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Superior Performance Analysis of Poly (lactic acid) Composites Using Fuzzy TOPSIS Method

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Abstract. LA is naturally Occurs organically is acidic. Therefore, the Making PLA an eco-friendly material can be used. Although there are many ways to synthesize PLA, None of them are simple or not easy ones implement. Research significance: Polylactic acid (PLA) is biodegradable and Recyclable made of polyester. Glucose or A Lactic acid by fermentation of sucrose is produced as a raw material and more refined to purity. Methology: Therefore, they need a lot of care and attention. Fuzzy TOPSIS method, a more classical MCDM one of the methods is known as and developed by lee, The basic concept of this method is, Selected Alternative: Young's Modulus (GPa), Ultimate Tensile Strength (MPa), Elongation (%) and impact toughness (kJ/m2). Evaluation Option: Pure PLLA, PLLA–BCF2, MA-PLLA–BCF2, PLLA–KBCF2, PLLA–NBCF2. Result: from the result it is seen that MA-PLLA–BCF2 and is got the first rank whereas is the PLLA–KBCF2 got is having the lowest rank. Conclusion: The value of the dataset for Poly (lactic acid) in Fuzzy TOPSIS method shows that it results in MA-PLLA–BCF2 and top ranking.

1. Introduction

Polylactic acid (PLA), monomer units Aliphatic due to linking ester bonds Classified as polyester, misc Applications play an important role in biomedical field Received: sutures, bone fixation screws, Devices for drug delivery, incision surfaces. FDA-Approved - Polylactic acid by FDA As a A generally safe (GRAS) polymer Approved and for food contact is safe. Aliphatic hydrocarbons like mineral oil should be fine -- straight-chain hydrocarbon molecules won't attack PLA. Aromatic hydrocarbons such as benzene or toluene can attack PLA. (Gasoline often contains aromatics like toluene.) So I'd say don't go for gasoline but diesel might be fine. Highly heat-resistant and high-impact PLA Development of microwaveable frozen meals Plates, hot food takeout containers and High-temperature, such as hot beverage cup lids For PS and PP in thermoform capable applications Allows use of renewable alternatives. The most classical MCDM known One of the methods, TOPSIS first was created Wang et al. This The basic idea of the method is that selected alternatives are from positive ideal solution Very short distance and far from negativity should be. TOPSIS (Order by similarity of ideal solution technique for option) One of the numbers. Multiple criteria Decision making methods. This is a simple one A method widely applicable to mathematics. Model. Further, Relying on computer support, this is the most suitable practice is proper. The TOPSIS technique is usually used to solve decision problems. This technique Based on the comparison between all the alternatives in the problem regarding your question AHP and TOPSIS based on different concepts methods. AHP is integration and its Pair wise comparison of criteria and alternative weights and is derived based on DM preferences. TOPSIS is distance based. That is, an ideal and non-ideal solution is assumed to exist.

2. Poly lactic acid

Biodegradable poly offers Physics relevant to biomedical engineering Chemical properties and biocompatibility. However, Low cell adhesion, biological inactivity, low Degradation rate and acidification of PLA products assocd Decomposition has some disadvantages like [1] Poly (lactic acid) (PLA) comes from resources The produced renewable are Linear aliphatic. Thermoplastic Polyester is a lactide ring is open polymerization or lactic acid monomers produced by polycondensation, and the monomer is obtained by fermentation of corn. [2] Poly(lactic acid) (PLA) is linear aliphatic Thermoplastic is essentially polyester latex produced by ring-opening polymerization. Through the fermentation of annually renewable resources Acid is produced from lactic acid is changed [4] Modified rice straw fiber and poly (acid First Lactic Biodegradable Composites) (PLA). ready were made PLA/MRSF with simple model MPa Compared to the increased mechanical properties shows the tensile strength of composites. PLA/MRSF Water absorption of composites is lower than PLA/RSF composites was [7] Not only is it better to make a BF/PLA blend, but PLA's Performance and low cost high value of bamboo- Feels like added utility, but refresh Reduces dependence on unsustainable fossil energy and ensures rapid decomposition of the mixture. More interface showed a self-weld fiber structure, illustrating a better mech balance [9] there is New and better of intrinsic characteristics and environmental influence there is a growing interest in using basically active ingredients. Nowadays, because of their versatility, composites have a wide range Used in applications such as automatic, They play a leading role in various fields. Depending on the end use and Raw materials, manufacturing process end profoundly affect the properties of the product. [10] Short aand long industrial hemp fiber Reinforced. PLA in composites crystalline of PLA was also clean increased by alkaline treatment of the fibers. For the nucleation potential of fibers. [11] In recent years, bio-based polymers

