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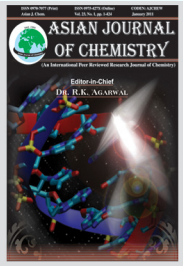

Effect of Titanate Coupling Agent on Mechanical Properties of Rice Husk Polypropylene Composites

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Easy availability, low cost and biodegradable nature of lignocellulosic materials necessitated the development of thermoplastic composites, based on commodity plastic such as poly propylene (PP). It can be reinforced with rice husk, a type of lignocellulosic material abundantly available in nature. Preheating of rice husk and its proper size is beneficial for achieving good mechanical strength. Titanate coupling agent is very useful for enhancement in mechanical properties of rice husk polypropylene composites. These composite have potential as good building material.

Key Words: Commodity, Tensile strength, Coupling agent, Lignocellulosic, Rice husk.

INTRODUCTION

Polymer composites have revolutionized the materials world and occupy the distinct place today. Due to their superior properties such as high strength/weight ratio, chemical resistance nature, low creep, they are widespread use in automobile, sport, aerospace industries *etc*. Thermo set composites consists polyester, epoxy matrix reinforced with glass, carbon and aramid fibers for various applications[1]. Their limitations such as non-reusable nature, abrasiveness, anisotropy, low production opened the door for thermoplastic composites[2]. Thermoplastics composites based on commodity plastics such as polyethylene, polypropylene, polystyrene, can be reinforced with fillers $CaCO_3$, talc, mica, rice husk, wood flour *etc*. and are cheaper, non-abrasive in nature and have high production rate.

Long life of polymers and their non-biodegradable nature is a cause of concern for environment[3]. With the advancement in technology; environmental friendly polymers utilizing the lignocellulosic materials (rice husk, wood flour, bagasse *etc*.) are developed. Popularly known as green composites, they are economical, have good mechanical properties, less abrasive in nature and reduce burden on environment. Polypropylene (PP), commonly used plastic, can be reinforced with abundantly available rice husk[4]. Strength of rice husk polypropylene composites can be enhanced by adding suitable coupling agents[5]. Polymer composites thus prepared have potential applications in building and automotive industries[6,7].

EXPERIMENTAL

Polypropylene: Polypropylene was procured from M/S Reliance industries (Grade 110MA). MFI: 11.50 g/10 min, moisture content: 0.039 %, HDT: 104 ºC, tensile strength at yield (50 mm/min) D 638: 36 MPa, Notched Izod impact strength (23 ºC) D 256: 27 J/m.

Rice husk: It was obtained locally and was grinded to fine powder: bulk density (g/cm^3): 338.4, moisture content (%): 6.8, ash content (%): 14.4.

Coupling agent: It was supplied by the M/S Indian Products Manufacturing Company (IPMC) , Pune (Ezebond titanate coupling agent: EB 1019 A), percentage of coupling agent: 0.3-0.9 % (of the total weight of rice husk and polypropylene).

Moisture remover: It was purchased from M/S Vin Poly Additives, New Delhi and additional level was 2 %.

Method: Rice husk powder was preheated in oven at 110 ºC. Polypropylene was mixed with rice husk along with coupling agent and moisture remover in carefully weighed amount. Above mixture was mixed and preheated in the hand molding machine and finally collected in two cavity molds. Mold was kept in semiautomatic compression molding machine at the process conditions maintained below.

Processing temperature: 200 ºC, clamping pressure: 1.5 tons/inch^2, heating time: 15 min, cooling time: 20 min.

Sheets of 155 mm × 155 mm were prepared by above process. Manufactured sheet were tested from CIPET, Amritsar as per the standard procedures for tensile, modulus abrasion, impact strength. Tensile testing machine was supplied by M/S Lloyd, England (100 KN), gauge length was kept 50 mm and testing speed was fixed at 50 mm/min. Izod impact tester was supplied by CEAST, Italy, sample size was 63.5 mm × 12.7 mm having thickness 3.2 mm. Abrasion tester was made of Tabler Industries and sample size was 4″ × 4″ and weight of 500 g was applied on both ends. Hardness test was carried out in our laboratory.

RESULTS AND DISCUSSION

Results for various mechanical properties are tabulated in the Table-1 for studying the effect of coupling agent on the

TABLE-1
COUPLING AGENT *VERSUS* MECHANICAL PROPERTIES OF RHPP COMPOSITE

Property	Coupling agent (%)			
	0.3	0.5	0.7	0.9
Tensile strength (Kgf/cm^2)	108.40	149.80	154.70	175.10
Modulus (Kgf/cm^2)	28.45	30.45	30.82	31.54
Impact strength (Kgf/cm)	1.26	1.16	1.03	0.97
Abrasion resistance (mg/1000 cycles)	15.0	14.4	12.3	11.0
Hardness	73.25	75.25	75.88	78.13

rice husk polypropylene composites. It is observed that with increase in percen-tage of coupling agent from 0.3-0.9 %, tensile strength of RHPP composites increases due to better bonding compati-bility) between polypropylene and rice husk. Therefore titanate coupling agent is very effective in increasing the tensile strength of RHPP composites up to *ca.* 60 %, at the addition level of 0.9 % (Fig. 1). There had been increase in modulus from 28.45-31.54 kg/cm^2 (Fig. 2) by increasing the percentage of coupling agent, though increase is not as significant as tensile strength. It might be due to corresponding less change in elonga-tion compared with tensile strength (due to improved bonding between rice husk and poly propylene). Impact strength decrease from 0.126-0.097 Joules with increase in percentage of coupling agent. Decrease in impact strength is due to high stiffness owing to higher tensile strength noticed in RHPP composites. So, addition of coupling agent doesn't have positive result on impact strength as reported in Fig. 3.

