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Research paper

A Review on Preparation of Medium Density Fiberboard with Different Materials

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Abstract

The number of papers had reviewed on natural composites recently, but related to medium density fiberboard there is no any review. So this paper completely concentrates on the preparation of medium density fiberboard. The MDF plays an important role in wood industries for manufacturing the furniture's and interior design at home. Generally MDF was prepared with fibers and with some synthetic resins, additives if necessary. There were various fibers and resins used to prepare the board for different applications. Here this paper describes about the various types of materials like wheat straw, banana stem, rubber wood, etc., and various resins like urea formaldehyde, phenol formaldehyde, etc., were used for the preparation of MDF. The main purpose of discussing about MDF preparation was to know different methods of making the board. This will helps the researchers for further research on MDF material selection and processing of board making.

Keywords: *Medium density fiberboard, urea formaldehyde, additives, resin*

1. Introduction

Generally, when the wood materials are used as source, then the properties of the fiber board like strength, structure and composition will be considered has the basic one because the panel occupies a maximum volume of the fiber. Generally, the woods were basically formed of two layers which were sapwood and Heartwood. The sapwood layers were moist, light and living layer which gives nutrients from its root to leaves. Next was Heartwood, this layer was dead, but darker and harder, due to resins or gum formation which blocked all. Then the wood was classified into two, based on leaves fall, which were hardwood and softwood. The hardwood was deciduous tree. e.g., oak, teak, walnut, etc. The softwood was coniferous trees. E.g., pine, redwood, etc. But both the wood materials was used for furniture making and decorative works. Generally any type of plant was made of fibers. The fibers were classified into two, namely insoluble fiber and soluble fiber. The basic characteristic of insoluble fiber was, it does not dissolve in water, but it has the capacity to absorb it. But soluble fibers will dissolve in water and it forms like a kind of gel. The insoluble fibers consist of cellulose, hemicelluloses and lignin. Generally in the wood cellulose contains 60 to 70%, hemicellulose contains 15 to 20% and remaining lignin. The cellulose and hemicelluloses were fibrous bulk of a tree and lignin which acts as adhesives that holds the fibers together.

The soft woods were used for making MDF. Medium density fiberboard was made of lignocellulosic fibers and were mixed with a synthetic resin or any suitable bonding substance that are combined together by applying pressure and heat. Generally medium density fiberboard has good properties in surface finish and density, so the board was commercially used in wide application in household purpose. With these, the board was used for making the furniture and molding because the material has overall moderate density, straight edged composite and good resin contact.

Moreover, thin plywood and other hardboard can be replaced by medium density fiberboard.There were major purpose of doing research on the MDF was its application in interior design, package box making and good surface finish. Machining process can be done very easily on this board. Due to good surface finish on the board, painting and varnishes can be done. This board was very comfortable in doing design work, making drills and polishing on the surface. The utility of MDF was greatly increased in recent days. Nowadays, the MDF was made with different materials like recycled paper, carbon fiber, glass particle, scrap, bamboo, etc. While making the MDF board, resin was used for hardening the fiber. This was selected based on the properties and mostly used urea-formaldehyde, phenol formaldehyde and melamine. These resins were thermosetting material and have a property of high hardness.

2. Selection of Different Materials

All type of wood was composed of cellulose, lignin, hemicelluloses, and minor amounts (usually less than 10%) of extraneous materials contained in a cellular structure. Based on this, composition and structure, the characteristics of wood will be hard or soft, then heavy or light, then stiff or flexible. Medium density fiberboard (MDF) is a generic term for a panel primarily composed of lignocellulosic fibers

and compact density throughout the panel. Here the authors had selected the material based on the lignin properties, based on the availability of the materials and some peculiar advantage of the fiber. For some example, rubber wood is highly susceptible to bio deteriorating organisms such as insects and fungi because of its high starch and sugar contents. Similarly banana fiber has specific strength and it makes light weight composites. There were different types of material used for the preparation of MDF like Wheat, soybean straw, Straw, wood mixture, Empty fruit bunch of oil palm, Bagasse fiber, etc.