There is a lot of emphasis on usage. Poly(lactic acid) (PLA) in these bio-based polymers Considered together, they are petroleum based Polymers are characterized by their biocompatibility, biodegradability, It is a very important alternative due to biodegradability and relatively good mechanical strength. [12] Considering the increasing energy crisis, many efforts have been made to replace traditional Petroleum based plastics and Bio-based plastics derived from renewable plant resources. Among them, derived from corn or starch Polylactic acid (PLA), at its best bio Much attention due to compatibility, mechanical properties attracted and high transparency. However, the flammability of PLA is its Limits applications to multiple cases. [13] Polylactic acid (PLA), renewable Biodegradability synthesized from raw materials Blended Polyester Medical, Packaging and Textiles Widely used for fiber applications. Its Due to the Versatility and relatively cheap price, last PLA is the most promising of the decade One of the polymers. However, some PLA sectors due to major shortcomings Compatibility may be restricted [14]. Experimental results related Microwave and Terahertz For electromagnetic reactance in limits Theoretical Predictions and Experimentation of GNP/PLA Composites A comparison of observations is presented. Signature The last part of the copy is the penetration into the actual compounds and is devoted to discussing the results presented with the effects of aggregation. The concluding section Further processing of the studied materials The most important general conclusions for the application Sums it up. [15] Poly (lactic acid) (PLA), a Renewable bio-polyester in general is received starch Fermented corn is the most widely studied One of the polymers. Moisture after several months PLA degrades by hydrolysis when exposed to petroleum Makes it an attractive green alternative to oriented polymers. [16] This study of jute/poly(lactic acid) (PLA) composites Examined physical Behavior, especially thermal characteristics and educational behavior. Twill and plain woven jute fabrics as reinforcements, nylon Film stacking of fabrics-reinforced PLA composites Using the method, the coefficient of thermal expansion Using compounds prepared. [17] Torch Polylactic acid (PLA) is renewable and natural biodegradable polymer materials is in the environment can be hydrolyzed or degraded by microorganisms, May eventually become CO2. and H2O will be destroyed. Therefore, mixing starch with PLA Starch/PLA composites produced by biodegradable composites, and once discarded do not have a negative impact on the environment.[18] Large scale production of polylactic acid (PLA). By introducing, polyolefin and other bulk With composites based on polymers Can provide basis for competing products A bio-based thermoplastic with properties Polymer is available. [19] Biocomposites are polylactic acid (PLA) and Made from wood. A deep eutectic solvent Sapwood and Construction and Demolition by (DES). Lignin was extracted from waste (CDW), and A portion of the recovered lignin is miscalcified in desertification modified with the anhydride. [20] One promising polymer These applications include Polylactic acid (PLA) is renewable and natural biodegradable polymer materials is lactic acid is First, low molecular weight PLA in 1932 Coordinated by Carothers. And more molecular as a result of further work by DuPont The weight product was patented in 1954. [21] Polylactic acids (PLA) are expensive and sometimes very weak compared to conventional thermoplastics. Applications. The point is, it's "green." Considered as "Polymer", it is a renewable agricultural Fermentation and Polymerization from Resources A combination of; Hence, its production than comparable petroleum-based plastics Consumes less fossil resources. [22] The At temperatures of 23, 51 and 69°C, different ari Polylactic acid/rice with husk contents Hydrolytic of husks (PLA/RH) composites Decompositions Thermal properties, chemical composition, molecule Weight and morphology study done decomposers.[23] PLA is a Based on wheat, corn and sugar Sources of starch are from sugarcane Derived, cellulose etc Thermoplastic aliphatic polyester. Process ability.[24] Highly hydrophilic surface of cellulose (PLA) Hydrophobic polymers such as poly(lactic acid) is Fiber makes it harder to prevent clumping. Satisfactory Nanocellulose dispersions are often thin films is achieved. Different implementation strategies significant challenges must be overcome solve this problem. [25]

