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Performance analysis of bio-polymer composites

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Abstract: Increasing concern exists today about the preservation of our ecological systems. Most of today's synthetic polymers are produced from petrochemicals and are not biodegradable. The bio-based biodegradable products have raised great interest to apply in the Industrial applications. Bio-polymers are the polymer that is developed from living beings. The materials prepared from single biopolymer are shown under performance properties towards numerous industrial applications. It is worthwhile to explore the biopolymer composites to acquire desired qualities by blending the chosen biopolymers with required additives. Moreover, the bio-polymers have efficiency in conjugation with numerous additives, it is easy to obtain the properties of engineering materials in these composites. The mechanical properties are studied for series of biopolymer composites are prepared by blending of Carboxy Methyl Cellulose (CMC) with Poly Vinyl Alcohol (PVA).
Key words: Biodegradable, bio-polymer, Carboxy Methyl Cellulose, Poly Vinyl Alcohol.

1. Introduction

Over few decades, plastics have become a common material used in many aspects of our lives. Plastics are also a common compound of debris in water resources across the world which affecting the all kind of water bodies, land ecosystem and creating major environmental issues [1]. Approximately 140 million tons of synthetic polymers are produced for various purposes across the globe every year [2]. In India, the plastic usages are estimated by around 100Kg per person each year [3]. Since the synthetic plastics are resistance to degradation over the long period, there is a scarcity among the scientist to develop material pertaining the characteristics of plastics. Plastics that are formed from non-renewable feed stocks are generally petroleum-based, and reinforced by glass or carbon fibers [4]. Renewable resource feed stocks include microbial-grown polymers and those extracted from starch. In place of plastics, biopolymer materials came to the industrial fields for novel engineering applications. The biopolymers are non-metallic compounds of high molecular weight and obtained from variety of natural resources. In general the single biopolymers cannot meet the different engineering applications. Thus the blending of biopolymers with desired additives are increased interest in the preparation of biopolymer composites [5]. The choice of biopolymers are dependent on the usage and process method employed. The biopolymers have properties of conjugation with wide variety of resins, it could be used to reinforce the materials according to the applications [6]. The blending of biopolymers with resins played a vital role in degradation process in the environment. Cellulose derivatives widely used in low temperature engineering applications [7]. The commercially available cellulose materials such as methyl cellulose, ethyl cellulose, hydroxy ethyl cellulose, hydroxyl propyl cellulose and cellulose acetate are blended with numerous starch and proteins which are accomplished excellent barrier properties [8]. Recently, D. R. Lu et al reported that the incorporation of starch to synthetic polymer impart the biodegradability of synthetic polymer when the starch is consumed by microorganisms [9] and also described the mechanistic work of the microorganism action on the composites. It created the interest to incorporate the Poly Vinyl Alcohol (PVA) with Carboxy Methyl Cellulose (CMC).

2. Experimental Work

2.1 Materials

PVA and CMC are purchased from chemical agent. The hardness of the composites are evaluated by Rockwell hardness tester. The tensile strength of the prepared materials are tested by using Universal testing machine (UTM).The test film is cut into uniform shaped according to ASTM D882-02[10]. The five samples were tested for each formulation at both with and without moistures.

2.2 Sample Preparation

The PVA and CMC are dried in oven for 24 hours at 80^{o}C before pre-mixing and to remove moistures. The compounding of PVA/CMC at different blend ratios were done with addition of palm cooking oil. The compositions are stirred uniformly at rate of 60 rpm. Then, resultant composites are molded as thin films in the ASTM formulations. Figure 1 shows a 100 % Poly Vinyl Alcohol (PVA) product. Figure 2 shows a 100 % Carboxy Methyl Cellulose (CMC) product. Figure 3 shows a 20 % Poly Vinyl Alcohol (PVA) and 80 % Carboxy Methyl Cellulose (CMC) product.

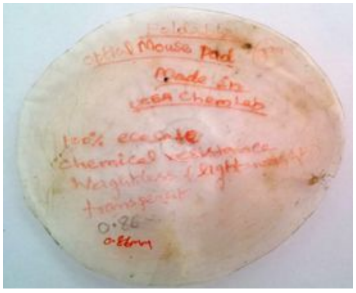

Figure 1 PVA 100 %

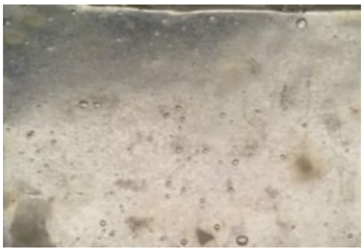

Figure 2 CMC 100 %

Figure 3 CMC 80 % and 20 % PVA

3. Results And Discussion

The samples were prepared by using PVA as base and CMC is propositioned as indicated in the table-1 .The compounds are tested for physical and mechanical properties.

