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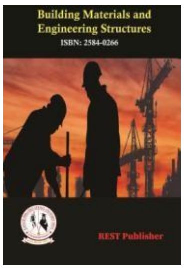

Assessment of Pyrolysis Material Selection Using WPM as an Auxiliary Tool

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Abstract: *Producing energy from agricultural wastes is particularly complex since it involves a wide range of variables, including social, economic, and environmental factors in the current phase of energy growth. In this study, "ranking was accom-plished using a hybrid multi-criteria decision-making (MCDM) model based on the weight obtained using the analytical hierarchy technique". It is proposed to use WSM to determine whether using locally accessible biomass is feasible. Dur-ing pyrolysis, in order to improve the output of bio-oil, a number of criteria are set down for this goal. The suggested ap-proaches are well-aligned with one another and perfectly replicate the trial results."This study includes seven biomass al-ternatives and seven evaluation standards. Sugarcane bagasse is regarded as the best biomass material out of the other seven". In order to establish its utility, the bio-oil produced from the biomass material with the highest ranking was exam-ined using gas chromatography (GC) and Fourier-transform infrared (FTIR) spectroscopy for its physical, elemental, and chemical contents. The thermo chemical conversion process, in particular, is clarified by this research in novel ways.*

1. INTRODUCTION

Since 20 years ago, the University of the Basque Country has been creating conical spouted bed reactors of laboratory size for the pyrolysis of several solid wastes, including waste tires [3, 4] and biomass [2, 3]. The results demonstrate that it is a successful replacement for traditional fluidized beds [5]. Actually, "spouted beds provide excellent solid mixing, little segregation, and a high level of dispersion flexibility for gas flows [6, 7, 8]. Olazar et al.'s research [9] also demonstrated that the cylindrical spouted bed can handle biomass particles like chips and clippings without the need for inert material". In a recent review of biomass flow in multiple phases in spouted beds, Cui and Grace [10] came to the conclusion that additional re-search is required to look into alternate spoke bed configurations and to optimize operating conditions to reduce spouting gas while increasing process efficiency and lowering operating costs. The logistical management of biomass supply to big, centralized processing units (biorefineries) presents significant challenges because of the low density and high moisture levels of the materials being delivered. Fast decomposition is one of the pre-treatments for energy density at the local level that is frequently used to address this problem. Reactor design and performance are the primary determinants of the power consumption and usability of fast pyrolysis plants. Fluidized beds (bubbling and circulating) continue to be simpler to construct and operate even though some reactor designs, surgical designs, as well as spinning cone designs, have increased process effectiveness. "The maximum bed height and the particle width/gas inflow ratio of particle diameter limit the scaling up of spout-ed bed technology [11]. By including a draught tube that serves as a spout-annulus interface, these restrictions can be bypassed [12–17]. The past several years have seen study on a number of internal devices, including non-porous [18], porous [19, 20], and open-sided [13], for a variety of processes, including coal combustion, drying, coating, and hydrocarbon pyrolysis". Several methods have been used to evaluate the chemical makeup of cigarette smoke [1-4]. Over 4800 different sub-stances have been discovered, some of which are poisonous because to their carcinogenicity or cytotoxicity. It is necessary to identify potential sources for these constituents and investigate their genesis processes in order to comprehend how certain smoke constituents are formed. As a plant substance, tobacco is a tremendously intricate biomass matrix. It has more than 2500 chemical components, including biopolymers, non-polymers, and inorganic substances. In the burning area of a ciga-rette, when the tobacco is exposed to temperatures ranging from ambient to 950 8C in the presence of different oxygen con-centrations, tobacco smoke is produced [5]. The logistics of transporting materials with a high moisture content and low density present significant challenges for the supply (biorefineries), which are massive, centralized processing facilities for biomass. The typical approaches to address this issue involve localized pretreatments for energy densification, and the most promising method is quick pyrolysis. Fast pyrolysis plant operability and energy efficiency are primarily influenced by reac-tor performance and design. "Even though some reactors, such as rotating cone and ablative designs, have improved process efficiency, fluidized bed reactors (bubbling and circulating) are still simpler to construct and operate [1Conical spouted bed reactors are being created on a lab scale at the University of the Basque Country for application in the pyrolysis of different solid wastes, such as biomass [2], used tires [3], and plastics [4]. According to the findings [5], it is an alternative to conventional fluidized beds. Spouted beds actually provide good solid mixing with little segregation [6,7] and a lot of flexibility in the gas flow distribution [8]. The study by Olazar et al. [9] also showed that the conical spouted bed is capable of handling biomass particles like chips and shavings without the need of inert material. Cui and Grace [10] have concluded from their recent study on biomass multiphase flow in spouted beds that additional research is needed to examine various spouted bed configurations and optimize operating conditions in order to reduce the amount of shouting gas and improve process efficiency while lowering expenses for operation. The particle diameter/gas input diameter ratio and the maximum bed height are two variables that limit the scaling up of the spouted bed technology [11]. By including a draft tube that functions as the spout-annulus contact, these limitations can be overcome [12–17]. Many internal device types have been investigated recently for a range of processes, including coal combustion, drying, coating, and hydrocarbon pyrolysis, including non-porous [18], porous [19,20], and open-sided [13] devices".

