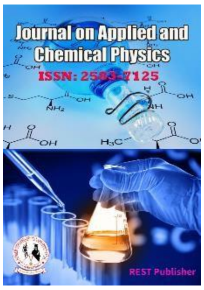
Journal on Applied and Chemical Physics

Vol: 3(4), December 2024

REST Publisher; ISSN: 2583-7125
Website: https://restpublisher.com/journals/jacp/

DOI: https://doi.org/10.46632/jacp/3/4/1



A Review on Selecting material suitable for a statically loaded thermal conductor using the TOPSIS Method

***Chandrasekar Raja, Ramya sharma, M. Ramachandran, Vidhya Prasanth**
REST Labs, Kaveripattinam, Krishnagiri, Tamil Nadu, India.
*Corresponding Author Email: chandrasekarrajarsri@gmail.com

Abstract: *It is crucial to choose the right material for a permanently attached heat conductor since it has an impact on the performance, security, and efficacy of thermal management platforms. Key ideas and the significance of the research are highlighted in this description of the selecting process. Determine the suitability of a material by taking into account its thermal conductivity, mechanical strength, temperature resistance, corrosion resistance, cost-effectiveness, ease of manufacture, and environmental impact. Effective heat transfer is guaranteed by optimal thermal conductivity, while structural integrity under consistent stresses is guaranteed by mechanical strength. The substance must be corrosion-resistant in the required conditions and tolerate the anticipated temperature range. Decision-making is also influenced by factors including cost, production requirements, and environmental sustainability. Thermal conductivity, mechanical strength, and overall material efficiency can all be improved through research and material optimisation. The focus of research is on enhancing productivity, security, innovation, and sustainability across a range of businesses that depend on efficient thermal management.*

Keywords: *Copper-2-beryllium (cast), Copper–cobalt–beryllium (cast), Electrolytic tough-pitch, h.c. copper, soft (wrought), MCDM.*

1. INTRODUCTION

The materials of choice must typically run at a constant workload with very near to room temperature thermal performance. It is classified as a late concept type of design. The heat transfer medium must be encircled by a thin layer of metal that has been bent in order to transport heat via a thermally loaded conductor. The needed parameters for heat transfer determine the sheet thickness. This sheet has to be able to support the enamel throughout the process of hardening and resist a static compressive load [1]. By choosing an appropriate material for a statically loaded heat conductor, the suggested approach can be put to use. The fixed heat conductor in this renowned material selection issue is a circular sheet of metal that encloses the heat-transfer medium. The needed heat transfer conditions determine the thickness of the sheet. Throughout the hardening process, the sheet should be able to maintain a steady compressive stress and resist bending. The cost of the sheet material utilised has an impact on the high volume of conductors produced. The intended mechanical and thermal qualities, as well as the price of the components in relation to the practical demands, are the factors to consider for this particular application. TOPSIS is the most appropriate strategy in this situation considering the algorithm put out by Cicek and Celik [2]. A material selecting model known as ELECTRE was put forward by Shanian and Sawatoko utilising the MADM technique. The choice of mass-produced, non-heat-treatable cylindrical cardboard material was the writers' main concern. The thermal performance of such substances is typically under constant load and extremely similar to room temperature. The heat transfer medium must be encircled by a metal sheet in order to carry heat via a thermally loaded conductor. The needed parameters for heat transfer determine the sheet thickness. This sheet must be able to support any enamel throughout the hardening process and resist a static compressive load. All 12 criteria for choosing subjects were expressed quantitatively [3]. Bipolar plates offer four functions in a cell stack: (i) rigidity for the MEA; (ii) dispersion and segregation of the fuel and oxidizer; (iii) the flow of electrons across the stack; and (iv) a solid electrical connection with Micro diffuser. Bipolar plates must have the following qualities: (i) high electrical conductivity, (ii) high mechanical strength, (iii) high gas permeability, (iv) low mass and size for FC stack, (v) low cost/ease to produce through high automation, and (vi) low cost of materials. Bipolar plates consisting of machining or moulded graphite are used in modern decks. Usually, bipolar plate material run at constant loads and provide thermal performance around PEMFC temperatures. For power as well as heat conduction via the loaded bipolar plate in the fuel cell layer, a flat plate situated in the space among the cells should be utilised. The required plate thickness is determined by the shape and size of the heat transfer field channel, the power delivered, and the flow produced over it. Throughout the fuel cell stack's operation, this plate must withstand heat deterioration [4]. Investigations are made on the issue of plane splitting in in homogeneous materials with thermally loaded surfaces. To find mixed modal stress intensity factors (TSIFs), an interaction energy integral technique (IEIM) was modified. In non-homogeneous materials having interfaces subject to thermal loading, the domain's independence of the revised IEIM still holds true. Thus, regardless of whether non-homogeneous objects possess connections in the integrated domain, updated IEIM can be utilised to derive their TSIFs. To address a number of thermal fracture issues, the updated IEIM is linked using the extended finite element method (XFEM) comparable goods [5]. The composite shows significant failure stress and remarkable resistance to oxidation whenever the FM-bonding is robust and the intermediate layer sticks strongly to the fibre. SiC-matrix composites, when properly designed and manufactured with toughness, display critical release of energy rates on the order of 10 kJ/m2, whereas monolithic SiC-ceramics were of the scale of about 100 J/m2.In addition, no fatigue failure occurs under the 75% ultimate failure stress, making them fewer fatigue-susceptible than metal and alloys underneath static loading [6]. Compared to not using it, coupling agent considerably improves the wetting of hydrophilic (polar) natural fibres with a hydrophobic (non-polar) matrix, increasing the tensile strength under semi-static stress. During swing and quasi-static stress, the low-molecular binding agent AR 504 results in a modest reduction in flexural modulus. In comparison to MAH-modified PP, the composite lacking a coupling agent has a slightly higher storage modulus. This effect is lessened when employing the high-molecular coupling agent HC5 [7]. Shear is a symptom of plastic instability, which occurs when destabilising mechanisms—such as thermal or geometric softening—predominate and traditional stabilising