

## Carboxymethyl cellulose (CMC) preparation from mixed office wastepaper deinked and bleached bagasse pulps: characterization and comparison

### Abstract

Bagasse Soda bleached pulp as a non-wood fiber and mixed office wastepaper deinked pulp as a recycled fiber were carboxymethylated in aqueous alkaline medium using mono-chloro acetic acid (MCA) as etherifying agent under identical conditions. The chemical composition of the pulps including  $\alpha$ -cellulose, hemicellulose, lignin, extractives and ash content, water retention value, intrinsic viscosity, carboxyl group and pH were determined.  $\alpha$ -cellulose content as the most important character of the derivatization was determined as 84.66% in DIP and 71.33% in bagasse pulp. DIP non-polysaccharide compound (lignin, Ext. and ash) was 5.92% compared to 2.36% for bagasse pulp. Cellulose carboxymethylated were done and the degree of substitution (DS), viscosity, purity, pH and yield of the prepared CMC was also determined and found to be dependent upon the source of the cellulose pulp. Viscosity and purity were higher in CMC produced from DIP (981 cPs and 93%, resp.) compared to the bagasse pulp (680 cPs and 87.33% resp.), which is attributed to its originally higher  $\alpha$ -cellulose content. Yield and D.S were higher in CMC prepared from bagasse (168.8% and 0.57 resp.) compared to DIP (155% and 0.45 resp.), which are originated from lower crystallinity and molecular mass compound in bagasse, resulted in higher substitution of carboxymethyl groups. Generally, the local cellulose pulp resources should be considered as feasible and available alternatives for cellulose derivatives production, contributing to solving industrial problems resulting from fiber resources shortage.

**Keywords:** carboxymethylcellulose production, bagasse pulp, office waste pulp.

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## The effect of tension wood on roughness of poplar wood and its modification by steaming

### Abstract

In this research, the effect of tension wood on the roughness of poplar wood in tangential and radial sections was investigated. Steaming at 120 °C for 30 and 60 min was also applied to reduce the roughness. The potential use of roughness measurement technique for macroscopically detection of tension wood was one of the main objectives of this research. Before roughness measurement and for an accurate sampling, the detection of tension wood was carried out using Herzberg reagent and microscopic evaluations. The roughness of samples was measured by stylus profilometer at 12% moisture content and the surface quality was also studied by stereo-microscope. The results showed that there is no significant difference in the radial and tangential roughness between tension and normal wood. No difference was also observed between the roughness of tangential and radial sections of both types of woods. In contrast, stereo-microscopic studies clearly showed the higher roughness of tension wood. Steaming for 30 min increased the roughness but the treatment for 60 min had a decreasing effect on the roughness of both types of woods. Overall, it can be concluded that the roughness measurement technique cannot be used as a suitable method to nondestructively detect the poplar tension wood.

**Keywords:** roughness, poplar wood, steaming, tension wood.

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## The effect of adding the nanoclay particles and compatibilizer on the properties of composite made from polypropylene- *Haloxylon* wood flour

### Abstract

This study was conducted to investigate the effect of nanoclay particles and amount of compatibilizer on the physical and mechanical properties of wood-plastic composites made from the polypropylene- *Haloxylon* wood flour. For this purpose, *Haloxylon* wood flour with 50% weight ratio was mixed with polypropylene. Polypropylene-graft-maleic anhydride (at two levels) and nanoclay (at three levels) were used, respectively, as compatibilizer and filler. Mixing process of materials was done in extruding machine and test specimens were fabricated by using the injection molding machine. Then, the mechanical tests including bending, tension and impact strength and physical tests including water absorption and thickness swelling were done on the samples according to the ASTM standards. To investigate how compatibilizer operates, Fourier transform infrared spectroscopy (FTIR) was used. Morphological study of nanocomposites was done using X-ray diffraction (XRD) and scanning electron microscopy (SEM). The result showed that by adding the nanoclay particles up to 4 percent, physical and mechanical properties were improved, but impact strength decreased. Also by adding the compatibilizer, physical and mechanical properties were improved. The results of infrared spectroscopy showed that by adding the compatibilizer, the amount of hydroxyl groups (OH) decreased due to the linkage with maleic anhydride and formation of ester groups. Moreover, investigation of the morphology of nanocomposite by X-ray diffraction showed that the distribution of clay nanoparticles in polymeric matrix was of intercalation type and with adding nanoclay, the distance between layers increases. The results of scanning electron microscopy also showed an improvement in the interface between the fibers and the polymer matrix after adding the compatibilizer.

**Keywords:** maleic anhydride polypropylene, *Haloxylon* wood, mechanical and physical properties, nano-clay particles, wood-plastic composite.

