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Different Percentage of Resin for Particle Board Manufacturing from ProsopisJuliflora

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ABSTRACT

There are three main components present in wood cellulose, hemicelluloses, and lignin. Lignin is a natural binder in tress; lignin percentage is less than cellulose and hemicelluloses in wood. During preparation of particle board glue application is needed as an artificial binder. For that purpose resin preparation is required to compile the differ layers of wood dust or chips this adhesive material is useful as a binder in particle board. The particle boards were prepared from 8 to 12 per cent resin content with 0.5 and 1.0 percent wax emulsion. Thickness of the board varied from 7.5 mm to 8.9 mm while, moisture content varied from 8.1 to 11.4 per cent. Density of the particle board varied from 0.61 to 0.76 g/cm3. Water absorption test of the boards for 2 hours and 24 hours soaking in water varied from 18.07 to 61.06 per cent and 35.72 to 84.57 per cent, respectively. Boards prepared form 11 per cent resin content with 0.5 per cent wax emulsion and 12 per cent resin content with 0.5 and 1.0 per cent wax emulsion met the requirement of IS specifications. Physical properties were examined as per the procedure laid down in IS: 2380 and IS: 3087.

Keywords: *Resin, Wood, Particle Board, Lignin*

INTRODUCTION

During the 1970s and early 1980s, *Prosopisjuliflora* was known as miracle tree because of its fast growth and wide adaptability. *Prosopisjuliflora* is an evergreen tree native to Mexico, South America, Central America and the Caribbean to India where it is still wide spread today primarily in dry low land region. *Prosopisjuliflors*, is a multi-purpose tree, which yields 10-15 tons of wood per acre in 2 years and 15-20 tons in 2 ½ -3 years' time. *Prosopisjuliflora* is also a source of bio-manure and vegetable oil. Its leaves are used as fodder for cattle feeding. The estimated availability of Prosopisjuliflorain India is around 20 lakh tons per year, out of which AP alone contributes 15-16 lakh tons and Gujarat 1-2 lakh tons.

The history of the first introduction of *Prosopisjuliflora* into India is about 130 years old. Introduction of the species was first seriously attempted in 1870 Owing to its fast growth and drought hardness, the species has since been introduced in many other part of India from the north-west to extreme southern part. The species proved its potential as versatile plantation forestry species from the very first introduction has been grown in highly saline area, alkaline soils, coastal area, sand dunes of the Thar Desert, in ravines of many north, central and south Indian rivers, and in dry and degraded grass lands.

Prosopisjuliflora has become acclimatized exotic in large part of arid and semi-arid tropical India. It is found especially in areas with 150-750 mm annual rainfall and maximum shade temperature of 40-45oC from north-west to south, the species is distributed from the state of Punjab to Tamil Nadu and in an east west direction, is found from Kutch region of Gujarat State to drier part of Orissa. The state where it mainly occur sis AP, Delhi, Haryana, Karnataka, MP, Maharashtra, Punjab, Rajasthan, Tamil Nadu and Uttar Pradesh .

Prosopisjuliflora fast growing, nitrogen-fixing and tolerant to arid conditions and saline soils . *Prosopisjuliflora* has grown up to height of 12 meters. Its stem is green-brown, sinuous and twisted with axial and strong thorns. Its bark is red-brownish and rough and the root system has a deep taproot that allows the tree to reach deep water tables.

Prosopisjuliflora has been the focus of a great deal of research in the past few decades (National Research Council, 1977 and

International Development Research Centre, IDRC, 1983). This species has been planted in many tropical countries, including south-east Asia and Africa as a shade tree for commercial crops, alley cropping or agro-forestry for wood production. *Prosopisjuliflora* is a multipurpose tree of great importance in the tropics region. This species were recognized as highly valued to the ecological remedy. It's capability of nitrogen fixation, rapid growth, and deep root system makes it very useful in reforestation, bioremediation, and soil conservation. It suppresses nature's grasses and stabilizes the soils. Under this perspective, the use of *Prosopisjuliflora* in soil restoration has been studied by several researchers. The survival and regeneration of *Prosopisjuliflora* are excellent and the shoots emerging from coppiced stumps showed progressive increase in their average height and diameter.

A Particle board is a board or sheet constituted from fragments of wood and other lignocellulosic materials, bonded with organic binders with the help of one or more agents like heat, pressure, humidity, catalyst, etc. The study and practices of science and technology of adhesive, plywood, laminated wood and other building boards and allied subject come under "composite wood". In India, three main types of wood based panel viz., plywood including block board, flush door and particle boards are manufactured. There is a considerable increase in demand for such products because such products have advantage over solid wood in addition to some of its physical and mechanical properties; they inherit from their main constituent wood.

