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Effect of moisture content on calorific value of some Nigerian soft wood

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Abstract
This work studied the effect of moisture content on the calorific value of some Nigeria soft wood. The Nigeria soft wood considered in this work includes Egbu, Uchakakiri, Akpu and Ube. The experiment was performed at Projects Development Institute, Enugu. The moisture content of 10%, 15%, 20% and 25% were used to determine the calorific value of the soft woods. The experiment showed that the calorific value of the softwood determined decreases with increasing moisture content. Calorific value at 10% moisture content of the wood considered was higher than other values. From the experiment the maximum calorific value obtained from the experiment was at 10% moisture content. It was also observed that Ube has lower calorific value at 20% moisture content.

Keywords: Calorific Values, Moisture Content, Softwood, fuel, Combustion.

Introduction

The moisture content of a fibrous fuel (wood) is important in determining the plan area required in the combustion chamber to produce a given steam output. Practically, it is very difficult to burn fuels having more than 58% moisture without pre-drying.

However, in most fuels, there is very little choice in moisture content since the type of fuel, its origin and treatment determines it. It is desirable to use fuel with low moisture content because heat loss due to its evaporation before gasification or carbonization is consideration and the heat budget of the combustion reaction is impaired.

Thus in order to reduce the moisture content of fuel some pre-treatment of fuel is required. Generally desirable moisture content for fuel should be less than 20% for effective combustion.

Between zero moisture content and the fiber saturation point, wood shrinks as it loses moisture and swells as it absorbs moisture. Above the fiber saturation point, there is no dimensional change with variation in moisture content. The amount of shrinkage and swelling differs in the tangential, radial, and longitudinal dimensions of the piece.

Engineering design should consider shrinkage and swelling in the detailing and use of lumber.

Shrinkage occurs when the moisture content is reduced to a value below the fiber saturation points (for purpose of dimensional change commonly assumed to be 30% MC) and is proportional to the amount of moisture cost below this point. Swelling occurs when the moisture content is increased until the fiber saturation point is reached, and then the increase ceases.

For each 10% decrease in moisture content below the fiber saturation point, wood shrinks about one thirtieth (1/30) of the total possible shrinkage, and for each 1% increase in moisture content, the piece swells about one thirtieth (1/30) of the total possible swelling. The total swelling is equally numerically to the total shrinkage. Shrinking and swelling are expressed as percentages based on the green dimensions of the wood. Wood shrinks most in direction tangent to the annual growth rings, and somewhat less in the radical direction or across these rings. In general, shrinkage is greater in heavier pieces than in softwood. As a piece of green or wet wood dries, the outer parts are reduced to a moisture content below the fiber saturation point much sooner than are the inner parts. Thus the whole piece may show some shrinkage before the average moisture content reaches the fiber saturation point.

More so, as the wood shrinks from loss of initial moisture (about 29%) and dries fully, drying shrinkage around the circumference amount to about 8%, while radial shrinkage is about 4%. Since the circumferential shrinkage is twice the radial shrinkage, stresses develop as the wood dries. When these stresses exceed the wood's tensile strength, cracks develop. The size and the moisture content of the log govern the size of the crack. In logs with large diameters the cracks, which result from natural drying, may be large. It is felt that cracks do not generally have any detrimental effect on thermal transmittance or stress values. As the relative humidity of the air changes so the width of the cracks also varies in accordance with the log's moisture content.

2. Methods and Materials

Sourcing of Material

The identification and felling of the trees was done by assistance of forestry experts.

Cutting of Thesamples into Shorter Logs
This was done after measuring 20cm length of each sample using measuring tape. The cutting was done using the hard saw.

Smoothening of the Edges
For even evaporation during seasoning the samples were smoothened at their edges using disc sender machine.

Measurement of Initial Masses of Each Sample Cut
The measurement of the mass of each sample was done using meter balance. The meter balance is a very sensitive measuring instrument, which has sensitive counter connected to a peizo material, which changes its resistance with change in load on it. The meter balance has an accuracy of about 0.00001.

Determination of Moisture Content
The automatic moisture meter known as mettler balance was used during the determination of the moisture content. The mettler is graduated into scales, which ranges from $14\% - 31\%$ moisture content range. The meter is used basically for determination of percentage contents of moisture of wood, plastics and concrete. The mettle has a two probe pins, which from both negative and positive electrode. The two pins were inserted into the wood sample, which complete the circuit. The mettle is powered by dry cells, when the system is put on, current and voltage flow to the pins, the amount of moisture contained in the wood sample will then affect the resistance to the flow of current. Then the pointer inside the mettle will deflect with the change in moisture content as a result of change in resistance. The deflection is then read directly from the calibrated meter reading.

