Analysis of Hardness and Wear Rate of Polypropleyne Based Polymeric Composite through Grey Relational Technique

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Abstract— Over the last years natural composite materials have been the dominant emerging materials over plastics, fibers and ceramics. The volume and number of applications of natural composite materials have grown steadily, penetrating and conquering new markets relentlessly. The composites should not be regarded simple as a combination of two materials. The interest in polymeric composite materials is rapidly growing both in terms of their industrial applications and fundamental research. They are renewable, cheap, completely or partially recyclable, and biodegradable. Their availability, renewability, low density, and price as well as satisfactory mechanical properties make them an attractive ecological usage for the manufacturing of composites. The research on the present work shows that we can successfully manufactured Polypropylene based composite, which are widely used in the industrial field, especially in automotive applications, due to their excellent mechanical properties and low cost. This research is directed towards obtaining the optimal values of mechanical properties of organic polymer composite material for different objectives. Though the primary objective was to minimize the cost of the composite, simulations were also performed to obtain specific desired properties of the composite (irrespective of the composite cost). The latter simulation results are useful optimization of mechanical properties during machining of composite material using grey relational method.

Keywords: Polypropleyne, Grey Relational Technique

I. INTRODUCTION

Composites are fundamentally blends of two materials in which one of the materials, called the reinforced stage, is as filaments or particles that is implanted in another material called the lattice stage. The essential elements of the framework are to move worries between the reinforced fiber/particles and to shield them from mechanical or potentially natural harm while the nearness of filaments/particles in a composite improves its mechanical properties, for example, quality, solidness and so forth. A composite is hence a synergistic blend of at least two full scale constituents that contrast in physical structure and synthetic synthesis and which are insoluble in one another. The goal is to exploit the predominant properties of the two materials without settling on the shortcoming [2].

A. Types of Composite Materials

Broadly, composite materials can be classified into three groups on the basis of matrix material. They are:

1) Metal Matrix Composite
2) Ceramic Matrix Composite
3) Polymer Matrix Composite

1) Metal Matrix Composite:

Metal Matrix Composites have numerous focal points over solid metals like higher explicit modulus, higher explicit quality, better properties at raised temperatures and lower coefficient of warm development. In light of these characteristics metal lattice composites are getting looked at for wide scope of uses viz. burning chamber spout (in rocket, space transport), lodgings, tubing, links, heat exchangers, auxiliary individuals and so on.

2) Ceramic Matrix Composites:

One of the fundamental targets in delivering clay matrix composites is to build the sturdiness. Normally it is trusted and without a doubt regularly found that there is an accompanying improvement in quality and firmness of artistic lattice composites.

3) Polymer Matrix Composites:

Most normally utilized framework materials are polymeric. The purposes behind this are twofold. When all is said in done the mechanical properties of polymers are lacking for some auxiliary purposes. Specifically their quality and solidness are low contrasted with metals and pottery. These challenges are overwhelmed by reinforced different materials with polymers.

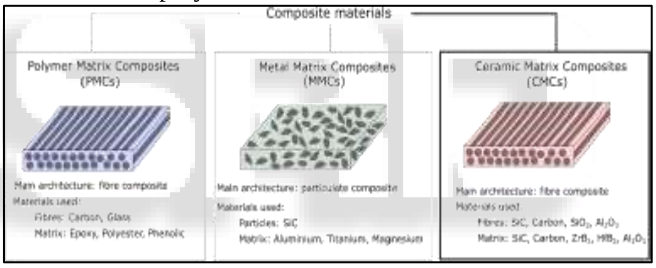

Fig. 1.1: Types of Composites

B. Types of polymer composites:

Extensively, polymer composites can be characterized into three gatherings based on reinforced material. They are:

- Fiber reinforced polymer (FRP)
- Particle reinforced polymer (PRP)
- Structural polymer composites (SPC)