3. Fuzzy TOPSIS method

Beijing Metro using Fuzzy TOPSIS method is a case study Assessment service quality of an organization proposed. when assessment process, Beijing Metro Operating Co., Ltd. 8011Surveys are from 16 operating metro lines were collected. Not very satisfactory for passengers The three are the exchange, the experience of traveling in the vehicle and the purchase or recharge of tickets Factors are evaluated. It should be greatly improved in metro travel and future construction city administration. [1] Trapezoidal hesitation fuzzy set, trapezoidal hesitation intuitionist fuzzy set, Interval-valued trapezoidal reluctance is intuitive Fuzzy number, trapezoidal Fuzzy number, trapezoidal Interval Hesitation Intuitive Fuzzy Topsis method, interval-valued trapezoidal Reluctance is an intuitive fuzzy topsis method and Comment cubzyicsoidal fuzyidation Introducing. [2] Fuzzy TOPSIS on bid/no-bid decisions Factors in the framework to demonstrate the approach are a example In practice, some factors May not be used or Product, industry and other factors depending on market characteristics may be included [3] He proposed that hybrid methods began With a survey for data collection. of the data obtained Basically to prioritize project risks A relative importance index was used. Construction projects are then Fuzzy AHP and Fuzzy TOPSIS methods are categorized by For Fuzzy Bussy Cup (Bahp). linguistic variable of overall construction projects Used to create positive weights. [4] Demonstrated Fuzzy DEMATEL, Fuzzy VIKOR, Fuzzy AHP and Fuzzy TOPSIS are problem-solving facility layouts are for approaches. Fuzzy AHP and Fuzzy TOPSIS A comparison between methods has been carried out [5]. The criterion Environment, economy, society, energy organization and transport Different alternative and criterion weights by five expert groups in the field of organization Performance was determined. Finally, EVCS site alternatives Fuzzy Topsys method were ranked using EVCS located in the Transition District in Beijing Site A2, which has the highest ranking scores and selected as the optimal site result shows that [6] Oil and gas protection Based on criteria only Fuzzy TOPSIS for selecting suppliers field This is the first study to use Qualified contractors Selection of oil and gas companies It is an important step in the success of programs and activities. A strong Selection process, appropriate criteria Considering that,

