EFFECT OF SPECIES, PARTICLE SIZE AND COMPACTING PRESSURE ON RELAXED DENSITY AND COMPRESSIVE STRENGTH OF FUEL BRIQUETTE

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OUTLINE OF PRESENTATION

- Introduction
- Research Objectives
- Materials and Methods
- Results and Discussion
- Conclusion

INTRODUCTION

- Sustainable development and the role of energy in the development process worldwide are vital issues that have been gaining more attention and concern over the last few decades.

- Fossil fuels supplied about 80% of world primary Energy demand in 2004 and their use is expected to grow over the next 20 – 30 years (IEA, 2006).

- However the nearly total dependence on fossil sources of energy is not ideal in that:

- Crude oil reserves are limited and unevenly distributed in the world, with the most important reserves in politically unstable regions.

- Fossil energy use is also responsible for about 85% of the CO_2 emissions produced annually (IEA, 2003). This significantly adds to the greenhouse gas emissions.

- The above and others are the important reasons to find other means of getting energy for the ever-growing demand for energy world wide.

- Renewable sources of energy are the fastest-growing source of world energy, with consumption increasing by 3.0 percent per year (EIA, 2009).

- This is due to its environmental friendliness leading to strong government incentives for increasing renewable penetration in most countries around world (EIA, 2009).

- Previous studies on economic impact of using biomass energy clearly show that the benefits of production of briquettes for many economies clearly exist.

- However, there are several important factors that limit its utilization. The main reason is the high production cost of various bio-energy fuels. The production cost does not match the production price of fossil fuels such as coal.

- Hence, there is an urgent need to cut down the production cost to make bioenergy affordable.

- This can best be done through research work to improve upon existing technology for production.

RESEARCH OBJECTIVES

The objectives of this study are to determine the:

- Effects of species, particle size and compacting pressure on the relaxed density and compressive strength of briquette.

- Mathematical relationship between relaxed density of briquette and species density, particle size and compacting pressure.

OBJECTIVES Cont'd

- Mathematical relationship between compressive strength in cleft of briquette and species density, particle size and compacting pressure.

MATERIALS AND METHODS

Materials

- Lower density species: *Triplochiton scleroxylon* and *Ceiba pentandra*
- Medium density species: *Aningeria robusta* and *Terminalia superba*
- High density species: *Celtis mildbreadii* and *Piptadenia africana*

Material preparation

- Sawdust was sun dried at an average relative humidity and temperature of 75% and 28^{o}C respectively for five days.

- Sawdust was graded into three particle sizes: $P < 1mm$, $1mm \leq P < 2mm$ and $2mm \leq P < 3.35mm$ using an automatic sieve shaker.

Briquetting process

- 90g of sawdust of each species and particle size was weighed and filled into a mould of 55.3-mm ID × 52.5-cm height.

- Pressing was done using manual hydraulic press, a mould and a piston.

- Compacting pressures used were: 10MPa, 20MPa, 30MPa, 40MPa and 50MPa.

- 25 briquettes were made for each compacting pressure level , particle size and species.