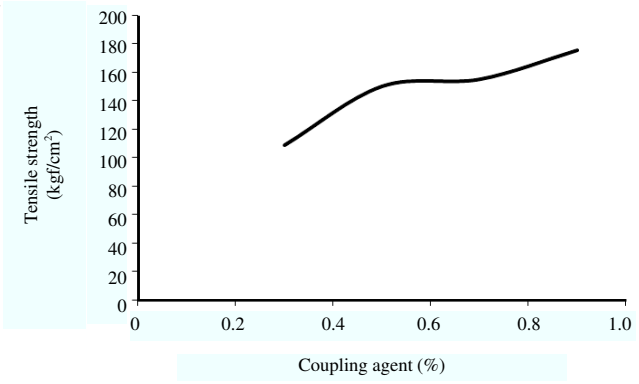

Fig. 1. Tensile strength *versus* coupling agent

Abrasion resistance and hardness values are reported in Figs. 4 and 5, respectively. Abrasion resistance decreases to 11 mg from 15 mg (per 1000 cycles), decrease in weight loss (good abrasion) is an indication of good abrasion resistance properties of RHPP composites. It may be due to better cohesiveness in rice husk and poly propylene owing to better bonding (high tensile strength). Hardness increases from 73.25 to 78.13 with increase in coupling agent percentage. This increase is justified since tensile is proportional to hardness value as reported in literature.

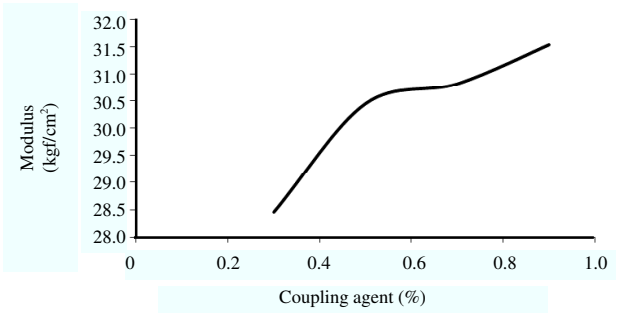

Fig. 2. Modulus *versus* coupling agent

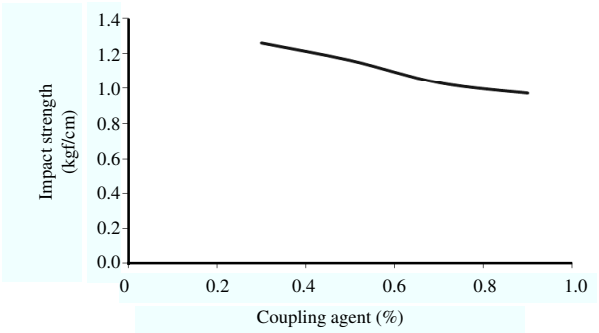

Fig. 3. Impact strength *versus* coupling agent

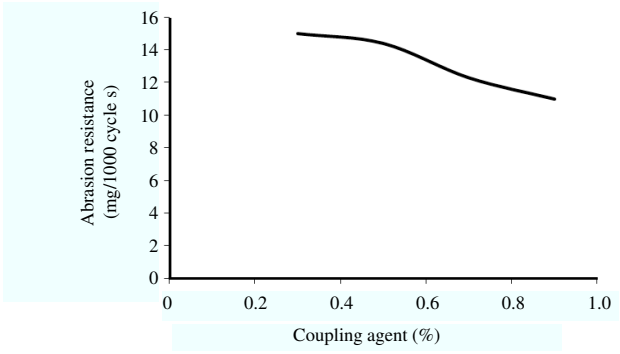

Fig. 4. Abrasion resistance *versus* coupling agent

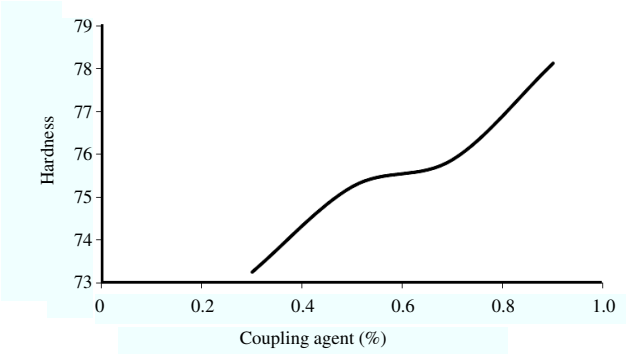

Fig. 5. Hardness *versus* coupling agent

Conclusion

Improvement in the mechanical properties of rice husk polypropylene composite is possible by using the titanate coupling agent. It enhance the modulus, hardness and abrasion properties of rice husk polypropylene composites, significant improvement in tensile strength of rice husk polypropylene composites (*ca.* 60 %) is possible by using the titanate. Improvement in impact strength is not possible by addition of titanate, therefore suitable impact modifiers can be used to obtain required impact strength in rice husk polypropylene composites.

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