gives it more credibility selection.[7] proposed a Fuzzy TOPSIS method interval of valued fuzzy sets basically. They modified the information of the example presented by Chen for the purpose of debugging with their method and used their method to solve the modified example.[8] In a real word situation, Due to incomplete or unobtainable information Human judgments are often involved, including preferences Be vague and his/her choice Exact number cannot be estimated from data, data are general Fuzzy TOPSIS as it is fuzzy/precise We try to extend to the data. [9] Since Fuzzy logic is an ideal to support MADM methods , which is combined with the TOPSIS method is used. Fuzzy Tapsis two methods together called methods. Fuzzy topsis is classical is an extension of the Topsys method required Alternate/criterion evaluation values language specific.[10] An ambiguous positive is best for determining the order of alternatives Solution (FPIS) and ambiguous negative ideal Solution (FNIS). By calculating the distance Proximity coefficient is defined. Fuzzy TOPSIS method of our work Based on the results, study which do it best primary crusher for mining? shows. [11] Fuzzy TOPSIS enables AHP-fuzzy AHP to come to a decision in a short time, eliminating many procedures that need to be done only in the solution. Full AHP-Fuzzy AHP solution, criteria and If the number of alternatives is sufficiently small Only, pair wise done by assessor The number of comparisons should be reasonable. limit.[12] Use the The AHP method calculates the Scale weights and alternative applications TOPSIS method to determine ranking. Using the method Feng et al to assess the performance of organizations Wang different planes TOPSIS. TOPSIS and Fuzzy TOPSIS methods in different applications and so on In solving attribute decision problems are used. are commonly used. [13] Since Criteria are AHP Fuzzy for Fuzzy and Uncertain Weight Estimation TOPSIS method is used. Five types The spillways are alternatively, nine criteria were selected. To compound the problem, the criteria are trigonometrically ambiguous are expressed as numbers. [14] Using a neutral A project portfolio or similar Parts of the project method for calculating the overall complexity score, Obscure topics presented here include, When dealing with problems driven by project complexity Easier discussions and more consensus allows [15] The main objective For an organization from among the available alternatives To select appropriate information systems is To create a fuzzy TOPSIS system. Uncertain Multi-Criteria Decision Making under character The problem is described as a process, [16] From the selected alternative positive ideal solution (PIS) Should have very short distance ie cost Maximizing criteria and benefit The solution should be to reduce the criteria based on opinion.[17] Fuzzy Decision Testing and Evaluation Lab (DEMATEL), Fuzzy ANP and Fuzzy TOPSIS is an integral fuzzy based on Proposed MCDM method, green procurement, green Green considering the design Evaluate and select suppliers. Green logistics, and reverse logistics. [18] A unique A ten-parameter critical model was developed and SCM To assess the risks associated with failures, Used for the first time. Proposed Fuzzy TOPSIS model is offshore oil and gas Performance of the conventional FMEA technique in the field and That can significantly improve compatibility The results indicate. [19] Integrating AHP with Topsis. Fuzzy TOPSIS is used to solve the decision problem The most popular method is MCDA. Fuzzy TOPSIS is Comprehensive in solving real-world complex problems against criteria selected with the application It is a primary technique for evaluating multiple alternatives. [20]

4. Result and Discussion

Young's modulus (GPa) it is seen that PLLA–KBCF2 is showing the highest value for Pure PLLA is showing the lowest value. Ultimate tensile strength (MPa) it is seen that MA-PLLA–BCF2 is showing the highest value for PLLA–KBCF2 is showing the lowest value. Elongation at break (%) it is seen that MA-PLLA–BCF2 is showing the highest value for PLLA–NBCF2 is showing the lowest value. Impact toughness (kJ/m2) it is seen that PLLA–KBCF2 is showing the highest value for MA-PLLA–BCF2 is showing the lowest value.

TABLE 1. Poly (lactic acid) in Fuzzy TOPSIS method on the data set.

	DATA SET			
	M1	M2	M3	M4
Pure PLLA	71.08	269.53	39.15	28.05
PLLA–BCF2	79.12	392.97	43.69	37.30
MA-PLLA–BCF2	84.08	442.58	59.18	23.10
PLLA–KBCF2	93.17	228.28	44.60	47.59
PLLA–NBCF2	78.33	306.41	37.96	25.89

Table 1 shows the Poly (lactic acid) of the Alternative: M1, M2, M3, and M4. Evaluation Option: Pure PLLA, PLLA–BCF2, MA-PLLA–BCF2, PLLA–KBCF2, PLLA–NBCF2.