mechanisms—such as strain hardening and strain rate hardening—are diminished. This plastic localisation ought to be shunned in many applications, but it is the preferable decomposition technique in others. High-density kinetic energy resistance armour penetrators are made mostly of tungsten (W) or tungsten heavy metal alloys (WHA), which must have "self-sharpening" behaviour, preferably under high loading (strain). Ratios To accomplish it, the plastic flow has to be localised, which means that cracks must only grow to the proper diameters in these severely deformed shear bands in order to reject the materials that would otherwise enter the penetration channel [8]. In this illustration, a batch of extremely delicate parts involves the mass manufacture of a circular cardboard sheet that cannot be heated. The sheet is required to work under steady load and experience heat transfer in this renowned material selection challenge. The heat transfer medium must be encircled by a metal sheet in order to carry heat via a thermally loaded conductor. The needed parameters for heat transfer determine the sheet thickness. The material being used has to be ready to support any enamel throughout the hardening process and resist a static compressive load.Since all of the data are numerical, the objective weight is determined using the entropy technique [9]. For application in aircraft constructions needing high strength, Al-Li 2099 alloy possesses low density, high stiffness, high damage tolerance, superior corrosion resistance, and weldability. Extrusions made of alloy 2099 can be used in substitutes for 2xxx, 6xxx, and 7xxx aluminium alloys in situations such lower wing stringers and fuselage structures that are static and dynamically loaded. Due to cold working, the second-generation Al-Li alloys are prone to cracking and distortion when interference fit fasteners are installed. These issues lead to poor elongation and work hardening characteristics. The third generation of Al-Li alloys have increased ductility and cold workability. Extrusions made from alloy 2099 offer excellent machining, forming, forming, and surface finishing characteristics. In comparison to 7075-T73 and 7050-T74 plate products, 2099 plate and forged products function better in terms of strength, modulus, density, and corrosion performance. Compared to 2024-T3511 or 2026-T3511, T8E67 temper offers superior hardness, significantly improved corrosion resistance, and higher strength. Compared to 2024-T3511, alloy 2099 has improved fatigue crack development resistance. This drawback has been removed in the third-generation Al-Li alloys like 2199 through alloy optimisation, heat-mechanical processing, and precipitation microstructure control [10]. A'static' loading state that may involve both elastic and plastic deformation and several contact conditions coexist. in that The stress distribution, which is normally Hertzian, therefore has to be overlaid (and maybe modulated or regulated) on the stresses brought on by any additional contact type(s) in the elastic portion of the deformation. obviously, both the substrate and the coating have an impact upon the stress distribution, therefore the latter's impact must be completely taken into account. Repetitive surface stressing causes surface fatigue, which weakens the outer layer by causing cracks to form or other deterioration. This makes it easier for one among the aforementioned wear systems, such extraction or micro-ploughing, to remove material from the surface. Fretting wear is always connected to oscillations or vibrations in the area of contact that have an amplitude small enough to guarantee the creation of a substantial amount of wear particles. When these particles come into contact with metals like steel, they oxidise, which frequently causes friction to increase and produces hard oxide particles that start wear processes like micro-ploughing. Thermal processes have a significant impact on wear for polymers, possibly more so than for metals and ceramics. But instead of being a wear mechanism in and of itself, this thermal influence affects which wear processes prevail and how much wear happens [11]. The usage of storage systems is required for future solar energy applications due to the intermittent and variable characteristics of solar radiation or the requirement to employ solar energy systems under constant and steady loads. PCMs are used in greenhouses, space heating and cooling, waste heat recovery systems, and water heaters using solar energy storage [12]. Design engineers have been obliged to create aviation systems that deliver the greatest efficiency with the least amount of energy use due to the limited supply of supplies (raw materials and fuels) and their continual usage. Advanced aircraft designs are necessary given the long-term objectives of aviation research organisations (like ACAR in Europe) and rising environmental regulations globally. The goal of travelling farther and faster in bigger, more fuel-efficient aircraft leads to simpler aerodynamics that reduce an aircraft's total weight. Improved architecture aims to make aircraft "as light as possible" in order to save fuel and energy. besides to being lightweight, materials' chemistry must also meet a number of other requirements, including having a high heat capacity, being hard, resisting oxidation, having good thermal conductivity, being strong, resisting corrosion, and having a low density [13]. The subcritical propagation of fractures and cracking caused by stress corrosion generated by moisture in the brine interacting with the glass, resulting in the breakdown of the glass structure and accelerated propagation of cracks in glass-containing systems, are strongly related to the long-term stability of ceramics. Since Y-TZP cores possess a polycrystalline microstructure, they're glass-free and are immune to this problem. As a result, Y-TZP cores' long-term stability can be increased. Flexural strength of Y-TZP samples studied in vitro ranged from 900 to 1200 MPa.Fracture toughness of 21 Y-TZP-based materials was 9–10 MPa/m1, almost twice as high as that of alumina-based materials and higher than that of lithium disilicate. almost three times as much. – based goods. Fracture resistance of Y-TZP FPDs was found to be above 2000 N in a laboratory investigation assessing them under static load [14]. It is expected that random variable variances are small compared with their averages. For the purpose of trying to address random dispersal in numerous parameters of the system, a first-order perturbation method is used. Second-order statistics are then used to determine the mean as well as the standard deviation of each of the system variables. For FGM plates & layered FGM plates that include alumina (Al_2O_3) and Ni, precise numerical results are reported. In-depth discussion is given to the impact of different random factors and boundary restrictions on changes in temperature, plate thickness, and randomised bending properties [15].

