

Particle board density and surface quality

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Abstract – In this study, density and surface layer properties affecting particle board quality were examined and a compilation was made with the latest studies. This study compiles critical information regarding density and chip quantity, significant parameters in the production of particle board. Particle board, a composite material derived from wood residues, offers the advantage of containing fewer wood defects than solid wood. Its ability to be customized in terms of size and density renders it superior to solid wood material. Over the last five decades, particle board production and utilization have seen a remarkable surge, and this trend is anticipated to continue. Meeting the growing demand necessitates the development of low-density particle board with robust mechanical and physical properties, making it imperative for further research in this domain. This not only enhances competitiveness in global board production but also contributes to the preservation of ecological balance. The amount of wood used on the particle board surface also affects the sanding allowance. Removing large amounts of wood chips from the plate surface during surface calibration deteriorates the surface quality. For this reason, the amount of wood used on the surface and the sanding thickness are important in particle board production. The quality of particle board should be improved by conducting more research on this subject.

Keywords – Particle Board, Surface Layer, Density, Wood Product, Forest

I. INTRODUCTION

The rapid increase in human population has also led to an increase in the consumption of forest products. The increase in wood raw material consumption has increased the pressure on forests [1]. For this reason, the ecological balance has been negatively affected. Developments especially after the industrial revolution have caused people's consumption habits to change. Environmental concerns have shaped people's understanding of consumption. People have started to prefer more ecological and environmentally friendly products [2], [3]. In this context, forest products production and marketing strategies have been shaped to protect the ecological balance. In particular, wood raw material was used in the most efficient way. For this purpose, wood residues and all kinds of ligno-cellulosic materials have begun to be used in forest products [4], [5].

Producing more environmentally friendly products also means protecting natural resources. In this context, production aimed at protecting forest resources comes to the fore. Conscious consumers also pay attention to the interactions of the products they purchase with the environment before production and after consumption [6], [7] (Fig. 1) The extent to which the wood material used in the furniture they purchase affects forest resources attracts the attention of consumers and becomes a subject of study for forestry industry.



Fig. 1 Costumers purchasing habits

Forest Stewardship Council (FSC) issues certificates for sustainable forest products to companies operating in the forest industry (Fig. 2). The FSC is often regarded as the leading forestry certification program, established by environmental organizations in 1993. It is viewed as strict by industry groups and criticized as too lenient by some environmentalists. FSC places a strong emphasis on environmental health and imposes stricter criteria compared to the Sustainable Forestry Initiative (SFI), particularly in terms of limiting clear-cutting and chemical pesticide use.



Fig. 2 Wood that is stamped with the Forest Stewardship Council (FSC) logo has been harvested sustainably, image: Coastal Treated Products Company

The forest products sector is trying to meet its increasing production with increasing wood production in state forestry department. This results in the production of trees in the forest before the administrative period is completed. Wood raw material that is not produced from forests using appropriate management techniques causes the forest areas to decrease.

The psychological pressure on forestry department in our country to increase their wood production is increasing. In order to reduce this pressure, industrial plantations are being built with

fast-growing forest trees to meet the wood raw material needed by the industry in our country and around the world. In addition, the need for forest products is tried to be met with wood composite products [8]–[10].

Today, one of the most produced wood composite materials in the world and in our country is particle board [11]. Particle boards are frequently preferred in the furniture industry due to their features such as having fewer physical defects than solid wood material and being able to be produced in desired sizes [12]. Especially for kitchen cabinet, wardrobe, dining table, coffee table, bookcase, etc. The construction of products has become easier with the use of chipboard. The fact that it can be found in the desired color and pattern and that surface treatments are not required has led manufacturers to use particle board in the furniture industry [13], [14]. For this reason, there has been a significant increase in chipboard production in our country in the last 50 years.

While chipboard manufacturers compete with each other, this has led to an increase in chipboard product diversity and quality. Board manufacturers have increased their production capacities significantly in the last 20 years in order to maintain their market dominance. The increase in production capacity has caused plate producers to compete in the purchase of wood raw materials. As a result, the wood production pressure on state forestry department has increased, causing the enterprises to produce at full capacity. What can be done regarding wood production is limited to the amount of forest resources and this limit has been reached. For this reason, board manufacturers are looking for new ligno-cellulosic materials that can replace wood raw materials in particle board production. However, ligno-cellulosic materials used other than wood are not as high quality as wood materials. This reduces the competitiveness of companies.

For this reason, manufacturers have tried to overcome the wood raw material problem by producing low-density particleboard by using less wood raw material. Low density plate production also has some disadvantages. For example, low surface vertical adhesion resistance and screw retention resistance, and high thickness swelling in humid environments can be counted among the disadvantages of low-density chipboards.

One of the most important disadvantages of low-density boards is errors such as color fluctuations and glue stains that occur during surface coating. In order to eliminate these errors, the surface density of the boards must be kept at the highest possible level. The easiest way to achieve this is to increase the amount of fine chips used in the surface layer. This results in the use of more raw materials. For this reason, the highest surface density must be achieved with the minimum use of wood raw materials. To achieve this, the amount of chips used in the surface layer and the layer thickness cleaned from the plate surface after the sanding process must be adjusted in the best possible way.

