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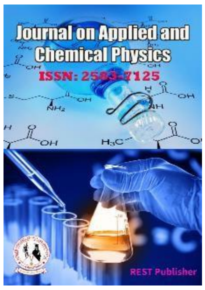

Metallic Bipolar Plates for Polymer Electrolyte Fuel Cell (PEFC) Used in Electric Vehicles using the WSM Method

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Abstract: *Metallic Bipolar Plates for Polymer Electrolyte Fuel Cell (PEFC) used in electric vehicles. Electric vehicles use electrolytic polymeric fuel cells (PEFCs) built of bipolar sheet metal. Along with the MEA, One of the most essential components of a PEFC cell is the bipolar plate. since they support the MEA, provide rigidi-ty to the layer, and even allow for gas diffusion. Electrical conductivity is provided by the entire electrode surface. The control of heat and the ejection of product water are two additional benefits of a well-prepared bipolar plate [103-105]. In the PEFC stack, bipolar plates are placed between the MEAs so that each of them offers a link to one end of a MEA and, on the other side, to the cath of an adjacent MEA. Bi-polar panels should be small and thin to reduce For PEMFCs, a variety of metal bipolar plates are now being investigated to suit the demands of lowering costs, increasing stacking size, lowering weight, and raising energy density. The quality of interest strategy was compared to the best answer (TOPSIS) the multi-attribute decision-making approach (MADM) in this work, the optimal substance for a metallic bi-polar plate is selected using (MADM). For electrolyte polymer fuel cells (PEFCs), which can have numer-ous competing objectives? Material designers can choose the best material based on preset criteria with the use of a suggested algorithm tool. The theoretical framework is followed by a case study on the mate-rial selection for a PEFC bipolar plate. A list of all the products that meet the requirements for selection, including production costs, by dividing each of our objectives by a user-supplied weight, we divide our audience into a single goal via the weighted sum approach. One of the most popular methods is this one. When considering overall weights, one concern is determining how much weight to give each goal. The primary goal governs are added with varying weights in the weighed total approach, and the sum is then optimized. The goal that function is optimized while another is constrained to a variable's value in the electrically operated constraint approach you can generate an integrated analysis by combining several inputs and weights using the Total Weight function. In that several raster inputs representing various fac-tors can be easily mixed, mixing weights or relative importance, it is comparable to the Weighted Overlay function. 316 austenitic stainless steel,310 austenitic stainless steel,317l austenitic stainless steel,316l aus-tenitic stainless steel, aluminum (gold plated), aisi 446 ferritic stainless steel, aisi 436 ferritic stainless steel, aisi 444 ferritic stainless stee, aisi 434 ferritic stainless stee,304 austenitic stainless steel, titanium (coated with nitride), a560 (50cr–ni). the density of an object, the tensile strength, the expansions coeffi-cients, conductivity of heat, thermal diffusivity, and fracture toughness are some of the other characteris-tics of bipolar plates that should be considered. From the result it is seen that titanium (coated with ni-tride) is got the first rank whereas is the 310 austenitic stainless steel having the lowest rank. The first ranking titanium (coated with nitride) is obtained with the lowest quality of 310 austenitic stainless steel.*

Keywords: *MCDM, titanium, bipolar plate's elastic modulus, density, and tensile strength.*