2. METHODOLOGY

Taking decisions is a crucial aspect of daily and professional life for both individuals and organisations. Despite techniques that use multiple criteria give decision-makers the essential tools, they vary with regard to of underlying theory and assumptions. Therefore, making the best decision is just as crucial as using the appropriate decision-making process. Researchers have concentrated upon the TOPSIS (Technique for Order Efficiency Similar to Ideal Solution) technique, one among the most popular multi-criteria decision-making techniques, and several enhanced variations of the approach have been suggested. The typical TOPSIS method is taken into consideration in this study, which employs a method of simulation to experimentally demonstrate the underlying causes of the method's drawbacks [16]. A set of stages can be used to express the TOPSIS concept:The propensity treatment is applied to each original criterion. Typically, we convert the cost criteria into benefit criteria, as is detailed below;The difference method ($X'_{ij} = 1\ X_{ij}$) relates to the relative criteria, whereas the reciprocal ratio method ($X'_{ij} = 1/X_{ij}$) relates to the absolute criterion.After treating the tendency, create a matrix. Do the normalised decision matrix calculation. A. Aij is normalised to its value. Compute the matrix of A's positive and negative ideal answers. Utilising the n-dimensional Euclidean distance, determine the distances between objects. The ratio should be calculated for each option Ri. Calculate the Sequence in Which to List Alternatives Using a Ratio Value of Ri [17]. Amongst MCDM techniques, the TOPSIS approach is the second most prevalent. Numerous academics have altered or expanded the TOPSIS approach to address specialised issues and used TOPSIS to answer basic or complicated issues in a variety of fields. The main development tendencies of all MCDM approaches for resolving simple and complex problems are amply recovered by the TOPSIS method and the majority of its applications for handling various challenges. In this context, a systematic survey is required to summarise the most recent TOPSIS method research that has been done [18]. Evaluations of performance and weights for criteria are provided as precise values in the TOPSIS process. The TOPSIS method was recently expanded by Abo-sinna and Amer to address multi-objective nonlinear programming issues. Jahanshaloo et al. expand the TOPSIS concept and create an algorithm for resolving issues involving several criteria. In a real-world setting, for instance, human judgements and tastes are frequently unclear and are unable to be evaluated using precise numerical statistics since the facts (attributes) are frequently not very known due to inadequate or unattainable information. are typically fuzzy or imprecise, thus we attempt to expand TOPSIS to include fuzzy data [19]. The TOPSIS approach is frequently employed in academic writing. For instance, Behzadian et al. examined 269 papers that used this methodology, whereas Salih et al. examined 170 papers that used Fuzzy-TOPSIS. TOPSIS-VIKOR (Wu et al., Baccour, Ploskas, and Papathanasiou), DEA-TOPSIS (Subbiah et al., Wang et al.), and Fuzzy- TOPSIS-ELECTRE (Ferreira et al.) are other hybrid algorithms and expansions that are being developed. Yet, due to the literature assessment undertaken by de Farias Ayres and Ferreira 55 and the fact that, according to our expertise, only four studies have yet to be released, the conventional version of the approach suggested by Hwang and Yoon was selected as the topic of this paper. In order to improve the normalisation procedure and hypothetical alternates, Garca-Cascales and Lamata proposed modifications; Chenoussi et al. examined the impact of four normalisation processes on RRP; Mufassal and Muzagir suggested integrating two new evaluates called a weighted proximity index and overall proximity value; and (iii) Cables et al. suggested integrating both of the fresh measures to reduce RRP. Note Introduce the idea of an ideal technique as a novel idea to describe an ideal resolution [20]. The TOPSIS approach was created particularly to work with information that only had real values. Since it is frequently challenging to offer accurate projections of options with according to local criteria, these estimations are frequently regarded as gaps. There aren't many articles that focus on TOPSIS intervals expansions, but the few that do are based on various heuristic methods for defining both positive and negative ideal solutions. Real values or intervals which can't be reached in the decision matrix provide these ideal answers. Assumptions and restrictions of established techniques. Through the use of numerical examples, we demonstrate how a "direct intervals extension of the TOPSIS method" can produce final rankings of alternatives that are noticeably different from those produced by techniques that are already well-known. Expectations and restrictions of established techniques. Through the use of numerical examples, we demonstrate how a "direct interval extension of the TOPSIS method" may generate final rankings of options that are noticeably different from those produced by methods that are already well-known [21]. Normalisation is a conversion method that uses a standard scale to produce numerically equivalent input data. Pre-processing ought to be done after data collection to ensure comparability and make the data helpful in decision-making modelling. In general, transferring data values to a standard scale—typically falling between the unity interval [0, 1]—results in data normalisation and standardisation. An arbitrary threshold between 0.1 and 0.9 is occasionally adopted because specific models implode to a value of zero, but in this study, we only take into account popular similarity-based normalisation methods. The members' collective functions can be evenly raised or diminished. expense or advantage [22]. It has an impact on DAD. Different normalisation techniques produce different normalised data, and the diversity of the normalised data can vary from the initial data, or the DAD. According to studies, mean normalisation does not affect DAD, however MMN does. IE serves as an indication in the present investigation to quantify DAD. As a result, by contrasting the IEs of unprocessed information with normalised data, the impacts of normalisation on DAD may be examined. DAD has an impact on CFAW and CFAV. Since IE is used for calculating DAD and EM bases weight calculations on IE of characteristics, CFAW is inextricably linked to DAD. DAD is connected to CFAV. For instance, DAD is zero and CFAV is clearly 0 if the contents of the attribute were identical across every option. In the following scenario, the connection among DAD and CFAV will be examined further. Affects CFA are CFAW and CFAV. The entire effect of attribute weights and attribute values is represented by the CFA factor. A bigger CFAW or CFAV of an attribute suggests a larger CFA of the attribute when CFAV or CFAW is stable, based on the estimation methods for all three factors. Therefore, CFA is impacted by both CFAW and CFAV. The decision outcome of the entropy-based TOPSIS approach is impacted by CFA. While the exact proximity of every option is dependent upon DIS and DNIS, CFA reflects the mean contribution made by attributes to DIS and DNIS. As a result, CFA influences how the entropy-based TOPSIS technique decides [23]. Risk, according to decision-making theory, is the likelihood of an unfavourable event happening. Whenever the effect of the occurrence materialises, the more the degree of outcome ambiguity, the larger the hazards. The vast majority of current research have concentrated on objective assessment and have ignored the subjective elements that assist different decision-makers in differentiating the various implications of risk occurrences in order to increase the effectiveness of the measures taken. since many decision-makers adopt varying opinions on an identical risk event. Variations in Vulnerability As a guiding concept for making decisions with danger, Newman and Morgenstern established the theory of expected utility under risk, which is based on the exact logic of a human beings behavioural assumption. Risk aversion, risk neutrality, and risk seeking are the three types of risk attitudes for human behaviour [24]. The combined TOPSIS-DOE programme relies on a straightforward analysis of the experimental design, which requires very little mathematical computation. In this paper, multiple linear regression analysis with the TOPSIS method and DOE are utilised to find important variables via matching a polynomial to experimental data. The cost, time, and number of computational steps associated with employing the TOPSIS model were significantly lowered by the regression meta-model. Comparing TOPSIS meta-model use to other MADM approaches like AHP, DEA, ELECTRE, SAW, and GRA, it is incredibly straightforward and simple to implement. Improvement in rating.

Another benefit of this meta-model use is that, unlike the VIKOR and GRA techniques, it lacks a computational procedure that is impacted by the inclusion of a new coefficient [25].

Evaluation parameters:

Compressive stress (MPa): A particular kind of mechanical stress known as compressive stress, which is expressed in megapascals (MPa), develops when an object is exposed to an external force that has a tendency to compress or decrease its volume. It is the compressive load produced by the force exerted per unit area perpendicular with the material's surface.

Ultimate tensile stress (MPa): Ultimate tensile stress, measured in megapascals (MPa), which is the highest stress an object can bear before failing or rupturing under tensile (pulling) forces. It denotes the highest load per unit area that a substance can support without breaking or permanently deforming.

Static load index: The Static Load Index (SLI) is a code of digits that represents the highest load that a tyre can support when it is stationary or in a static environment. It is a standardised rating system created by regulatory organisations and tyre producers to offer details about a tire's capacity to carry loads.

Spring back index: In sheet metal forming procedures, the phrase "spring back index" is frequently employed. When a sheet of metal gets shaped or bent then freed from the forming tool, there is an elastic recovery or rebound which takes place.

Bend force index: In the setting of sheet metal bending operations, the phrase "bend force index" is employed. It is a gauge that shows the amount of resistance or pressure needed to bend a sheet metal part at a certain angle.

Density (Mg/m3): A basic physical characteristic known as density measures a substance's mass per unit volume. It shows how closely together a material's particles or molecules are in a specific area. In mathematics, density is determined by dividing the substance's mass (m) by volume (V).

Alternate parameters:

Copper-2-beryllium (cast): A cast alloy called copper-2-beryllium (Cu-2Be) is frequently used as a thermal conductor because of its superb combination of thermal characteristics. It is an alloy of copper and a trace amount of beryllium, usually approximately 2% by weight.

Copper–cobalt–beryllium (cast): Due to its outstanding thermal characteristics, the cast alloy copper-cobalt-beryllium (Cu-Co-Be) is frequently employed as a thermal conductor. This material is an alloy of copper, beryllium, and cobalt.

