International Journal of Mechanical Engineering and Robotics Research

ISSN 2278 – 0149 www.ijmerr.com
Special Issue, Vol. 1, No. 1, January 2014
National Conference on "Recent Advances in Mechanical Engineering" RAME – 2014

Research Paper

STUDY OF MECHANICAL PROPERTIES OF MEDIUM DENSITY FIBER BOARD COMPOSITES BASED ON VARIOUS RESINS IN COMPARISON WITH PARTICLE BOARD

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Polymer matrix composites have very wide range of applications. Medium density fiber board is a composite with wood fiber as reinforcement in resin as matrix. Composite samples were prepared using Phenol Formaldehyde (PF), Urea Formaldehyde (UF) and Melamine Formaldehyde (MF) resins as matrices separately for different resin glue system combinations with fibers of wood as reinforcement for different volume fractions. Mechanical and physical properties of these were studied and compared with particle board. Phenol formaldehyde based Medium density fiberboard showed excellent durability under humidity exposure and hence can be used for exterior applications. Urea Formaldehyde and Melamine Formaldehyde based Medium density fiber board were found suitable for indoor applications as it has less tolerance towards water. The research concluded that medium density fiber boards were found to have better properties over particle boards in both indoor and outdoor applications.

Keywords: Medium density fiberboard, Phenol Formaldehyde (PF), Urea Formaldehyde (UF), Melamine Formaldehyde (MF), indoor and outdoor applications

INTRODUCTION

Due to the rapid depletion of the solid woods and the difficulty in getting large flat panels, man learned to create wood products to suit his needs; these are called engineered woods, of which MDF (Medium Density Fiberboard) and particle boards are two examples. The basic idea for the use of these materials instead of wood is to compensate for anisotropy in strength of natural wood, to use wood of minor quality and wood waste of the wood working industry, to obtain better and more economical possibilities for the production of various shaped parts. The competitiveness and development of the wood working industry are of utmost importance for the development of thermosetting plastics. This industry is largest user of the urea-,

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melamine-,and phenol resins. Thermosetting resins which are widely used phenol formaldehyde resins, urea formaldehyde, melamine formaldehyde resins.

The strength of the adhesive bond formed by these thermosetting resins are attributed to several factors like high polarity, low viscosity etc. to improve specific properties additives are used like hydrophobic agents for water repellence, fungicides and insecticides for resistance of board towards termites and microorganisms, for flame retardancy ammonium phosphate, boric acid or borax is used.

In the present study resin of different molar ratio is prepared and their properties are optimized. MDF sample was prepared using the optimized resin and compared with particle board for various mechanical and physical properties.

METHODOLOGY

Resins of phenol formaldehyde, urea formaldehyde (UF) and melamine formaldehyde (MF) is prepared separately in 1:1.10 ,1:1.15, 1:1.20 molar ratios as per Brage Golding, (1959) and they are called with PF1, PF2, PF3, UF1, UF2, UF3, MF1, MF2, MF3 hereafter respectively.

These resins are tested for various properties like pH Value, solid content, viscosity, specific gravity, water tolerance, gelation time, formaldehyde content (Haslam and Willis, 1972).

Using the optimum resin obtained from above procedures, MDF of 12 mm thickness is prepared in laboratory conditions using wood fibre 600gm,resin 145 gms, wax emulsion 22 gms hardener(20% NH4Cl sol) 7.2ml by following the procedure given by BIS Handook(1995) with temperature of plates maintained between 145-155°C and pressure used 600psi. MDF of 12 mm thick thus prepared is cut as per the samples sizes required for various tests. Tests for mechanical properties and chemical properties tensile strength, modulus of rupture (interbond), density, water absorption, formaldehyde content, moisture content are carried out (B.I.S. Handbook,1995).

RESULTS AND DISCUSSION

Different Properties of phenol formaldehyde, urea formaldehyde and melamine formaldehyde resin are studied. Density increases with increase in PF molar ratio as shown by Figure 1. Byung-dae park *et al*.(2001) have found that synthesis parameter have an effect on the thermal behavior of phenol formaldehyde resin.

Gel time, ph value, total non-volatile solid content gets increased with increase in PF molar ratio as shown by Figures 2, 3 and 4.

Figure 1: Variation of Viscosity with Increase in P/F Molar Ratio in Different Resins

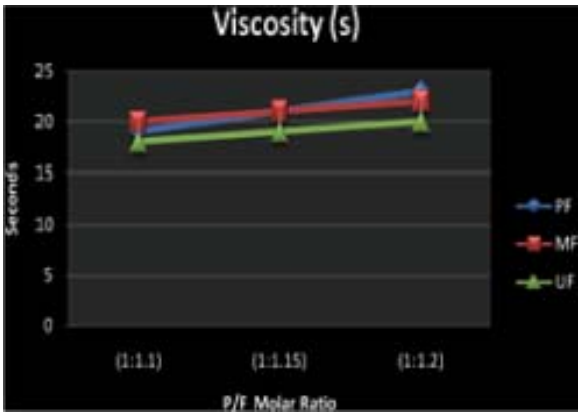


Figure 3: Variation of Gel Time with Increase in P / F Molar Ratio in Different Resins

