International Journal of Science and Research (IJSR)
ISSN (Online): 2319-7064, Impact Factor (2013): 4.438
www.ijsr.net

Wealth from Waste Rice Husk

V.A.Khati[1], R. N. Singru[2], D. D. Duryodhan[3]

[1]Department of physics Sainath junior College, Nagpur, India

[2]Principal, Tai Golwalkar College of Science, Ramtake, India

[3]Department of Chemistry, Adv.Yadavrao Dhote College, Rajura, Chandrapur, India

Abstract: ***The technological trend towards waste utilization and cost reduction in industrial processing has attracted use of Rice Husk as a value added material. Both rice husk (RH) and Rice Husk Ash (RHA) has been found suitable for wide range of domestic as well as industrial applications. Considering the importance and increasing demand of this material, a systematic study based on properties and industrial applications has been carried out and reviewed in this paper. General process for precipitation of silica and activated carbon from rice husk has been discussed. Potential and suitability of RH for use in possible new areas in near future has also been highlighted.***

Keywords: Rice Husk; Rice ceramic composite; metallurgy

1. Introduction

Rice husk is one of the most widely available agricultural wastes in many rice producing countries around the world. Globally, approximately 600 million tons of rice paddies are produced each year. On average 20% of the rice paddy is husk, giving an annual total production of 120 million tones [1]. In majority of rice producing countries much of the husk produced from processing of rice is either burnt or dumped as waste [2]. Burning of RH in ambient atmosphere leaves a residue, called rice husk ash. For every 1000 kgs of paddy milled, about 220 kgs (22 %) of husk is produced, and when this husk is burnt in the boilers , about 55 kgs (25 %) of RHA is generated[3]. Rice husk removal during rice refining, creates disposal problem due to less commercial interest. Also, handling and transportation of RH is problematic due to its low density. RHA is a great environment threat causing damage to land and surrounding area where it is dumped. Therefore, commercial use of rice husk and its ash is the alternative solution to disposal problem. In this paper we have discussed a preliminary analysis of the numerous reported properties and uses of rice husk and its ash. Attempt has been made to collect data and information from various research work related to RH and RHA. Rice husk contains 75-90 % organic matter such as cellulose, lignin etc. and rest mineral components such as silica, alkalis and trace elements [4]. A typical analysis of rice husk is shown in table 1. The content of each of them depends on rice variety, soil chemistry, climatic conditions, and even the geographic localization of the culture [5].

Table 1: Typical analysis of rice husk [6]

Property	*Range*	*Property*	*Range*
Bulk density (kg/m3)	96-160	Hydrogen,%	4-5
Hardness(Mohr's scale)	5-6	Oxygen,%	31-37
Ash,%	22-29	Nitrogen,%	0.23-0.32
Carbon, %	≈ 35	Sulphur,%	0.04-0.08

Rice husk is unusually high in ash compared to other biomass fuels in the range 10-20%. The ash is 87-97% silica [7], highly porous and light weight, with a very high external surface area. Presence of high amount of silica makes it a valuable material for use in industrial application. Table 2 shows constituents of RHS. Other constituents of RHA, such as K2O, Al2O3., CaO, MgO, Na2O, Fe2O3 are available in less than 1 %ref. Various factors which influence ash properties are incinerating conditions (temperature and duration), rate of heating, burning technique, crop variety and fertilizer used. [8] The silica in the ash undergoes structural transformations depending on the conditions of combustion such as time and temperature.

Soluble silicates produced from silica are widely used in the glass, ceramics, and cement as a major component and in pharmaceuticals, cosmetics, and detergents industries as a bonding and adhesive agents (Anon., 1997;Laxamana, 1982).