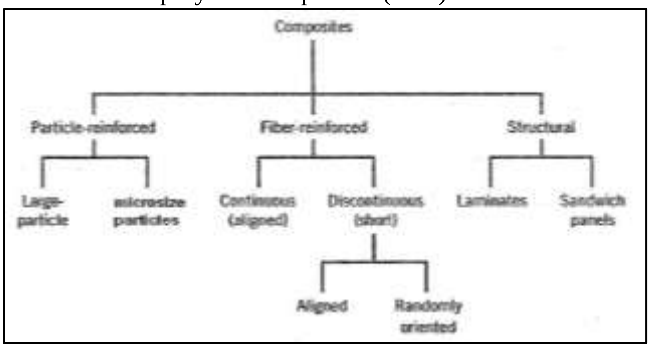

Fig. 1.2: Types of Polymer Composites

C. Grey Relational Analysis Method:-

Grey relational analysis method uses an exact model of information as it defines situations through no information as black, and those by way of perfect information as white. In actual situations involvement of

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these extremes can be described as living being grey, hazy or fuzzy. Therefore, a grey system means that a system in which part of information is known and part of information is unknown. With this definition, information and quality form a continuum from a total lack of information to complete information – from black through grey to white. Since uncertainty always exists, one is always somewhere in the middle, somewhere between the extremes, somewhere in the grey area [7].

Grey analysis then comes to a clear set of statements about system solutions. At one extreme, no solution can be defined for any system with no information available. On the other extreme, a system with perfect information has a unique solution. In the middle, grey systems will give a variety of available solutions. Grey analysis does not attempt to find the best solution, but does provide techniques for determining a good solution, an appropriate solution for real world problems.

Let $x_i(k)$ is the value of the number i listed project and the number k influence factors.

Usually, three kinds of influence factors are included, they are:
1) Benefit – type factor (the bigger the better),
2) Defect – type (the smaller the better)
3) Medium – type, or nominal-the-best (the nearer to a certain standard value the better).

II. LITERATURE SURVEY

Joshi et al. [2020] looked at life cycle ecological execution of normal fiber composites with glass fiber strengthened composites and found that common fiber composites are naturally prevalent in the particular applications examined. Common fiber composites are probably going to be ecologically better than glass fiber composites as a rule for the accompanying reasons: (1) regular fiber creation has lower ecological effects contrasted with glass fiber creation; (2) normal fiber composites have higher fiber content for proportionate performance, reducing all the more contaminating base polymer content; (3) the light-weight characteristic fiber composites improve eco-friendliness and diminish emanations in the utilization period of the segment, particularly in auto applications; and (4) finish of life cremation of normal strands brings about recuperated vitality and carbon credits.

Rana et al. [2020] in their work demonstrated that the utilization of compatibilizer in jute strands expands its mechanical properties. At 60% by weight of fiber stacking, the utilization of the compatibilizer improved the flexural quality as high as 100%, rigidity to 120%, and sway quality by 175%. The accompanying ends might be drawn from this paper:
1) The sharp increment in mechanical properties and diminishing in water ingestion esteems after expansion of the compatibilizer.
2) Every one of these outcomes legitimize that the job of jute fiber was not as a filler fiber however as a strengthening fiber in an appropriately compatibilized framework.
3) This framework delivered another scope of low-vitality, ease composites having fascinating properties and ought to be given need over exorbitant and high-vitality combination fortifying fiber at every possible opportunity.

Shah and Lakkad [2020] attempts to look at the mechanical properties of jute-reinforced and glass-reinforced and the outcomes shows that the jute strands, when brought into the pitch lattice as support, significantly improve the mechanical properties, however the improvement is a lot of lower than that got by presentation of glass and other elite filaments. Thus, the jute strands can be utilized as a support where unobtrusive quality and modulus are required. Another likely use for the jute strands is that, it tends to be utilized as a filler‟ fiber, supplanting the glass just as the sap in a fiber wound part. The fundamental issue of the current work has been that it is hard to present a huge amount of jute strands into the JRP covers in light of the fact that the jute filaments, not at all like glass filaments, absorb enormous measure of sap. This issue is incompletely defeated when hybridsing‟ with glass filaments is completed.

Beam et al. [2019] in their work, Jute strands were exposed to salt treatment with 5% NaOH answer for 0, 2, 4, 6 and 8 h at 300C. It was discovered that improvement in properties both for strands and fortified composites. The filaments after treatment were better, having less hemicellulose content, expanded crystallinity, decreased measure of imperfections bringing about unrivaled holding with the vinylester sap. As strands, the enhancements in properties were dominating around 6–8 h treatment while as composites, it was greatest when fortified with 4 h-treated filaments at 35% fiber loadings.