2. MATERIALS AND METHODS

Using the WPM (Weighted Product Model) methodology, we will assess smart sensor networks based on the four factors in this study. Different approaches to understanding the vacancy have been investigated using real-time HVAC zone management to save energy without compromising occupant comfort. The air conditioning system is known as an AHU. Condi-tioned air is transmitted using a collection of self-assembling components (fans, cooling coils, filters, humidifiers, and damp-ers) built into the construction package and assembled as a single unit with metal pipe work attached. The Weighted Product Model (WPM) is a well-liked strategy for multi-scale decision making (MCDM) and criterion choice evaluation (MCDA). The weighted sum version (WSM) and this are very similar. The primary difference is that multiplication has replaced addition as the primary mathematical operation. Multi-criteria decision-making (MCDM) is a technique for incorporating alternative overall performance into quantitative standards and creating a solution that calls for consensus. The WPM approach was employed in this study to rank the data, and it is the best option. Alternative and Short distance the solution that is the farthest away from the original solution is chosen, although the comparison of these distances is unimportant. Long Range ra-dio, WiFi, and Low Energy Bluetooth. Depending on our needs and how well they align with our vocations, it can be very difficult to choose the right laptop model. It can be really challenging to choose the right model from the many that are available on the market. Furthermore, it may be impossible to include all the desired specifications in a single model. To avoid these perplexing situations, MCDM methodologies (Salomon and Whitaker, 2007) give decision-makers a way to choose the best options among various available options while taking into account various competing criteria. This research paper focused on how to choose the best laptop model for students since their opinions are typically obtained through a physical market survey and it is obviously crucial to select the right laptop from among the thousands of models that are currently on the market (Adali and Işk, 2017). "From the past studies, several researchers have adopted different multi-criteria decision support tools (Araujo et al., 2017) e.g. The Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS) (Hwang and Yoon, 1981), ELimination Et Choix Traduisant la RE alité (ELECTRE) (Costa et al., 2018; Roy, 1968), data envelopment analysis (DEA) (Climaco et al., 2010), simple additive weighting (SAW) (Fishburn, 1967; Mac-Crimon, 1968; Triantaphyllou and Mann, 1989), VlseKriterijuska Optimizacija I Komoromisno Resenje (VIKOR) (Duck-stein and Opricovic, 1980) etc. in different field of applications e.g. project analysis (Saisse and Lima, 2019), business and financial sector (Nery, 2017; Salomon and Whitaker, 2007), educational sectors (Donizetti de Lima et al., 2017; Endler et al., 2017), global suppliers network development and logistics (Grillo et al., 2018; Resende de Carvalho et al., 2017), water man-agement (Costa and Amato Neto, 2017), supply chain management (Reis et al., 2017) etc. for strategic decision making (Moraes Vieira et al., 2017)". "With the rapid development of computer technology in recent few years, multi criteria deci-sion making (MCDM) techniques also gaining its importance and serves as an effective tool for analyzing complex decision-making problems (Karande et al., 2016). MCDM methodologies also find its own importance in industrial sectors, e.g. Afsha-ri et al. (2010), applied simple additive weighting approach for the personnel selection problem in their research work. Ayhan (2013), implemented Fuzzy-AHP for supplier selection in a gearmotor company and later Venkateswarlu and Sarma (2016), implemented SAW and VIKOR techniques for the selection of suppliers."

3. RESULT AND DISCUSSION

TABLE 1. Pyrolysis selection

	Cellulose	Hemi cellulose	Volatile matter	Moisture content
Sunflower shell	31.08	139.53	29.15	22.05
Hard wood	29.12	142.97	33.69	27.30
Wheat straw	24.08	122.58	29.18	23.10
Sugarcane bagasse	23.17	128.28	24.60	17.59
Corn cob	33.33	186.41	27.96	18.89

Table 1 lists the characteristics of the biomass materials used in this experiment. Alternatives such as "sunflower shell, hardwood, wheat straw, sugarcane bagasse, and corn cob" were chosen, and five evaluation criteria including "cellulose, hemicelluloses, volatile matter, moisture content, and ash content" were also used.