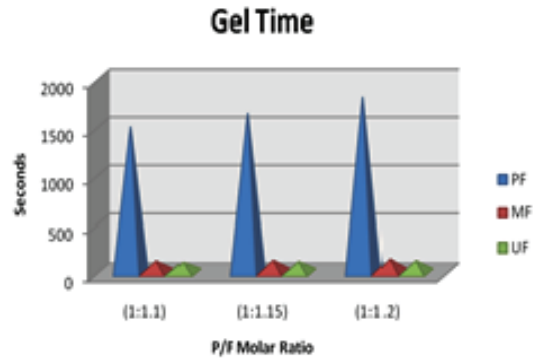


Figure 3: Variation of pH Values with Increase in P / F Molar Ratio in Different Resins

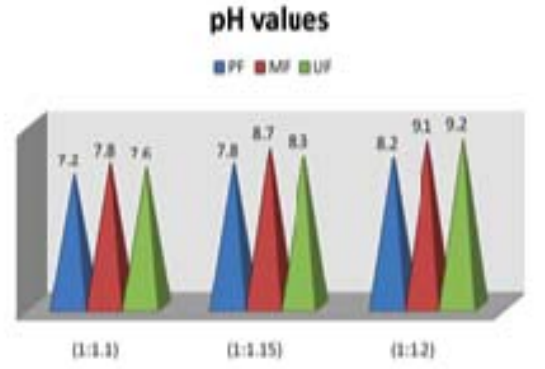
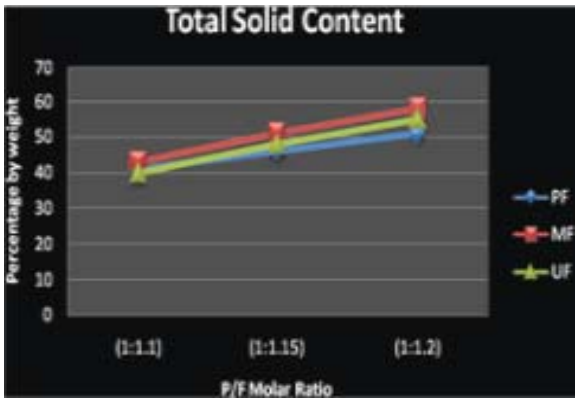
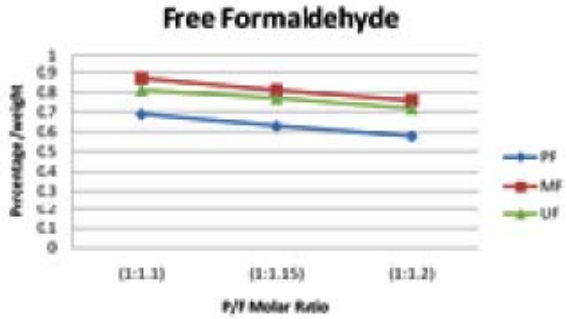


Figure 4: Variation of Total Solid Content Values with increase in P / F Molar Ratio in different Resins



Gel time, pH Value and total non volatile solid content are higher in MF resins compared to PF and UF resins. Free formaldehyde content increases with decrease in PF molar ratio as formaldehyde content in total gets reduced as shown by Figure 5.

Figure 5: Variation of Formaldehyde Values with Increase in P / F Molar Ratio in Different Resins



Optimum properties are of PF2, UF2 and MF2 resin with 1:1.15 molar ratios as all properties are seen increasing with increase in PF molar ratio except free formaldehyde content. But since free formaldehyde content causes serious harms to persons when exposed to it (Allan Hildesham *et al*., 2001) and over exposure may even lead to cancer it cannot be allowed beyond some standard values as per the country standards. Using this resin MDF samples of 12 mm thickness were prepared and tested for different properties and also compared with properties obtained for particle board of same thickness (Table 1). From table 1 we can see that internal bond strength given by modulus of rupture in MDF is about 50% higher than particle board. MDF has lower water absorption compared to particle board.

Table 1: Properties of MDF in Comparison with Particle Board

S. No.	Property	MDF Specimen 12 mm Thickness			12 mm Thick Particle Board
		PF	UF	MF	
1.	Density (kg/m^3)	810	795	800	610
2.	Moisture content (%)	5.2	6.72	6.00	8.00
3.	Water absorption 3% (max)2 hrs soak	2.5	2.85	2.9	4.00
	24 hrs soak	9.2	12.8	13.1	16.40
4.	Swelling in water (24 hrs)Thickness	2.4	5.6	5.8	7.10
	Length	0.24	0.31	0.32	0.41
	Width	0.23	0.33	0.33	0.37
5.	Modulus of Rupture (N/mm^2)	56.6	48.3	47.2	35.5
6.	Tensile strength perpendicular top surface (N/mm^2)	1.8	0.92	0.90	0.80
7.	Tensile strength perpendicular top surface (kg/cm^2)	275.6	235.4	223.3	180.1
8.	Formaldehyde content (mg/100gm of dry board)	10.1	36.2	38.4	–

The linear expansion due to general absorption indicates stability and durability of MDF is far in excess of particle board. Particle boards on long time exposure causes dampness due to high relative humidity's causes its decay adversely. MDF is more resistant to the attacks from termites and microorganism.

CONCLUSION

Ease of machining is much better in MDF compared to particle board since it consists of dense fine grained surface. The main difference between MDF and particle board is density as the former is a much denser product than the latter. The difference in density stems from how they are manufactured.

For the end-user, the main difference between particle boards and MDF is strength. The higher density of MDF makes it stronger and more resistant to breaking when under heavy loads. This is very important in making shelves that are going to hold heavy objects. Over extended periods of time, particle boards can begin to sag due to the consistent weight. MDF is also prone to sagging but is more resistant compared to particle boards.

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