Table 2: A typical composition of rice husk

Constituents		**weight**
Silica (SiO2)		94.50
Calcium oxide (CaO)		00.48
Manganese oxide (MnO)		01.09
Magnesium oxide (MgO)		00.23
Iron oxide(Fe2O3)		00.54
Aluminum oxide(Al2O3)		00.21
S,P2O5,K2O,Na2O		Traces

Silica also has been used as a major precursor for a variety of inorganic and organ metallic materials which have applications in synthetic chemistry as catalysts, and in thin ®lms or coatings for electronic and optical materials (Lender and Ruiter, 1990; Brinker and Scherer, 1990). Mizuki et al. (1993) and Krishnaro and Godkhindi (1992) have investigated the formation of silicon carbide from rice hulls at high temperatures and Maeda and Komatsu (1996) studied the semiconductor properties of silicon carbide produced from rice hull. Semiconductor industries require pure silica, currently produced by smelting quartz in a high temperature furnace, to produce ultrapure polycrystalline silicon and silicon hydride. Development of a simple low energy chemical method for producing pure silica should lead to a variety of industrial applications for RHA.

2. Application of Husk

Suitability of RH to be used for different applications depends upon the physical and chemical properties of the husk such as ash content, silica content etc. Direct use of rice husk as fuel has been seen in power plants. Apart from its use as fuel, RH finds its use as source raw material for synthesis and development of new phases and compounds. A detailed description related to application of rice husk in industrial sectors as well as other fields has been given below.

A. As a Fuel in Power Plant [9]

Rice husk is mostly used as fuel in boilers for processing paddy and generation of process steam. Heat energy is produced through direct combustion and/or by gasification. Small sector process industries use fixed low capacity boilers, which are manually fired using rice husk as a fuel. Partial and uneven fuel combustion lead to smoke emission and decrease the fuel efficiency. As husks are available virtually for free, the boiler efficiency and the degree of combustion were the issues of receiving the latest attention. Plants with capacity 2-10 MW range can become commercially viable and this biomass resource can be utilized to a much greater extent than at present. It has been seen that to produce 1MWh, approximately 1 tonne of rice husk is required. So, the technical and economic factors decide the effective use of rice huck as fuel for power generation. Also, rice husk has been used as an useful and alternative fuel for household energy. [10] RH is also used as fuel in brick kilns, in furnaces etc [11].

B. Formation of Activated Carbon [12]

Due to presence of large amount of hydrocarbon such as cellulose and lignin content, rice husk can be used as a raw material to prepare activated carbons which are complex porous structures.

They are obtained by two different processes: the ―physical‖ or ―thermal‖ activation and the ―chemical‖ activation. In the former carbonization is followed by char activation; in the second one, carbonization and activation are performed in a single step, using a chemical agent. Physical activation of rice husk produces activated carbon that exhibits very low specific area. Activated carbons are effective adsorbents due to their micro porous structure.

C. As a source of Silica and Silicon Compounds [13, 14]

Apart from organic component, presence of up to 20% silica makes rice husk a promising raw material source for a number of silicon compounds such as silicon carbide, silicon nitride, silicon tetrachloride, zeolite, silica, and pure silicon. The applications of such materials derived from rice husks are very comprehensive. The above compounds prepared in powder form are characterized by high purity and fine dispersity [15].

D. Porous SiO2/C composite from RH

During heat treatment of RH in inert atmosphere, organic compounds decompose and partly change to H2O, CO, CO2, and volatile compounds, remaining carbon and SiO2[16]. The porous SiO2/C composites with a high surface area have been fabricated by heating the pellets in inert atmosphere. Porous SiO2/C composite was able to be fabricated through a simple one-step firing process. The pore characteristics of the products could be controlled by changing the molding pressure, raw RH particle size, and heat treatment temperature. Heating at 1000º C displayed the optimal properties such as 87% porosity and 450 m2/ g specific surface area. Larger RH particles resulted in products with higher strength. [17].

E. Insulating fire brick using RH [18]

Bricks made using rice husk develop plenty of pores during heat treatment due to burning out of organic material. The more the percentage of rice husk in a brick, the more porous would be the brick and better thermal insulation. Presences of entrapped air in pores have thermal insulating characteristics and thus make the porous fire brick structure suitable for back up insulation.

F. Other uses

RH is used as a raw material for production of xylitol, furfural, ethanol, acetic acid, lingo sulphonic acids. It is used as cleaning or polishing agent in metal and machine industry, in manufacturing of building materials etc [19]. RH has been used as an industrial raw material e.g , as an insulating board material, fillers in plastics, filling material, building materials, for making panel board, activated carbon etc[20].Little effort has been made to manufacture composite products based on two surface structure of rice husk [21]. Despite so many well established uses, little portion of rice husk produced is utilized in a meaningful way, remaining part is allowed to burn in open piles or dumped as a solid waste. Rice Husk ash finds large number of industrial applications which are described below.