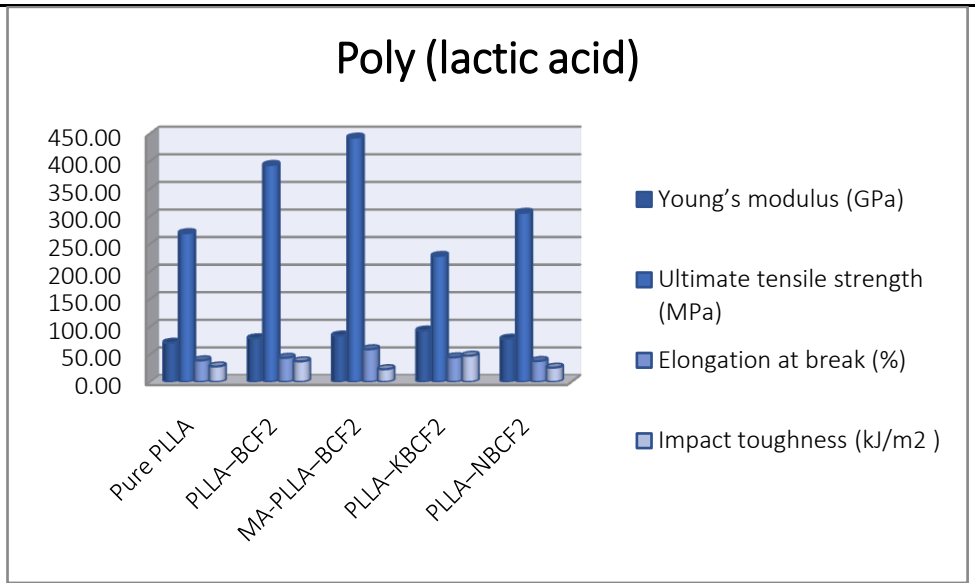

FIGURE 1. Poly Lactic Acid

Figure 1 shows the Poly (lactic acid) of the Alternative: M1, M2, M3, and M4. Evaluation Option: Pure PLLA, PLLA–BCF2, MA-PLLA–BCF2, PLLA–KBCF2, PLLA–NBCF2.

TABLE 2. Squire Rote of matrix

5052.3664	72646.421	1532.723	786.8025
6259.9744	154425.42	1908.816	1391.29
7069.4464	195877.06	3502.272	533.61
8680.6489	52111.758	1989.16	2264.808
6135.5889	93887.088	1440.962	670.2921

Table 2 shows the Squire Rote of matrix value.

TABLE 3. Fuzzy Significance

Importance	**Symbol**	**l**	**m**	**u**
Very little	EL	0	0	0.1
Very little	VL	0	0.1	0.3
Low	L	0.1	0.3	0.5
Medium	M	0.3	0.5	0.7
High	H	0.5	0.7	0.9
very high	VH	0.7	0.9	1
Very high	EH	0.9	1	1

Table 3 shows the ambiguity significance Subjectivity of the decision maker regarding the importance of weights Collect ratings. The following table Using the subjective evaluations of the decision maker Basically fuzzy significance coefficients or Calculate the weights equations.

TABLE 4. The criteria's on a linguistic scale

	DM1	**DM2**	**DM3**
M1	EH	VL	M
M2	L	EH	VH
M3	L	M	VH
M4	L	M	VL

Table 4 shows the criteria's on a linguistic scale.

TABLE 5. Selected ambiguities The Linguistics of Decision Makers Using Convert estimates to quantitative values number

	DM1			**DM2**			**DM3**		
M1	0.9	1	1	0	0.1	0.3	0.3	0.5	0.7
M2	0.1	0.3	0.5	0.9	1	1	0.7	0.9	1
M3	0.1	0.3	0.5	0.3	0.5	0.7	0.7	0.9	1
M4	0.1	0.3	0.5	0.3	0.5	0.7	0	0.1	0.3

Table 5 shows the Using the selected Linguistic evaluations of decision makers convert to quantitative values fuzzy number.