1. INTRODUCTION

To address the demands for lower expenses, size compacting, decreased weight, and increased power density, many types of metallic bipolar plates are currently being researched for PEMFCs. The difficulty of choosing a material for metal bipolar plates for polymeric electrolytic fuel cells (PEFCs), that frequently entails several and competing goals, is addressed in this work using a stacking technique. The same priority is the right response. (MADM strategy). A material designer can use a prescribed technique tool to select the best material based on predetermined criteria. A case report on material selection for a bipolar plate in PEFC is presented after the the-oretical introduction [1]. Fuel cells (FC) are a device for converting energy that uses electrochemical oxidation rather than combustion to transform fuel straight into electricity and heat. There are different FC types based on their design and working philosophy. Proton-conducting polymeric electrolytic membranes (PEM) form the foundation of proton-electrolyte membrane fuel cells, or PEMFCs. A proton-conducting PEM is sandwiched among two porous electrodes in a PEMFC. Hydrogen at the anode provides electron to the anode to ca and enter its electrolyte as positive ions (HC), whereas oxygenation at the cathode is reduced to form counterions (O 2 or OH). Equivalent ions join to form water near the cathode, and electrons move across a circuit outside of it to create an electric current [2]. His preferred electrochemical technique for establishing a society powered solely by hydrogen is the use of PEFC. A genuine fuel cell is made up of a polymer sheet, an electrocatalyst, a gas diffusion layer, a bipolar plate, and an end plate. Here are three distinct types of research that were done with resource conservation in mind. The Pt anode's electrolyte content must be reduced first. Reactant selectivi-ty is a second difficulty because a simple methanol battery system can be created without bipolar plates. The electrolyte's reaction. Stainless steel, a third metal, is utilized to increase the bipolar plates' resistance to corro-sion [3]. The use of polymeric electrical fuel cells (PEFCs) as an achievable alternate energy source for electric vehicle applications is becoming more and more popular. However, performance, durability, and reliability difficulties need to be rectified before the PEFC in hydrogen-powered cars can be commercialised. The capaci-ty to cold start in frozen sub-zero buildings, including all the significant technological limits mentioned above, is essential for the long-term reliability and guaranteed working of PEFC vehicle engines [4]. The most effective way to introduce and promote the use of electric vehicles is to use PEM fuel cells. Due to size and weight re-strictions, metal bipolar plates that are water-cooled are chosen for use in automobile fuel cells. Graphite, stain-less steel, nickel that has been gold-plated, carbon fiber composite materials and acid-resistant iron are a few examples of the sophisticated and pricey material combinations that are employed to fulfil certain obligations and specifications. Because they need more labour or precious metals, these plates are more expensive to make. Others with excellent resistance to chemicals, hardness, and electrical conductivity include metalloid nitrides as CrN, VN, and W2N. This substance thus satisfies the fundamental criteria for the top layer. Tradi-tional manufacturing techniques like PVD and CVD are costly, have sluggish deposition rates, and result in lay-ers with thin walls. These limitations make it impossible to guarantee the bipolar plate's lifetime performance. The contributor developed and measured a different technique for creating bipolar plates. It is anticipated that the stabilization of the chrome electrode and the thermos chemical processes employed to create the chromi-um nitride would complement one another. Both processes have undergone extensive research and are capable of being produced in large quantities. The treatment with heat of the chrome layer makes it possible to inte-grate the welding process [5]. These bipolar plate of polymer electrolytes fuel cells (PEFCs) are commonly made of stainless steel. The majority of the stainless steels surface is shielded by a passive layer, which pre-vents corrosion. In contrast, the passive film lowers the interface impedance (ICR) for interaction among the bipolar plate and the gas diffusion layer. It is made up of different metal oxides. High resistance to corrosion and low ICR were also necessary. In order to attain a low ICR of the stainless-steel material (SUS304), a car-bon coating is created using plasma-enhanced chemical vapor deposition. Atomic force microscopy and Ra-man spectroscopy were used to examine carbon-coated SUS304. We evaluated the activity of anodic polariza-tion under PEFC conditions of operation. The potential application of carbon-coated SUS304 as a bipolar plate element in PEFC was considered in light of the findings of ICR tests conducted before and after anodic polarization [6]. Hydrogen and oxygen undergo a chemical reaction to produce power. On the anode and cathode sides, it is made up of a polymer film, bipolar plates, and a gas diffusion medium. One of the most alluring uses for PEFC is in the automotive sector, which offers emissions-free source energy with increased efficiency, lower fuel costs, and a greater density of energy. Recent studies have enhanced electrochemical procedures and decreased resistance, enhancing PEFC's technical performance. Ing et al. The effectiveness of PEFC can be increased by 8% by altering the flow field to encourage reactions movement at the lowest point of the catalytic layers. Tian and Qin advise using Zr55Cu30Al10Ni5 as a bipolar plate for PEFC since it has a lower resistance than the more used 316L material. At high temperatures of 100°C, a unique nanocomposite covering has been created to boost proton conductivity. The main obstacles to commercialization are cost re-duction, long-term sustainability, and energy efficiency. The PEFC working temperature must be increased in order to maintain the price of fan cooling and radiators for automotive applications within reach. In order to handle all the aforementioned issues at high temperatures, it is vital to take into account kinetic parameters such pressure, stoichiometric ratio (SR), and humidity [7]. In order to create Ti bipolar wafers in polymer elec-trolytic film fuel cells (PEMFC), (a-C) film coating is used. The extremely resistant A-C film coating, which is made feasible by the low growing temperature, enables a bipolar plate and electrode assembly (MEA) sheet to have a contact resistance over its surface of up to 440 cm2. Reduces the fuel cell's output. On the other hand, when the growth temperature increased to 600 °C, a 103 cm thick weakly resistive a-C film coating was creat-ed. On its top layers, the a-C film-coated and MEA displayed low contact resistance (20 m). Consequently, an a-C film-coated fuel cell containing Ti bipolar flakes [8]. It has been suggested that the creation of fuel cell ve-hicles, which are affordable to operate and capable of lowering CO2 emissions, is the solution to these issues. Several problems, such as miniaturization, weight reduction and greater durability, cost reduction, and im-proved low temperature, have come up in our efforts to manufacture PEFC-powered cars. The key element that directly influences PEFC performance is the material employed within the (GDL) and (MEA). However, although having no direct impact on the overall efficiency of the power generation, the bipolar plate's material accounts for practically all PEFC. The material's thinness allows for substantial miniaturization. The bipolar plate also generates less heat as it is lighter [9]. A high energy density, effective, and clean energy source is needed for mobile devices and vehicles operating in urban settings, which has sparked growing interest in pol-ymer electrolytic fuel cells (PEFCs). Attention because a hydrogen/air fuel cell process only requires water, hy-drogen is the perfect fuel for fuel cell cars. It is completely pollution-free and boasts a very high capacity for converting internal fuel into energy. The creation of effective, reliable, and affordable materials is essential for the widespread use of polymeric electrolytic fuel cell (PEFC)-based technologies. Over the past few decades, much research has been put into understanding the immediate electrochemical oxidation of alcohols and hy-drocarbons. One of the liquid organic fuels with the most advantageous characteristics for handling and storing at low temperatures is methanol. Before the technique is widely used, some problems including poor electro-chemical performance, pricey fuel cell components, stabilization times, etc., need to be solved. Therefore, it is a considerable challenge to design high-performance, low-cost bipolar plates, enhanced electrolytes, and poly-meric electrolytic films which satisfy performance and durability criteria. The fundamental goal of research is to create affordable materials, such novel membranes and hydrocarbon electrodes made of less expensive metals. Therefore, creating new materials is essential for a world driven by sustainable energy. The most recent advancements in novel electrocatalysts, catalytic aids, electrodes, membranes, fillers, and bipolar devices will be covered in this special issue [10]. The size and efficiency of the fuel cells utilized by fuel cell vehicles (FCVs) were drastically decreased because to the switch from carbon sheets to the formerly employed metal bipolar plates. To further lower the cost of the fuel cell, it is better to use a less expensive base metal for the metal bipo-lar plates with a less expensive surface treatment method. Commercial grade stainless steel is specifically thought of as a potential base metal. As we already know, the corrosive atmosphere within a fuel cell's cham-ber leads the metallic bipolar plates to corrode, and this corrosion can impact the battery's ability to produce energy. In this context, electrochemical investigations employ commercial-grade stainless steel [11]. A graphite bipolar plate, platinum catalyst, & fluor sulfonic acid polymer electrolyte are the three most expensive parts of a modern PEFC. The usage in precious metal catalysts raises resource concerns rather than cost ones, despite the fact that technical advancements might theoretically drastically lower the costs of both of the previous groups. Acidic polymeric electrolytes are a key prerequisite for PEFC over Pt catalysts. Particularly, only pre-cious metals are resistant to the corrosive effects of acids. The fact that Pt is not adequately stable at fuel cell working conditions is a serious issue with current PEFC technology [12]. Because of their outstanding mechani-cal qualities, high electrical and thermal conductivity, wide variety of supplies, and capacity to make extremely thin metal sheets, metallic materials have captured the attention of scientists. Ions that have been dissolved can harm catalysts and membranes, which lower the fuel cell's output. They are vulnerable to corrosion due to the acidic & humid surroundings of PEM fuel cells, though. Additionally, the surface of the stainless steel may develop a natural oxide layer over time, which can inhibit heat and electron transmission while increasing the contact resistance among the electrode holder with the bipolar plate. Ehtisham and others. Metal PP-induced solute ions may decrease the polymer membrane's ability to transport ions, which can lower cell productivity. Wang and his associates. Makes et al. Eventually, the stainless-steel components rusted in the MEA, detecting a drop in output voltage [13]. The usage of fuel cells with an electrolyte made of polymer PEFC in handheld devices, fuel cell automobiles, and other applications has a lot of potential. High rigidity, low air permeation, high conductivity, superior corrosion resistance, etc. are requirements for PEFC. Due to its excellent chemical stability, high electrical conductivity, and low gas permeability, carbon is one of the preferred substrates of PEFC bipolar sheets. However, because of their weak mechanical strength, carbon composites are challenging. Metals are another excellent alternative, although under PEFC operating conditions, less expensive metals are more likely to corrode. Thus, carbon-coated metal has recently gained popularity. The substances thus found have potential for usage as bipolar plate substances. We discovered that metals with carbon coatings made using a plasma-enhanced chemical vapor deposition process have good corrosion resistance and strong electri-cal conductivity, including carbon steel and nickel-plated stainless steel [14]. PEMFCs, also known as protons exchange membrane fuel cells, present a possible replacement for conventional energy sources. There are still serious problems with cell stability and longevity. The impact of roughness of the surface on metallic bipolar plates is the subject of this essay. Sandblasting creates a range of large-scale surface roughness's. Sand comes in particle sizes. The results of the AC impedance experiment demonstrate that when the overall surface roughness is anywhere from one to two m, the porosity of the carbon paper's surface with the brittleness of the bipolar plate match nicely. The optimal situation reduces the fuel cell's contact resistance loss. The high fre-quency resistance of the source surface is 5 mX greater than the surface. A fresh bow develops in the low fre-quency region. The bipolar plate's consequent uneven roughness considerably increases the mass transfer re-sistance and contact resistance. In order to examine the ideal surface roughness, this work integrates entire ef-fectiveness curve (I-V) with AC impedance data. We can benefit from PEMFC's knowledge of resistance to contact and mass transfer. The suggested surface treatment allows for quicker assembly of metallic bipolar plates and enhances the surface effect [15].

