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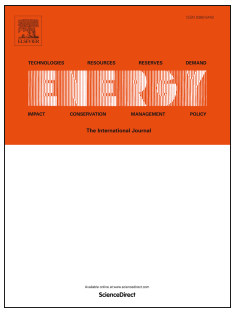

Energy efficiency and emission assessment of a continuous rice husk stove for rice parboiling

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Energy efficiency and emission assessment of a continuous rice husk stove for rice parboiling

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Abstract

The study presents a performance evaluation of an integrated rice parboiling stove (IRPS) fuelled with either rice husk or wood in comparison with the three stone fire (TSF) stove currently being used. The stoves were initially tested using the water boiling test. The efficiency, fire power and specific fuel consumption of IRPS were found to be 29%, 16kW and 0.14kg/kg rice husk, respectively. To enhance continuous steam production, a heat exchanger extension was made to the IRPS and the efficiency re-evaluated using the indirect boiler efficiency estimation approach, together with pollutants emission factors and safety. The stove efficiency after the extension increased to 46%. The emission factors for CO, CO_2 and C_xH_y were in ranges from 10.6-12.0, 785-793, 0.4-2.2 g/kg of rice husk, respectively. Comparison between rice husk and wood combustion in IRPS shows that emission factors for rice husk were significantly lower than wood but decrease with stove fire power.

1 Introduction

Rice has become an important crop and the most rapidly growing food for population in Sub-Saharan Africa [1]. This is evident in the rise in per capital consumption which has increased by more than 50% in the last two decades [2]. In 2012, more than 62%[1] [3] of rice within the region was locally produced. To enhance the physical and nutritional quality of local rice, a pre-milling technology known as parboiling is adopted [4-6]. This three-stage starch gelatinization process rectifies the problem of cracks and incomplete grain filling and lead to many favourable changes including easy shelling, higher head rice yield, fewer broken rice, increase resistance to insect and nutrient retention [7], reduced disintegration and solubilisation of kernels on cooking [8], hence, improving consumer preference for local parboiled rice. The process as practiced in the sub-region is arduous and energy intensive with thermal energy provided through combustion of fuelwood in an inefficient three-stone fire (TSF) stove.

[1] Estimated from FAOSTAT