Electrolytic tough-pitch, h.c. copper, soft (wrought): Due to its remarkable thermal qualities, soft, wrought electrolytic tough-pitch, high conductivity (ETP HC) copper is frequently utilised as a thermal conductor. It is a superior grade of copper that has undergone electrolytic refinement to guarantee good conductivity and purity.

Electrolytic tough-pitch, h.c. copper, hard (wrought): Due to its advantageous thermal characteristics, electrolytic tough-pitch, high conductivity (ETP HC) copper is frequently employed as a thermal conductor in its hard, worked state. ETP HC copper is a premium copper that has been electrolytically refined to increase purity and conductivity.

Wrought aluminum alloy: Due to their advantageous thermal characteristics and light weight, wrought aluminium alloys are commonly utilised as thermal conductors. These alloys are made using a shaping technique, like rolling or extrusion, that gives the material particular mechanical and thermal properties.

Wrought austenitic stainless steel: Due to a special combination of qualities, wrought austenitic stainless steel, a type of stainless steel, is frequently employed as a thermal conductor. It is a member of the family of iron-chromium-nickel alloys, with the performance improved by the inclusion of molybdenum and titanium.

Commercial bronze, CuZn10, soft (wrought): Due to its favourable thermal characteristics, commercial bronze, specifically CuZn10, is frequently used as a thermal conductor in its soft, wrought form. Commercial bronze is an alloy with a nominal composition of 90% copper and 10% zinc, largely made of the metals copper (Cu) and zinc (Zn).

Carbon steel (annealed): Due to its advantageous combination of mechanical and thermal qualities, carbon steel in its annealed state is frequently used as a thermal conductor. Iron and carbon make up the majority of the alloy that is carbon steel, with trace amounts of additional metals.

3. RESULT AND DISCUSSION

TABLE 1. Selecting a material suitable for a statically loaded thermal conductor

selecting a material suitable for a statically loaded thermal conductor						
Material'sno.	CS	UT	SL	SB	BF	D
Copper-2-beryllium (cast)	560	940	2916	0.78	15,183	8.25
Copper–cobalt–beryllium (cast)	460	600	2395	0.71	12,472	8.65
Electrolytic tough-pitch, h.c. copper, soft (wrought)	50	210	260	0.08	1355	8.94
Electrolytic tough-pitch, h.c. copper, hard (wrought)	340	380	1770	0.48	9218	8.95
Wrought aluminum alloy	190	295	1966	0.25	20,317	2.67
Wrought austenitic stainless steel	690	1030	2174	1.55	5909	8.06
Commercial bronze, CuZn10, soft (wrought)	95	270	520	0.17	2711	8.63
Carbon steel (annealed).	267	355	720	0.48	1957	7.08

Table 1 Selecting a material suitable for a statically loaded thermal conductor using the Analysis method in TOPSIS with various alternate and evaluation parameters.

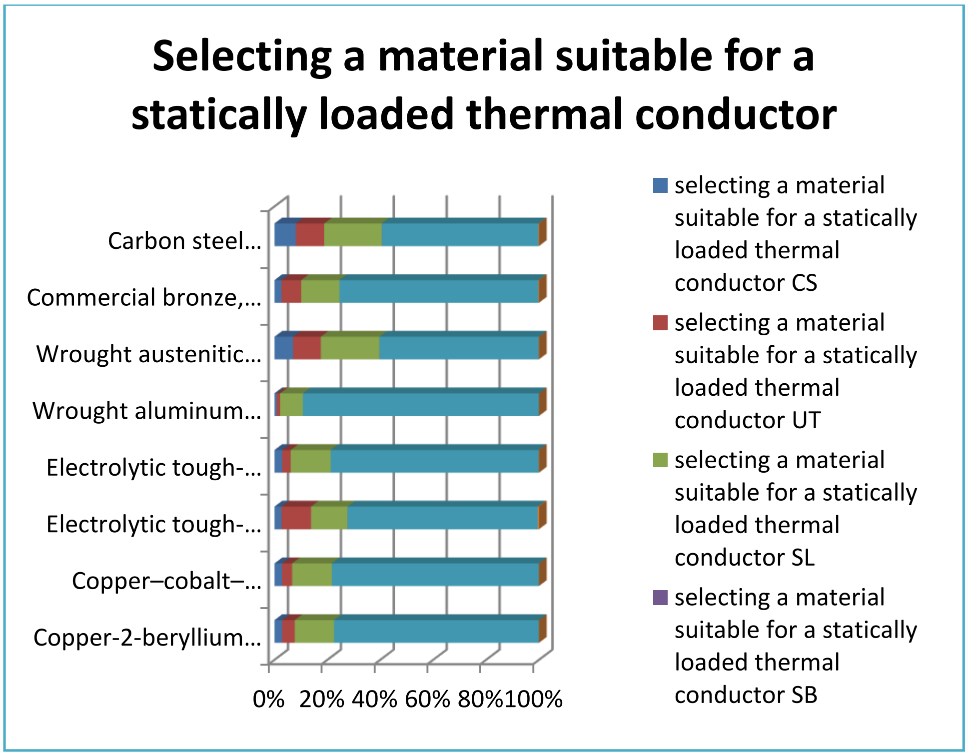


FIGURE 1. Selecting a material suitable for a statically loaded thermal conductor

Figure 1 Selecting a material suitable for a statically loaded thermal conductor for Analysis using the TOPSIS Method with various alternatives and evaluation parameter.

TABLE 2. Normalized Data

Material'sno.	Normalized matrix					
Copper-2-beryllium (cast)	0.503746	0.563881	0.563066	0.386461	0.4974	0.369096
Copper–cobalt–beryllium (cast)	0.413791	0.359924	0.462464	0.351778	0.408587	0.386992
Electrolytic tough-pitch, h.c. copper, soft (wrought)	0.044977	0.125973	0.050205	0.039637	0.04439	0.399966
Electrolytic tough-pitch, h.c. copper, hard (wrought)	0.305846	0.227952	0.341779	0.237822	0.301985	0.400414
Wrought aluminum alloy	0.170914	0.176963	0.379626	0.123866	0.665592	0.119453
Wrought austenitic stainless steel	0.620687	0.61787	0.41979	0.767967	0.193581	0.360596
Commercial bronze, CuZn10, soft (wrought)	0.085457	0.161966	0.10041	0.084229	0.088813	0.386097
Carbon steel (annealed).	0.240179	0.212955	0.139029	0.237822	0.064112	0.316752

Table 3 Normalized Data for selecting a material suitable for a statically loaded thermal conductor Analysis using the TOPSIS Method with various alternative and evaluation parameter which is done by dividing the particular value by square root of sum of all the values available in the row.

