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AUGUST

BIOPOLYMERS

Multifunctional starch-based barrier materials

Pradnya Rao, Chinmay Satam, Ashok Ghosh, and Peter W. Hart

Starch-based Materials	WVTR, g-mm/m²/d	RH, %	Temperature, °C	Form	Reference
Hydroxypropylated and oxidized potato starch, citric acid	1.0*	50	23	Coating	[16]
Hydroxypropylated, starch, citric acid	1.1-2.9*	50	23	Coatings	[17]
Starch, chitosan, glutaraldehyde crosslinked	9.3-16.4	50	25	Film	[18]
Oxidized corn starch, bentonite	8.9	65	22	Film	[19]
Potato starch, sodium hypochlorite	10.4	75	25	Film	[18]
Potato starch, nano SiO_2	70	90	25	Film	[20]
PBS, starch, and Cloisite 30B clay	8.8	90	38	Pellet Composite	[21]
Starch and acrylated epoxidized soybean oil	14.1	90	38	Films	[22]
Crosslinked wheat starch, sodium montmorillonite, TiO_2	105	97	23	Film	[23]

* Water vapor transmission rate (WVTR) value normalized with respect to coating thickness instead of film thickness.
PBS = poly(butylene succinate); SiO_2 = silicon dioxide; TiO_2 = titanium dioxide.

Water vapor barrier properties of starch-based materials.

Natural and renewable polymer-based barrier materials play an inevitable role in a sustainable economy. Most commercially available barrier materials are either based on multiple layers of synthetic polymers or petroleum-based chemicals. Tremendous amounts of research are being done in academia and industry to replace these synthetic barrier materials with natural and environmentally friendly materials.

This study summarizes the application of starch-based materials for various barrier applications, such as water vapor, oxygen, liquid water, oil, and grease. Also, exotic starch-based barrier materials for the application of sound, ultraviolet, and thermal barrier applications are reviewed. The potential of starch-based materials to offer antimicrobial and antiviral properties is discussed. Finally, the authors summarize commercially available starch-based barrier material. This study highlights how the industry can explore new ways of using starches for traditional and non-traditional barrier applications.

PULPING

Technological evaluation of *Pinus maximinoi* wood for industrial use in kraft pulp production

Marina Ulian Coelho, Francides Gomes Da Silva, Jr., Flaviana Reis Milagres, Silvana Meister Sommer, Carlos Augusto Soares Do Amaral, and Fabrício Antônio Biernaski

Parameter	*Pinus maximinoi*	*Pinus taeda*
H-factor	2295	2295
Active alkali, % NaOH on wood	24.4 (±0.1)	25.1 (±0.0)
Kappa number	28.1 (±1.1)	27.5 (±0.2)
Total yield, %	47.9 (±0.2)	47.5 (±0.3)
Reject content, %	0.43 (±0.5)	0.10 (±0.2)
Screened yield, %	47.5 (±0.7)	47.4 (±0.1)
Intrinsic viscosity, cm³/g	945 (±52.2)	875 (±41.1)
Specific wood consumption, m³/o.d. metric ton	5.281 (±0.07)	5.437 (±0.01)
Black liquor solids, metric tons/o.d. metric ton	1.613 (±0.03)	1.637 (±0.01)

V. Pulping results.

Table V of the study: Pulping results.

This study characterized *Pinus maximinoi* wood and evaluated its performance for pulp production. *P. maximinoi* wood is an alternative raw material for softwood pulp production in Brazil due to its higher growth rates in tropical zones, with greater volumetric productivity.

Samples of *Pinus taeda* wood were used as reference material. For both species, researchers used wood chips from 14-year-old trees for the technological characterization, pulping, bleaching process analysis, and pulp properties.

A modified kraft pulping process was carried out targeting kappa number 28±5 percent on brownstock pulp. The bleaching sequence was applied for bleached pulp with final brightness of 87±1 percent ISO. Refinability and resistance properties were measured in the bleached pulps. Compared to *P. taeda wood, P. maximinoi* showed slightly higher basic density (0.399 g/cm³) and higher holocellulose (64.5 percent), lignin (31.1 percent), and extractives content (4.5 percent), along with lower ash content (0.16 percent). *P. maximinoi* tracheids showed greater wall thickness (6.4 µm) when compared to *P. taeda* tracheids.

