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Mechanical property study of plywood bonded with dimethylol dihydroxy ethylene urea crosslinked rice starch- natural rubber latex-based adhesive

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ABSTRACT

There has been an increase in the demand for adhesives due to the increasing applications of plywood panels in the home furnishings and decorative items industries around the world. Most of the wood-based panels industry depends on synthetic adhesives due to its low cost and high performance. However, because synthetic adhesives emit the carcinogenic gas formaldehyde and increase the risk of human health, there is a growing interest in developing non-toxic and eco-friendly wood adhesives made from renewable materials. The present research aims to develop a bio-adhesive for plywood bonding based on two biopolymers: natural rubber latex (NRL) and dimethylol dihydroxy ethylene urea (DMDHEU) crosslinked rice starch. A bio-adhesive was ultimately formulated with varying weight ratio of NRL and DMDHEU crosslinked rice starch at 1:3, 1:1 and 3:1 respectively. Mechanical characteristics of plywood samples fabricated with the formulated bio-adhesive were measured using IS 17,304 and ISO 12466–1-2007 via hot press at 120 °C. The modulus of rupture (MOR) of plywood glued with Dm-B was 63 MPa, the modulus of elasticity (MOE) was 6480 MPa, and the internal bonding (IB) was 1.48 MPa, each of which met the ISO 12466–2-2007 and IS 303 standards. According to the findings, Dm-B had a profound impact on the performance of adhesion properties and contributed to the elimination of the use of hazardous synthetic adhesives.

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1. Introduction

In recent decades, manufacturers have vowed to use sustainable materials in the development of wood products. The objectives are in line with the organization's strategy at performance improvement and environmental impacts reduction, such that competitiveness and sustainability show up as equally major elements [1]. In this regard, wood is a sustainable material with sophisticated properties that are of keen importance due to its low environmental impact [2]. Wood is primarily used to produce particleboard, fiberboard, and plywood [3]. On the one hand, adhesive is essential in the fabrication of wood products because it determines their durability, strength, and efficiency(See Fig. 1.).

A number of downfalls involved in the fabrication of wood products were outlined, due largely to the use of synthetic resins in the gluing phase of boards. The majority of wood products adhesives are urea formaldehyde, melamine-formaldehyde, and phenol-formaldehyde [4]. Synthetic adhesives have a dominant position due to their superior bonding properties and board reliability, stifling the growth of sustainable-based adhesives that are formaldehyde free. Even so, the International Agency for Research on Cancer has classified formaldehyde as a cancer causing compound [5]. Lifelong exposure to formaldehyde has also been linked to sinus cancer and leukemia.

Thus, the driving factors for a researcher to establish bio-based adhesives as an substitute to synthetic adhesives are the legislation on formaldehyde emissions from wood-based products industry and consumer's interest in the bio-adhesives [6]. A bio-based adhesives are obtained from biological materials such as plants, living creatures, or aquatic animals, and research has been conducted to develop various high-quality bio-based adhesives [7,8]. Natural

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