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## Effect of bagasse chemical pulping and coupling agent on the physical - mechanical properties of composites based on bagasse pulp/Low density polyethylene

### Abstract

In this research, effect of reinforcing bagasse pulp and raw bagasse fibers and applying coupling agent MAPE (maleic anhydride polyethylene) were studied on the physical-mechanical properties of low density polyethylene (LDPE) composites. Fresh bagasse was collected from an experimental field in Khuzestan and after investigating the anatomy and chemical properties of different pulp fibers including monoethanolamine (MEA) bagasse pulp, alkaline sulfite-anthraquinone (AS) bagasse pulp, bleached soda (BS) bagasse pulp, unbleached soda (UNS) bagasse pulp and raw bagasse fibers (B) were prepared. Then, composites with 30wt.% fiber content were manufactured by twin-screw extrusion followed by the compression molding processing. The mechanical and physical properties of these composites were analyzed and compared. The results revealed that the chemical pulping dissolved a fraction of lignin and hemicelluloses so that the linkage potential and aspect ratio of bagasse fibers were improved and consequently, as compared with the raw bagasse fibers, bagasse pulp fibers showed a better reinforcing capability. The best overall properties were achieved with MEA and AS/AQ fibers. Addition of 5% (wt/wt) of coupling agent MAPE resulted in a significant enhancement in the tensile strength, tensile modulus and impact strength in line with the improvement of the fiber-matrix interfacial adhesion, making the transfer of stress from the matrix to the rigid reinforcement more effective.

**Keywords:** wood-plastic composites, bagasse pulp fibers, low density polyethylene (LDPE), mechanical properties.

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## Comparing the performance of different glutaraldehyde catalysts in chemical modification of poplar wood

### Abstract

In this study, the effect of different catalysts on chemical modification of poplar wood and physical properties of the resulting product was evaluated. 12.5% HCl and water soluble salts containing ZnCl<sub>2</sub>, CaCl<sub>2</sub>, AlCl<sub>3</sub>, MgCl<sub>2</sub> (based on the weight of glutaraldehyde) and 1% Al<sub>2</sub>O<sub>3</sub>, SiO<sub>2</sub> and ZnO nanoparticles (based on the weight of glutaraldehyde) were used. After heating in oven for 48 hour, modification with glutaraldehyde and MgCl<sub>2</sub>, ZnO nanoparticles, SiO<sub>2</sub>, Al<sub>2</sub>O<sub>3</sub>, ZnCl<sub>2</sub>, AlCl<sub>3</sub>, CaCl<sub>2</sub> and HCl as catalysts were resulted in 14.5, 12.57, 10.62, 8.69, 8.51, 7.19, 5.97 and 5.41 % weight gain, respectively. After 24h of soaking in water, the physical properties of modified specimens, such as water absorption, volume swelling and ASE were measured. The highest and lowest bulking were calculated for Mgcl<sub>2</sub> and Hcl catalysts with 6.98 and 2.37%, respectively. The modification in presence of Mgcl<sub>2</sub> catalyst showed the highest increase of density with average of 0.55 g/cm<sup>3</sup>. The highest and lowest water absorptions were measured as 79.61 and 45.32% in the modification with HCl and MgCl catalysts, respectively. HCl with acidic quality can break ether bonds in hemiacetal and even acetal structure. Modification with MgCl<sub>2</sub> showed the best result in comparison with other catalysts. It is likely that the formation of a complex of magnesium with oxygen, could resulted in activate carbonyl groups in glutaraldehyde and creation of crosslinks.

**Keywords:** glutaraldehyde, chemical modification, catalysts, physical properties, WPG.

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## The effect of soy-flour mesh size and its adhesive acidity changes on shear strength of plywood

### Abstract

In this study, the effect of soy flour mesh size and the change of adhesive's acidity made from it on shear strength of plywood was evaluated. For this aim, soy flour particles were classified in three levels mesh sizes (60, 100 and 140 mesh) by ASTM Sieves. To obtain soybean adhesive with different acidities, sodium hydroxide and sulfuric acid were used. The results showed that the acidity of soy adhesives changes by addition of sodium hydroxide and sulfuric acid to soy slurry. Moreover, the mesh size of soy flour affected the shear strength of plywood made from soy flour adhesives. The shear strength of plywood made from soy flour with 140 mesh was higher than other specimens. Also, the increase of soy flour adhesive's acidity by sodium hydroxide resulted in an increase of shear strength of plywood. The shear strength of plywood made from soy adhesives was lower compared with the plywood made from urea formaldehyde resin but it was acceptable according to EN-314 standard.

