COMPARATIVE STUDY OF MOISTURE ADSORPTION CAPACITIES OF COCONUT PITH, SILICA GEL AND THEIR COMPOSITE

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ABSTRACT

This paper presents the results of the research on the use of coconut pith as a desiccant. The results obtained for the coconut pith were compared with those for silica gel (standard desiccant) and a composite mixture of coconut pith and silica gel. The comparative study was carried on volume equivalent of coconut pith and silica gel (2g dry pith and 5g silica gel) because comparing the adsorption capacities on volume equivalent is more relevant than on weight equivalent. The moisture adsorption capacities were investigated under varying relative humidity. The results showed that coconut pith had the highest drying capacity of 0.4g water/g dry pith at 98 % relative humidity, compared with 0.18g water/g dry silica gel and 0.34g water/g dry composite. These results showed that high degree of dryness can be achieved by using coconut pith as a desiccant. Overcoming the problem of low bulk density in coconut pith will certainly make it a better and cheaper industrial desiccant than silica gel.

INTRODUCTION

Coconut pith or coir dust is the fluffy refuse obtained during the extraction of coir fibre from the coconut husk which forms the exocarp of the coconut fruit, cocos nucifera.L It is available in coconut dehusking centres which abound in the coastal area of the tropical countries. The light coconut pith is extracted by manually or mechanically ruffling the coir fibre (Enine, 2002). It has low bulk density and is often compressed in form of briquettes for easy transportation. Coconut pith is generally regarded as waste but can be used as fuel. It is also used in reclamation of low lying areas and mulching of soil. There have been a number of researches on the suitability of coconut pith in biogas production, developing good quality light weight polymers, chemical degradation of coconut pith to yield monomers like phenol, furfurals, briquetting of carbonized and non-carbonized pith for production of solid fuel. Interest in coconut pith has also risen in the areas of natural fibre reinforced composites (NFRC) as filler materials capable of serving as localized tensile reinforcement and volume fillers within several types of polymer matrices (Adewuyi, 2004).

Other possibilities also being investigated include the use of coir dust in the production of building materials such as boards, insulating materials, expansion joint fillers, light weight porous bricks (Keracraft, 2004). A major constraint in the utilization of coconut pith is its high moisture adsorption capacity. This has led to investigations in the use of coconut pith and its composites as drying agent for drying air and other gases. These researches are very promising as it has been shown that the pith can hold ten times its weight of water (Cole, 2002). Due to its desiccant capacity, composted coir dust has been noted as an excellent organic manure for indoor plants (Keracraft, 2004).

MATERIALS AND METHOD

The materials used for the experiments include: coconut pith/coir dust, silica gel, a composite of coconut pith and silica gel, and sulphuric acid. The equipment used was laboratory desiccators. In the experiment, the equilibrium adsorption capacity of coconut pith was determined by allowing the coconut pith to come to equilibrium in different humidities.

5 grammes of silica gel was used which was the volume equivalent of 2 grammes of coconut pith. The composite consisted of 50/50 volume equivalent of both samples (1 gram of dry pith and 2.5 grammes of silica gel).

Environments of varying humidities were created by placing sulphuric acid solutions of different concentrations in desiccators. Eight laboratory desiccators containing sulphuric acid solutions of varying concentrations (1M, 2M, 3M,...8M) were prepared and allowed to stand for 24 hours. Environments of relative humidity varying from 10 100 % were thus produced in the desiccators. Two grammes of the pith samples were weighed and spread on eight Petri dishes. The Petri-dishes were placed on top of inverted beakers inside the desiccators. The samples were weighed at interval of one hour until their weights became constant. The moisture content at the final weight represented the equilibrium adsorption capacity of the pith sample at that humidity. The experiment was repeated with silica gel and composite mixture of coconut pith and silica gel. The specific gravity of the sulphuric acid solutions were measured at the end of each experiment and the relative humidity of the air in each desiccators determined from the graph of relative humidity versus specific gravity of the sulphuric acid solutions.

RESULTS AND DISCUSSION

The summaries of results obtained are presented on Table 1 and Figure 1.0

Table 1: EQUILIBRIUM MOISTURE CONTENTS OF THE EXPERIMENTAL SAMPLES

Relative humidity (x100) of air in desiccator (%)	Equilibrium moisture content (wt. of H_2O/wt.of dry desiccant		
	Coconut pith	Silica gel	Coconut pith/silica gel composite
98	40.0	18.0	33.6
93	31.0	18.0	24.0
87	24.0	17.6	18.0
79	16.0	17.0	13.6
71	14.0	17.0	12.0
46	12.5	9.0	10.6
28	10.0	7.0	8.6
13	7.5	4.6	5.0

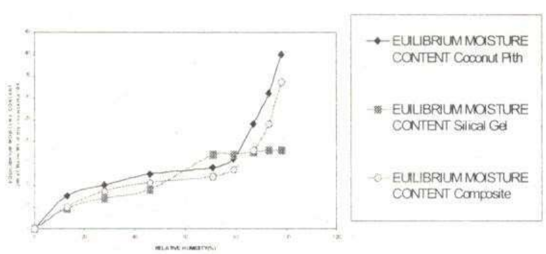

FIG. 1.0 EQUILIBRIUM LINES FOR COCONUT PITH, SILICA GEL AND THEIR COMPOSITE

DISCUSSION

Figure 1.0 shows the equilibrium moisture content against relative humidity for coconut pith, silica gel and the composite mixture of coconut pith and silica gel. The graph shows that coconut pith has better water holding capacity than silica gel and the composite. The equilibrium line for the pith shows that its moisture content increased sharply after about 70 %relative humidity. The composite also showed an increase in moisture content after 65 % relative humidity. Silica gel removes moisture from gases by virtue of the fact that the moisture vapour adsorbed into the extended internal areas of the material by capillary action and condensation of molecular layer on the surface is at lower partial pressure than that of water vapour in the gas stream. The highly porous structure of coconut pith offers an enormous extended surface area on which water molecules may be held by van der Waal forces. Also, since the surface is wetted, large volumes of water can be held within the pores by capillary condensation (Kirk and Othmer, 1887). It has been shown that most porous adsorbent such as silica gel, clay and molecular sieves rely more on physical adsorption than chemical adsorption. Physical adsorption involves weak intermolecular forces (van der Waals forces and electrostatic interactions) between the moisture and the surface (Sorbent System, 2006) The composite mixture of coconut pith and silica gel combines both properties and adsorbs moisture better than silica gel but slightly lower than the coconut pith.

CONCLUSION

The results obtained from this research clearly show the feasibility of using coconut pith as a desiccant. It has been shown that coconut pith is capable of producing a very high degree of dryness. Except for its low bulk density, coconut pith satisfies almost all the requirements of a good solid desiccant. Moreover, it is extremely cheap and available in abundance as waste after the extraction of coconut fruit.

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