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Study of Rice Husk Ash by Infrared Spectroscopy

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Abstract- The present work presents an infrared spectroscopy (IR) in a sample of rice husk ash (RHA) burnt without temperature control. The rice husk ash was because of the potential application of this material in concretes. The spectrum of this assay was obtained using Fourier Transform Infrared Spectroscopy, with a medium infrared spectrometer (MIR). The infrared spectrum region covers between 4000-400 cm-1. A mixture of pure KBr with RHA was carried out, the mixing ratio was 1: 100 and, a tablet of this mixture was made with the aid of a manual press to perform the test. The results obtained were compared with results already presented in the literature, thus being able to observe that that no band was found referring to impurities in this sample, and the sample was adequate with the presented literature.

Keywords*- Rice Husk Ash, Spectroscopy, Infrared*

I. Introduction

With the growing concern with environmental issues, the use of materials considered waste has been widely studied in civil construction. Mineral ashes from different agro-industrial activities stand out among the residues, which have high percentages of silica and other oxides, and can be used as pozzolans [1]. Plant residues such as rice husk ash (RHA) have been studied by several researchers who observed that this ash presents good results in several applications, for example, when used in mortars and concrete.

Rice husk is an abundantly available agriculture waste materials, a residue generated by the rice milling process, containing maximum amount of siliceous ash. Burning of rice husk in air produces rice husk ash (RHA) containing 85%–98% silica [2]. The characteristics of this material can vary widely, depending on the firing process to which the bark is subjected [3].

In most rice-producing countries, several studies are being carried out to increase the possibilities of reusing this material since its simple disposal can cause environmental problems due to the amount of residual carbon present as well as being highly harmful to human health, due to the amount of silica present, which can cause the lung disease known as silicosis[4].

Useful applications of rice husk are desirable to mitigate environment pollution and health hazard. Studies explore the cementing properties of RHA and its possible use as a low-cost construction material by partially replacing OPC (ordinary Portland cement) in concrete improving the final properties of the formed product [5].

According to Pouey (2006) [6], the possible replacement of cement by RHA relieves, in a way, the high consumption of non-renewable natural resources, which, once consumed, cannot be replaced in the short term. Considering the importance of using rice husk ash in the application of concretes, research through different characterization methods is important.

For the development of this research, rice husk ash from the burning of rice husk without temperature control and in the open was used, from the municipality of Alegrete-RS, one of the rice producing regions in Brazil with the purpose of comparing the infrared spectrum of this material with spectra found in the bibliography.

II. Infrared Spectroscopy

Infrared spectroscopy monitors the interaction of functional groups in chemical molecules with infrared light, resulting in predictable vibrations that provide a "fingerprint" characteristic of the chemical or biochemical substances present in the sample [7].

Infrared spectroscopy is used in chemistry and industry to identify and characterize molecules and in this work it was used to characterize a sample of rice husk ash and to make a comparison with analyzes already carried out with this type of material previously.

The infrared spectrum of an RHA sample shows the absorption spectrum in the infrared region, Figure 1 [8] shows the characteristic absorptions of the functional groups present in a sample of RHA. In the 3431 cm^{-1} band, the presence of -OH groups of silanois (Si-OH) and siloxanes (Si-O-Si-OH) is indicated, a fact that is confirmed by the intense absorption in 1096 cm^{-1}, attributed to the vibrations of asymmetric Si-O-Si stretch. The band at 793 cm^{-1} is due to vibrations of symmetrical stretching Si-O-Si and at 467 cm^{-1} indicates connections of the Si-O type. The weak absorption observed at 619 cm^{-1} is characteristic of crystalline cristobalite [8]. The rice husk ash that was used in this test is from CIVAB - Cooperativa Central Agropecuária dos Irrigantes do Vale do Banabuiú LTDA (Alto Tiradentes, Morada Nova - CE), also an RHA produced without controlled temperatures.

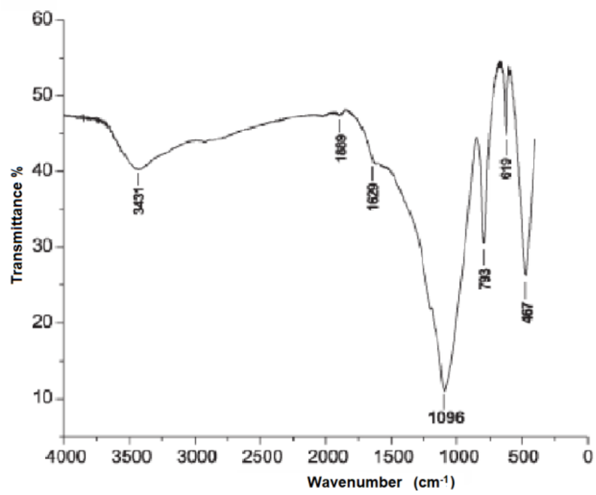

Figure 1. Infrared spectrum of an RHA sample [2].