2. MATERIALS AND METHOD

2.1. 316 Austenitic Stainless Steel: The austenitic chrome-nickel steel 316 has better corrosion resistance than other chrome-nickel steels. This stainless steel is perfect in applications wherein exposure to chemical pollutants and marine environments are an issue.

2.2. 310 Austenitic Stainless Steel: Alloy 310 (UNS S31000), an austenitic stainless steel, is designed for appli-cation in high-temperature, corrosion-resistant operations. Up to 2010°F (1100°C), the alloy may survive mod-erate cyclic oxidation.

2.3. 317L Austenitic Stainless Steel: Low carbon austenitic steel 317L (UNS S31703) is a corrosion-resistant stainless steel made of chromium, nickel, and molybdenum. The alloy provides superior resistance to chloride cracking and general wear than the more commonly used 304/304L and 316/316L classes because of the sub-stantial amount of these elements.

2.4. 316L Austenitic Stainless Steel: The development of alloy 316/316L (UNS S31600/S31603), a chromium-nickel-molybdenum austenitic stainless steel, was made to improve the corrosion resistance of alloy 304/304L in moderately corrosive conditions. It is frequently applied to treat streams that contain chlorides or halides.

2.5. Aluminums (Gold Plated): Due to its distinct combination of physical, chemical, and electrical qualities, aluminum is gold plated. Low contact due to the high electrical conductivity of gold

2.6. AISI 446 FERRITIC STAINLESS STEEL: A ferritic stainless steel with a chromium concentration greater than 23%, UGI® 446. Thus, it has some of the best corrosion resistance among ferritic stainless grades.

2.7. AISI 436 FERRITIC STAINLESS STEEL: A ferritic stainless steel designed for primary shaping into wrought items is AISI 436. The annealed condition is appropriate for the cited qualities. The AISI number for this material is 436. The S43600 UNS code is used.

2.8. AISI 444 FERRITIC STAINLESS STEEL: A ferritic stainless steel with ATI 444TM alloy's low nitrogen and carbon content and 18% chromium content also contains 2% molybdenum. Columbium and titanium are added to the alloy to stabilise it and increase its resistance to intergranular corrosion.