**Keywords:** soy adhesive; soy flour classifying; shear strength; urea formaldehyde resin; plywood.

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## The effect of altitude on bending creep behaviour of hornbeam (Case Study: Nowshahr Meshelak Branch)

### Abstract

This study aimed to investigate the effect of altitude on the bending creep behaviour of hornbeam lumber (*Carpinus betuluse*). For this purpose, 9 hornbeam trees were selected from three different altitudes (400, 800 and 1100m. a.s.l.) from forestry projects of Meshelak Nowshahr. 54 clear samples were cut from the mature wood at breast height. The prepared samples (dimensions: 2.5 × 2.5 × 41cm) were conditioned in a room at temperature of 20 °C and relative humidity of 65 %. After 3 weeks of conditioning, relative creep and creep modulus were measured using the four points flexural creep test in 20% maximum of deflection load. The results indicated that the effect of altitude on creep parameters were significant. The maximum and the minimum relative creep were, respectively, observed in 800 and 400m. a.s.l. and the maximum and the minimum creep modulus were, respectively, observed in 400 and 800m. a.s.l. Analysis of variance (ANOVA) indicated that the altitude has significant effect on the flexural strength and modulus of elasticity, which in turn caused a decrease in the creep parameters.

**Keywords:** altitude, creep modulus, hornbeam, relative creep.

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## Effect furfurylation on physical properties and surface quality of two woody species (beech and silver fir)

### Abstract

The objective of this study was to investigate the effect of furfurylation on water absorption, thickness swelling, contact angle, and surface roughness of wood in two species i.e. beech (*Fagus orientalis*) and silver fir (*Abies alba*). In this regard, two different values of furfurylation of beech and silver fir wood specimens were carried out in the form of low level and high level and compared with control specimens. The furfurylation and polymerization of furfuryl alcohol monomers were carried out, respectively, using impregnation under pressure and heat catalyst. For evaluating the water absorption and thickness swelling, specimens were subjected to long-term water immersion, and their dimensional changes were determined at different times. The surface roughness and contact angle testes were also carried out. The results indicated that the water absorption and thickness swelling were reduced. The results also indicated that the drop contact angles were decreased and surface roughness were increased by increasing of furfurylation level.

**Keywords:** furfurylation, contact angle, surface roughness, water absorption, thickness swelling.

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## Modification of NSSC pulp broke fibers using layering method and investigating its effect on prepared paper properties

### Abstract

In the current study, modification of NSSC pulp broke fibers was done by forming starch polymeric multilayers, using layer-by-layer (LbL) layering method. After fiber slushing and preparation of pulp suspension with 0.5% consistency and conductivity formation of about 437  $\mu\text{s}/\text{cm}$ ; the experiments of fibers treatment were conducted by adding 1 mM water solution of NaCl to build the polymeric layers (up to 5 consecutive layers). Afterwards, water retention value (WRV) of fibers was calculated in samples to evaluate the influence of this method on fibers hydrophilicity. The fibers were then used to prepare standard handsheets ( $60\pm 3\text{g}/\text{m}^2$ ) and the physical and strength properties of sheets were evaluated as a function of the number of layers deposited on the fibers. The results showed that the WRV index of the fibers was improved by the LbL treatment of NSSC broke pulp fibers, due to an increase in starch electrostatic absorption. Successive variation in paper in the form of an increase in apparent density and a decrease in paper thickness confirmed the construction of starch multilayers on the surface of broke fibers. Formation of such multilayers on broke fibers has led to a considerable improvement in tensile index (from 13.21 N.m/g to 30.65 N.m/g) and burst index (from 1.23 kPa.m<sup>2</sup>/g to 2.36 kPa.m<sup>2</sup>/g). Moreover, the prepared scanning electron micrographs approved the compaction of sheet web and improvement of paper mechanical properties as a result of an increase in inter-fiber bonding.

**Keywords:** broke fibers, starch, NSSC pulp, fiber modification, paper properties.

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## Recognition and rating of effecting indexes on the consumption of pulp and paper industry production from different poplar plantation sites in Iran

### Abstract

In line with the population growth, the need for wood consumption increases. For a long time, this need was supplied by natural forests. However, forest harvesting in Iran has decrease for many reasons and plantation of the fast growing trees (e.g. poplar, eucalypt, and paulownia) has been introduced as an alternative. One of the most demanding industries is pulp and paper which needs considerable amounts of raw wood materials, each year. This industry can continue its production by using poplar wood. This research was conducted with the aim of assessing the practical characteristics of poplar wood in paper production industry by using a nondestructive test method. Poplar's plantation sites were selected in areas of country that poplar trees were planted widely. Analytic hierarchy process (AHP) in Expert choice 11 software was performed for locating the production of different sites in pulp and paper industry. Moreover, for field studies of this research, the questionnaires were prepared and sent to experts and university professors with experiences in this industry. The results showed that among the five main indices influencing in pulp and paper production, fiber morphological features are the first priority with weighting value of 0.43. Production allocations with their weighting values determined Sari (0.24), Fouman (0.23), Lashtnasha (0.18), Abhar (0.17), and Zanjan (0.16), as superior plantation sites, respectively.