3. Preparation of Medium Density Fiberboard

Wood or any other lignocellulosic material shall be cut into small chips/particles on a suitable chipping machine. These chips shall be steamed and defibrated in the suitable defibrating machine. These fibers, thus produced shall be dried in flash dryers and blended with resin and wax. The blended fibers shall then be formed into mats by air felting and pressed into panels by passing into the press under controlled heat, pressure and time conditions.

Ayrilmis N et al (2011) has explained about the preparation of MDF with the rubber wood fiber as the main source. In this, he has prepared the fiber by thermo-mechanical refining process without any chemicals. This fiber was measured by oven dry weight, which was 2-3% and then 50% of urea formaldehyde resin were used as an adhesive and 20% of ammonium chloride were used as hardener in the solid content. These fibers were treated for 15 to 30 min under the pressure with the temperature of 120 to 180 ºC. After completing all this process, the fiber was kept in rotary drum, then urea formaldehyde were added using air- atomized spray at 11% based on the weight of the fiber and 1% of hardener were added based on the resin. These were formed into the mat on aluminum plate and then cold pressed to reduce the height to make dense. Then these were electrically heated with the press under the temperature of 160 ºC. At last, the panel was papered for testing the properties.

Norul Izani MA et al (2013)here an empty fruit bunch of oil palm was considered as the source for preparing the MDF panel. At first EFB fiber was obtained by treating the EFB. Treatment of EFB fiber to remove residual oil was carried out by soaking in 2% NaOH for 30 min at room temperature and boiled in water at 100 °C for 30 min or a combination of the two (Ridzuan et al. 2002). Treated EFB samples were filtered out and washed several times with distilled water until free from NaOH (for the absence of alkalinity). Then the EFB fiber was produced through thermo-mechanical process. These fibers were mixed with phenol formaldehyde resin in the rotating drum with the help of a pneumatic spray gun. The fiber was taken with oven dry weight measurement. Then the mat was prepared in the wooden mold manually. These mats were cold pressed and the hot pressed

under the temperature of 175 ºC with the pressure of 160kg/cm for 5 min. Finally, these panels were taken for testing.

Yuliati Indrayani, et al. (2015) in these, pineapple leaf fiber was taken for preparation of MDF. The fiber was cut into 35cm long and dried to 5% moisture content. These fibers were mixed with two types of phenol formaldehyde which was low molecular weight PF and high molecular weight PF. Here there were no additives used. But resins were mixed with water and methanol for forming an impregnation solution of resin, in order to reduce the viscosity. Then the fiber was blended with impregnation solution and made into the mat by hand forming. The mat was hot pressed for 10min at the temperature of 160 ºC with the pressure of 4.5 MPa. Then the panel was used for testing.

Alireza ashore et.al (2009)Here bagasse fiber was used as source material to produce MDF. These were taken and dried to get 0.4-.08mm particle size. Then the particle was converted to fiber by refiner mechanical pulping process. Later, these fibers were dissolved with an MA (Maleic anhydride), which was 10% of oven dried fiber and 4.5 ml of acetone. The mixture was mixed thoroughly and placed inside the fume hood, then acetone was evaporated and heated for 180 min at 110 º C.Then the fiber was dried to 2-3% on oven-dry weight to reduce the moisture content. Then the fiber was mixed with urea formaldehyde resin using drum blender. These were made into the mat and pressed without heat transfer. After then by electrically heated and pressed using a hydraulic press under the pressure of 30kg/sq m for 4 min. Later the panel was made for testing the properties of MDF.

MD. Mamunur Rashid et.al (2014)In this, bananas stem and mid rib of leaf was used for the preparation of medium density fiberboard. Here both stem and mid rib were taken and dried by air, then these were chopped into 1 inch and submerged in the sodium hydroxide solution. Then these were washed to remove the chemicals. Later, both types were taken in a single disc refiner and made into fiber. Then the fiber was dried in an oven at 103 ºC to reduce the moisture content and kept in a plastic bag.Then the fiber was blended with urea-formaldehyde with 20% on the dry weight basis. These were taken and made into mats for the MDF panel in the iron frame. The mat was hot pressed for 8 min with the pressure of 3N/sq. and the temperature of 170 ºC. After these, the panel was taken for testing the properties of MDF.