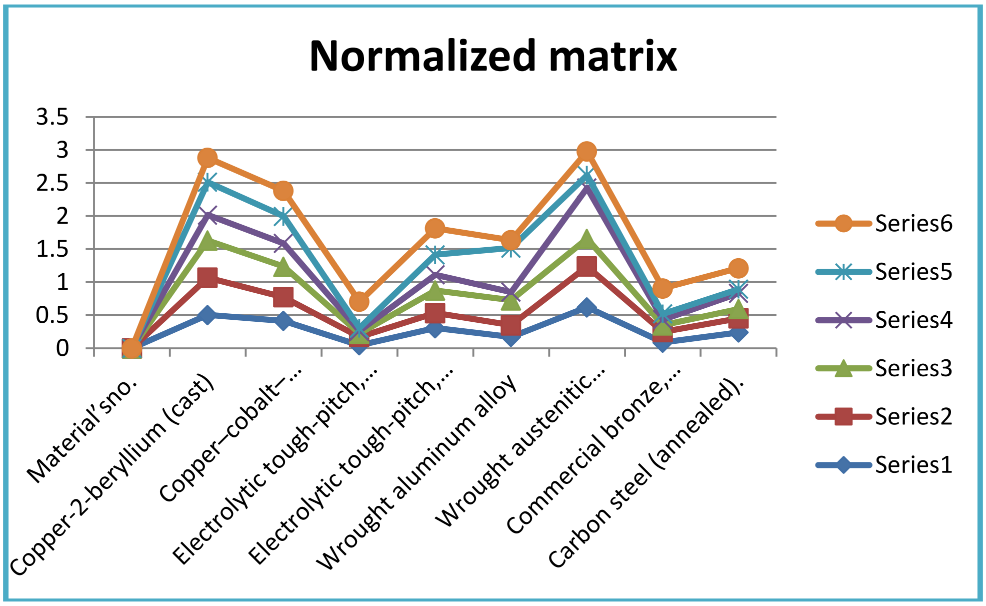


FIGURE 2. Normalized Data

Figure 2 Normalized Data for Selecting a material suitable for a statically loaded thermal conductor using the TOPSIS Method with various alternative and evaluation parameter which is done by dividing the particular value by square root of sum of all the values available in the row

TABLE 3. Weight

Material'sno.	Weight matrix					
Copper-2-beryllium (cast)	0.166667	0.166667	0.166667	0.166667	0.166667	0.166667
Copper–cobalt–beryllium (cast)	0.166667	0.166667	0.166667	0.166667	0.166667	0.166667
Electrolytic tough-pitch, h.c. copper, soft (wrought)	0.166667	0.166667	0.166667	0.166667	0.166667	0.166667
Electrolytic tough-pitch, h.c. copper, hard (wrought)	0.166667	0.166667	0.166667	0.166667	0.166667	0.166667
Wrought aluminum alloy	0.166667	0.166667	0.166667	0.166667	0.166667	0.166667
Wrought austenitic stainless steel	0.166667	0.166667	0.166667	0.166667	0.166667	0.166667
Commercial bronze, CuZn10, soft (wrought)	0.166667	0.166667	0.166667	0.166667	0.166667	0.166667
Carbon steel (annealed).	0.166667	0.166667	0.166667	0.166667	0.166667	0.166667

Table 4 Identifying a material suitable for the weright matrix by dividing 1 by number of 6 columns.

TABLE 4. Weighted normalized decision matrix

Material'sno.	Weighted normalized matrix					
Copper-2-beryllium (cast)	0.083958	0.09398	0.093844	0.06441	0.0829	0.061516
Copper–cobalt–beryllium (cast)	0.068965	0.059987	0.077077	0.05863	0.068098	0.064499
Electrolytic tough-pitch, h.c. copper, soft (wrought)	0.007496	0.020996	0.008367	0.006606	0.007398	0.066661
Electrolytic tough-pitch, h.c. copper, hard (wrought)	0.050974	0.037992	0.056963	0.039637	0.050331	0.066736
Wrought aluminum alloy	0.028486	0.029494	0.063271	0.020644	0.110932	0.019909
Wrought austenitic stainless steel	0.103448	0.102978	0.069965	0.127994	0.032263	0.060099
Commercial bronze, CuZn10, soft (wrought)	0.014243	0.026994	0.016735	0.014038	0.014802	0.06435
Carbon steel (annealed).	0.04003	0.035493	0.023171	0.039637	0.010685	0.052792

Table 4 Weighted Normalized decision matrix for selecting a material suitable for a statically loaded thermal conductor Analysis using the TOPSIS Method with various alternative and evaluation parameter which is done by multiplying the normalized matrix and weight matrix.

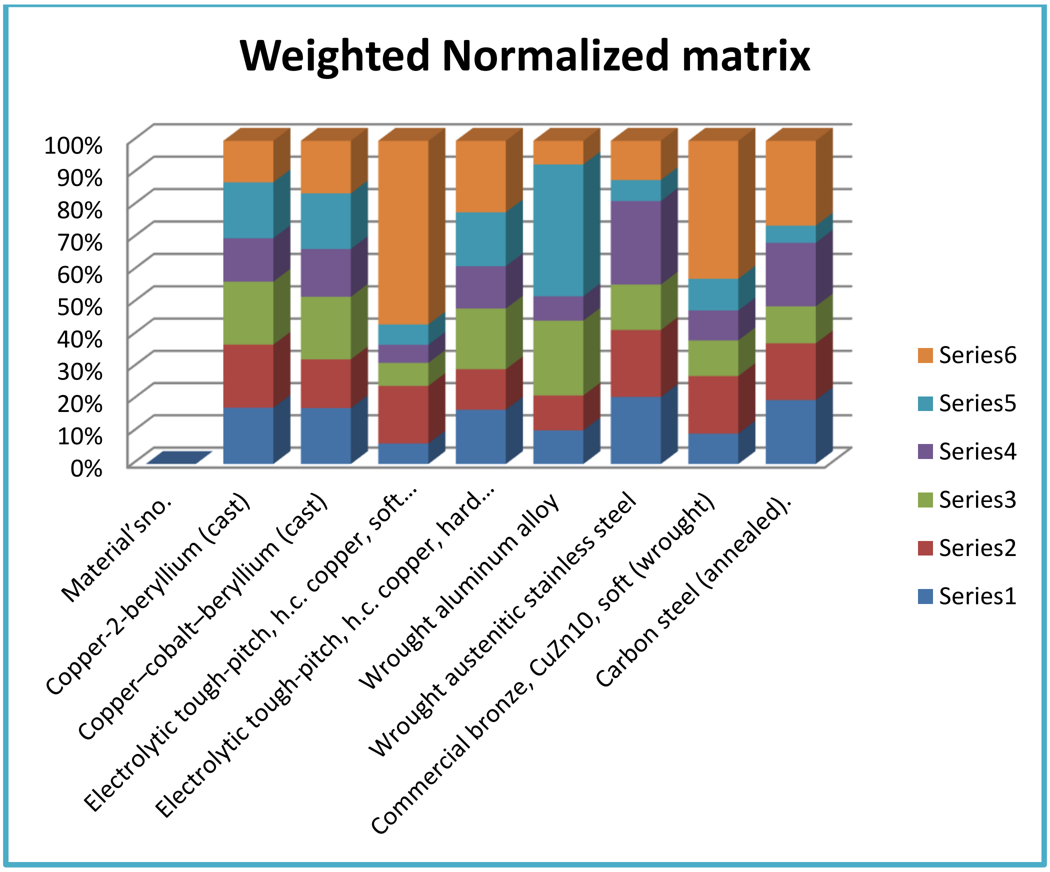


FIGURE 3. Weighted normalized decision matrix

Figure 3. weighted normalized decision matrix with various alternative and evaluation parameter which is done by multiplying the normalized matrix and weight matrix.