2.9. AISI 434 FERRITIC STAINLESS STEE: High-alloy steels include stainless steels. Due to the high chro-mium concentration of 4–30%, they have great corrosion resistance. Based on the crystalline structure, they can be divided into three groups: ferritic, austenitic, and martensitic steels.

2.10. 304 AUSTENITIC STAINLESS STEEL: This stainless steel is austenitic. It has less conductivity in both electricity and heat than carbon steel. It is magnetic, albeit less so than steel.

2.11. TITANIUM (COATED WITH NITRIDE): tin, sometimes referred to as Tinite, is a very tough ceramic substance that is frequently employed as a physical vapour deposition (PVD) coating on titanium alloys, steel, carbide, and aluminium components to enhance the surface qualities of the substrate.

2.12. A560 (50CR–NI): A560 50Cr-50Ni by ASTM. A nickel base steel that falls within ASTM's A560 category for castings made of chrome-nickel alloy. UNS# R20500

3. EVALUATION PARAMETERS

ELASTIC MODULUS OF BIPOLAR PLATE: A bipolar plate's elastic modulus is dependent on the material used in its construction. Fuel cells frequently employ bipolar plates, which are typically constructed of materials like graphite, stainless steel, or composites. The stiffness or resistance to deformation of a material under an applied force is measured by the elastic modulus.
DENSITY: A fundamental physical characteristic known as density gauges how much mass is present in a particular volume of a substance. It is usually stated in terms of mass per unit volume and is denoted by the symbol "" (rho). Density is calculated as follows:
Density () = Mass (m) / Volume (V).
TENSILE STRENGTH: The maximum stress or load that a material can endure without breaking or deforming permanently is known as its tensile strength. It measures how well a material can withstand being stretched or pushed apart.
EXPANSION COEFFICIENT: A material's expansion or contraction in reaction to temperature changes is measured by its expansion coefficient, commonly known as the thermal expansion coefficient or coefficient of thermal expansion (CTE). It measures the fractional change in a material's size or volume per change in temperature.
THERMAL CONDUCTIVITY: Thermal conductivity is a property that quantifies a material's capacity to conduct heat. When there is a variation in temperature between two objects, it describes the rate at which heat travels through the item
THERMAL DIFFUSIVITY: The rate at which heat diffuses through a substance in relation to its capacity to conduct heat is known as thermal diffusivity.
FRACTURE TOUGHNESS: A material's resistance to crack propagation or breakage under applied force is measured by its fracture toughness, a mechanical property. It gauges a material's capacity to endure the expansion of pre-existing defects or fissures.

Method: Weighted sum reduction is a common idea that may be applied both alone and in conjunction with other methods in multi-objective optimisation. This has various consequences for understanding the weighted sum method's properties. The conceptual importance of weight and strategies to improve the effectiveness of the approach with regard to priority assertions has not been thoroughly examined, despite the fact that there are numerous well-known applications. The terminological restrictions of this strategy are addressed in publications and sample literature. Pareto ideal group. Despite its limitations in understanding the Pareto optimal set, the weighted sum approach for multi-objective optimisation (MOO) is still commonly used to provide many solution points via one solution point representing the same weights and preferences. Take into account the choice of individual weights [16]. The proposed reaction calculated sum method [focuses on understudied areas by introducing additional restrictions to the discrepancy and adjusts the weights rather than applying a priori weighting values. It has been demonstrated that the adaptive weighting technique yields uniformly distributed answers, locates Pareto optimal answers in non-convex regions, and disregards non-Pareto optimal responses. This third criterion, which is based mostly on traditional cross-border equality standards, may be a possible drawback of an effective multi-objective approach. Two computational instances and a straightforward structural optimisation issue show the potential of this potent method [17]. The suggested adaptive weighting sum technique alters the weights rather than applying a priori weighting results, and it [focuses on understudied regions through including additional inequality constraints and modifies the weights. It is established that the adaptive weight sum method produces uniformly distributed results, locates Pareto optimal solutions for non-convex regions, and disregards non-Pareto optimal results. Given that it is mostly based on traditional cross-border equality standards, this final argument could be a possible drawback of an effective multi-objective strategy. The potential of this potent technique is illustrated by two numerical examples with a straightforward structural optimisation issue [18]. There has not been any analysis of the proposed reactive weighted sum strategy, which concentrates on areas by adding further limitations on disparities and adjusting weights adaptively rather than utilising a priori weighting decisions. As traditional crossing of boundaries depends on egalitarian needs, this latter component may be a potential constraint of a multi-objective method that is typically successful. The potential benefits of this potent approach are illustrated by two numerical instances and a simple structural optimisation problem [19]. There hasn't been any research done on the proposed reactive weighted sum strategy, which prioritises regions by putting more restrictions on inequalities and adjusting weights adaptively rather than utilising predetermined weights. In non-convex regions, the adaptive weighted total technique discovers Pareto optimal solutions and rejects non-Pareto optimal alternatives while producing uniformly distributed solutions. Due to the reliance on egalitarian criteria in traditional boundary crossing, this latter component may be a possible drawback of a multi-objective method that is generally successful. This powerful method's potential is shown by two numerical instances and a simple structural optimisation problem. The hyper cone’s vertex angle is updated automatically [20]. This method divides the MOP into a number of single-objectives using the weighted sum method. Iterative optimisation problems are then used to approximate each function's objective using a metamodeling approach. Each objective function's relative importance is determined flexibly by accessing newly presented points from the current cycles and nominated points. With single-objective issues, the confidence zone approach is utilised to locate Pareto spots. The proposed technique successfully and evenly generates points for various Pareto front types, according to numerical findings [21]. The weighted sum approach examines mutation rate information gathered from unrelated people who have and have not been affected by a certain collection of variations. It searches for circumstances in which those who are affected experience more changes than those who are not. A group (gene, route, highly preserved region, etc.) is to which each variant belongs. N, until frequent mutations entirely dominate the test, the weighted sum technique reveals rare mutations in unaffected individuals. A group having more of these types of mutations has a few abnormalities in each of its members. The CMC approach suggests establishing a spike rate limit to stop this impact [22]. The ash gas-weighted sum approach, created by Hotel initially in relation to geotropic methods, has been shown to be effective at calculating radioactivity in settings without ash participation. Any non-gray radiated problem can be handled within the bounds of the grey gas-weighted sum paradigm (an incompressible medium inside a black-walled envelope) by any preferred solution method after substituting the medium's colour with an equivalent grey colour. a substance with a constant coefficient of absorption. The well-known P-l approach for precise integral equations and grey medium equilibrium solutions is used in a few instances of thermal and radiative equilibrium systems. The outcomes demonstrate the equivalentity of the method and the proportionality of the spectrum results as well as the significant computing time savings (at least 95%) [23]. in numerous bioinformatics uses, such as association studies spanning the genome, meta-analysis is increasingly being employed as a technique. Two well-known methods make up the fixed-effects modelling approach, which is frequently used for aggregate analysis: the weighted average with inverse variance methodology and the sum-weighted z-score technique. Previous investigations have shown that the two approaches function similarly, but their unique features and connections have not been thoroughly examined [24]. In numerous bioinformatics uses, such as association studies spanning the genome, aggregate analysis is increasingly being employed as a technique. Two well-known methods make up the fixed-effects modelling approach, which is frequently used for meta-analysis: the weighted average with inverse variance methodology and the sum-weighted z-score technique. Previous investigations have shown that the two approaches function similarly, but their unique features and connections have not been thoroughly examined This study also shows that to increase the carbonation efficiency of ACR, effluent from a ready-mixed plant can be sprayed on it. Additionally, pressure carburizing and traditional carburizing with optimised RCA have comparable mechanical characteristics and strengths. In light of this, pressurised carbonization can be replaced with optimised conventional carbonization [25]