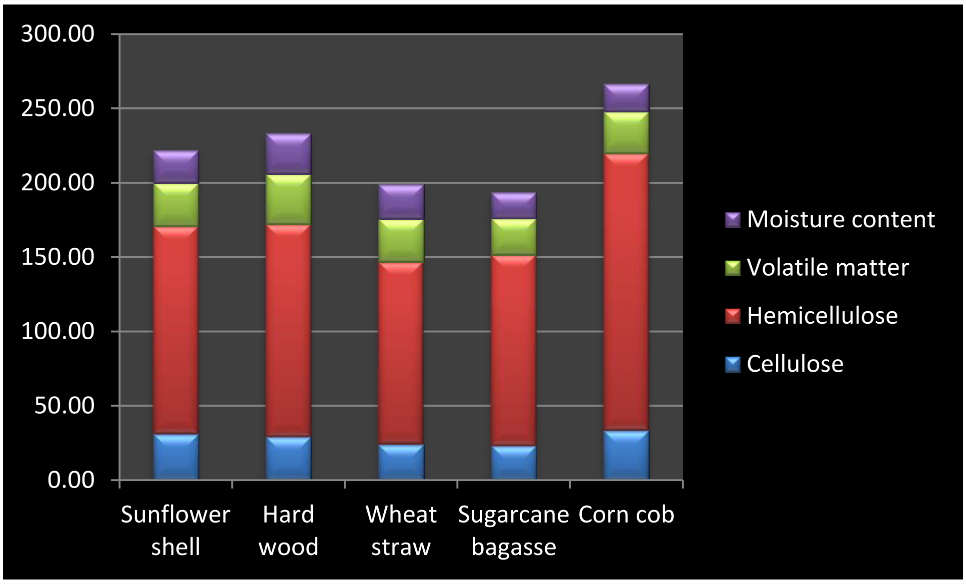

FIGURE 1. Pyrolysis selection

The characteristics of the biomass materials employed in this investigation are graphically represented in figure 1. "Sunflower shell, hardwood, wheat straw, sugarcane bagasse and corn cob" were taken as alternatives and five evaluation criteria such as "cellulose, hemicelluloses, volatile matter, moisture content and ash content" were taken.

TABLE 2. Performance Value

Performance value			
0.93249	0.74851	0.84391	0.79773
0.87369	0.76697	0.73019	0.64432
0.72247	0.65758	0.84304	0.76147
0.69517	0.68816	1.00000	1.00000
1.00000	1.00000	0.87983	0.93118

Table 2 Performance Value shows the informational set for properties of biomass materials.

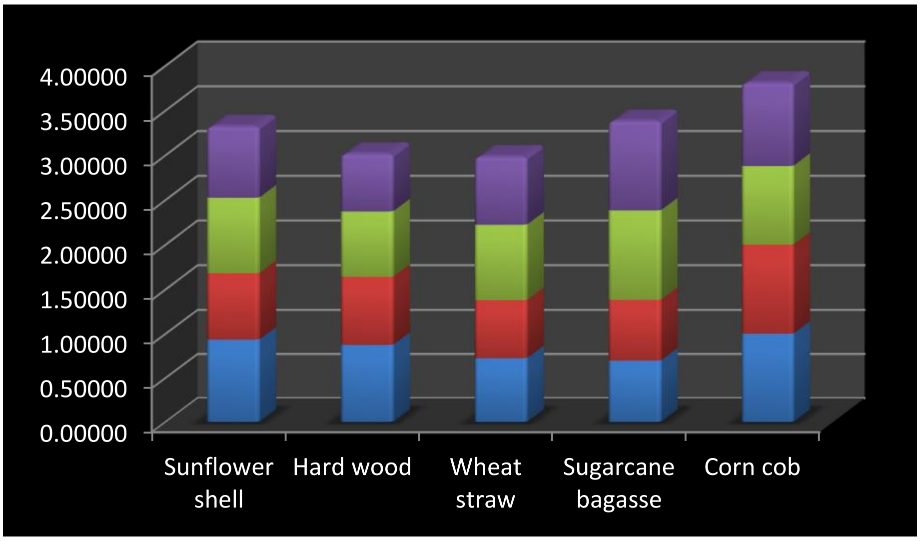

FIGURE 2. Performance Value

TABLE 3. Weight

Weight			
0.25	0.25	0.25	0.25
0.25	0.25	0.25	0.25
0.25	0.25	0.25	0.25
0.25	0.25	0.25	0.25
0.25	0.25	0.25	0.25

Table 3 shows the weight distributed equally among evaluation parameters "cellulose, hemicelluloses, volatile matter, moisture content and ash content". The sum of weight distributed among evaluation parameters is one.

