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Investigation of Proximate Analysis of Coal and Coconut Shell – A Review

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Abstract: The power generation in Malaysia has grown so widely and they are dependance towards fossil fuel sources has invited harmful effects to the nature. This research is done to investigate the proximate analysis of coal and CSP via ASTM testing and their efficiency to generate power. In this experiment, coal and coconut shell are grounded into particles by a ball mill and went through ASTM E871, E872 and D1102 for proximate analysis. The findings showed the moisture analysis, volatile matter, ash content, fixed carbon and heating value of both coal and coconut shell. The efficiency evaluated showed that coal can be replaced with coconut shell for power generation as it is less harmful to the nature and has better combustion efficiency.

Keywords: Proximate Analysis, Coconut Shell

1. Introduction

Malaysia is a country that depends highly on power generation for its economic growth [1]. As we all know, Malaysia naturally confides in on mainly coal, natural gas and fuel oil as its fossil fuel sources for power generation [2].

Coconut shell can be listed down as an example of biomass source to replace coal in energy production. It is commonly utilized as a source of organic fertiliser due to its ability to preserve the farmlands' moisture and reduces the loss of nutrients when agriculture is done [3].

Coal is a resource that has been used widely in our country and it is also said to be easily available for a cheap price. This causes and effect of burning coal as it leads to emission of Greenhouse gases (GHGs) which causes degradation of environment and changes of climate.

In this case, we are considering the usage of coconut shell as biomass source to produce energy. This research focuses on proximate analysis of coal and coconut shell to identify the compatibility of coconut shell as source of fuel replacing coal.

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1.1 Proximate Analysis

PA is the most widely recognized & least complex type of coal/coconut shell assessment, which is utilized to figure design of fuel, its applicable properties and worth of its energy. Proximate analysis decides MA, AC, VM, FC, and HV. Customarily, the guidelines of proximate analysis are framed dependent on a couple of establishments which incorporates International Organization of Standardization (ISO), the American Society for Testing and Materials (ASTM), the German Institute for Standardization (DIN) and the British Standards Institution (BSI). Even though there are contrasts, the guideline applied, and methodology carried out are for the most part comparable. For the most part, proximate analysis is resolved gravimetrically after warming a sample under explicit conditions like atmosphere, temperature, and time.

1.2 Effects of Particle Size on Combustion

Particle size is a main consideration in deciding the restrictions during response [4]. The intra-molecule heat and mass exchange impacts are significant in devolatilization of millimetre-sized biomass particles. The coarser particles require more residence extra time because of its low dissemination rates. The little particles consume more rapidly than the coarser ones [5]

2. Materials and Methods

2.1 Materials

Materials used are coal and coconut shell. The sample preparation process is as the flowchart attached.

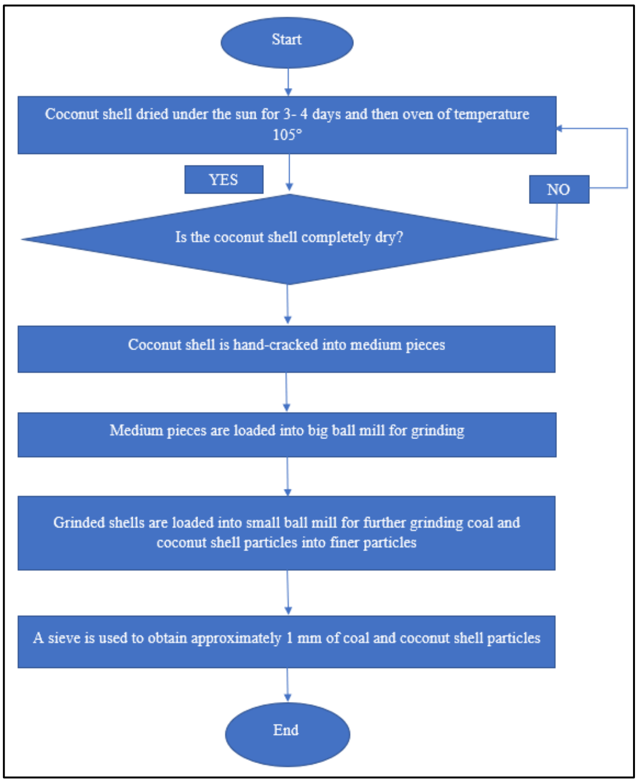

Figure 1: Sample Preparation Flowchart

2.2 Methods

The testing done in proximate analysis are moisture analysis, volatile matter analysis and ash content analysis. The following steps are showed in the flowchart below respectively.