TABLE 6. Calculate aggregated Fuzzy weights

	L-FW	M-FW	U-FW
M1	0.40	0.53	0.67
M2	0.57	0.73	0.83
M3	0.37	0.57	0.73
M4	0.13	0.30	0.50

Table 6 shows the Calculate aggregated Fuzzy weights food, water, Antibiotics, agriculture Land.

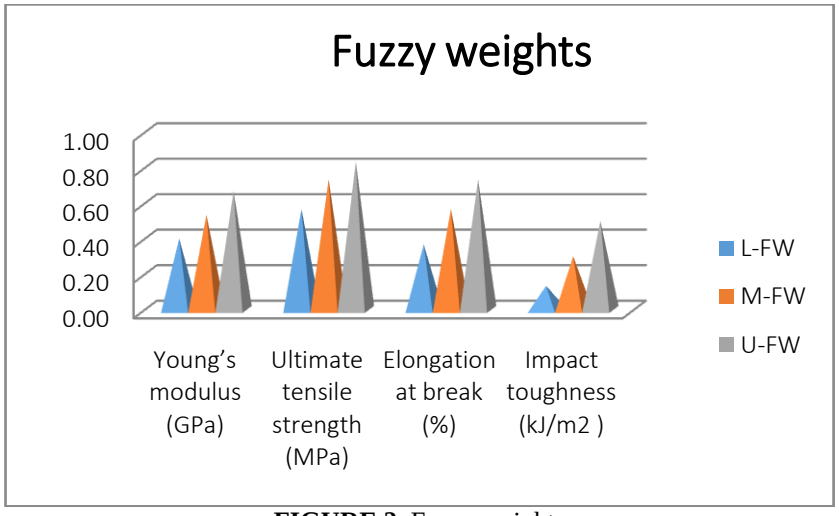

FIGURE 2. Fuzzy weights

Figure 2 shows the graphical representation the aggregated Fuzzy weights food, water, Antibiotics, agriculture Land.

TABLE 7. Normalized Data

Normalized Data			
M1	M2	M3	M4
0.390114	1.47928205	0.384379	0.373277282
0.43424	2.156767214	0.428954	0.496372285
0.461463	2.42904556	0.581036	0.30740482
0.511352	1.25288653	0.437888	0.63330716
0.429905	1.681693366	0.372696	0.344532935

Table 7 Normalized Data shows the Alternative: Table 1 shows the Poly (lactic acid) of the Alternative: M1, M2, M3, and M4. Evaluation Preference: Pure PLLA, PLLA–BCF2, MA-PLLA–BCF2, PLLA–KBCF2, PLLA–NBCF2. The Normalized data is calculated from the data set value is divided by the sum of the square root of the column value.

TABLE 8. Weighted normalized decision matrix

Weighted normalized decision matrix											
Young's modulus (GPa)			Ultimate tensile strength (MPa)			Elongation at break (%)			Impact toughness (kJ/m2)		
0.1560	0.2080	0.2600	0.8382	1.0848	1.2327	0.1409	0.2178	0.2818	0.0497	0.1119	0.1866
0.1736	0.2315	0.2894	1.2221	1.5816	1.7973	0.1572	0.2430	0.3145	0.0661	0.1489	0.2481
0.1845	0.2461	0.3076	1.3764	1.7813	2.0242	0.2130	0.3292	0.4260	0.0409	0.0922	0.1537
0.2045	0.2727	0.3409	0.7099	0.9187	1.0440	0.1605	0.2481	0.3211	0.0844	0.1899	0.3166
0.1719	0.2292	0.2866	0.9529	1.2332	1.4014	0.1366	0.2111	0.2733	0.0459	0.1033	0.1722

Table 8 Shows the Weighted normalized decision matrix Fuzzy weighted decision matrix by multiplying the normalized matrix with corresponding fuzzy weight.

