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COEFFICIENT OF STATIC FRICTION OF PALM KERNEL SHELL ON SELECTED STRUCTURAL SURFACES

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ABSTRACT

An experiment was conducted to measure the static coefficient of friction of palm kernel shell (PKS) on plywood, galvanized iron and glass.

The results of the test showed that the coefficient of static friction of PKS increases with moisture content irrespective of the surface employed. The values of coefficient of static friction obtained varied from 0.42 to 0.75 on plywood, 0.34 to 0.62 on galvanized iron and 0.32 to 0.56 on glass for moisture contents ranging from bone dry to 18.4% wet basis. This implies that PKS is most resistant to flow on plywood and least on glass. A statistical analysis showed that these variations with structural surfaces were significant. Further similar work using the cracked palm kernel is recommended.

INTRODUCTION

The separation of kernel from shell in the production of palm kernel oil has continued to attract greater interest in recent times. The rise in demand of the palm kernel oil and cake which are respectively used for human food and animal feed has necessitated a corresponding need to develop new and more effective methods of separation of the shell from the kernel.

Palm kernel shell (PKS) is separated from the kernel by three methods which are hand picking, clay bath separator and hydrocyclone. The two latter methods involve the soaking of the mixture of kernel and shell in water, at the end of which the kernel will have to be dried again using either mechanical drier or sun drying before it could be stored or processed. The PKS will also have to be dried before it could be used as domestic fuel. Considering these facts, a lot of time is wasted and more energy used for the separated kernels to be processed hence it is necessary to develop an effective method of separation of the shell from the kernel without the application of water.

In developing this effective method of separation, the friction property of PKS is a parameter which needs to be investigated. The frictional force acting between surfaces at rest with respect to each other is called force of static friction. The static friction is that necessary to start motion, once the motion is started, the frictional force usually decreases so that smaller force is required to maintain motion. The friction force existing between the surfaces in relative motion is called force of kinetic friction.

The methods used by various investigators to determine static and dynamic coefficient of friction of agricultural materials have usually been designed to suit the particular conditions of the material. The usual method of inclined plane has been used for rough rice, cereal grains and Karingda seeds (Suther and Das 1996) and a horizontal table employed for friction studies of grains on various surfaces was done by Syndy *et al.*, (1967).

This paper discusses the results of an investigation carried out to measure the static coefficient of friction of PKS on three structural surfaces namely plywood, galvanized iron and glass.

MATERIALS AND METHODS

Samples and Equipment

The palm kernel shell used for this research work is the Dura variety which is the most abundant variety in the South Western Nigeria. A table of changeable tops comprising of plywood, galvanized iron sheet and glass and boxes of various dimensions were made for the experiment.

Measurement of Static Coefficient of Friction

The coefficient of static friction of PKS on the selected structural surfaces was determined using the procedure presented by Stepanoff, (1969). Four wooden boxes of varying dimensions 15x10x10cm^3; 16x15x10cm^3; 20x15x10cm^3 and 30x20x15cm^3 were used. The material (PKS) was conditioned to different moisture contents ranging from bone dry to 18.4%.

A box was tied by a chord passing over a frictionless pulley attached to a pan at the other end. Weights were put into the pan until the empty box started to slide and the sum of the weights (W_1) was recorded. The box was filled with PKS and weight (W_2) put into the pan. The weight (W_2) just sufficient to cause the box and PKS to slide was recorded. The coefficient of static friction was calculated as the ratio of limiting force to the corresponding normal force.

$$f = \frac{W_2 - W_1}{W}$$

where f = coefficient of static friction
W_1 = weight to cause sliding of empty box
W_2 = weight to cause sliding of filled box
W = weight of PKS in the filled box

RESULTS AND DISCUSSION

The results of the experiments are presented in Fig. 1. The static coefficient of friction of PKS for all the three surfaces increased with moisture content. At all levels of moisture content, the values were highest for plywood, followed by galvanized Iron sheet and least for glass. To further investigate the influence of a structural surface on the co-efficient of PKS, a statistical analysis shown in Table 1 was carried out.

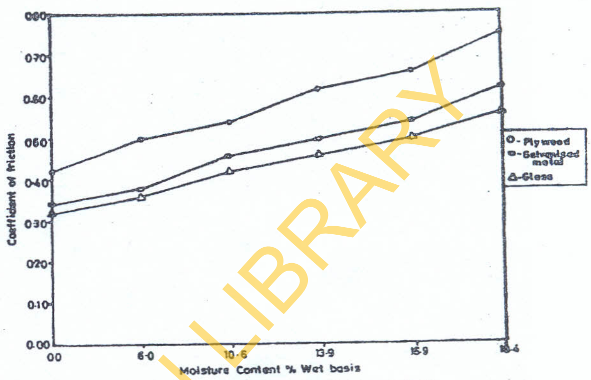

Fig. 1: Graph of Static Fiction against Moisture Content

Table 1: Summary of ANOVA for coefficient of static friction of PKS on plywood, galvanized iron and glass surfaces.

Source of variation	Variation or sum of squared deviations	Degree of freedom	Variance
Within columns	0.2775	15	0.0185
Between columns	0.068	2	0.034
Total	0.3455	17	

$$Z = 1.15129 \log \tfrac{0.2775}{0.0185} = 0.1354 \qquad F = \tfrac{0.2775}{0.0185} = 15$$

From tables of Z and F, values read were 0.6341 and 3.555 respectively as against the calculated values of 1.354 and 15. The variation is significant at 5% level indicating that the structural surface has an influence on the coefficient of static friction of PKS.

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

The coefficient of PKS was found to increase with increase in the moisture content of PKS on the three surfaces tested. From bone dry condition to 18.4% MC, these variations were found to be from 0.42 to 0.75 on plywood, 0.34 to 0.62 on galvanized iron sheet and 0.32 to 0.56 for glass. The coefficient of static friction is therefore highest for plywood and lowest for glass.

RECOMMENDATIONS

This work has made available information on the coefficient of PKS on some structu surfaces. Similar work needs to be done using the palm kernel from which it will ultimately be separated. Such work will provide information and basis for comparison between the coefficients of PKS and kernel which will aid in the design of appropriate separation methods.

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