Hossein Yousefi (2009)In this, canola straw was used to prepare the medium density fiberboard, which was taken from north of Iran and adhesive used with straw was urea-formaldehyde. At first the raw straw was taken and fiber was processed, then it was chopped and soaked in tap water for 1 hour and steamed for 2, 5 and 8 min. Here the pressure and temperature was 8 bars and 170 ºC respectively. Later the straw was taken to an atmospheric refiner for pulping. Then the pulp was dried to remove the moisture content up to 2 to 3% from the convective oven at 100 ºC. Finally the fiber was taken into drum blender with the speed of 20 rpm and resin was sprayed, based on weight percentage. Then the mat was prepared and materials were placed, based on the shape to have the board. The mat were pre-pressed and post-pressed with the pressure of 32kg/cm2 at 170 ºC for 6min and cut into the ASTM standard for testing the properties.

Raquel Arevalo et.al (2015)Here cellulose fiberboard was prepared without any binders and adhesives. In this, the flax fibers were taken and supplied by EKOTEX co Ltd (Japan), which contains 70% cellulose, 16% hemicellulose and 2% lignin. Initially the fiber was 20mm length, which was cut with the help of salted valley beater and fibrillated in the water. Then the pulp was pressed with the partial dewatered material. These were again pressed at room temperature with 90% water content. Later pulp was pressed at 10 bars with room temperature for the formation of interfiber interaction. In this, water content was further reduced to 50%. The precursor cake was formed by hot pressing for the temperature of 140 ºC to dry the water content up to 3%. Now the lignin content was low, but that makes plasticization for self-binding mechanism. To avoid warpage, the pulp cake was placed between aluminium plate and glass fabrics. Finally the cake was hot pressed with 40 and 80 bars at a temperature of 140 ºC for 25 min, then these were taken for testing the properties of the board.

Salim Hiziroglu et.al (2008)In this, bamboo and rice straw were chopped into very small pieces and defibrated using at a pressure of 0.75Mpa and at a temperature of 165 ºC for 2 mins. Then the fibers were dried and maintained with 5% moisture content. In the rotating drum, the dried fiber, 9% of urea formaldehyde resin and 0.5% of wax were added and mixed thoroughly. These were placed in the panel of 35cm X 35cm and compressed at a pressure of 5MPa for 6 mins and at a temperature of 160 ºC.Similarly, other panels were

made for 15cm X 15cm and decorated with melamine and urea formaldehyde on the surface. These were compressed with a pressure of 10kg/cm^2 at a temperature of 110 ºC. Then the samples were taken for finding the roughness test.

H.A.Aisyal et.alHere kenaf cone was taken and cut into 2-4cm with the help of refiner, which was equipped and runs at a speed of 5000 rpm with a diameter of 300 mm refiner plate. Then these were refined at a pressure of 3,5and 7 bars for 5min and dried in an oven. The fibers were measured randomly using stereo microscope. Later the fibers were mixed with 12% urea formaldehyde resin with the help of a rotary drum blender and made a mat of 300 mm X 300 mm in 10mm thickness. Finally the mats were pressed with the temperature of 175 ºC at a pressure of 3MPa for 5mins. Then the samples were used to test the properties.

Md. Nasir et.al (2013)In this, the rubber wood fibers were considered as a source material, which was washed and air dried. Then the fiber was calculated to measure the lignin content. The laccase enzyme was used to prepare the fiber board, for the enzyme activity. The fiber was taken up to 200 gms and suspended in deionized water to prepare the solution in the rotary reactor for stirring at a temperature of 25 ºC with controlled PH level at 5. Later the enzyme was mixed to obtain ligin oxidation. After the reaction, the fiber was filtered and dried.

Ligin contained solution was air dried in an oven at a temperature of 70C and again heated below 100 ºC for 5 hrs to become solid content. Finally, the fibers were dried added with concentrated orgnoslavligin, which acts as adhesive were mixed in a rotating drum. Then urea formaldehyde resin was sprayed with the mixture in the drum. The mat was prepared with the dimension of 200 X 200 mm and hot pressed for 40 mins at a temperature of 180 ºC and at a pressure of 5 MPa. The mat was cut to test the properties of the material.