Particle board is reconstituted constructional panel particularly developed as a substitute for natural constructional wood and is made from low grade waste woods or from certain agricultural ligneous wastes. In that respect, particle board assumes one of the greatest importances in the wood panel products industry from the point of view conservation of scarce forest resources in a country. Particle board offers a mean to utilize as much as the forest and industrial wood waste as possible because it is so tolerant of wood quality and a wide variety of species, both soft wood and hard wood can be used. There is no doubt that the particle board is going to stay for a long time due to plenty of raw materials, manufacturing properties and product properties. Particle board was first manufactured in Bremen, Germany in 1941. The raw material was dried spruce dust blended with 8-10% Phenol resins. The boards were produced in large sizes 3m x 2m with thickness varying from 4-25 mm. A high pressure of 80-100 kg/cm2 and temperature of 160 degree were used. Due to fine particles, the density of the board was too high ranging from 0.9 to 1.1 g/cc. In the year 1942, Ross and co-workers in Germany established a particle board unit in which beech veneer were chopped by using wing beater and urea formaldehyde (8-10%) as binder. The board was found useful in panelling and interior walls.

In India, the first particle board plant was set up in late 1950s at Sitapur in Uttar Pradesh by M/s Plywood products with the capacity of 1500 tones. There are presently about 12 wood based and agriculture lignocellulosic waste based particle board units in India with total installed capacity of 64,100 tones. Particle boards are now finding increased applications as building material besides furniture. India was rich in forest wealth having a huge land area under forests but unfortunately, the forest resources is depleting due to increase of population and other causes. The gap between supply and demand is increasing day by day, shortage of the raw material is being experienced in the country. In view of this some substitute in raw materials for solid has been developed. Composite wood like plywood, particle board, MDF, block board, etc., playing major role in providing one of the most important substitute for timber in various applications in furniture industries, building constructions, railways, automobiles, etc.

The manufacture of wood-based panels has been brought about by the ever increasing cost of logs and lumber, which in turn has caused managers of the world's forest resources to investigate ways and means of using trees more efficiently. Wood composites can utilize low grade logs such as thinning, bowed and twisted logs. They can also use wood waste material. All sawmills produce a lot of residue in the form of chips, sawdust and slabs. These residues can be utilized to manufacture many composites such as particle board.

Particle board is mainly used for structural purpose as well as substitute for solid wood. The major uses of particle board are as core material in furniture, store fixtures and laminates, sink tops and sliding doors. It is widely used in the manufacture of cabinets for TV sets, loudspeakers and tape recorder etc. Greater quantities of particle board are also used in the automobile construction, sports goods, and

packing cases and for various specialized uses for example bodies of buses, railway coaches, ship building etc. Due to low thermal conductivity and good acoustical properties, low density particle board is extensively used in lecture halls.

A large quantity of sawdust is available from the saw mills which is not finding any economic use and is mostly burnt as fuel. However, in some countries sawdust and planer shavings are important raw materials for manufacture of particle boards. It is possible to make particle boards from many species of wood in almost any form regardless of particle boards depend upon various factors such as wood species, size and shape of the particles, density of the raw material and the amount and type of resin used.

The problem of the shortage of the wood as raw material is becoming very severe day by day. *Prosopisjuliflora* growing in most part of the country which is easily available in large quantities is one such lignocellulosic wood material can be utilized for the preparation of the particle board.

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Material And Methods

Details of the material used and the procedure for preparation of resin for particle board employed during the course of investigation are as given below.

Experimental Details

Prosopisjuliflora as wood raw material was used for the preparation of particle boards. The particle boards were prepared from different resin content i.e. 8, 9, 10, 11 and 12 per cent. Similarly, the boards were also prepared with 0.5 and 1.0 per cent wax emulsion as a sizing agent. At each resin content , three particle boards were made i.e. without wax emulsion and with 0.5 and 1.0 per cent wax emulsion.

The particle boards were examined as per the procedure laid down in IS: 2380 and IS: 3087.

Chemical Raw Material

Chemical raw material namely phenol, formalin and sodium hydroxide (NaOH) were used for the preparation of phenol formaldehyde resin as an adhesive used for preparation of particle board.

Procedure for Preparation Phenol Formaldehyde Resin

1000 g of phenol was taken in a round bottom flask. Then 1200 g of formalin was added in the flask. The pH of whole solution was maintained at 9-9.5 by adding 50 g of NaOH dissolved in 100 ml of water. The round flask with solution was mounted on a heating mantle and observed till actual reaction started inside the flask. Actual reaction started when first time the bubbling was seen in the solution. The solution was refluxed for 30 minutes. The resin was kept for cooling. Cooled resin was analysed for suitability in making particle board.