4. ANALYSIS AND DISCUSSION

TABLE 1. Date Set

	E1/3/ρ	(σF)1/3/ρ	σf/Eα	corrosion rate (in/year)	hydrogen permeability
316 austenitic stainless steel	0.729	2.812	0.147	0.081	5.1
310 austenitic stainless steel	0.84	2.781	0.094	0.081	5.4
317L austenitic stainless steel	0.867	3.214	0.133	0.23	5.3
316L austenitic stainless steel	0.768	2.714	0.111	0.081	2.2
aluminium (gold plated)	2.474	5.814	0.036	2	160
AISI 446 ferritic stainless steel	0.822	3.24	0.246	0.105	0.69
AISI 436 ferritic stainless steel	0.891	3.141	0.2	0.105	0.69
AISI 444 ferritic stainless steel	0.821	3.1	0.198	0.105	0.69
AISI 434 ferritic stainless steel	0.95	3.351	0.159	0.105	0.69
304 austenitic stainless steel	1.018	3.735	0.092	0.081	5.4
titanium (coated with nitride)	1.824	5.792	0.142	0.061	0.32
A560 (50Cr–Ni)	0.952	3.342	0.2	0.005	4.2

Table 1 According to the Analysis approach in the WSM Alternative, Table 1 lists the materials utilised for metallic bipolar

plates for polymer electrolyte fuel cells. For materials such as AISI 446 ferritic stainless steel, AISI 316 austenitic stainless steel, 310 austenitic stainless steel, 317L austenitic stainless steel, aluminium (gold-plated), 316L austenitic stainless steel, and 310 austenitic stainless steel, the table shows the bending-stiffness of lightweight panels (E1/3/), stress, force, and density (F) 1/3/, the ratio of stress (f) to elastic module.

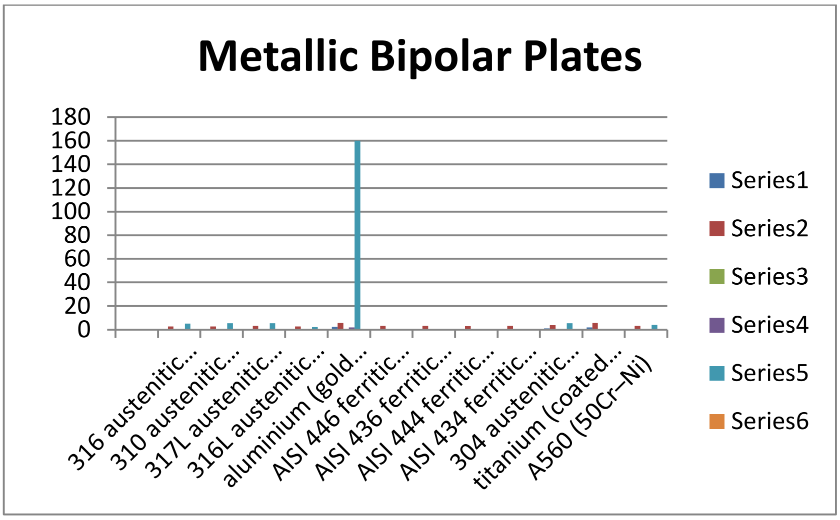

FIGURE 1. Metallic Bipolar Plates for Polymer Electrolyte Fuel Cell (PEFC).