TABLE 5. Positive Matrix

Material'sno.	Positive matrix					
Copper-2-beryllium (cast)	0.103448	0.102978	0.093844	0.006606	0.007398	0.019909
Copper–cobalt–beryllium (cast)	0.103448	0.102978	0.093844	0.006606	0.007398	0.019909
Electrolytic tough-pitch, h.c. copper, soft (wrought)	0.103448	0.102978	0.093844	0.006606	0.007398	0.019909
Electrolytic tough-pitch, h.c. copper, hard (wrought)	0.103448	0.102978	0.093844	0.006606	0.007398	0.019909
Wrought aluminum alloy	0.103448	0.102978	0.093844	0.006606	0.007398	0.019909
Wrought austenitic stainless steel	0.103448	0.102978	0.093844	0.006606	0.007398	0.019909
Commercial bronze, CuZn10, soft (wrought)	0.103448	0.102978	0.093844	0.006606	0.007398	0.019909
Carbon steel (annealed).	0.103448	0.102978	0.093844	0.006606	0.007398	0.019909

Table 6 Positive Matrix for Selecting a material suitable for a statically loaded thermal conductor using the TOPSIS Method with various alternative and evaluation parameter by finding the greatest number available in the row for benefit and finding the lowest number in on benefit criteria

TABLE 6. Negative matrix

Material'sno.	Negative matrix					
Copper-2-beryllium (cast)	0.007496	0.020996	0.008367	0.127994	0.110932	0.066736
Copper–cobalt–beryllium (cast)	0.007496	0.020996	0.008367	0.127994	0.110932	0.066736
Electrolytic tough-pitch, h.c. copper, soft (wrought)	0.007496	0.020996	0.008367	0.127994	0.110932	0.066736
Electrolytic tough-pitch, h.c. copper, hard (wrought)	0.007496	0.020996	0.008367	0.127994	0.110932	0.066736
Wrought aluminum alloy	0.007496	0.020996	0.008367	0.127994	0.110932	0.066736
Wrought austenitic stainless steel	0.007496	0.020996	0.008367	0.127994	0.110932	0.066736
Commercial bronze, CuZn10, soft (wrought)	0.007496	0.020996	0.008367	0.127994	0.110932	0.066736
Carbon steel (annealed).	0.007496	0.020996	0.008367	0.127994	0.110932	0.066736

Table 6 negative Matrix for Selecting a material suitable for a statically loaded thermal conductor using the TOPSIS Method with various alternative and evaluation parameter by finding the least number available in the row for benefit and finding the highest number in on benefit criteria

TABLE 7. SI Plus, Si Negative, Ci and Rank

Material'sno.	Si+	Si-	Ci	Rank
Copper-2-beryllium (cast)	0.10599	0.152759	0.590377	1
Copper–cobalt–beryllium (cast)	0.108155	0.129116	0.544172	3
Electrolytic tough-pitch, h.c. copper, soft (wrought)	0.159436	0.159544	0.500169	7
Electrolytic tough-pitch, h.c. copper, hard (wrought)	0.116034	0.126571	0.521717	5
Wrought aluminum alloy	0.151229	0.131316	0.464761	8
Wrought austenitic stainless steel	0.132435	0.161105	0.548836	2
Commercial bronze, CuZn10, soft (wrought)	0.147519	0.149613	0.503524	6
Carbon steel (annealed).	0.125515	0.139781	0.526887	4

Table 7 Shows the Si plus, Si negative, Ci and rank. SI Plus maximum value Electrolytic tough-pitch, h.c. copper, soft (wrought) = 0.159436 and Minimum value Copper-2-beryllium (cast)= 0.10599. Si negative used maximum value Wrought austenitic stainless steel =0.161105and minimum value Electrolytic tough-pitch, h.c. copper, hard (wrought)= 0.126571. Ci maximum value Copper-2-beryllium (cast)= 0.590377 and minimum

value Wrought aluminum alloy =0.464761. The final result of ranking Copper-2-beryllium (cast) is got first rank and Wrought aluminum alloy is got lowest ranking.

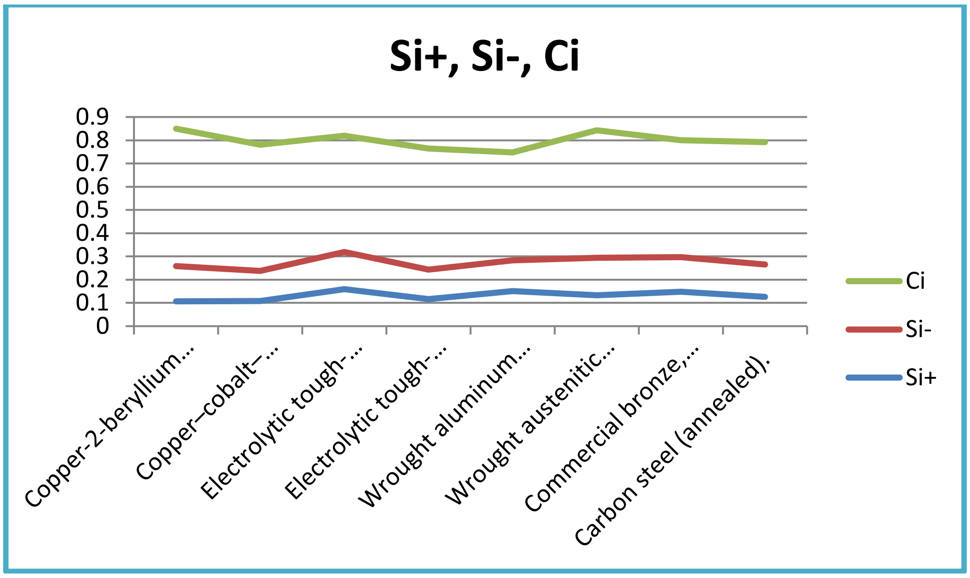


FIGURE 4. Weighted normalized decision matrix

Shows the figure 4. Si plus, Si negative, Ci. SI Plus maximum value Electrolytic tough-pitch, h.c. copper, soft (wrought) = 0.159436 and Minimum value Copper-2-beryllium (cast)= 0.10599. Si negative used maximum value Wrought austenitic stainless steel =0.161105and minimum value Electrolytic tough-pitch, h.c. copper, hard (wrought)= 0.126571. Ci maximum value Copper-2-beryllium (cast)= 0.590377 and minimum value Wrought aluminum alloy =0.464761.