Statistical Analysis
ANOVA test was performed with software SPSS 16.0 to see the statistical significant differences between the softwoods with different moisture content. The statistical significance level was selected at p-value<0.05.

3. Result and Discussion

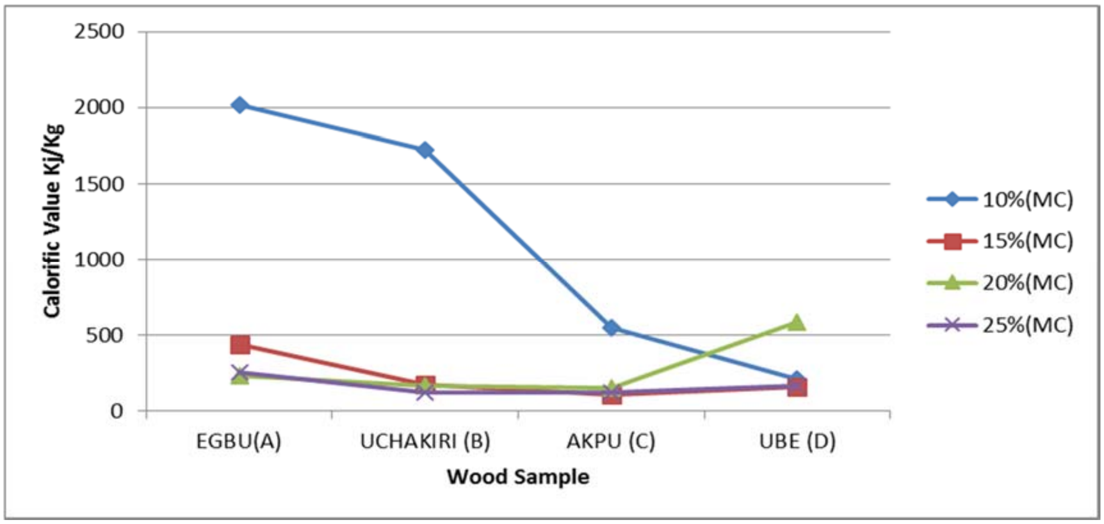

Fig 1: A graph of Calorific Value Versus wood samples

The calorific values obtained from the four Nigeria locally sourced soft wood samples was analyzed from the figure 1 above. The result show that the calorific values of the wood samples very according to the percentage moisture content. The calorific value of the sample is also dependent on the resinous constituent present.
From the result, the calorific values of the four samples varied from
$2.014 \times 10^3\ KJ\ /\ kg\ to\ 2.13 \times 10^2\ KJ\ /kg\ at\ 10\%\ M.C$ (moisture content).
Also at 15% moisture content, the calorific values varied from $4.27 \times 10^2\ KJ\ /kg\ to\ 1.65 \times \frac{10^2 Kj}{kg}$
At 20% moisture content, the calorific values varied from 2.33 $\times 10^2 KJ/Kg$ to $5.84 \times 10^1 KJ/kg$ and 15% has the least value.
The 15 percent moisture content was taking to be the reference percent because at 10% moisture content it is assume that the wood sample is air-dried and the effect on the calorific value of the sample might not be significant and hence serves as a control experiment.
It is also noticed that the calorific value reduces with increase in moisture content.

From previous work done by F.O Akinbode of department of mechanical engineering, federal university of technology Minna. 1g of a soft wood analyzed at 7.5% moisture content has calorific value of 2.278×10^4 KJ/kg. This result when compared with the result obtained from sample A (Egbu) at 10% moisture content which is 2.014 x 10^3 Kj /kg using 1.2g is in the same range. Thus, this suggests that wood sample (softwood) at percentage moisture content below 10% posses higher calorific values.
From literature, moisture contents above 20 percent affects calorific value of woods and thus 15% moisture content is ideal to give the highest calorific value of any wood sample. In other words, 15% moisture content is ideal for analysis of calorific valve of wood samples.

4. Conclusion

The moisture content of any wood determines the calorific value of the wood. The experiment conducted with four Nigerian softwood, Egbu, Uchakiri, Akpu and Ube confirmed that the calorific value of a wood increases with a decrease in the moisture content. It was observed from the result of the experiment that at 10% moisture content Egbu has more calorific value and at 20% moisture content Akpu has lower calorific value.

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