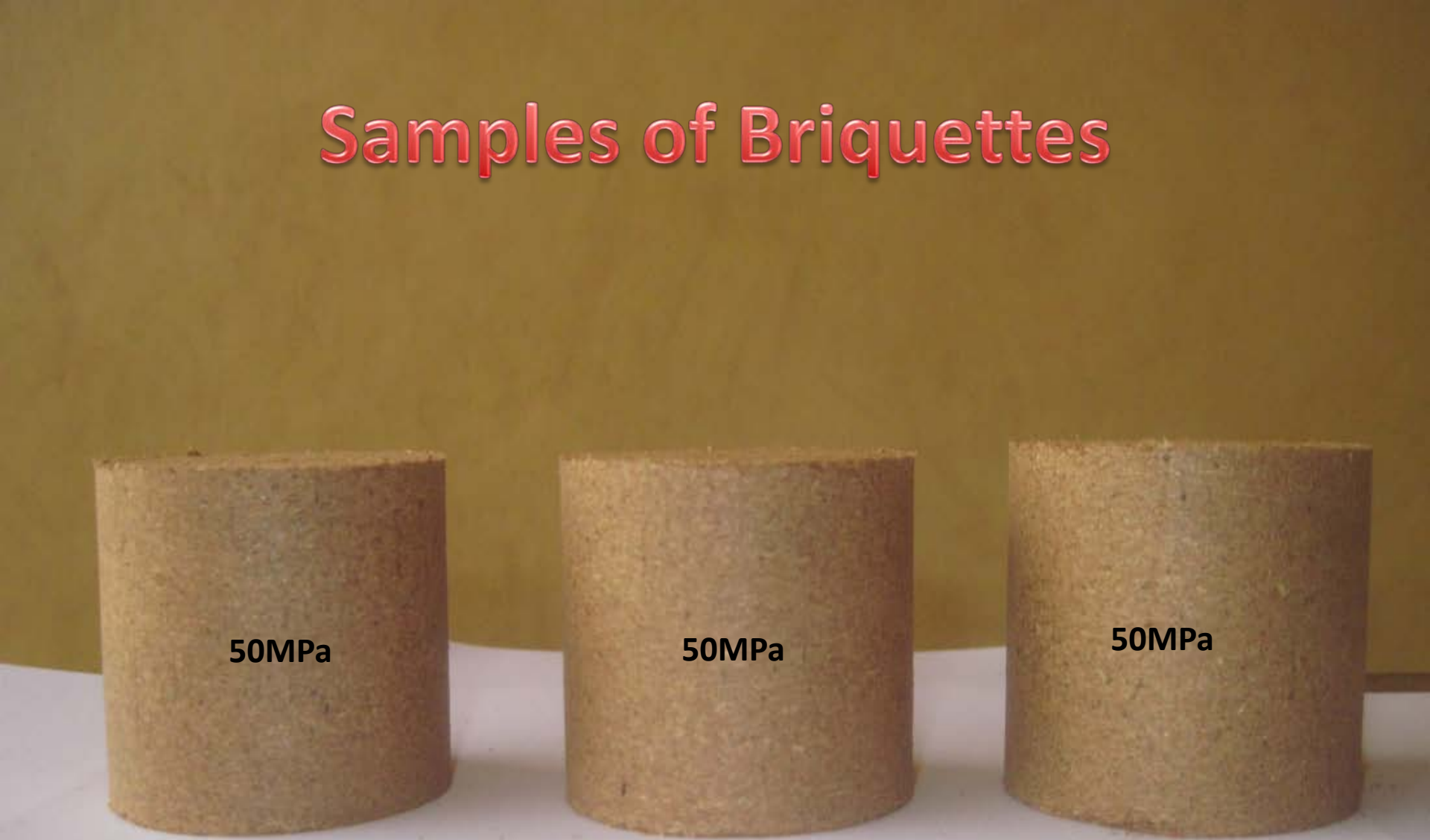
Relaxed density

Relaxed density of the briquettes was determined 30 days after removal from the pressing device in accordance with ISO 3131-1975.

Compressive strength

Compressive strength in cleft of briquettes was determined in accordance with ASTM D 2166-85 using an Instron Universal Strength testing machine.

Samples of Briquettes



RESULTS AND DISCUSSION

1. Relaxed density

- **TABLES 1a, b & c** indicates the relaxed density of briquettes produced.

2. Correlation analysis

Between relaxed density and particle size

Pearson's r = -.188, p-value = .000; N = 450; 1-tailed, $\alpha = 0.05$

Between relaxed density and compacting pressure

Pearson's r = .901, p-value = .000; N = 450; 1-tailed, $\alpha = 0.05$

3. Three-way ANOVA

TABLE 2 indicates the result of ANOVA for relaxed density of briquettes produced.

$R^2 = 0.9907$; RMSE = 11.24

4. Multiple linear regression

TABLE 3 indicates the result of multiple linear regression of relationship between relaxed density and species density, particle size and compacting pressure.

Mathematical relationship between relaxed density and species density (S), particle size (P) and compacting pressure (CP) is:

Relaxed density = 334.651 + .125S – 23.997P + 6.639CP

5. Compressive strength in cleft

TABLES 4a, b & c indicates the compressive strength of briquettes produced from the selected species and particle size.

6. Correlation analysis

Compressive strength and particle size

Pearson's r = .179, p-value = .000; N = 450; 1-tailed, α = 0.05

Compressive strength and compacting pressure

Pearson's r = .670, p-value = .000; N = 450; 1-tailed, α = 0.05).

7. Three-way ANOVA for compressive strength

In **TABLE 5** is the result of ANOVA of compressive strength in cleft of briquettes produced.

$R^2 = 0.9802$; RMSE = 2.1162

8. Multiple linear regression

TABLE 6 is the result of multiple linear regression of the relationship between compressive strength and species density, particle size and CP levels.

Mathematical relationship between compressive strength in cleft and species density (S), particle size (P) and compacting pressure (CP) is:

Compressive strength = 19.923 - .046S + 2.957P + 0.637CP

CONCLUSIONS

❖The type of species, compacting pressure and particle size, as well as their interactions have significant effect on the, relaxed density and compressive strength in cleft of briquettes produced.

❖There exist a mathematical relationship between relaxed density and species density (S), particle size (P) and compacting pressure (CP) defined by:

Relaxed density = 334.651 + .125S – 23.997P + 6.639CP

❖There exist a mathematical relationship between compressive strength and species density (S), particle size (P) and compacting pressure (CP) defined by:

Compressive strength = 19.923 - .046S + 2.957P + 0.637CP

THANK YOU

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