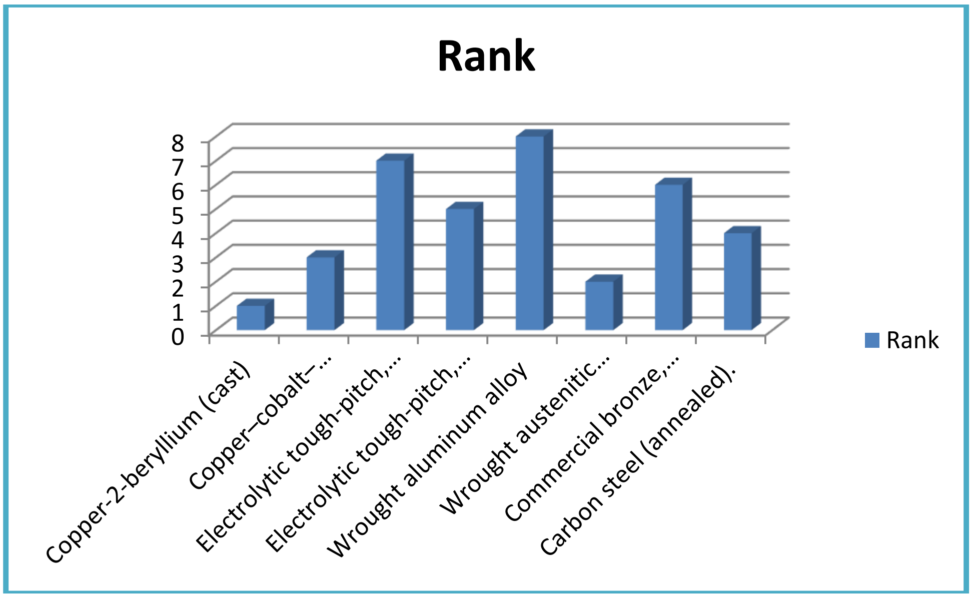


FIGURE 5. Final result of rank

The figure 5 Shows The final result of ranking Copper-2-beryllium (cast) is got first rank and Wrought aluminum alloy is got lowest ranking.

4. CONCLUSION

The materials of choice must typically run at a constant workload with very near to room temperature thermal performance. It is classified as a late concept type of design. The heat transfer medium must be encircled by a thin layer of metal that has been bent in order to transport heat via a thermally loaded conductor. The needed parameters for heat transfer determine the sheet thickness. Usually, bipolar plate material run at constant loads and provide thermal performance around PEMFC temperatures. For power as well as heat conduction via the loaded bipolar plate in the fuel cell layer, a flat plate situated in the space among the cells should be utilised. The required plate thickness is determined by the shape and size of the heat transfer field channel, the power delivered, and the flow produced over it. Throughout the fuel cell stack's operation, this plate must withstand heat deterioration. a batch of extremely delicate parts involves the mass manufacture of a circular cardboard sheet that cannot be heated. The sheet is required to work under steady load and experience heat transfer in this renowned material selection challenge. The heat transfer medium must be encircled by a metal sheet in order to carry heat via a thermally loaded conductor. The needed parameters for heat transfer determine the sheet thickness. The TOPSIS approach is frequently employed in academic writing. For instance, Behzadian et al. examined 269 papers that used this methodology, whereas Salih et al. examined 170 papers that used Fuzzy-TOPSIS. TOPSIS-VIKOR (Wu et al., Baccour, Ploskas, and Papathanasiou), DEA-TOPSIS (Subbiah et al., Wang et al.), and Fuzzy- TOPSIS-ELECTRE (Ferreira et al.) are other hybrid algorithms and expansions that are being developed. The TOPSIS approach was created particularly to work with information that only had real values. Since it is frequently challenging to offer accurate projections of options with according to local criteria, these estimations are frequently regarded as gaps. There aren't many articles that focus on TOPSIS intervals expansions, but the few that do are based on various heuristic methods for defining both positive and negative ideal solutions. Real values or intervals which can't be reached in the decision matrix provide these ideal answers. It has an impact on DAD. Different normalisation techniques produce different normalised data, and the diversity of the normalised data can vary from the initial data, or the DAD. According to studies, mean normalisation does not affect DAD, however MMN does. IE serves as an indication in the present investigation to quantify DAD. As a result, by contrasting the IEs of unprocessed information with normalised data, the impacts of normalisation on DAD may be examined.

REFERENCES

[1]. Shanian, A. and, and O. Savadogo. "A material selection model based on the concept of multiple attribute decision making." *Materials & Design* 27, no. 4 (2006): 329-337.

[2]. Jahan, Ali, Md Yusof Ismail, S. Shuib, Dayangku Norfazidah, and K. L. Edwards. "An aggregation technique for optimal decision-making in materials selection." *Materials & Design* 32, no. 10 (2011): 4918-4924.

[3]. Ayyalasomayajula, Madan Mohan Tito, and Sailaja Ayyalasomayajula. "Support Vector Machines in Virtual Screening for Therapeutic Exploration Using Radial Basis Function (RBF) Kernel for Kinase Inhibitor Discovery."

[4]. Verma, Pradeep. "Transforming Supply Chains Through AI: Demand Forecasting, Inventory Management, and Dynamic Optimization." Integrated Journal of Science and Technology 1, no. 9 (2024).

[5]. Rao, R. Venkata, and Joao Paulo Davim. "A decision-making framework model for material selection using a combined multiple attribute decision-making method." *The International Journal of Advanced Manufacturing Technology* 35, no. 7-8 (2008): 751-760.

[6]. Shanian, Ali, and Oumarou Savadogo. "TOPSIS multiple-criteria decision support analysis for material selection of metallic bipolar plates for polymer electrolyte fuel cell." *Journal of Power Sources* 159, no. 2 (2006): 1095-1104.

[7]. Guo, Licheng, Fengnan Guo, Hongjun Yu, and Li Zhang. "An interaction energy integral method for nonhomogeneous materials with interfaces under thermal loading." *International Journal of Solids and Structures* 49, no. 2 (2012): 355-365.

[8]. Naslain, Roger R. "SiC-matrix composites: nonbrittle ceramics for thermo-structural application." *International Journal of Applied Ceramic Technology* 2, no. 2 (2005): 75-84.

[9]. Wielage, B., Th Lampke, H. Utschick, and F. Soergel. "Processing of natural-fibre reinforced polymers and the resulting dynamic–mechanical properties." *Journal of materials processing technology* 139, no. 1-3 (2003): 140-146.

[10]. Ayyalasomayajula, Madan Mohan Tito, Santhosh Bussa, and Sailaja Ayyalasomayajula. "Forecasting Home Prices Employing Machine Learning Algorithms: XGBoost, Random Forest, and Linear Regression." ESP Journal of Engineering & Technology Advancements (ESP-JETA) 1, no. 1 (2021): 125-133.