**Keywords:** wood plantation, wood fibers biometry, nondestructive test, analytic hierarchy process, locating poplars wood.

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## Study on long term creep of two different types of compressed wood sheets used in library shelves

### Abstract

In this study, the creep behaviors of composite panels used in library shelves were investigated. For this purpose, two types of wood-composite panels (medium density fiberboard and particleboard), and three types of covering including synthetic laminates, natural veneer, and without cove, as well as two types of wood joints (fixed and detachable) were used. Dimensions of the book-shelves were in actual shelf size, that is, 1,000 × 300 mm. Totally, 48 shelf specimens were prepared. For the creep test, a 23.5 kg loading level was applied in the center part of the shelves. Measurements on the creep behavior were carried out over 155 days at different intervals. Results indicated that the type of wood-composite as well as the type of veneer had statistically significant effect on the creep behaviors of panels. The lowest creep was observed in MDF panels. Moreover, those panels covered with natural veneer demonstrated significantly lower creep values. The type of joint also had a significant effect on the creeping behavior of the shelves, though not as conspicuous as the type of panels and veneers. Based on the results of the present research project, it is suggested that in order to increase the service life of library shelves it would be better to produce the shelves from MDF panels covered with natural veneers; these shelves should be fixed on supports.

**Keywords:** creep, MDF, particleboard, veneer, wood-composite panels.

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## The effect of chemical treatment of wood flour on some properties of wood-plastic composite

### Abstract

This research aimed to investigate the effect of chemical treatment of wood flour on some physical, mechanical and morphological properties of wood-plastic composite. Chemical treatment of wood flour at 7 levels i.e. without treatment, acetylation, benzylation, mercerization, magnesium hydroxide, calcium hydroxide and warm water treatment were considered as variable factors. To evaluate the reaction of wood flour with chemical materials, weight percent gain (WPG) were calculated. After chemical treatment, wood flour and polypropylene were mixed with weight ratio of 60 to 40 and 4 per hundred compound (phc) of coupling agent in the extruder and then the specimens were fabricated by injection molding method. Mechanical tests including tensile, flexural and impact strength and physical examination, including water absorption and thickness swelling was performed on specimens according to ASTM standards. Moreover, to study the morphology of the composites, scanning electron microscopy (SEM) was used. The results showed that the mechanical strength increased and physical properties such as water absorption and thickness swelling decreased after chemical treatment. As a result of chemical treatments, the weight of wood flour increased while the highest value was of the benzylation treatment. Results of SEM showed an improvement in cross linking between fibers and polymeric matrix due to the chemical treatment, in a way that in treated samples, exiting of fibers out of the matrix was not observed.

**Keywords:** chemical treatment of wood flour, weight percent gain, morphology, wood plastic composite, chemical modification of wood flour.

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## A novel method for cellulose modification in aqueous media via alkoxy silane chemistry

### Abstract

Surface modification of cellulose, as the world's most abundant polymer, plays an important role in sustainable chemistry. Microcrystalline cellulose, Avicel, was modified by an alkoxy silane under mild conditions in water, at room temperature and with a catalytic amount of sodium hydroxide. (3-Mercaptopropyl)-trimethoxysilane in three concentrations of 535, 1074, 1614  $\mu\text{mol/mL}$  (100, 200, 300  $\mu\text{L}$  of silane, respectively) was grafted onto cellulose; then the modified cellulose was characterized by FTIR spectroscopy as well as solid state  $^{13}\text{C}$  NMR and  $^{29}\text{Si}$  NMR spectroscopy. Increasing the concentration of the alkoxy silane from 353 to 1074  $\mu\text{mol/mL}$  increased the ratio of siloxane bridges with the cellulose backbone, while by increasing the silane concentration from 1074 to 1614  $\mu\text{mol/mL}$ , the ratio of siloxane bridges relative to covalent links with the cellulose backbone was enhanced from 34% to 66%.

**Keywords:** cellulose modification, cellulose surface chemistry, microcrystalline cellulose, alkoxy silane chemistry, (3-mercaptopropyl)-trimethoxysilane.

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## Environmental impact assessment of comfortable furniture production process using LCA

### Abstract

This study focused on the collecting of a comprehensive life cycle inventory data for comfortable furniture in two different production processes (B1 and B2) located in Tehran, I. R. Iran, and analyzed the environmental impacts during the production process as gate to gate investigation. The results revealed that emissions in production process B1 were higher than that of production process B2. The reason for this is that basic operations such as sawing and frame assembling along with final operation have been done in the same unit for case B1. Textile production and usage, and polyurethane foam were identified as the main hotspots, respectively. Moreover, the results showed that comfortable furniture production process has the highest effects on ecosystem quality, human health, and resources (fossil fuels and mines), respectively.

**Keywords:** Life cycle assessment, comfortable furniture, ecosystem quality, human health.

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