Figure 1 shows in series 1, the aluminium (gold plated) has the highest value and 316 austenitic stainless steel has the lowest value. In series 2, aluminium (gold plated) has the highest value and 316L austenitic stainless steel has the lowest value. In series 3, AISI 446 ferritic stainless steel has the highest value and aluminium (gold plated) has the lowest value. In series 4, aluminium (gold plated) has the highest value and A560 (50Cr–Ni) has the lowest value. In series 5, aluminium (gold plated) has the highest value and titanium (coated with nitride) has the lowest value.

TABLE 2. Normalized Data

		Normalized		
0.294665	0.48366	0.597561	0.061728	0.062745
0.339531	0.478328	0.382114	0.061728	0.059259
0.350445	0.552804	0.54065	0.021739	0.060377
0.310428	0.466804	0.45122	0.061728	0.145455
1	1	0.146341	0.0025	0.002
0.332255	0.557276	1	0.047619	0.463768
0.360146	0.540248	0.813008	0.047619	0.463768
0.331851	0.533196	0.804878	0.047619	0.463768
0.383994	0.576367	0.646341	0.047619	0.463768
0.411479	0.642415	0.373984	0.061728	0.059259
0.737268	0.996216	0.577236	0.081967	1
0.384802	0.574819	0.813008	1	0.07619

Table 2 provides normalised data for the following properties: bending stiffness of lightweight panel (E1/3/), stress, force, and density (F) 1/3/, corrosion rate (in year), hydrogen permeability for materials such as AISI 446 ferritic, 316 austenitic stainless steel, 310 austenitic stainless steel, 317L austenitic stainless steel, and 310L austenitic stainless steel, as well as the ratio of stress (f) to elastic modulus (E)

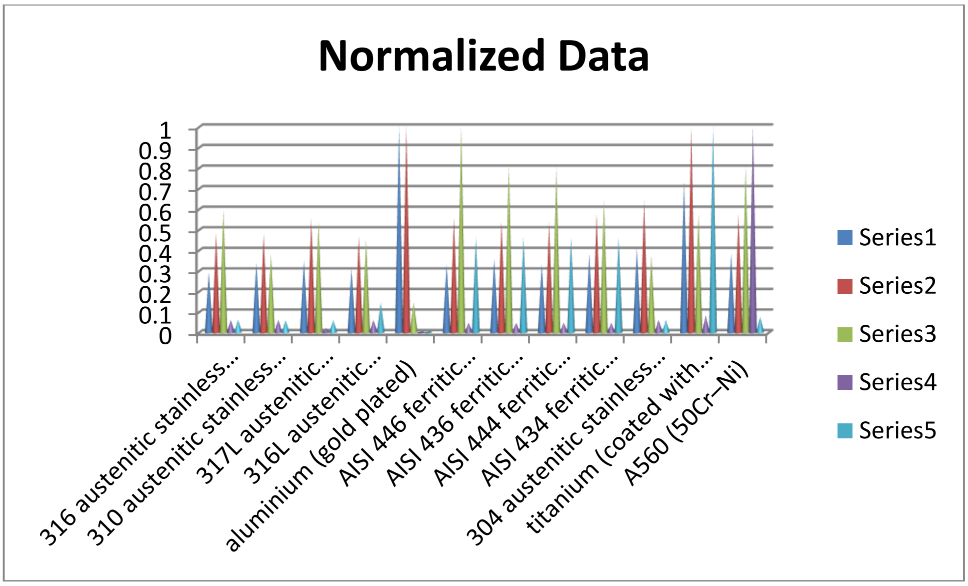

FIGURE 2. Normalized data.

Figure 2 provides normalised data for the following properties: bending stiffness of lightweight panel (E1/3/), stress, force, and density (F) 1/3/, corrosion rate (in year), hydrogen permeability for materials such as AISI 446 ferritic, 316 austenitic stainless steel, 310 austenitic stainless steel, 317L austenitic stainless steel, and 310L austenitic stainless steel, as well as the ratio of stress (f) to elastic modulus (E) is also the Maximum in Normalized value.

TABLE 3. Weightages.

		Weight		
0.20	0.20	0.20	0.20	0.20
0.20	0.20	0.20	0.20	0.20
0.20	0.20	0.20	0.20	0.20
0.20	0.20	0.20	0.20	0.20
0.20	0.20	0.20	0.20	0.20
0.20	0.20	0.20	0.20	0.20
0.20	0.20	0.20	0.20	0.20
0.20	0.20	0.20	0.20	0.20
0.20	0.20	0.20	0.20	0.20
0.20	0.20	0.20	0.20	0.20
0.20	0.20	0.20	0.20	0.20
0.20	0.20	0.20	0.20	0.20

Table 3 Weights used in the analysis are shown in Table 3; we apply the same weights for each parameter.

TABLE 4. Weight normalized decision matrix.

Weighted normalized decision matrix				
0.058933	0.096732	0.119512	0.012346	0.012549
0.067906	0.095666	0.076423	0.012346	0.011852
0.070089	0.110561	0.10813	0.004348	0.012075
0.062086	0.093361	0.090244	0.012346	0.029091
0.2	0.2	0.029268	0.0005	0.0004
0.066451	0.111455	0.2	0.009524	0.092754
0.072029	0.10805	0.162602	0.009524	0.092754
0.06637	0.106639	0.160976	0.009524	0.092754
0.076799	0.115273	0.129268	0.009524	0.092754
0.082296	0.128483	0.074797	0.012346	0.011852
0.147454	0.199243	0.115447	0.016393	0.2
0.07696	0.114964	0.162602	0.2	0.015238

