

CHAPTER-11. INTRODUCTION

Growing population and pressure for higher standards of living are producing the need for more food, energy, and materials. Simultaneously, mountains of wastes are polluting our environment. Waste is an act or omission by which it is rendered of less value. Wastes from different sources are summarized in Table 1.1.

Table 1.1 - Wastes From Different Sources

Sources	Products	Effects
1. Industrial Wastes	Industrial gases, smoke, (carbon monoxide, carbon dioxide, sulphur dioxide hydrocarbons, etc.) and dust particles.	Air pollution
2. Radioactive Wastes	Radioactive gases, liquids and solid.	Thermal pollution
3. Agricultural Wastes	Stalks, vines, stems and plant waste materials.	Air pollution
4. Miscellaneous	Wastes from animals, automobiles, household appliances, furniture, industrial metal scrap, demolition wastes, power plant fly ash, waste water from industries and institutions and industrial effluents.	Air and Water pollution

Among them the use of agricultural waste is very urgent for a country like India. The production of rice, one of the major food crops of India and the world, generates one of the major wastes of India and the world, namely rice husk and straw. Efforts over the years to utilize these materials have resulted in minor usage, mostly in low-value applications in the agricultural area. Little advantage is taken of the high energy content, amorphous character of the silica present, or the highly cellular structure of either the rice husk or the straw. Disposal of the rice husk is a particularly serious problem which requires special attention because of the large quantities which can accumulate in the vicinities of the rice mills. Efforts to utilize the rice husk have been handicapped by their abrasive character, poor nutritive value, high resistance to degradation, low bulk density and high ash content.

The disposal of rice husk remains perhaps the largest agricultural by-product utilization problem in the world. The magnitude of this problem is obvious when one realizes that the world production of rice is over 400 million tons, resulting in more than 60 million tons of rice husk and potentially more than 12 million tons of ash. Even in the United States of America, which produces more than five million tons of rice, the problem of disposing of rice husk becomes significant. Disposal can be a particular problem in areas of that country, such as California, where the field burning of rice husk is no longer permitted because of environmental considerations.

Some of the major outlets for disposing of rice husk now in practice are litter and bedding materials for animals and poultry, roughage in animal feeds, pesticide carrier, filter media and pressing aids. Consideration was also given several years ago to use rice husk ash (RHA) as a filler for rubbers.<sup>1</sup> Little information is available on that particular RHA except that it was an ash of incompletely burned rice husk and contained a large fraction of carbon.

Ash derived from rice husk would have the properties of a semi-reinforcing filler. Although predominantly carbonaceous in nature, it contains considerable silica in a hydrated amorphous form; whether it is an opaline silica or a silica gel is not certain. As rice husk is a natural product, its composition varies with the location where the rice is harvested. The major ingredients of the rice husk are ash 13-39%, cellulose 34-44%, lignin 23-30% and moisture 8-15%. The ash content of rice husk is high enough to yield a filler by burning away the organic fractions. Chemical analysis shows that the ash is primarily a highly pure silica and that no metal constituents are present in sufficient quantities to cause deleterious effects upon the properties of polymers. Analysis of the ash derived from rice husk from rice grown over the past century throughout the world are presented in Table 1.2.

Table 1.2 - Average Reported Values of Composition  
of RHA (1871-1970)<sup>3</sup>

Constituent	%
SiO <sub>2</sub>	86.0 - 91.3
K <sub>2</sub> O	0.58- 2.5
Na <sub>2</sub> O	0.6 - 1.75
CaO	0.2 - 1.15
MgO	0.12- 1.96
Fe <sub>2</sub> O <sub>3</sub>	trace- 0.54
P <sub>2</sub> O <sub>5</sub>	0.2 - 2.85
SO <sub>3</sub> <sup>-</sup>	0.10- 1.13
Cl <sup>-</sup>	trace- 0.42

Other metals in parts per million: Al 54, Cu 2, Fe 45,  
Mn 4, Sn 10 and B 1.

Abo-El-Enein et al.<sup>2</sup> studied the surface properties, effect of time of firing from 500 to 1400°C on pore structure and crystallite size of RHA by thermal treatment. Further, they studied infrared spectroscopy and X-ray diffraction and the results obtained were compared with those of silica gel. The results showed that by X-ray diffraction analysis, no crystalline phase was detected at 700°C and this step was attributed to the destruction of the silanol groups. It also showed that cristobalite phase was detected from 900 to 1200°C and tridymite

was detected from 1300 to 1400°C. No quartz was detected at any firing temperature. It was shown by infrared spectroscopy, that silica gel lost its OH group above 1200°C, while rice husk silica lost its OH group at about 700°C and it was maximum only at 500°C.

El Sayed et al.<sup>4</sup> treated rice husk with lime and sodium hydroxide solutions at various concentrations, temperatures and time. The lime treatment was not effective in reducing the silica content of rice husk, but at low sodium hydroxide concentrations the ash content increased, while at higher concentrations it decreased linearly. The ash content initially decreased with an increase in temperature reaching a minimum at 50-60°C, after which it increased with further increase in temperature. The optimum conditions for silica reduction in rice husk were achieved by treatment with 12% sodium hydroxide based on rice husk weight for 1 hr at 50-60°C using a liquor ratio of 7:1.

Schmidt et al.<sup>5</sup> made filter aid material by treating rice husk with a dilute acid, i.e., 2.5% sulphuric acid at 100-250°C, washing the product with water, drying the residue and heating the dried residue at 500°C. The product consisted of silicic acid and carbon. The heating was carried out in the presence of zinc chloride to remove carbon and a highly, pure, silicic acid was obtained.

Schuster Ernst<sup>6</sup> recovered the valuable constituents of waste rice husk by treatment with dilute acid to extract furfural

by degasification in the absence of air to obtain synthesis gas and by slow heating or gasification to obtain light coloured ash with a high silica content and a minimum amount of carbon. The previously treated husk was heated in a combustion chamber, either stationary or in motion, to 800°C at  $25 \pm 10^\circ/\text{min}$  for 30-40 min or at 550-600°C for 1 hr. The ash content of rice husk constituted 15%, of which = 90% was silica.

Narasimhan et al.<sup>7</sup> washed, dried and treated the rice husk with hydrogen fluoride for 24 hr to remove all silica. After separation by filtration and redrying, the husk was carbonized with sulphuric acid. The activated carbon was recovered after washing, filtration and drying. The spent fluorosilicic acid was treated with ammonia to obtain amino silicic fluoride, from which silica was precipitated. After separation of silica, the filtrate was treated with sodium aluminate to produce cryolite.

Mehta et al.<sup>8</sup> described a new process of rice husk disposal, which promised not only to utilize the energy content of the rice husk but also produced an ash which could be useful for a variety of industrial applications, especially as a filler for rubbers. The burning time and temperature in the furnace were controlled, so that the cellular structure of the rice husk was not generally disrupted and the silica produced remained in a porous, amorphous form having a large surface area.

Chatterjee et al.<sup>9</sup> burned rice husk in air which gave