**POWER GENERATION USING HUSK**

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**Abstract**

***This paper presents a novel generation of electricity using husk. Every year approximately J 20 million tones of paddy is produced in India. This gives around 24 million tones of rice husk and 4.4 mil/ion tones of Rice Husk Ash every year. Major three uses of Rice Husk Ash are in the steel, cement and refractory bricks industry. Besides this it can be utilized in several other applications. In India rice husk is used for cattle feeding, partition board manufacturing, '0 many small scale applications and rice husk ash is used in land filling, s*o many industrial applications. But this uses are not in a systematic manner and also rice husk has very low food value. Being fibrous it can prove to be fatal for the cattle feeding. Use of rice husk ash or rice husk in land filling is also an environmentally hazardous way of disposing waste. In this paper we have discussed a preliminary analysis of the numerous reported uses of rice husk. The use of rice husk for electricity generation in efficient manner is likely to transform this agricultural by product or waste into a valuable fuel for industries and thus might help in boosting the farm economy and rural development. India being the second largest rice producer in the world, systematic approach to this material can give birth to a new industrial sector of rice husk ash in India.**

**Keywords: economy; electricity generation; rice husk; rice husk ash**

**1.INTRODUCTION**

Rice is major food grain for the people of the

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southern and some of the northern states in India, and also for the people of at least 15 other countries in the world. Production of rice paddy is associated with the production of essentially two byproducts, rice husk and rice bran. Husk, also called hulls, consists of the outer shell covering the rice kernel. As generally used, the term rice husk refers to the byproduct produced in the milling of paddy and forms 16-25% by weight of the paddy processed. In the majority of rice producing countries much of the husk produced from the processing of rice is either burnt for heat or dumped as a waste. India alone produces around 120 million tones of rice paddy per year, giving around 24 million tones of rice husk per year. Farm income can be increased both directly and indirectly if economically profitable means of utilizing rice husk generated are utilized in industry. There are many reported uses of rice husk such as a fuel in brick kilns, in furnaces, in rice mills for parboiling process, in the raw material for the production of xylitol, furfural, ethanol, acetic acid, lignosulphonic acids, as an cleaning or polishing agent in metal and machine industry, in the manufacturing of building materials, etc(Govindarao, 1980). Despite having so many well established uses of rice husk, little portion of rice husk produced is utilized in a meaningful way, remaining part is allowed to bum in open piles or dumped as a solid waste or it is used as a cattle feeding. Farmers are getting very less prices for their paddy harvested. There are so many reasons associated with rice husk for not being utilized effectively, like, (1) lack awareness of its potential to a farmers and industry persons, (2) insufficient information about proper use, (3) socio-economic problems, (4) penetration of technology, (5) lack of interest, (6) lack of

environmental concerns, (7) inefficiency of information transfer, etc. Solution to the problems associated with utilization of this solid waste needs to be worked out not only from the quality point of view but quantitatively as well, because quantity of rice husk produced is very large. But. the most promising and profitable use of this biomass is its use for the electrical energy generation in efficient way, besides this using rice husk in bio-power generation adopting efficient equipment gives very valuable by product(Fang at. el, 2004).

**2. USEOF RICE HUSK AS A FUEL IN CO GENERATION POWER PLANT**

The use of rice husk-fired boilers for the generation of process steam generation has already been applied at a large number of locations throughout the country (Aggarwal. 2003). The decision regarding the choice of fuel for process steam is made based on the availability of rice husk. Other techno-commercial consideration and cost benefits. Such small-sector process industries use fixed, great fire-tube boilers with low capacity. which are manually fired, using rice husk as a fuel. Such combustion practices and boiler designs are primitive in nature and have built-in problems of partial fuel combustion and low efficiency. As husks were available virtually for free. the boiler efficiency and the degree of combustion were the issues of receiving the least attention. Partial and uneven combustion of husks in the furnaces of the boilers also would lead to smoke emissions. Combusted rice husk give the Rice Husk Ash (RHA), will be discussed in later part. Many more plants in range of 2-10 MW range cab become commercially viable in the country and this biomass resource can be utilized to a much greater extent than at present. In this paper we have discussed the use of rice husk in cogeneration power plants of capacity varying from 2MW to 10 MW captive power plants. Some of technical and economic analysis has been discussed here. Energy balance and related analysis of 5 MW power plants are given below.