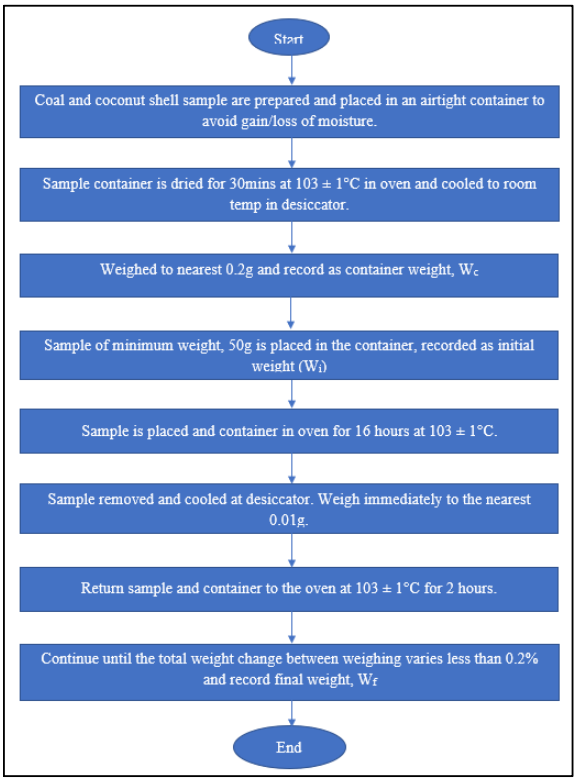

Figure 2: Moisture Analysis Flowchart

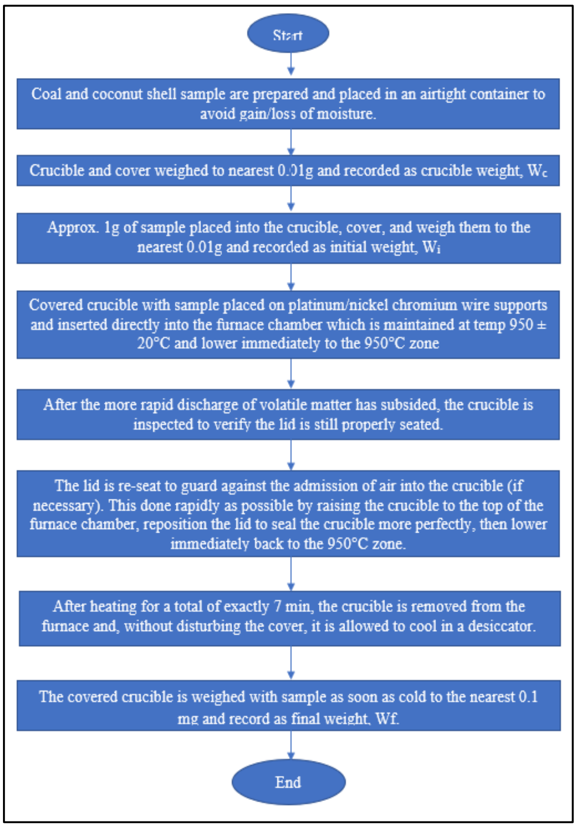

Figure 3: Volatile Matter Analysis Flowchart

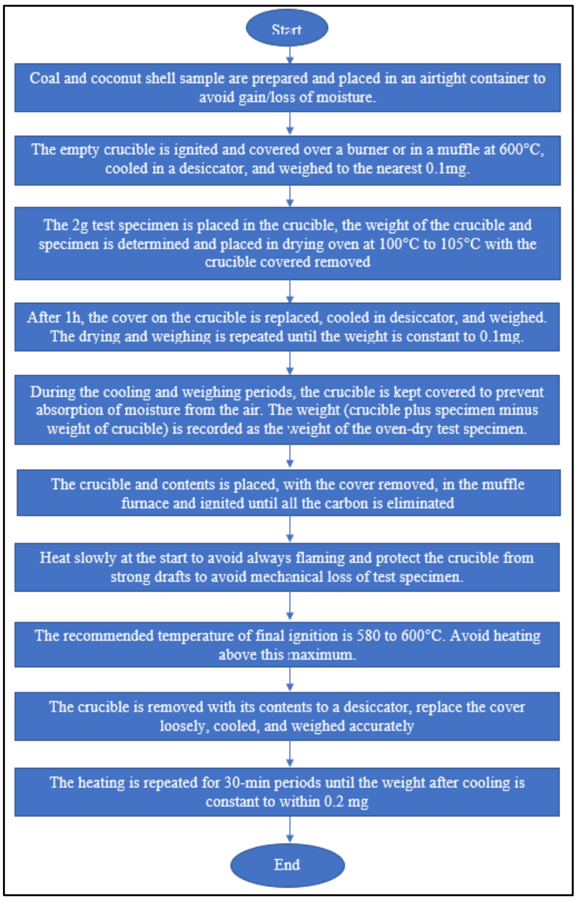

Figure 4: Ash Content Analysis Flowchart

3. Results and Discussion

3.1 Results

Table 1: Proximate Analysis and Ultimate Analysis of Coconut Shell and Coal

	Proximate Analysis (wt%)	
Coal	Parameter	Coconut Shell
9.43	Moisture	7.40
19.79	Volatile Matter	74.27
13.99	Ash Content	0.73
46.79	Fixed Carbon	17.60
	Ultimate Analysis (wt%)	
58.96	Carbon	48.02
4.16	Hydrogen	6.5
1.02	Nitrogen	0.1
0.56	Sulphur	0.01
11.88	Oxygen	44.64
	Gross Heating Value (kcal/kg)	
5500		4523

3.2 Discussions

From the results above, the moisture of coal is stated to be slightly higher than of the coconut shell. The value of moisture in coal is 9.43% whereas the moisture of CSP is 7.40%. Theoretically, moisture absorbs heat, therefore, when the coal is recorded to have a slightly higher moisture, the tendency of reducing the relative efficiency of heating increases when the combustion of coal takes place causing the hating value of coal is higher than of coconut shell. High moisture content in coal causes the delay of ignition which means longer time is required for drying, thud reduces devolatilization. The lower moisture percentage in CSP proves that it has lesser tendency in reducing the relative efficiency of heating.

As for the volatile matter, coconut shell has a way higher percentage compared to coal which is 74.27% and 19.79% respectively. The vast difference is due volatile that releases at a rapid rate, resulting in higher reactivities in coconut shell. When the volatile matter is high, it proves that CSP are reactive and can be easily converted into gas, thus producing less char. Fuel characteristics depends on yields and rate of release which is lignin and cellulose also temperature and heating rate, thus explains the high volatile matter of CSP. CSP begin to devolatilize and swell at lower temperature compared to coal particles due to the overall lower molecular weight of condensed-phased organic constituents.

