural regions.

In the rural sector of India, almost all the kitchens are highly energy inefficient and unhealthy because of the traditional mud stoves (*chulha*) which depends on firewood or local biomass as the source of fuel.

These stoves use the natural air to feed oxygen, which causes inefficient burning and thick smoke. This indoor smoke filled kitchen may adversely affect the health of the women and even her family. In addition to effect on general breathing, it may lead to eye discomfort for everyone in the house when exposed to dense smoke. Inhaling the fire smoke has been linked to pneumonia in children, and chronic bronchitis, and asthma in adults. In fact, it was observed that just a day's exposure to smoke can lead to accumulation of a carcinogenic compound Benzopyrene, which is almost equivalent to 14 days of cigarette smoking! Almost 5, 00,000 death every year in India alone is because of burning biomass fuels in the kitchen.

The use of firewood or local biomass not only leads to health problems because of pollutants like suspended particles, unburnt hydrocarbons, carbon monoxide etc [1] but also poses a threat of global warming due to the products resulting from incomplete combustion. All the products of incomplete combustion have severe effect than CO_2 [2]

Development of better and efficient stoves is the need of hour. This will help rural women continue with their traditional family values, while empowering them to select a way of cooking that does not put their lives at risk. The currently available cooking stoves are relatively expensive for most rural families to buy and hence, only few of the families in India who use open cooking fires will have access to these new technologies.

So, to make smokeless stove easily accessible in rural areas, design should be made locally, must be inexpensive with the features of the improved efficiency, i.e. frugal engineering is in high demand. This review article summaries the different types of stoves deigned and disseminated in India from time to time.

II. STOVES IN INDIA

After the single-pan stoves of Tamil-Nadu desgin type, two new single pan style stoves called Priyagni and Tara were marketed. The two were essentially open fire combustion-on-grate type with a shield in case of Tara. Priyagini was designed at Central power research institute, Bangalore and

Tara was degined by a private industry in New Delhi [3].

To improve the efficiency, three pan stoves were investigated and were built by many organizations both in India and abroad [4]. The ASTRA-Ole (cookstove) (Fig-1), the earliest improvised traditional stove innovated in India by Centre for Sustainable Energy & Technologies, formerly known as ASTRA, Indian Institute of Science (IISc) in early 1980s was considered the best in term of efficiency and fuel consumption according to Krishna Prasad [5-7]. The ASTRA ole design is a three-pan fuel efficient and smokeless mud stove built in situ to stringent specifications. This *chulha* is an eco-friendly stove that utilizes agricultural waste as the main fuel source. It had an efficiency of 40-45% in the laboratory and 35$\pm$ 6% under field conditions [8, 9] however in a two pan stove, the efficiency extracted in the first pan amounts to about 25% and the second to 12%, and the single pan stoves without chimneys seemed to have efficiencies not exceeding 25$\pm$5% compared to around 14 % for traditional stoves [10].

ASTRA-Ole's another improvised version called 'Ojas Chulha' uses fuel pellets and costs Rs.3,000. This eco-friendly stove uses a small fan, to blow air in order to ignite these pellets, which primarily consist of paddy stalks. There is a flame monitoring knob to adjust the flame according to need. The stove performance is sensitive to the dimensions of the stove and use practices. Thus, it is important to ensure quality construction according to design parameters and to provide education to obtain high performance.

Figure 1. ASTRA Ole stove

One of the innovative biomass smokeless stoves 'Oorja' (Fig 2) promoted by BP Energy India Limited, was developed in conjunction with the Indian Institute of Science, Bangalore, in 2006. The sale in India of over 400,000 "Oorja" stoves to households from 2006 onwards represents the largest commercially-based distribution of a gasification-type advanced biomass stove. BP's Emerging Consumer Markets (ECM) division and then successor company First Energy sold this stove and the pelletized biomass fuel on which it operates [11]. This stove runs on pellets made up of agriculture waste. The stove, costing Rs. 1500, has a chamber for burning pellets. A mini-fan, operated by rechargeable batteries and controlled by a regulator, blows air to fan the flames. Once the stove is fully charged, it provides 10 cooking cycles, each of 3 hours and can withstand a load upto 150 Kg and thus, handle heavy utensils.