**2.1 Energy Balance and Related Analysis of 5 MW Power Plant**

Given that plant has to operate for 24 hrs and 350 days a year. Minimum amount of electricity generated will be 42000 *MWh/year:*

5 x 24 x 350 = 42000 *MWh/year.*

Amount of heat required to be produced to produce *42000MWh/year* will be around 151200 *GJ/year:*

42000 x 3600 = 151200000 Ml/year = 151200 *GJ/year*

Considering that approximately 30% of heat generated "in the boilers will be converted 111 the electricity. The boilers need to provide 504000 *GJ/year.*

151200/0.3 = 504000 *GJ/year*

Based on calorific value of J3.33 GJ/tonne (Govindarao, 1980) for the rice husk to be used as and considering 90% combustion efficiency, the quantity of rice husk needed to produce the required amount of enetgy will be approximately.

504000 -i- 0.90 -i- 13.33 = 42000 tonnes/year (approx.)

This clearly indicates that to produce 1 MWh, approximately 1 tonne of rice husk is required. Since rice husk has ash content of 18%, the 5MW power plant can produce approximately 7500 tonnes/y of amorphous ash.

42000 x 18 % = 7560 tonnes/year of RHA (approx.)



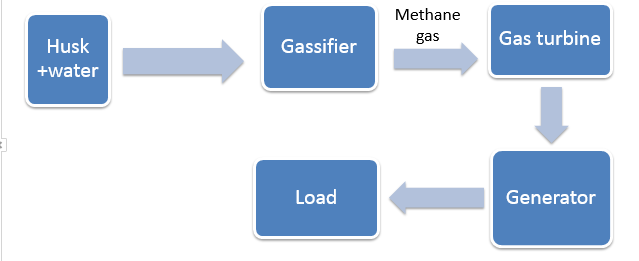
Fig. 2.1 Husk power plant

**2.2 Costs Benefit Analysis of using Rice Husk as a Fuel in the 5 MWH Power Plants**

Number of units produced in one hour will be 5000 KWh (5000 units) Restricting production cost to Rs. 2/KWh. Any industry persons would be ready to have power at Rs.2/KWh Cost of 5 MWh = Rs. 10000. Considering cost of fuel at 50 % of production cost, fuel cost will be Rs. 1000/MWh.

10000 x 0.50/5 = Rs. 1OOO/MWh. Cost of purchasing one truck load of rice husk, of pay load capacity of 8 tonnes, will be Rs. 8000 to produce 8 MWh. Let us consider Rs. 4000/truck is the cost of rice husk at rice mill and Rs. 4000/truck is the transportation cost of rice husk from rice mill to Power Plant. In Rs. 4000/truck it is practically possible to convey the rice husk from the distance of 100 kms. In this case rice mill owner will earn around Rs. 500/tonne from Rice Husk. If half of this profit is transferred to farmers will get around Rs. 250/tonne. Along with there are several fiscal incentive given by the Government of India like, Accelerated Depreciation on high efficiency equipment, tax holiday for five years and 30% exemption for next five years, exemption on central excise duty for renewable energy devices, including raw materials, components and assemblies. According to statistics available rice husk can be made available throughout year in the Northern, Southern, North-eastern and Eastern regions baring Western region. In case, availability of rice husk reduces other biomass like bagasse and other can be used in the multi-fuel combustion boilers. This analysis clearly indicates that captive power plants in the range of 2-8 MW range are practically feasible.