III. PROBLEM FORMULATION & METHODOLOGY

Keeping all the Literature Gap/Analysis in mind the present work will study the mechanical properties of the polymeric composite and to optimize them. Further an expert system will be developed for future predictions of the phenomenon. The objectives of present research are listed below:-
- To prepare the organic polymer composite and to give the shape by using injection moulding machine.
- To find & study the mechanical properties of the polymer composite.
- To optimize the hardness and wear rate using grey relational analysis.

IV. EXPERIMENTAL WORK

Material used for Work piece: Polypropleyne

Fig. 4.1: Machine used for manufacturing

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1) Hardness- The ability of material to withstand surface space and scratching (for example Brinnell hardness number). Hardness of Polymers (rubbers, plastics) is typically estimated by Shore scales. Shore A scale is utilized for testing delicate elastomers (rubbers) and other delicate polymers. Hardness of hard elastomers and most other polymer materials (Thermoplastics, Thermosets) is estimated by Shore D scale.
2) Wear Rate- Wear is "The expulsion of material from or the hindrance of a strong surface coming about because of rubbing or shock action." When surfaces slide more than each other, they not just experience contact, they also wear and material is lost from the two surfaces, in any event, when one is a lot harder than the other.

   Wear Rate can be resolved as follows:

$$k = \frac{\Delta w}{\rho \times L \times S}$$

A. Methodology and Calculations

1) Design of Experiment:

Design of Experiments (DOE) is broadly utilized in innovative work, where a huge extent of the assets go towards tackling enhancement issues. The way to limiting advancement costs is to direct as hardly any trials as could be expected under the circumstances. DOE requires just a little arrangement of trials and therefore assists with diminishing expenses.

S.No	Water (Wt %)	Epoxy (Wt %)	Hdpe (Wt %)
1	20	5	8
2	20	8	14
3	20	12	20
4	35	5	20
5	35	8	8
6	35	12	14
7	50	5	14
8	50	8	20
9	50	12	8

Table: 4.1: Design of experiments

S.NO	Grey Relational Coefficient		
	Hardness	Wear Rate	Rank
1	51	0.0044	9
2	54	0.0047	8
3	58	0.0040	5
4	83	0.0041	1
5	76	0.0049	4
6	80	0.0044	3
7	64	0.0030	2
8	67	0.0035	7
9	70	0.0039	6

Table 4.2: Result for GRA Coefficient

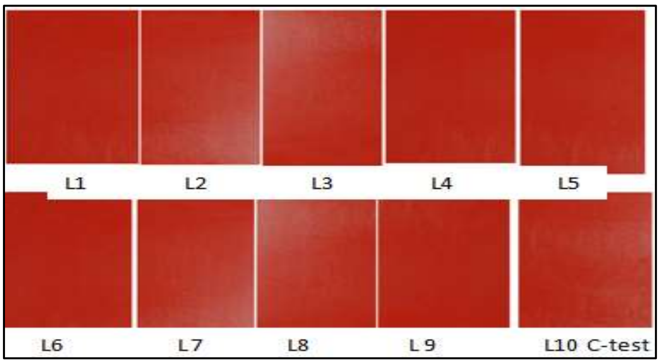

Fig. 4.2: Workpieces after testing

V. PREDICTING OPTIMUM PERFORMANCE

To figure the optimum response characteristics for hardness and wear rate by utilizing the connection:

Predicted Mean= N+ (A_2-N) + (B_1-N) + (C_3-N)

Here, N= Total mean of yield attributes (Hardness and Wear Rate).

A, B, C = Mean of yield attributes at ideal levels.

n = number of plan boundaries that impact quality characteristics.

Predicting Mean Hardness

= 67.00 + (79.67 -67.00) + (66.00 – 67.00) + (69.33 – 67.00)

= 81 Shore D

Predicting Wear Rate

= 0.0041 + (0.0045- 0.0041) + (0.0038- 0.0041) + (0.0039- 0.0041)

= 0.0040m^3/Nm

VI. RESULT & CONCLUSION

From data tabulation , we hereby comes to the conclusion that the optimum vaules for the response paramerters with changing the inut paramters as shown below in the table form.

Water (Wt%)	Epoxy (Wt%)	Hdpe (Wt%)	Wear Rate (m^3/Nm)	Hardness (Shore D)
35	5	20	0.0041	83

Table 6.1: Optimum values

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