TABLE 9. A+ & A-

A+	0.2045	0.2727	0.3409	1.3764	1.7813	2.0242	0.1366	0.2111	0.2733	0.0409	0.0922	0.1537
A-	0.1560	0.2080	0.2600	0.7099	0.9187	1.0440	0.2130	0.3292	0.4260	0.0844	0.1899	0.3166

Table 8 Shows the A+ Maximum, minimum value & A- Minimum, Maximum value.

TABLE 10. FPIS

	Pure PLLA	0.065994	0.683419	0.006723	0.022748
	PLLA–BCF2	0.041974	0.195923	0.032372	0.065258
	MA-PLLA–BCF2	0.027156	0	0.119884	0
	PLLA–KBCF2	0	0.846326	0.037513	0.112547
FPIS	PLLA–NBCF2	0.044334	0.537771	0	0.012822

Table 10. Shows the coordinates for the fuzzy positive ideal solution (FPIS).

TABLE 11. FNIS

	Pure PLLA	0	0.162907	0.113161	0.089799
	PLLA–BCF2	0.024019	0.650403	0.087512	0.047289
	MA-PLLA–BCF2	0.038837	0.846326	0	0.112547
	PLLA–KBCF2	0.065994	0	0.082371	0
FNIS	PLLA–NBCF2	0.021659	0.308556	0.119884	0.099725

Table 11. Shows the coordinates for the fuzzy Negative ideal solution (FNIS).

TABLE 12. Si+ & Si-

Si+	Si-
0.778884283	0.365866
0.335526927	0.809224
0.14704013	0.99771
0.996386156	0.148364
0.594926757	0.549824

Table 12. Shows the Euclidean distance of each alternative from positive and negative value calculated as. Where represents the distance between two fuzzy numbers calculated by S+, S- value.

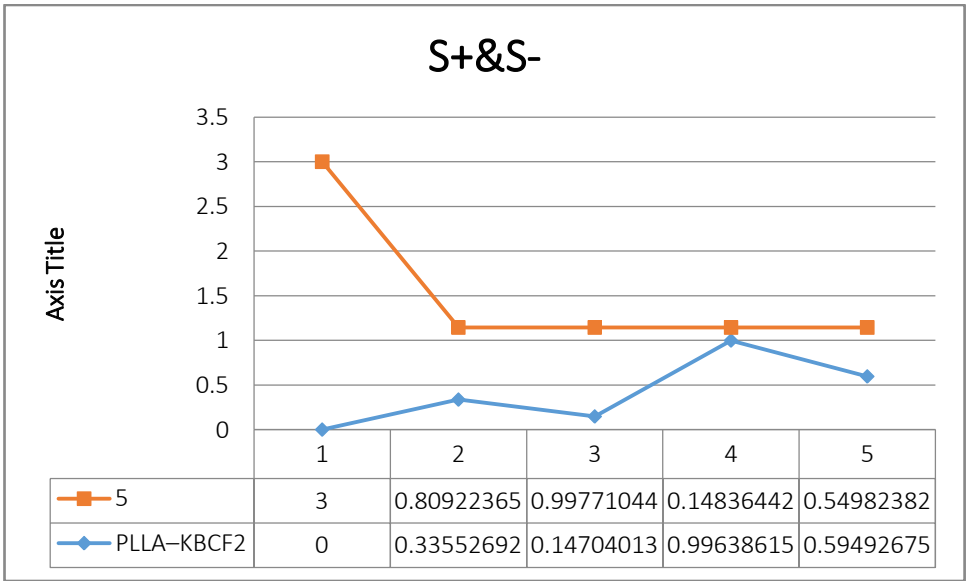

FIGURE 3. S+&S-

Figure 3 shows the graphical representation S+, S- value

TABLE 13. Rank

	Cci	Rank
Pure PLLA	0.319604	4
PLLA–BCF2	0.7069	2
MA-PLLA–BCF2	0.871553	1
PLLA–KBCF2	0.129604	5
PLLA–NBCF2	0.4803	3

Table 13 shows the closeness coefficient CCi of the alternatives are calculated using equation ranked as per descending order. the final result of this paper the Pure PLLA is in 4th rank, the PLLA–BCF2 is in 2nd rank, the MA-PLLA–BCF2 is in

1st rank, the PLLA–KBCF2 is in 5th rank and the PLLA–NBCF2 is in 3rd rank. The final result is done by using the Fuzzy TOPSIS method.