**2.3 Procedure of generation in plant**

 Fig. 2.3.1 Process in plant

**2.4 Gasification process**

### **Hydrolysis**

In general, hydrolysis is a chemical reaction in which the breakdown of water occurs to form H+ cations and OH- anions. Hydrolysis is often used to break down larger polymers, often in the presence of an acidic catalyst. In anaerobic digestion, hydrolysis is the essential first step, as Biomass is normally comprised of very large organic polymers, which are otherwise unusable. Through hydrolysis, these large polymers, namely proteins, fats and carbohydrates, are broken down into smaller molecules such as amino acids, fatty acids, and simple sugars. While some of the products of hydrolysis, including hydrogen and acetate, may be used by methanogens later in the anaerobic digestion process, the majority of the molecules, which are still relatively large, must be further broken down in the process of acidogenesis so that they may be used to create methane.

### **Acidogenesis**

Acidogenesis is the next step of anaerobic digestion in which acidogenic microorganisms further break down the Biomass products after hydrolysis. These fermentative bacteria produce an acidic environment in the digestive tank while creating ammonia, H2, CO2, H2S, shorter volatile fatty acids, carbonic acids, alcohols, as well as trace amounts of other byproducts. While acidogenic bacteria further breaks down the organic matter, it is still too large and unusable for the ultimate goal of methane production, so the biomass must next undergo the process of acetogenesis.

### **Acetogenesis**

In general, acetogenesis is the creation of acetate, a derivative of acetic acid, from carbon and energy sources by acetogens. These microorganisms catabolize many of the products created in acidogenesis into acetic acid, CO2 and H2. Acetogens break down the Biomass to a point to which Methanogens can utilize much of the remaining material to create Methane as a Biofuel.

### **Methanogenesis**

Methanogenesis constitutes the final stage of anaerobic digestion in which methanogens create methane from the final products of acetogenesis as well as from some of the intermediate products from hydrolysis and acidogenesis. There are two general pathways involving the use of acetic acid and carbon dioxide, the two main products of the first three steps of anaerobic digestion, to create methane in methanogenesis:

CO2 + 4 H2 → CH4 + 2H2O

CH3COOH → CH4 + CO2

While CO2 can be converted into methane and water through the reaction, the main mechanism to create methane in methanogenesis is the path involving acetic acid. This path creates methane and CO2, the two main products of anaerobic digestion.

**3. USE OF RHA IN SEVERAL INDUSTRIAL APPLICATIONS**

Suitability of RHA mainly depends upon the chemical composition of ash, predominantly silica

content in it. Silica content and its mineralogical structure depend upon the combustion time,temperature and turbulence during combustion. Silica content of RHA varies from 85%-95%. There is very large potential for RHA containing mainly amorphous silica as a commercial product. RHA has very good market value ranging from US$IOO/tonne to US$300/tonne in India and can be very important material from the quality consideration in several industrial applications.

**3.1 AS A REPLACEMENT TO SILICA FUME**

This finely ground RHA can be used replacement of silica fume in the production high performance concrete (Malhotra and Zhang, 1996). Currently silica fume is costing above US$600/tonne.This RHA contains more than 85 % of silica. Using rice husk in the power generation with such a high combustion efficiency and buming temperature below 600°C gives very valuable byproduct amorphous silica rich RHA. American Society of Testing and Materials place RHA in the same class as silica fume - that of highly reactive pozzolan. RHA which is suitable to replace silica fume can easily fetch price of US$I OO/tonne in India. Canadian boiler manufacturer have developed the reactor for combustion of rice husk for such a high efficiency at better temperature control (Torftech).

**3.2 As A TUNDISH POWDR IN STEEL CASTING INDUSTRIES**

RHA is used by the steel industry in the production of high quality flat steel. This type of steel is generally produced by continuous casting. In continuous casting a ladle of steel, containing more than 200 tonnes of molten metal at 165(} "C, empties into a tundish, a receptacle that holds the steel and controls its flow in the continuous process. RHA is an excellent insulator, having low thermal conductivity, high melting point, low bulk density and high porosity. It is this insulating property that makes it an excellent "tundish power". Tundish powders are used to insulate the tundish, prevent rapid cooling of the steel and ensure uniform solidification (Singhania). Traditionally ash is sold in bags which are thrown on to the top of surface of the tundish of molten steel. Approximately 0.5 to 0.7 kg of RHA is used per tonne of steel produced. Traditionally crystalline ash is preferred to use it as atundish powder.

