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Awareness of Phenol Amine in Chemistry using High-Performance Tannin Polyamine Adhesive

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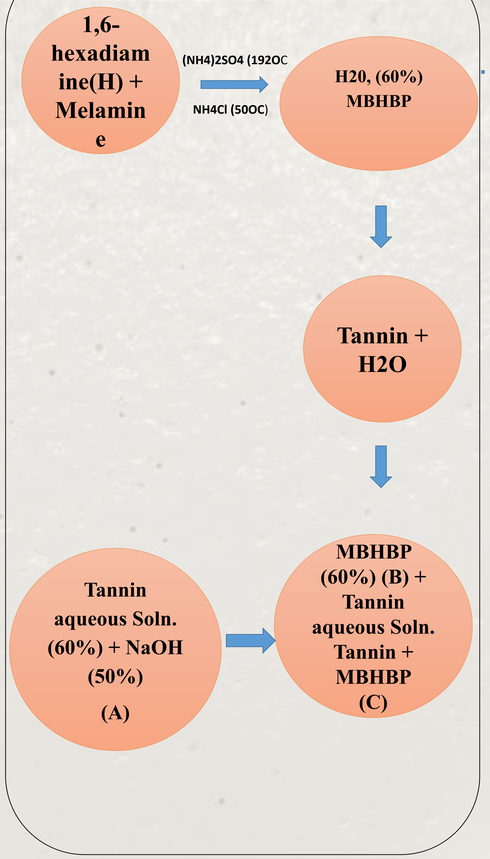
ABSTRACT

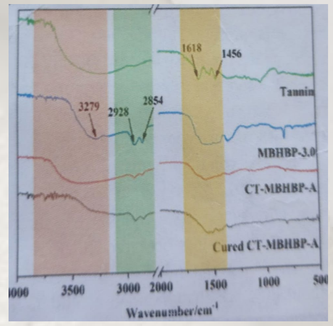
Condensed tannin-polyethyleneimine (CT-PEI) adhesives offer a strong bonding performance, which has been demonstrated earlier in research industries. The production of unsafe monomers and the substantial costs of the main sysnthesis of PEI are just two hindrance, which have prevented its hiring process in the wood industries. With the aim to manufacture polyamine-tannin adhesives, this study provides another application to PEI: Melamine-based highly branched polyamine (MBHBP), and this can be produced in a simple way, affordable and sustainable conscious ways. The shear strength of three-ply plywood, as revealed by plywood bonding tests, exceeded the performance of most previously reported tannin-based adhesives, left at 1.76MPa even after immersion in boiling water for three hours. The strength remained 1.20MPa even after soaking like 72 hours, revealing the CT-MBHBP adhesives's good water resistance. Through this study, the application of model reactions in combination with ESI-MS (Electrospray Ionization - Mass Spectrometry) assessments of the reaction products, this research also gives the first confirmation of the proposed mechanism methods for polyamine catechol crosslinking reactions. MHBHP-Melamine Based High Branched, has successfully synthensied to replaced PEI-Polyethyleneimine. The study provides our understandings of Phenol-amine chemistry through establishing the roles that Michael Addition and Schiff Base developed played in the establishment of crosslinking networks

INTRODUCTION

Condensed Tannin (CT) is a natural polyphenolic compound sourced from plants that can be easily extracted, making it a potential candidate for use in polymeric materials. CT provides an eco-friendly alternative to the conventional phenol found in phenol-formaldehyde resins (PF). When CT reacts with formaldehyde under mild alkaline conditions, it results in tannin formaldehyde resins (TF). However, when compared to PF resin, TF's bonding strength, especially its water resistance, is not as strong. This limitation could be attributed to CT's abundant phenolic hydroxyl groups and its intricate structure, which might impede effective molecular bonding. To address this, chains like Urea Formaldehyde (UF) and Phenol Formaldehyde (PF) were introduced. The underwater adhesive properties of mussel byssus, associated with the catechol amino acid 3,4-dihydroxyphenylalanine (DOPA), have broadened the scope for bio-inspired adhesive research. An eco-friendly adhesive called melamine-based highly branched polyamine (MBHBP) was developed as a PEI (Polyethyleneimine) substitute, crafted from melamine and 1,6-hexanediamine. The crosslinking mechanism of this adhesive was explored using model compounds, and the hypothesized mechanisms were validated by detecting Schiff base and Michael addition products through ESI-MS.

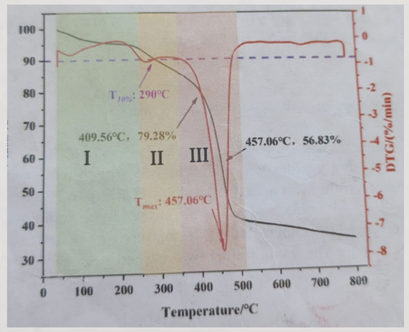
SYNTHESIS

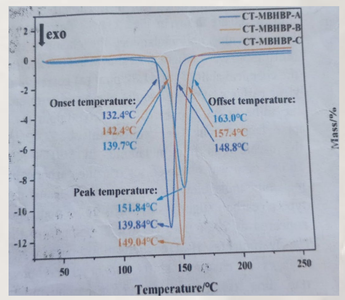




The FTIR of the peak 3454 shows the peak of -OH decreased, C=O and C=N bond at 1650cm-1

Based on TGA showed, minor weight loss from 30-250OC, a weight loss from 250-350OC and an excess weight loss between 400-450OC. Around 400-457OC weight stayed and that showed the thermal stability of CT-MBHBP





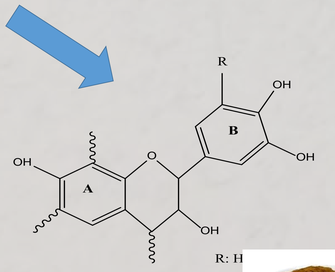
According to the DSC, hot press temperatures between 140-160OC was suitable for plywood panel process. Nevertheless a higher temperature of 180-200OC was applied to enable a fast and complete cure of the CT-MBHBP Aadhesive

CONCLUSION

The main Conclusion indicates that;
MBHBP holds potential as a substitute for PEI in polyamine-catechol adhesive manufacturing due to its straightforward and eco-friendly synthesis process, coupled with its strong reactivity towards catechol groups.
Tests on wood bonding performance demonstrated that CT-MBHBP displays outstanding water resistance, outperforming previously reported tannin-based adhesives in wet bonding strength. Furthermore, analysis using ESI-MS confirmed the formation of Schiff base and polyamine-catechol crosslinking networks in the reaction products.

THE EXTRACTION OF TANNIN

Tannin extracted from Berry tree



Tannin Powder

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