Analysis of Resin

Solid Content of the Resin

This is the amount of the solid resin present in 10 ml of resin solution. 10 ml of phenol formaldehyde resin sample was taken in Petri-dish and kept in oven at 105 ± 30C for drying till constant weight. The solid content was determined by applying the following formula.

$$\text{Solid content (\%)} = \frac{\text{Weight of the dry resin}}{\text{Weight of liquid resin}} \times 100$$

$$\text{Solid content (\%)} = \frac{(Z - A)}{(B - A)} \times 100$$

Where,

A = Weight of the petri dish
B = Weight of the petri dish + resin
(B – A) = Weight of the resin
Z = Oven dried weight of the resin + petri dish
(Z – A) = Weight of the dry resin

Ash Content of the Resin

This is the amount of the inorganic material present in 100 g of the solid resin. 100 g of phenol formaldehyde resin sample was taken in silica crucible covered with lid and placed in muffle furnace.

The resin was ashed at 3000C for about an hour, the temperature was increased slowly up to 700-

7400C and heating at this temperature was continued for 2 hours.

After cooling, the silica crucible were taken out from muffle furnace and placed in desiccators. The weights of silica crucible with and without ash were taken and percentage of ash was calculated.

$$\text{Ash content (\%)} = \frac{\text{Weight of the ash}}{\text{Weight of solid resin}} \times 100$$

$$\text{Ash content (\%)} = \frac{(C - A)}{(B - A)} \times 100$$

Where,
A = Weight of the empty silica crucible
B = Weight of the empty silica crucible + dry resin
(B -A) = Weight of the dry resin
C= Weight of crucible + resin after furnace
(C -A) = Weight of ash

Specific Gravity of Resin

Specific gravity of resin is the ratio of weight of resin to the weight of water. The specific gravity of phenol formaldehyde resin was determined using specific gravity bottle of 10 ml capacity. The specific gravity bottle was weighed as empty, with resin and water. Specific gravity of the phenol formaldehyde resin was calculated with the following formula.

$$\text{Specific gravity of resin} = \frac{\text{Weight of resin}}{\text{Weight of water}}$$

$$\text{Specific gravity of resin} = \frac{(Z - X)}{(Y - X)}$$

Where,
X = Weight of the empty specific gravity bottle
Y = Weight of the specific gravity bottle with water
(Y – X) = Weight of the water
Z = Weight of the specific gravity bottle with resin
(Z – X) = Weight of the resin

Results of Resin Analysis

The result of resin analysis is appended in Table1.

Table1. *Result of analysis of PF resin*

Solid content	41%
Specific gravity	1.028
Ash content	4.3%

Estimation of Amount Of Resin Required For Particle Boards

Example for calculation
Weight of dried particle - 500 g
Solid content of PF resin - 41%
Suppose,

$$\text{Calculation for 8\% resin content} = \frac{500 \times 8}{100}$$

$$= 40 \text{ g}$$

Since, resin is having 41 per cent solid content
Therefore,

$$\text{Weight of resin} = \frac{100 \times 40}{41}$$

$$= 97.56 \text{ g}$$

Weight of resin / board = 97.56 g (i.e.8 % resin content)

Accordingly, the amount of resin required for preparation of particle board was worked out for 9, 10, 11 and 12 per cent of resin content and as given in the Table 2.

Table2. *Amount of resin required for preparation of particle boards*

Sr. No.	Resin content (%)	Weight of resin required per board (g)
1	8	97.56
2	9	109.75
3	10	121.95
4	11	134.14
5	12	146.34

Results And Discussion

The results emerging from the present investigation entitled, Different Percentage of resin for particle board manufacturing from Prosopisjuliflora are presented in this chapter. The data obtained from the studies were

Examined as per procedure laid down in Indian standard specification (IS: 3087-1985) . The experimental results obtained during the course of present investigation in respect of physical properties of particle boards have been discussed as under.

Table1. *Physical properties with respect to thickness and moisture content of particle boards prepared from Prosopisjuliflora*

Sr.No.	Amount of resin used (%)	Thickness of the board (mm)	Moisture content of the board (%)
1	8	8.9	11.4
2	8*	8.9	10.9

3	8**	8.8	10.6
4	9	8.8	11.1
5	9*	8.7	10.7
6	9**	8.6	10.4
7	10	8.7	10.6
8	10*	8.5	10.2
9	10**	8.3	9.9
10	11	8.5	10.1
11	11*	8.4	09.7
12	11**	8.1	09.3
13	12	7.9	09.4
14	12*	7.7	08.7
15	12**	7.5	08.1
	Requirement of IS:3087 (1985)	-	**5 to 15**

** With 0.5 per cent wax emulsion.*

*** With 1.0 per cent wax emulsion.*

Table2. *Physical properties with respect to density of particle boards prepared from Prosopisjuliflora*