TABLE 4. Weighted normalized decision matrix

Weighted normalized decision matrix			
0.98268	0.93014	0.95846	0.94507
0.96681	0.93582	0.92440	0.89593
0.92195	0.90051	0.95821	0.93414
0.91311	0.91080	1.00000	1.00000
1.00000	1.00000	0.96850	0.98233

Table 4 shows the "weighted normalized decision matrix" values.

TABLE 5. Preference Score and Rank

	Preference Score	Rank
Sunflower shell	0.82794	3
Hard wood	0.74932	4
Wheat straw	0.74314	5
Sugarcane bagasse	0.83166	2
Corn cob	0.95139	1

Table 5 shows the preference score and rank of alternatives using the WPM method. The preference scores of Sunflower shell are 0.82794, Hardwood 0.74932, Wheat straw 0.74314, Sugarcane bagasse 0.83166 and Corn cob 0.95139. The rank Sunflower shell is third, Hardwood is fourth, Wheat straw is fifth, Sugarcane bagasse is second and Corn cob is first.

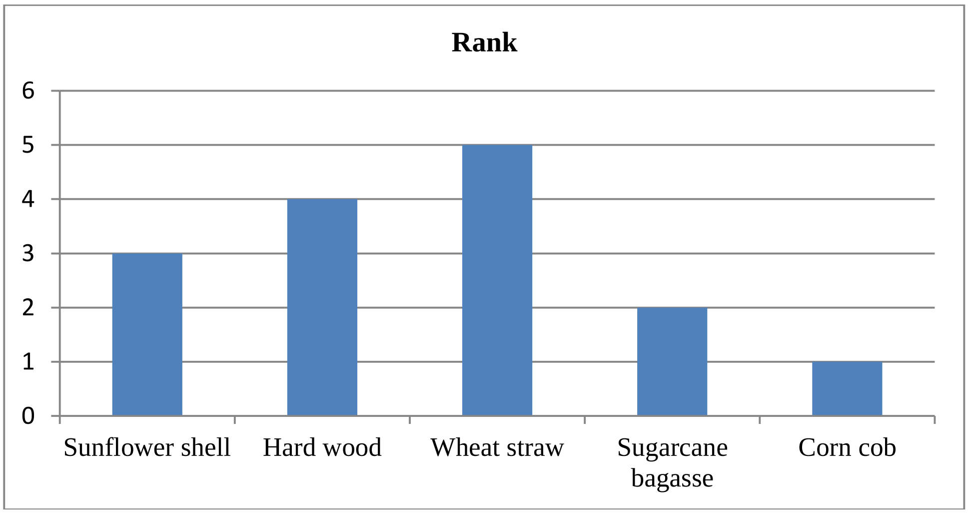

FIGURE 3. Rank

Figure 3 shows the graphical representation rank of alternatives using the WPM method. The rank Sunflower shell is third, Hardwood is fourth, Wheat straw is fifth, Sugarcane bagasse is second and Corn cob is first. Out of five selected biomass materials, hardwood is ranked top followed by Corn cob.

4. CONCLUSION

By feeding them at the same or a lower spouting flow rate as in conventional ones, suitable internal mechanisms can boost the solid circulation rate in spouted beds. Additionally, a wider range of steady working conditions are made possible by the draft tube, and hysteresis in the progression of pressure decrease with air velocity is avoided. A balance between the spouting flow rate, pressure drop, and solid circulation rate will determine the appropriate tube configuration. The type of raw material that needs to be processed, the required level of energy efficiency, or the desired level of product selectivity all have an impact on it. The average cycle time of the particles falls from 32 to 19 s when the entrainment height is increased from 50 to 110 mm due to the draft tube. The distribution of cycle times is significantly affected by inserting a draft tube, but very slightly by changing the entrainment height. As a result, it changes from a symmetric distribution without tube to one with a long tail for low entrainment heights. The draft tube has a significant impact on how the flow enters the annulus and spout. As a result, more gas passes through the annulus and over the bed as the height of the entrainment zone rises. The u/ums ratio has no impact on the air flow rate via the annulus, though. For a certain tube configuration, it is necessary to choose the appropriate operational u/ums ratio. Thus, for a specific reactor outlet site, this factor determines the maximum size of the particle that can be elutriated. The spouting velocity, particularly in the spout zone, has an impact on the gas residence duration as well. Experiments in a cold unit have shown that a conical spouted with bed draft tube satisfies the requirements for a rapid pyrolysis reactor, including compact dimensions, vigorous movement and good mixing, modest pressure drop, low fluidizing gas flow rate, and short gas residence time in the reactor.

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