Figure 2. Oorja Stove

Another low cost *chulha* 'ARTI Bharatlaxmi Stove' (Fig-3) was designed by Pune-based NGO Appropriate Rural Technology Institute (ARTI) for the rural poor. ARTI also conducts its own thermal efficiency testing. The stove is available for consumers in India, distributed by Samuchit Enviro Tech. It is most popular in the state of Maharashtra due to its simple design and affordable price i.e. Rs. 700/-. The stove is a single pot hole stove that consists of cement bricks and a cast iron fire grid and a pot holder, which are held together with a wire mesh. The setup is then fixed to the ground with a covering of mud. This smokeless *chulha* uses wood as fuel and can reduce

fuel consumption by 50%, bringing down the cooking time by 30%.

Figure 3. ARTI Bharatlaxmi Stove

Multinational Philips Company in collaboration with grassroots NGO also came up in the market with eco-friendly stove 'Low Smoke Chulha' (Fig. 4). This low smoke stove aims to be a modular cooking device that is easy to access, reduces indoor air pollution, easy to maintain and parts of the stove could be easily replaced. The stove also has a chimney connected for easy installation and cleaning, along with a soot collector. It also helps in saving 10 kilograms of firewood every day in every household.

Figure 4. Philips Low Smoke Chulha

Greenway Smart Stove (Fig. 5) designed by a start-up called Greenway Grameen Infra, is an all-steel stove that consists of a single burner that utilizes biomass fuels. This stove saves 65% of fuel and reduces smoke by 70%. This smart stove increases the efficiency of fuel burning by complete combustion of fuel placed in its hearth. An innovative lampshade-shaped reducer cone pulls air up from the bottom of the stove into the combustion chamber. The stove does not have movable parts and special training is not required for operating it. [12]

Figure 5. Greenway Smart Stove

TERI (The Energy & Resources Institute) developed 'TERI SPT_0610 stove' (Fig. 6), a single port metal stove that can utilize fuel such as wood, agriculture residue and cattle dung cake. Also came to known as Annapurna 'Unnat' Chulha.

The stove was tested by Indian Institute of Technology, Delhi and certified that it passed all the applicable government performance benchmarks. Ministry of New and Renewable Energy (MNRE), Government of India has approved the TERI stove technology and made it technically eligible for all the government funded projects.

The power charger has both AC and DC solar power supply, i.e. dual charging mode to cater to households without power. The stove body used to be of Stainless Steel and Lithium Cobalt Oxide batteries have been used to power the fan. Since the stove has high (~37%) thermal efficiency, it also reduces fuel consumption by 54% as compared to mud stove and also reduces the cooking time. It produces less smoke (almost 70% reduction in smoke) and is beneficial in terms of reduced indoor Air pollution and healthier environment for women and children. Thus, technology can be promoted in rural India, too at an economical rate, thus, benefitting the health of the people and in the process saving the environment from further degradation.

Figure 6 TERI SPT_0610 Stove

III. CONCLUSION

It has been found that since the laboratory tests are conducted under controlled conditions by well-trained personnel, laboratory tests of emissions and efficiency frequently give different results than the results from their on-site usage. In real world conditions, pollution levels are not only affected by emissions from cook stoves, but also by house size and construction, ventilation, fuel factors such as type, size and moisture content, and weather parameters including temperature, wind direction, humidity, and rainfall. As such, laboratory tests are unlikely to capture the true variability in performance characteristics that are experienced in real world households. [12-14]. However, based on he studies, compared to the Traditional clay Cookstove chulha, the Alternative cook stoves produced significant reductions in particulate matter less than 2.5 μm ($PM_{2.5}$) and CO concentrations which persisted after normalization for fuel consumption or useful energy [12]

The improved stove programme should be ‘‘demand driven’’ at all times, as against the government programmes that are target- and subsidy-driven. Generation of demand depends on the performance and impact of the stoves in delivering one or more of the intended benefits, such as saving in fuel and cooking time and removal of smoke.

It is important to analyze the cause or origin of the situations or environment that are instrumental in on-set of innovations required for rural development.

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