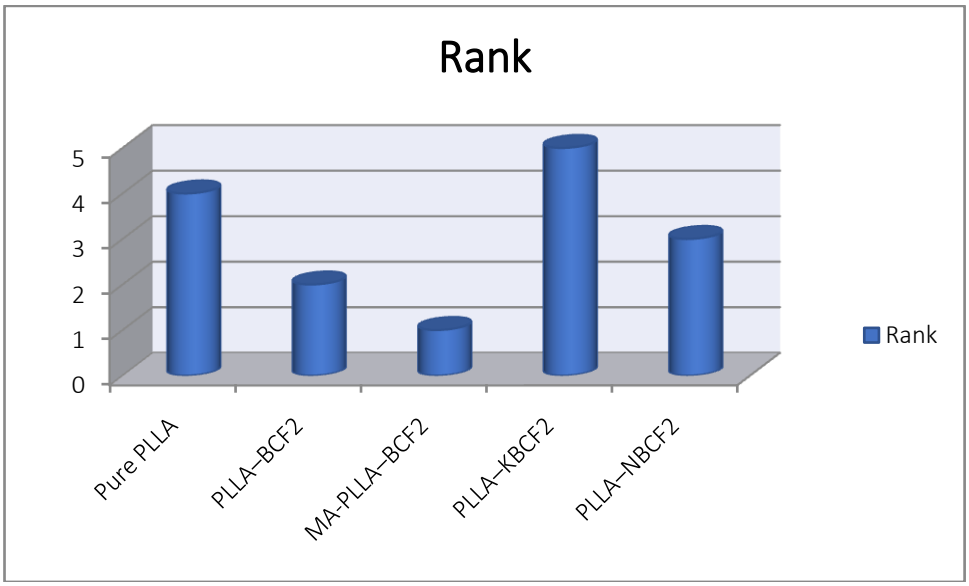

FIGURE 4. Rank

Figure 4 shows the graphical representation view the Pure PLLA is in 4th rank, the PLLA–BCF2 is in 2nd rank, the MA-PLLA–BCF2 is in 1st rank, the PLLA–KBCF2 is in 5th rank and the PLLA–NBCF2 is in 3rd rank.

5. Conclusion

Polylactic acids (PLA) are expensive and sometimes very weak compared to conventional thermoplastics. Applications. The point is, it's "green." Considered as "Polymer", it is a renewable agricultural Fermentation and Polymerization from Resources A combination of; Hence, its production than comparable petroleum-based plastics Consumes less fossil resources. The At temperatures of 23, 51 and 69°C, different air Polylactic acid/rice with husk contents Hydrolytic of husks (PLA/RH) composites Decompositions Thermal properties, chemical composition, molecule Weight and morphology study done decomposers. From the selected alternative positive ideal solution (PIS) Should have very short distance cost Maximizing criteria and benefit The solution should be to reduce the criteria based on opinion. Fuzzy Decision Testing and Evaluation Lab (DEMATEL), Fuzzy ANP and Fuzzy TOPSIS are an integral fuzzy based on Proposed MCDM method, green procurement, green considering the design Evaluate and select suppliers. Green logistics, and reverse logistics. A unique A ten-parameter critical model was developed and SCM to assess the risks associated with failures, Used for the first time. Proposed Fuzzy TOPSIS model is offshore oil and gas Performance of the conventional FMEA technique in the field and that can significantly improve compatibility the results indicate.

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