Table 4 bending-stiffness of lightweight panel (E1/3/), stress, force, and density (F) 1/3/, ratio of stress (f) to elastic modulus (E) multiplied by coefficient of thermal expansion (f/E), corrosion rate (in year), and hydrogen permeability for materials like 316 austenitic stainless steel, 310 austenitic stainless steel, 317L austenitic stainless steel, 316L austenitic stainless steel, aluminium, are all shown in Table 4

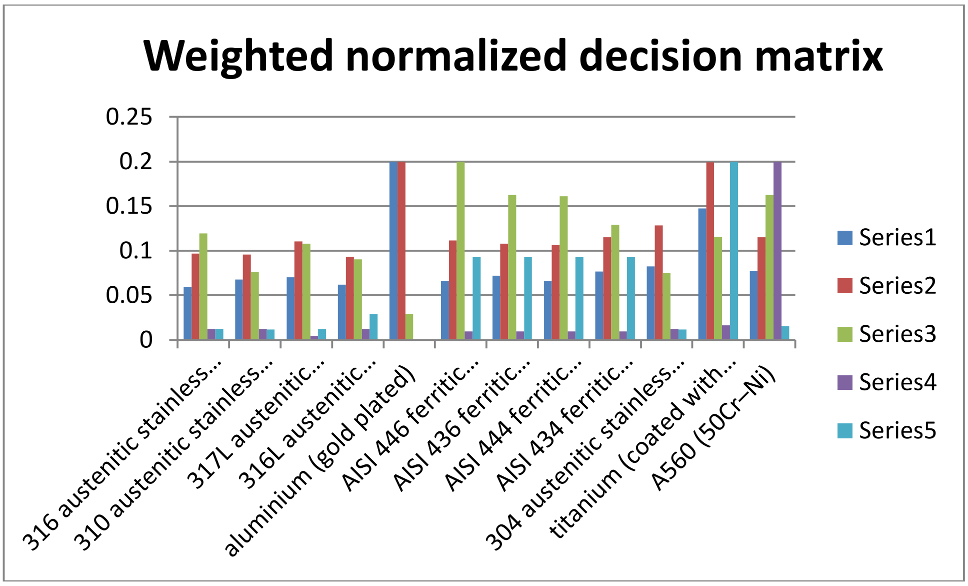

FIGURE 3. Weight normalized decision matrix.

Figure 3 shows the weighted normalized decision matrix: bending stiffness of lightweight panel (E1/3/), stress, force, and density (F) 1/3/, corrosion rate (in year), hydrogen permeability for materials such as AISI 446 ferritic, 316 austenitic stainless steel, 310 austenitic stainless steel, 317L austenitic stainless steel, and 310L austenitic stainless steel, as well as the ratio of stress (f) to elastic modulus (E) is also the Multiple value.

TABLE 5. Preference Score & Rank

	Preference Score	Rank
316 austenitic stainless steel	0.3000718	10
310 austenitic stainless steel	0.2641922	12
317L austenitic stainless steel	0.305203	9
316L austenitic stainless steel	0.287127	11
aluminium (gold plated)	0.4301683	6
AISI 446 ferritic stainless steel	0.4801836	3
AISI 436 ferritic stainless steel	0.4449577	4
AISI 444 ferritic stainless steel	0.4362624	5
AISI 434 ferritic stainless steel	0.4236179	7
304 austenitic stainless steel	0.3097731	8
titanium (coated with nitride)	0.6785373	1
A560 (50Cr–Ni)	0.569764	2

The final rankings of 316 austenitic stainless steel in position 10th, 310 austenitic stainless steel in position 12th, 317L austenitic stainless steel in position 9th, 316L austenitic stainless steel in position 11th, aluminium (gold-plated) in position 6th, AISI 446 ferritic stainless steel in position 3rd, AISI 436 ferritic stainless steel in position 4th, AISI 444 ferritic stainless steel in position 5th, AISI 434 ferritic stainless steel in position 7th, 304 austenitic stainless steel in position 8th, titanium (coated with nitride) in position 1st, A560 (50Cr–Ni) in position 2nd.

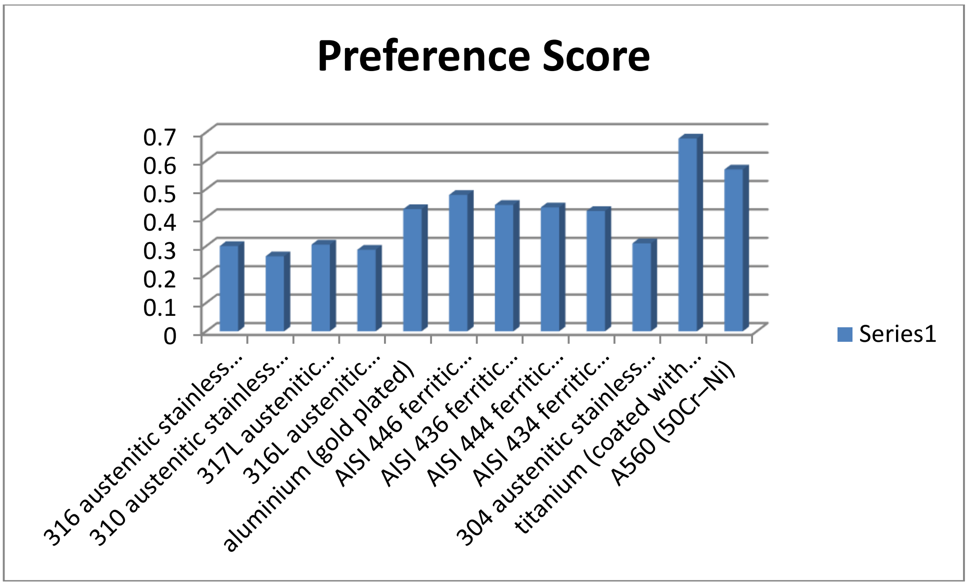

FIGURE 4. Preference Score.