The coconut shell shows decreased ash content value as to coal. The coal’s ash content is at 13.99% while coconut shell has 0.73% of ash content. Coconut shell particles showed way lower ash content as the particles has completed a more efficient combustion compared to coal. This is because when ash content is high, it indicates the incomplete residue of a combustion, and it clearly proves that coal did not perform a complete combustion as coconut shell. This proves that the combustion of CSP will be more efficient than the coal's which is why the coconut shell have the potential to replace coal for power generation.

The fixed carbon is determined through the formula of the removal of percentage of ash content, moisture and volatile matter added together from 100%. The heating value of coconut shell is 4523kcal/kg meanwhile the heating value of coal is 5500kcal.kg. The coconut shell particles have a lower heating value because those particles have increased oxygen concentration than coal.

4. Conclusion

This experiment achieved the objective as we have successfully conducted the proximate analysis of coconut shell and coal. In terms of investigating the efficiency of combustion for both coal and coconut shell, we have achieved the objective as the results from the proximate analysis clearly shows why coconut shell can be a good replacement for coal in power generation. This can be concluded from the values of moisture analysis, volatile matter and ash content of coal and coconut shell. The heating value of coal is 5500 kcal/kg whereas for coconut shell is 4523kcal/kg which shows the combustion of coal emits more heat and hazardous gas.

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