[11]. Wei, Q., T. Jiao, K. T. Ramesh, E. Ma, L. J. Kecskes, L. Magness, R. Dowding, V. U. Kazykhanov, and R. Z. Valiev. "Mechanical behavior and dynamic failure of high-strength ultrafine grained tungsten under uniaxial compression." *Acta Materialia* 54, no. 1 (2006): 77-87.

[12]. Jahan, Ali, Faizal Mustapha, S. M. Sapuan, Md Yusof Ismail, and Marjan Bahraminasab. "A framework for weighting of criteria in ranking stage of material selection process." *The International Journal of Advanced Manufacturing Technology* 58 (2012): 411-420.

[13]. Dursun, Tolga, and Costas Soutis. "Recent developments in advanced aircraft aluminium alloys." *Materials &*

Design (1980-2015) 56 (2014): 862-871.

[14]. Verma, Pradeep. "Sales of Medical Devices–SAP Supply Chain." International Journal of Computer Trends and Technology 70, no. 9 (2022): 6-12.

[15]. Matthews, A., Steven Franklin, and Kenneth Holmberg. "Tribological coatings: contact mechanisms and selection." *Journal of Physics D: Applied Physics* 40, no. 18 (2007): 5463.

[16]. Sharma, S. Dutt, and Kazunobu Sagara. "Latent heat storage materials and systems: a review." *International journal of green energy* 2, no. 1 (2005): 1-56.

[17]. Ayyalasomayajula, Madan Mohan Tito, Sathishkumar Chintala, and Sandeep Reddy Narani. "INTELLIGENT SYSTEMS AND APPLICATIONS IN ENGINEERING."

[18]. Ma, C., V. Pfahl, Z. Wang, Y. Chen, J. Chu, M. K. Phani, A. Kumar, W. Arnold, and K. Samwer. "Stick-to-sliding transition in contact-resonance atomic force microscopy." Applied Physics Letters 113, no. 8 (2018).

[19]. Singh, Paramjit, Harish Pungotra, and Nirmal S. Kalsi. "On the characteristics of titanium alloys for the aircraft applications." *Materials today: proceedings* 4, no. 8 (2017): 8971-8982.

[20]. Raigrodski, Ariel J. "Contemporary materials and technologies for all-ceramic fixed partial dentures: a review of the literature." *The Journal of prosthetic dentistry* 92, no. 6 (2004): 557-562.

[21]. Yang, Jie, K. M. Liew, and Sritawat Kitipornchai. "Stochastic analysis of compositionally graded plates with system randomness under static loading." *International Journal of Mechanical Sciences* 47, no. 10 (2005): 1519-1541.

[22]. Çelikbilek, Yakup, and Fatih Tüysüz. "An in-depth review of theory of the TOPSIS method: An experimental analysis." *Journal of Management Analytics* 7, no. 2 (2020): 281-300.

[23]. Ren, Lifeng, Yanqiong Zhang, Yiren Wang, and Zhenqiu Sun. "Comparative analysis of a novel M-TOPSIS method and TOPSIS." *Applied Mathematics Research eXpress* 2007 (2007).

[24]. Zavadskas, Edmundas Kazimieras, Abbas Mardani, Zenonas Turskis, Ahmad Jusoh, and Khalil MD Nor. "Development of TOPSIS method to solve complicated decision-making problems—An overview on developments from 2000 to 2015." *International Journal of Information Technology & Decision Making* 15, no. 03 (2016): 645-682.

[25]. Narani, Sandeep Reddy, Madan Mohan Tito Ayyalasomayajula, and Sathishkumar Chintala. "Strategies For Migrating Large, Mission-Critical Database Workloads To The Cloud." Webology (ISSN: 1735-188X) 15, no. 1 (2018).

[26]. Verma, Pradeep. "Effective Execution of Mergers and Acquisitions for IT Supply Chain." International Journal of Computer Trends and Technology 70, no. 7 (2022): 8-10.

[27]. Jahanshahloo, Gholam Reza, F. Hosseinzadeh Lotfi, and Mohammad Izadikhah. "Extension of the TOPSIS method for decision-making problems with fuzzy data." *Applied mathematics and computation* 181, no. 2 (2006): 1544-1551.

[28]. Sathiyaraj Chinnasamy, Chinnasami Sivaji, Vidhya Prasantha, M. Ramachandran,"Multi-Criteria Decision-Making Analysis of Information and Communication Technology Using VIKOR", R EST Journal on Advances in Mechanical Engineering, 3(2), June 2024, 10-14.

[29]. de Farias Aires, Renan Felinto, and Luciano Ferreira. "A new approach to avoid rank reversal cases in the TOPSIS method." *Computers & Industrial Engineering* 132 (2019): 84-97.

[30]. Dymova, Ludmila, Pavel Sevastjanov, and Anna Tikhonenko. "A direct interval extension of TOPSIS method." *Expert Systems with Applications* 40, no. 12 (2013): 4841-4847.

[31]. Vafaei, Nazanin, Rita A. Ribeiro, and Luis M. Camarinha-Matos. "Data normalisation techniques in decision making: case study with TOPSIS method." *International journal of information and decision sciences* 10, no. 1 (2018): 19-38.

[32]. Jindal, Mayank, Madan Mohan Tito Ayyalasomayajula, Dedeepya Sai Gondi, and Harish Mashetty. "Enhancing Federated Learning Evaluation: Exploring Instance-Level Insights with SQUARES in Image Classification Models." Journal of Electrical Systems 20, no. 7s (2024): 2516-2523.

[33]. Kalyan Phani, M., Anish Kumar, and T. Jayakumar. "Elasticity mapping of delta precipitate in alloy 625 using atomic force acoustic microscopy with a new approach to eliminate the influence of tip condition." Philosophical magazine letters 94, no. 7 (2014): 395-403.

[34]. Chen, Pengyu. "Effects of normalization on the entropy-based TOPSIS method." *Expert Systems with Applications* 136 (2019): 33-41.

[35]. Tsaur, Ruey-Chyn. "Decision risk analysis for an interval TOPSIS method." *Applied Mathematics and Computation* 218, no. 8 (2011): 4295-4304.

[36]. İç, Yusuf Tansel. "An experimental design approach using TOPSIS method for the selection of computer-integrated manufacturing technologies." *Robotics and Computer-Integrated Manufacturing* 28, no. 2 (2012): 245-256.

[37]. Ayyalasomayajula, Madan Mohan Tito. "Metadata Enhanced Micro-Partitioned Bitmap Indexes for Managing Large-Scale Datasets." PhD diss., Aspen University, 2024.

[38]. Pfahl, V., M. K. Phani, M. Büchsenschütz-Göbeler, A. Kumar, V. Moshnyaga, W. Arnold, and K. Samwer. "Conduction electrons as dissipation channel in friction experiments at the metal-metal transition of LSMO measured by contact-resonance atomic force microscopy." Applied Physics Letters 110, no. 5 (2017).

[39]. Manjula selvam, Vidhya Prasanth, M. Ramachandran, Ramya Sharama, "A Study on Economic Models of Animal Communication Methods" Journal on Innovations in Teaching and Learning, 3(2), June 2024, 13-19.