Figure 4 shows the preference score: 316 austenitic stainless steel 0.300071822 , 310 austenitic stainless steel 0.264192155, 317L austenitic stainless steel 0.305203019, 316L austenitic stainless steel 0.287127035, aluminium (gold plated) 0.430168293, AISI 446 ferritic stainless steel 0.480183632, AISI 436 ferritic stainless steel 0.444957697, AISI 444 ferritic stainless steel 0.43626244, AISI 434 ferritic stainless steel 0.42361791, 304 austenitic stainless steel 0.309773128, titanium (coated with nitride) 0.67853732, A560 (50Cr–Ni) 0.56976399.

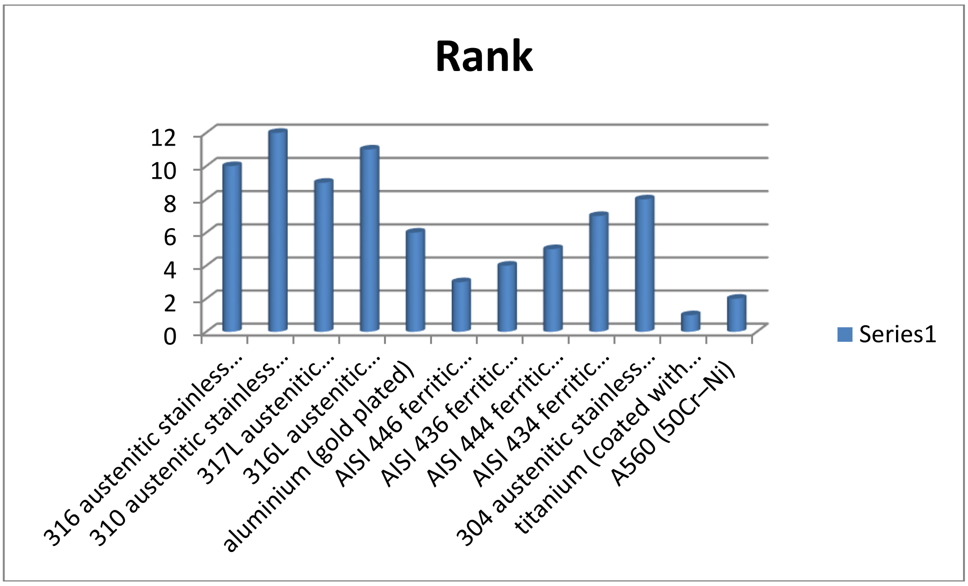

FIGURE 5. Rank.

The final rankings of 316 austenitic stainless steel in position 10^{th}, 310 austenitic stainless steel in position 12^{th}, 317L austenitic stainless steel in position 9^{th}, 316L austenitic stainless steel in position 11^{th}, aluminium (gold-plated) in position 6^{th}, AISI 446 ferritic stainless steel in position 3^{rd}, AISI 436 ferritic stainless steel in position 4^{th}, AISI 444 ferritic stainless steel in position 5^{th}, AISI 434 ferritic stainless steel in position 7^{th}, 304 austenitic stainless steel in position 8^{th}, titanium (coated with nitride) in position 1^{st}, A560 (50Cr–Ni) in position 2^{nd}.

5. CONCLUSION

For PEMFCs, many kinds of metallic bipolar plates are being investigated in order to satisfy the needs of lower costs, larger stacking, lighter weight, and higher power densities. The Multiple Attribute Choice Making (MADM) method is used in this work to apply an option-setting strategy for a perfect answer (TOPSIS) to a choice of components problem involving metal bipolar panels for electrolyte polymer fuel cell (PEFC). Objectives. According to the given criteria, the suggested algorithm tool will assist the material designer in choosing the most suitable materials for their models. A real-world example of the substance choice of a bipolar panel in a PEFC is presented after a review to the theoretical underpinnings. Fuel cells (FCs) are power plants that use electrochemical oxidation to transform the stored energy in fuels direct into electricity and heat. Depending on the surroundings, there are many FC types. A protons-conducting electrolyte polymer membrane (PEM) serves as the foundation for proton electrolytes membrane fuel cells (PEMFCs). This is how a PEMFC operates: a proton-conducting PEM is sandwiched between two porous electrodes. While oxygen moves from the cathode to counter ions (O 2 or OH) on the anode, hydrogen pushes electron to the electrodes and travels across the electrolytes as positive ions (HC). Water is created when compatible ions interact at the, to produce electrical energy. The decreased weighted total is a general idea that can be applied alone or in conjunction with other methods in multi-objective optimisation. Therefore, comprehending the weighted sum approach's characteris-tics has broad ramifications. There is no thorough research on the logical relevance of weights and ways to im-prove the efficiency of the technique with respect to a priori, despite the numerous documented implementa-tions of this method and literature addressing its flaws in presenting the Pareto optimal set. communicating preferences. The weighted sum approach for multi-objective optimisation (MOO) is frequently used to offer various solution points by modifying the same weights and indicating an endpoint, despite its limitations in re-vealing the Pareto optimal set. several weights. By altering weight choices and introducing additional disparity criteria in place of employing primary weight choices, the suggested adaptive weight sum technique concen-trates on understudied areas. The adaptive weighted sum method is demonstrated to produce uniformly dis-tributed solutions, locate the Pareto ideal solutions in non-convex regions, and disregard non-Pareto optimal solutions. This third issue is mostly brought about by the reliance on equality limitations imposed by natural boundary interference, which may be a flaw in the otherwise effective multi-objective strategy. Two numerical examples show the viability of this dependable strategy.

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