Table 1: selection of different materials and adhesives by different authors

S.NO	Author et.al	Materials	Adhesives	Additives
1	X.philip Ye	Wheat, Soybean straw	Urea formaldehyde	No
2	Hudaverdi eroglu	Wheat straw, Straw wood mixture	Formaldehyde	Ammonium chloride
3	Nadir ayrilmis	R. ponticum wood	Urea formaldehyde	Ammonium chloride
4	Zawawi ibrahim	Oil palm trunk	Urea formaldehyde	No
5	Ma norul izani	Empty fruit bunch of oil palm	Phenol formaldehyde	No
6	md.mamunau rashid	Banana stem and Midrib of banana leaf	Urea formaldehyde	No
7	Alireza ashori	Bagasse fiber	Urea formaldehyde	No
8	s.nami kartal	Pine, European oak, beech	Urea formaldehyde	Wax, Ammonium chloride
9	Md nasir	Rubber wood fiber,	Urea formaldehyde	No
10	Yuliati Indrayani	Pineapple Leaf Fiber	Phenol formaldehyde	No
11	Richard J.T. Lin	Pinus radiata D. Don	Yes	No
12	Nadir Ayrilmis	Eccentric pine stem woods	Urea formaldehyde	Wax, Ammonium chloride
14	S.mahzan	Recycled rubber, Coconut coir	Polyurethane	No
15	Mohammed Nasir	Enzyme treated rubberwood fiber	Organosolv lignin	No
16	Hossein Yousefi	Canola straw	Urea formaldehyde	No
17	Raquel Arevalo	Flax fiber	No	No
18	R.Hashim	rubberwood fibre	Urea formaldehyde	sodium aluminat, zinc borate and aluminium trihydrate
19	Salim Hiziroglu	bamboo and rice straw	Urea formaldehyde	wax

R.Hashim.et.al (2009)Here the board was prepared from rubber wood fiber and with 15% of oven dry weight of urea formaldehyde. The board was prepared with flame retardant, which contains sodium aluminate, zinc borate and aluminium rehydrate. The mats were prepared at a temperature of 180 ºC for 10 mins and at a pressure of 12 N/mm^2. Finally the boards were cut into IS STD pieces for testing the properties.

Derya Ustaomer.et.al (2009)In this, the author has considered commercial MDF, which were treated with different boron compounds like boric acid, sodium perborate tetra hydrate and borax. All these solutions were mixed with fibers and later dried through the oven. Then, these fibers were rotated inside the drum with spraying resin. Finally the mat was made and pressed with a pressure of 30kgf/cm^2 for 5mins at a temperature of 190 ºC and tested the surface properties of the material.

Nadir Ayrilmis.et.al (2010) In this, the author has taken R.Ponticum woods, which were converted into small chips and then into fibers. These fibers were refined through thermo-mechanical process.

The panel was made with this mixture with the addition of ammonium chloride, which acts as a hardener. Then the panel was hot pressed at a temperature of 200 ºC for 240 sec with a pressure of 4 N/mm^2. Finally, these were cut into pieces for testing the properties.

Soren Halvareon.et.al (2009) Here wheat straw was taken and converted into very small size through hammer milling. These were pretreated with hydrogen peroxide, diluted sulphuric acid and calcium chloride for activating the fibers, increase its moisture content and to improve the water repellant respectively.

Here resin was used to prepare the board. The refined fiber was processed in a pressure of 0.7 MPa with the rotational speed of 1500 rpm in a defibrator. The mat made in a dimension of 500 mm X 600 mm and then pressed for 1 min at a pressure of 1 MPa. The board was made to a thickness of 6mm and pressed at a temperature of 200 ºC for 1.5 min. Finally, this was cut into standard size for finding the properties.

4. Conclusion

This review will help the researcher for further preparation of medium density fiberboard. The materials can be selected based on the characteristics and availability for making the board. Mostly, the preparation of MDF was same for all materials and authors have used the same method.

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