Table 1 .The abbreviations of samples

S. No.	Samples	CMC (wt. %)	PVA (wt. %)
1	PVA	0	100
2	PVA/CMC-I	80	20
3	PVA/CMC-II	60	40
4	PVA/CMC-III	50	50
5	CMC	100	0

The tensile property of different films were measured and shown in fig.4 It is observed that the composite film of PVA /CMC-I breaks at 18.9 kN. The individual PVA and CMC are breaks at 15.7 kN and CMC has 9kN respectively. The high viscosity character of CMC get brittle when it used at 100%. It is noticed that the addition of 20% PVA into CMC has improved the elongation properties of the film.

At the same time, further addition of 40% and 60% of PVA with CMC is not remarkable improve the elongation of the film. It is inferred that the 80 % of CMC is the optimal conditions for the film formation. The increase in the tensile strength of the composites PVA/CMC-II and PVA/CMC-III is due the decrease in the filler filler interactions. The compounds PVA and CMC are soluble in hot water and also hydrophilic in nature.

Thus, the composites of PVA/CMC I is expected to be a good biodegradable property than PVA/CMC II and III, since latter compositions have less volume of CMC.

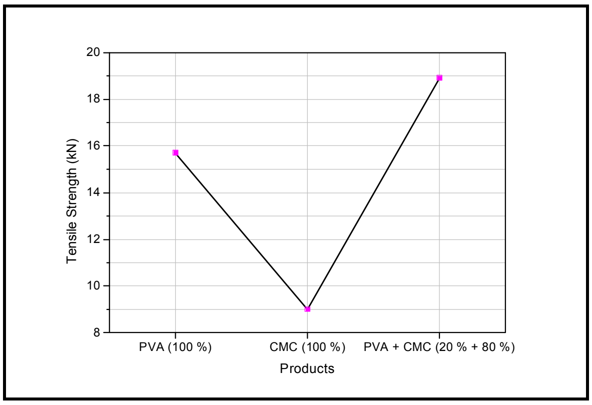

Figure 4. Tensile property of various Products

The loads were applied on the prepared composites. The displacement of the compounds PVC/CMC-I, PVA and CMC are measured by using UTM and results are plotted in graph fig.5. The PVA/CMC-I deformed at 4.8mm after breaking of the film. The CMC and PVA deformed to 1mm and 6.9 mm respectively. The addition of PVA could improve the deformation of the film PVA/CMC-I. But no significant improvement was observed while applying the similar procedures for the composites PVA/CMC-II and PVA/CMC-III. The hardness of the composites PVA and CMC-I, PVA and CMC by Rockwell hardness taster and results are plotted in graph (fig.6). A constant load of 150Kgf is applied on the film, as specification of ASTM. The PVA have gained the hardness of is 29.67, whereas 80% blended CMC for PVA/CMC-I composite obtained 23.67 in B scale. The CMC performed very low hardness of 22.33 against the applied load.

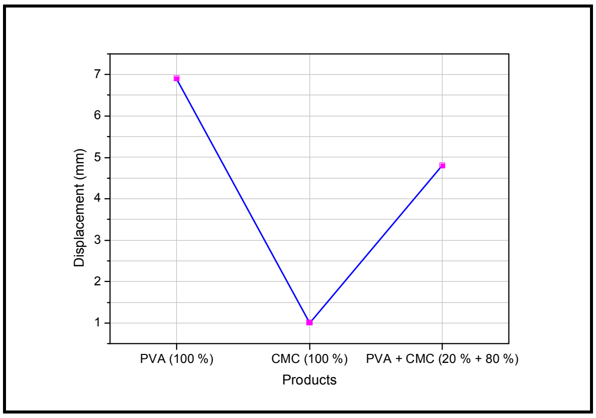

Figure 5. Displacement of various Products

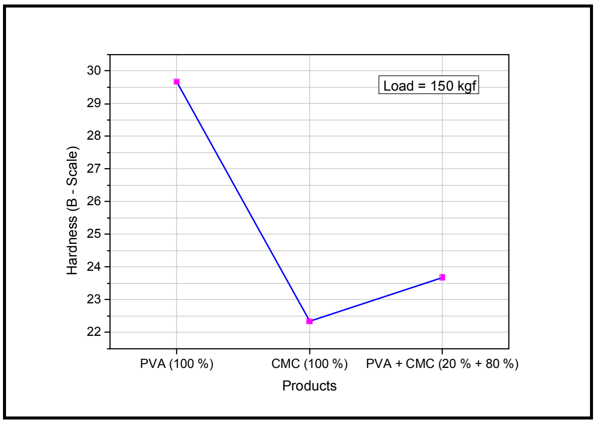

Figure 6. Hardness of various Products

4. Conclusion

The resin is non-biodegradable, we reduce the percentage of resin and maximum percentage of biopolymer in order to gain the synthetic polymer properties. Among the various combinations, the 20% PVA blend with CMC has played a vital role to develop the tensile strength and hardness for the composite film.

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