**3.3 AS AN ADMIXTURE IN LOW COST CONCRETE BLOCK MANUFACTURE**

Ordinary Portland cement (OPC) is expensive and unaffordable to produce low strength concrete block. Sometimes, it becomes economically feasible to produce low strength concrete block for masonry work by using pozzolanic materials along with lime and gypsum. RHA is mixed with lime and aggregates and cast of the required shape and sizes. Generally, around 7 MPa strength is achieved at 14 days with mix proportion of 20:80 ratio of lime:RHA as binder material along with some admixtures. Amorphous RHA is preferred for its use in the concrete manufacture. It is due to high pozzolanic property of amorphous R1-1A.

**3.4 MANUFACTURING REFRACTORY BRICKS**

One of the potentially major profitable uses of RHA is in manufacture of refractory bricks (Adylov et. al. 2005). Due to the insulating properties, RHA has been used in the manufacture of refractory bricks. Bricks from RHA were reponed to be good heat insulators up to extreme temperatures, such as 1450 oC, and have a low thermal conductivity of about 0.03 kcal/m hr oC and good resistance to compression. These are suitable for furnace bricks. Such bricks normally contain 80-98% ash and 2-20% CaO+MgO.

**3.5 CONTROL OF INSECT PESTS IN STORED FOOD STUFFS**

RHA has been found to be an excellent material to protect soybean seeds from bruchid beetles (Naito). The lethal effect of RHA on bruchid beetles has not yet fully analyzed. However, there are some indications. Diatomaceous earth has been used as an effective controller of pests. The high silica content of both diatomaceous earth and RHA must have a lethal effect on insects. RI-IA also includes a large amount of needle-like particles that are probably derived from the setae covering the outer surface of the rice husk. These needle-like particles may trigger a physical reaction on the skin of insects, and the resulting physical disturbance may help cause their death. It is also believed that RHA is useful for moisture adsorption also. The use of RHA enables fanners to store soybean and mung bean on a small scale and for a low cost.

**3.6 IN THE WATER PURIFICATION**

Some of reports have shown that RHA can be used as an absorbent after certain treatment (Topallar and Bayrak. 1999: Chou et. a!., 200 I). After acid wash and calcinations at 600°C for 4 hours of RHA was used to make pallets with reasonable strength to be utilized in a packed column. RHA was found to be good adsorbent for adsorption of Congo Red, vacuum pump oil, myristic acids, palmitic acids, stearic acids and mercury in the wastewater generated from industry.

**3.7 IN THE VULCANIZING RUBBER**

White RHA can be used as filler for natural rubber compounds (lsmail and Chung, 1998). White RHA increases mechanical properties, such as, tensile strength, tear strength, resilience and hardness, if used as a partial replacement of si lica as a bonding agent. The RHA be again cheaper option to silica.

**3.8 AS A FLUE GAS DESULPHURIZA-TION ABSORBENT**

Generally in coal fired boilers of power plants fly ash is used as a source of siliceous material for the preparation of absorbents for flue gas desulfurization. Mohamed et. al. (2005) studied the RHA as a siliceous material source for gas desulfurization. Lower hydration period and temperature favor the formation of absorbent with higher surface area. Absorbent prepared from RHA does have a high capacity in S02 absorption.

**4. CONCLUSION**

Rice husk is utilized where it is produced on small scales in brick kilns as a fuel. Despite having so many well established uses of Rice Husk, it is waste where large quantity is generated, especially in the southern, northern and eastern states. So many small size thermal power plants are coming up, based on rice husk as a fuel. But, none of them have concrete plans for utilization of RHA. As mentioned earlier RHA has good market value. Power plant should be installed not to generate electricity only but a very high quality RHA as well. This will further increase the financial benefits and will help us to improve farm economy indirectly. Prices for rice hull ash on the world market are approximately $200 per ton of ash (equivalent to $ 40 per ton of rice hulls, or $ 8 per ton of rough rice). This Competitive environment for the Rice Husk will helpful to fetch more prices of the rice husk for farmers.

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