II. DENSITY AND PARTICLE BOARD RELATIONS

Particle board density is one of the most important factors affecting quality. When the board density decreases, its mechanical properties decrease. Since the amount of glue is determined according to the amount of chips in board production, decreasing density also means decreasing the amount of glue. For this reason, the mechanical and physical properties of the boards that use less glue decrease.

Density distribution in the direction of the thickness of the particle board is important. To determine the density distribution, the profile density is determined and displayed graphically.

Previous research has yielded valuable insights into the qualitative impacts of various characteristics of raw materials, such as furnish configuration, compressibility, moisture content and its distribution, as well as the hot pressing conditions, encompassing factors like the type of press, pressing temperature, closing speed, applied pressure, and pressing duration, on the development of density profiles (Fig. 3) in particleboards. Notable academic works in this domain include those by Suchsland and Woodson [15] and Strickler [16].

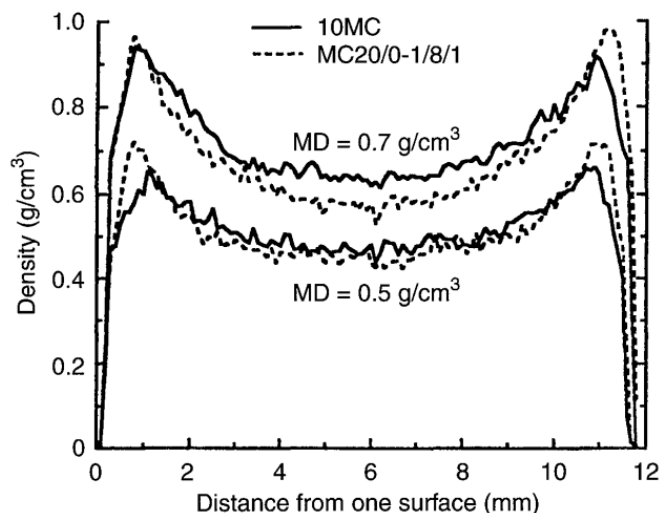


Fig. 3 Density profile of particle board [17]

Without glue and low-density particle board production studies were also carried out. Xu et al. studied about the manufacture and properties of low-density binderless particleboard from kenaf core and reported that the low-density kenaf binderless particleboards had good mechanical properties and dimensional stability relative to their low board densities. The board of 0.20 g/cm^3 density with a 10-min treatment time produced the following values: modulus of rupture 1.1 MPa, modulus of elasticity 0.3 GPa, internal bond strength 0.10 MPa, thickness swelling in 24 h water immersion 6.6%, and water absorption 355%. The thermal conductivity of the low-density kenaf binderless particleboards showed values similar to those of insulation material (i.e., rock wool), and the sound absorption coefficient was high. In addition, the boards are free from formaldehyde emission. Kenaf core appears to be a potential raw material for low-density binderless panels suitable for sound absorption and thermally resistant interior products.

Today, the production of particleboard with low density and high mechanical and physical properties is an important issue. Researchers are carrying out important studies on this subject and significant developments have been made in this regard. The sustainable use of wood raw material and the production of boards of the highest quality with the least amount of wood raw material mean the protection of forests.

III. SURFACE QUANTITY AND QUALITY OF PARTICLE BOARD

Particleboard is widely used as a substrate for various decorative overlays in furniture and interior products to reduce formaldehyde emissions and improve mechanical properties and dimensional stability. Surface roughness, a measure of fine irregularities on the panel's surface, is a critical factor influencing the quality and appearance of the final product, especially when using thin overlays. Surface quality depends on factors like particle size, resin content, pressing conditions, and raw material characteristics. Successful sanding operations are essential for achieving a uniform thickness and a smooth, flat surface in particleboard manufacturing, requiring consideration of factors such as board properties, sanding equipment, abrasive belt specifications, and machine setup [18].

The amount of chips (SL) used on the surface in particle board production varies between 30-35%. As the amount of SL increases, a denser and harder layer is obtained on the plate surface. In this way, plate top surface operations become easier and the surface quality increases. The surface layer density is always higher than the middle layer (CL). This is because it consists of thinner chips, thin chips have more surface area, and more glue is used.

The density of the surface layer amount is expected to be around 1000 kg/m³. At values below this density, the plate surface quality decreases. On it, the surface quality of the plate increases. However, using too much chip in the surface layer is undesirable as it will increase the amount of wood consumption. For this reason, it has become important to obtain a dense surface with a small amount of chips. It is easier to cover the surface of high density board with decor paper. B quality rate decreases during laminate processes.

IV. CONCLUSION

In this study, a compilation was made about density and chip quantity, which are important parameters in particle board production. Particle board is a composite material that can be produced from wood residues and contains fewer wood defects than solid wood material. The fact that it can be produced in desired sizes and densities makes particle board superior to solid wood material.

Particleboard production and use has increased dramatically in the last 50 years and continues to do so. In order to meet this increase, it is necessary to produce particleboard with low density and sufficient mechanical and physical properties. More research should be done on this subject to produce chipboard with high mechanical and physical properties at low density. This issue is important both in terms of increasing competitiveness in plate production in the world and preserving ecological balance.

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