Sr. No.	Amount of resin used (%)	Density (g/cm^3)
1	8	0.61
2	8*	0.62
3	8**	0.63
4	9	0.63
5	9*	0.64
6	9**	0.64
7	10	0.64
8	10*	0.66
9	10**	0.67
10	11	0.66
11	11*	0.67
12	11**	0.70
13	12	0.72
14	12*	0.74
15	12**	0.76
	Requirement of IS:3087 (1985)	**0.5-0.9**

Table3. *Physical properties with respect to water absorption (2hrs) of particle boards prepared from Prosopisjuliflora*

Sr. No.	Amount of resin used (%)	Sample weight (gm)		Water absorption 2 hrs (%)
		Initial	Final	
1	8	13.74	22.13	61.06
2	8*	13.75	21.16	57.67
3	8**	13.77	20.95	52.14
4	9	13.82	21.30	54.12
5	9*	13.83	20.70	49.67
6	9**	13.85	19.90	43.68
7	10	13.94	20.30	45.62
8	10*	13.96	19.37	38.75
9	10**	13.99	18.35	31.16
10	11	14.11	18.84	33.52
11	11*	14.14	17.67	24.96
12	11**	14.18	17.32	22.14
13	12	14.28	17.82	24.78
14	12*	14.30	17.32	21.11
15	12**	14.33	16.92	18.07
	Requirement of IS:3087 (1985)	-	-	**≤25**

Table4. *Physical properties with respect to water absorption (24 hrs) of particle boards prepared from Prosopisjuliflora*

Sr. No.	Amount of resin used (%)	Sample weight (gm)	Water absorption 24 hrs (%)

		Initial	Final	
1	8	13.74	25.36	84.57
2	8*	13.75	24.63	79.12
3	8**	13.77	23.87	73.34
4	9	13.82	24.29	75.75
5	9*	13.83	23.55	70.28
6	9**	13.85	22.59	63.10
7	10	13.94	22.89	64.20
8	10*	13.96	22.21	59.09
9	10**	13.99	21.28	52.10
10	11	14.11	21.72	53.93
11	11*	14.14	21.05	48.86
12	11**	14.18	20.36	43.58
13	12	14.28	20.83	45.86
14	12*	14.30	20.19	41.18
15	12**	14.33	19.47	35.87
	Requirement of IS:3087 (1985)	-	-	**≤ 50**

Table5. *Physical properties with respect to length swelling (2 hrs) of particle boards prepared from Prosopisjuliflora*

Sr. No.	Amount of resin used (%)	Sample size (mm)		Length swelling 2hrs (%)
		Initial	Final	
1	8	50	50.22	0.44
2	8*	50	50.21	0.42
3	8**	50	50.20	0.40
4	9	50	50.21	0.42
5	9*	50	50.20	0.40
6	9**	50	50.19	0.38
7	10	50	50.20	0.40
8	10*	50	50.18	0.36
9	10**	50	50.16	0.32
10	11	50	50.19	0.38
11	11*	50	50.17	0.34
12	11**	50	50.16	0.32
13	12	50	50.17	0.34
14	12*	50	50.15	0.30
15	12**	50	50.14	0.28
	Requirement of IS:3087 (1985)	-	-	**0.50**

Table6. *Physical properties with respect to Thickness swelling (2 hrs) of particle boards prepared from Prosopisjuliflora*

Sr. No.	Amount of resin used (%)	Sample size (mm)		Thickness swelling 2hrs (%)
		Initial	Final	
1	8	8.9	11.00	23.59
2	8*	8.9	10.91	22.58
3	8**	8.8	10.72	21.81
4	9	8.8	10.73	21.93
5	9*	8.7	10.33	18.73
6	9**	8.6	10.08	17.20
7	10	8.7	10.28	18.16
8	10*	8.5	09.70	14.11
9	10**	8.3	09.41	13.37
10	11	8.5	09.70	14.23
11	11*	8.4	09.22	09.76
12	11**	8.1	08.61	06.30
13	12	7.9	08.59	07.87
14	12*	7.7	08.16	05.97
15	12**	7.5	07.88	05.06
	Requirement of IS:3087 (1985)	-	-	**≤10.00**

CONCLUSION

From the above study, it is concluded that Prosopisjuliflora can be utilized for producing medium density particle boards. The boards produced with phenol formaldehyde resin confirmed to IS specification for medium density general purpose particle board. In this investigation varying amount of phenol formaldehyde resin were used for making particle boards from Prosopisjuliflora. As the amount of resin increased, density of the boards was increased while, moisture content, water absorption, length and thickness swelling properties were reduced. Satisfactory boards were prepared by using 11 and 12 per cent phenol formaldehyde resin met the requirement in respect of IS: 3087 (1985).

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