3. Materials & Methods

Analysis of rice husk ash

Precipitation of Silica – Chemical Reaction Involved

$SiO_2 + 2NaOH \rightarrow Na_2SiO_3 + H_2O$

$Na_2SiO_3 + H_2SO_4 \rightarrow SiO_2 + Na_2SO_4 + H_2O$

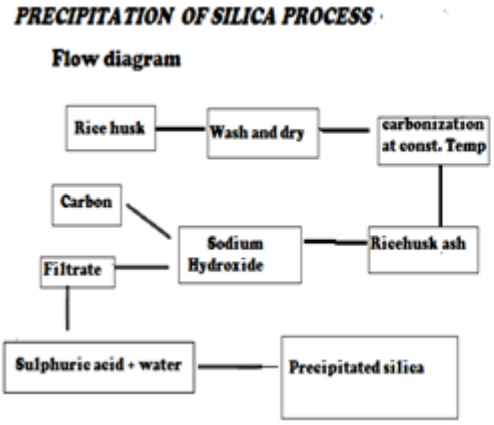
General process for precipitation of silica and activated carbon from rice husk

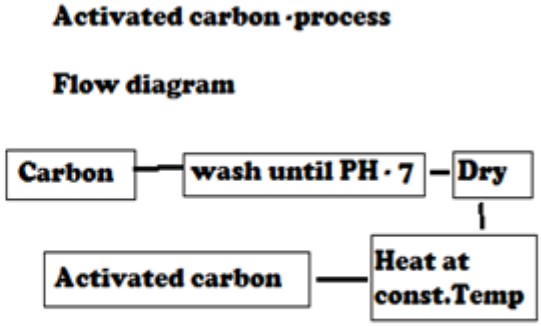
A known weight of rice husk is taken and sieved through 20 mesh size. It is then washed, cleaned and heated/carbonized to around 600°C for different time intervals (figure 2). It is treated with an activating reagent such as sodium hydroxide, zinc chloride, phosphoric acid for about 1 hour at 60°C. The activated rice husk and the solution containing the activating agent are then filtered. The activated rice husk so obtained is heated at a temperature of 900°C to get activated carbon. The filtered solution containing the activating agent is titrated with acid to precipitate silica powder.

The temperature at which rice husk is carbonized is very important since the surface area characteristic of ash depends on the temperature of formation of ash. The ash is obtained as follows rice husk is cleaned from dirt by sieving it with 20 mesh sieve. The rice husk ash so obtained produces a lot of smoke if kept directly in the furnace. In order to avoid this, the husk is first charred to black mass on a Bunsen burner. The mass is then heated & oxidized in an electric furnace at controlled temperature to obtain the ash.

The ash obtained is finely ground & sieved through 150 mesh sieve. The fraction passing through this sieve is then used for experimental run. The charred husk fraction is further carbonized at 550°C, 600°C, 650°C, and 700°C for 3 hours.

The raw material is mixed with the chemical agent and soaked for known amount of time. It is then dried and carbonized in the absence of air. Obtained char is treated with alkali to form sodium sil icate. Sodium silicate is treated with mineral acid and water to get precipitated silica.





4. Conclusion

- The procedure adopted in this paper to prepare precipitated silica from rice husk ash was successful and practically very sound. This innovative idea can be used out in future in the precipitated silica industry. The manufacture of silica from rice husk ash works out to be very cheap and cost effective as the main raw material, the rice husk ash can be obtained at low cost. Activated carbon obtained as the byproduct has a good market value.
- A general procedure is outlined for silica precipitation and activated carbon from rice husk.
- Precipitated silica and activated carbon was obtained from rice husk using the process outlined
- Analysis of yields of silica and activated carbon under progress.