Figure 2, characterization of another sample of RHA by infrared spectroscopy, shows characteristic bands similar to the sample in Figure 1. This sample was calcined at 700º/6h with a heating and cooling rate of 4ºC/min in air atmosphere, and it was locally collected in Kolkata, India [2].

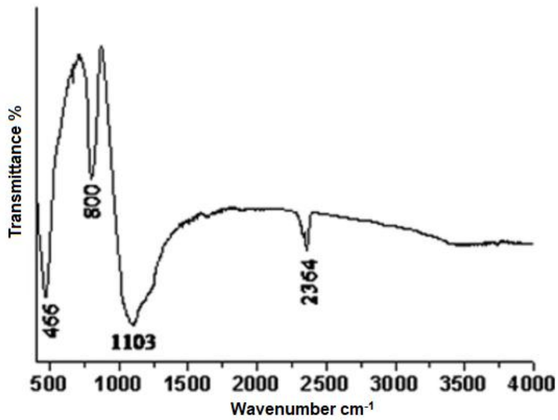

Figure 2. Infrared spectrum of an RHA sample [8].

III. MATERIALS AND METHODS

The infrared spectrum of this research was obtained using Fourier Transformed Infrared Spectroscopy (FTIR), with a medium infrared spectrometer (MIR) from the UTFPR-Campus Pato Branco Analysis Center. In this test, the infrared passes through the analyzed sample and the transmitted radiation is compared with that transmitted in the absence of the sample.

The Fourier Transform Infrared Spectroscopy used in this work provides evidence of the presence of functional groups present in the structure of substances, which can be used to identify a compound or investigate its chemical composition.

To perform the measurements, the infrared radiation passes through the sample and is compared with the radiation transmitted in the absence of a sample.

Transmission spectroscopy is the traditional infrared sampling method. This method is based on the absorption of infrared radiation as soon as it passes through the sample, being possible to analyze samples in liquid, solid or gaseous state. For solid samples, the material is mixed with a dry powder. This test was carried out with the use of potassium bromide (KBr), with 1 part of sample for 100 parts of KBr in tablet form.

The use of halide tablets involves mixing a solid sample with a dry powder, usually potassium bromide (approximately 1% of sample: KBr). The mixture is ground to a fine powder with a talc aspect. The mixture is compacted, thus producing a clean and translucent tablet. Potassium bromide is completely transparent in the medium-infrared region [9]. The infrared spectrum region covers between 4000-400cm-1. The interaction of this type of postponement with the RHA causes changes in the vibrational and rotational states of its molecules. For the analysis, a mixture of pure KBr with RHA was performed. The mixing ratio was 1: 100 and the choice of KBr is because in the analysis range, 4000-400cm-1, KBr does not show changes in the state of its molecules. After mixing, a tablet of this mixture was made with the aid of a manual press to perform the test.

IV. RESULTS

Figure 3 shows the infrared spectrum obtained for the RHA characterized in this work. Peak identification was performed based on studies by Silverstein et al, 2005[10].

Zone 1 (approximately 3500-3000cm-1) represents the symmetric and asymmetric -OH valence vibrations, which are -OH trapped. Zone 2 (1250-1100cm-1) indicates vibration due to H-O-H deformation, where there is the characteristic band of the silica bond with oxygen. Bands close to 500cm-1 are related to the metal oxygen (silicon).

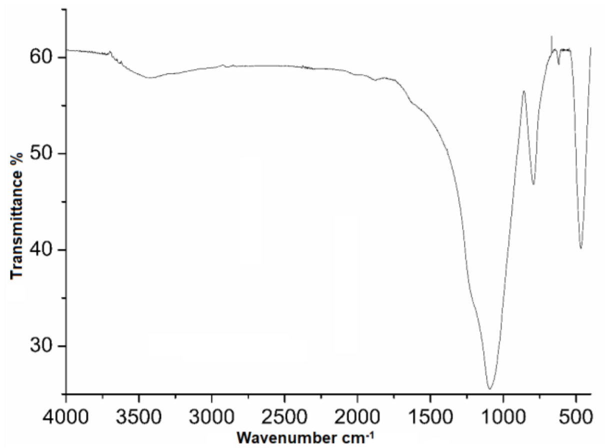

Figure 3. Infrared spectrum of the sample.

Comparing with Figures 1 and 2, the characterized RHA sample has similar bands to the bibliography, indicating that they are similar materials.

V. Conclusion

By comparing the spectra of the bibliographic review and the test performed, it is possible to find a striking similarity between them. The bands that approach 3000-3500cm-1, referring to the -OH stuck; the 1000-1250cm-1 bands, referring to the stretching vibration of the O-H-O bond, where there is the characteristic band between silica and oxygen; and bands 540 and 800cm-1, refer to the SiO2 balance and flexion mode, respectively.

This analysis allows us to state that the material tested is indeed a RHA, and in comparison with the spectra of the bibliography, it is possible to say that no band was found referring to impurities in this sample of RHA even though it is a material with open sky burning and without control.

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