References

[1] Giddel M.R and. Jivan A.P, Waste to Wealth, Potential of Rice Husk in India a Literature Review. International Conference on Cleaner Technologies and Environmental Management PEC, Pondicherry, India. January 4-6,2007.
[2] Mohd kamal N.L and Nuruddin M.F, Interfacial bond strength: influence of microwave incinerated rice husk ash
[3] Koteswara Rao. D and Pranav,Stabilization of expansive soil with rice husk ash, lime and gypsum –an experimental study International Journal of Engineering Science and Technology (IJEST)
[4] Madhumita Sarangi S. Bhattacharyya and R. C. BeheraRice Effect of temperature on morphology and phase transformations of nanocrystalline silica obtained from rice husk, 82: 5, 377 — 386
[5] Agus setyo muntohar ,Utilization of uncontrolled burnt rice husk ash in soil improvement dimensi teknik sipil, vol. 4, no. 2, 100 - 105, september 2002Issn 1410-9530
[6] Muthadhi A and Kothandaraman S, Rice Husk Ash — Properties and its Uses : A Review Rice Husk Ash May 2007 IE(I) Journal Vol 88,
[7] M. Rozainee, S.P. Ngo, A.A. Salema, Effect of fluidising velocity on the combustion of rice husk in a bench-scale fluidised bed combustor for the production of amorphous rice husk ash, Bioresource Technology 99 (2008) 703–713
[8] Mansaray, K. G. And Ghaly, A. E,Thermal Degradation of Rice Husks in an Oxygen Atmosphere', Energy Sources, Part A: Recovery, 1999 Utilization, and Environmental Effects, 21: 5, 453 — 466
[9] Assureira Estela, Rice husk – an alternative fuel in Peru.universtaria cuadra 18 Lima 32 Peru.
[10] http://apfeddb.iges.or.jp/__beta4__/doc/RISPO_GP004.pdf
[11] Shabbir H. Gheewala, and Suthum Patumsawad Emission Assessment of Husk Combustion for Power Production World Academy of Science, Engineering and Technology 53 2009.
[12] Cristina Dolly Granados, Rosa Venturini. Activated Carbons Obtained from Rice Husk: Influence of Leaching on Textural Parameters Ind. Eng. Chem. Res. 2008, 47, 4754–4757
[13] Matori K.A,. Haslinawati M.M, .Producing Amorphous White Silica from Rice Husk. MASAUM Journal of Basic and Applied Sciences, October 2009 Vol. 1, No. 3, 512
[14] Adylov G. T., Faiziev Sh. A., Paizullakhanov M. S. , Silicon Carbide Materials Obtained from Rice Husk Technical Physics Letters, Vol. 29, No. 3, 2003, pp. 221–223
[15] Nayak1 J.P, Bera J,Effect of sintering temperature on mechanical behaviour and bioactivity of sol–gel synthesized bioglass-ceramics using rice husk ash as a silica source Department of Ceramic Engineering, National Institute of Technology, Rourkela, Odisha 769008, India
[16] Seiji Kumagai , Junya Sasaki, Carbon/silica composite fabricated from rice husk by means of binderless hot-pressing Bioresource Technology (2009) 100 3308–3315
[17] TakanoriI Watari , Akihiro Nakata, Yoshimi Kiba, Toshio Torikai, Mitsunori Yada,Fabrication of porous SiO2/C composite from rice husks Journal of the European Ceramic Society 26 (2006) 797–801

[18] Emmanuel ogo onche, oliver nicholas namessan, gabriel abasiaka asikpo ,Property optimization of kaolin - rice husk insulating fire – bricks benjamin iyenagbe ugheoke‖ leonardo electronic journal of practices and technologies july-december 2006 issn 1583-1078 issue 9, p. 167-178
[19] Mehta P K. Siliceous Ashes and Hydraulic Cements Prepared there from.United States 4105459
[20] Farooquea K. N. M. Zamana, E. Halimb, S. Islama, M. Hossaina, Y. A. Mollahb and Mahmoodb A. J,Characterization and Utilization of Rice Husk Ash (RHA) from Rice Mill of Bangladesh'
[21] Takanorii Wata,Fabrication of Porous sio2/C composite from rice husks. Journal of the European Ceramic Society 26 (2006) 797–801