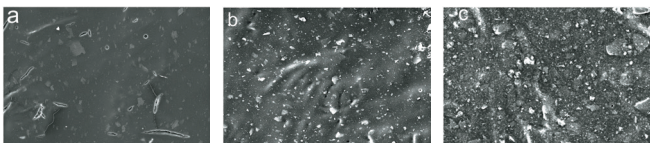
For the same kappa number, *P. maximinoi* and *P. taeda* resulted in similar screened yield, with an advantage observed for *P. maximinoi,* which resulted in lower specific wood consumption (5.281 m³/o.d. metric ton), and lower black liquor solids (1.613 metric tons/o.d. metric ton). After oxygen delignification, *P. maximinoi* pulp showed higher efficiency on kappa reduction (67.2 percent) and similar bleaching chemical demand as *P. taeda* pulp. Compared to *P. taeda* pulps, the refined *P. maximinoi* pulps had similar results and the bulk property was 10 percent higher. Results showed that *P. maximinoi* is an interesting alternative raw material for softwood pulp production in Brazil.

SEPTEMBER

COATING

Tetraethyl orthosilicate-containing dispersion coating—water vapor and liquid water barrier properties

Beko Mesic, Mathew J. Cairns, James H. Johnston, and Meeta Patel



Micrographs of talc-containing coatings: (a) TEOS-free latex-talc coating, which exhibits more crack defects; (b) TEOS-containing latex-talc coating; and (c) TEOS-containing latex-kaolin-talc coating.

An aqueous styrene-butadiene latex dispersion coating containing in-situ processed tetraethyl orthosilicate (TEOS) applied on paperboard demonstrated improved water barrier performance. Coatings containing TEOS equivalent to 0.8 percent silicon dioxide (SiO_2; dry basis) exhibited water vapor performance of < 25 g/m²/d (23°C, 50 percent relative humidity [RH]), and liquid water barrier performance Cobb 1800 s of < 6 g/m², when applied as a single-layer 18 g/m² coating. Cobb 1800 s barrier performance was still good (< 11 g/m²) at coat weights of 7–10 g/m². The use of filler materials such as kaolin improved the vapor barrier properties of the coating, but this was not critical to the liquid water barrier properties.

This work presents a feasible solution applicable within the conventional paper/paperboard coating process. It provides a new and effective approach and methodology to barrier coating of paper/paperboard to enhance the water vapor transmission rate (WVTR) and Cobb performance properties for use in packaging and other applications.

PULPING

Displacement washing of softwood pulp cooked to various levels of residual lignin content

Md. Mostafizur Rahman and František Potůček

This study investigates the influence of the degree of delignification of kraft spruce pulp cooked at seven different kappa numbers, ranging from 18.1 to 50.1, on the efficiency of displacement washing under laboratory conditions. Although the pulp bed is a polydispersive and heterogeneous system, the correlation dependence of the wash yield and bed efficiency on the Péclet number and the kappa number of the pulp showed that washing efficiency increased not only with an increasing Péclet number, but also with an increasing kappa number. The linear dependence between the mean residence time of the solute lignin in the bed and the space time, which reflects the residence time of the wash liquid in the pulp bed, was found for all levels of the kappa number. Washing also reduced the kappa number and the residual lignin content in the pulp fibers.

Of the basic brownstock washing operations, displacement washing is the most important and effective mechanism, and washing equipment is designed with emphasis on it. The information in this paper will enrich resources related to pulp washing that can impact end-product quality.

PAPERMAKING

Effects of phosphogypsum whiskers modification with calcium stearate and their impacts on properties of bleached softwood paper sheets

Haitang Liu, Xin Jin, Lin Chen, Xiaochen Zhang, Jie Li, Yongzhen An, Jing Liu, Chunxia Pang, and Yujie Gao

OTHER RESEARCH APPEARING IN *TAPPI JOURNAL'S* AUGUST 2021 ISSUE:

NONWOOD PULPING

Formic acid pulping process of rice straw for manufacturing of cellulosic fibers with silica
Akhouri Sanjay Kumar Sinha

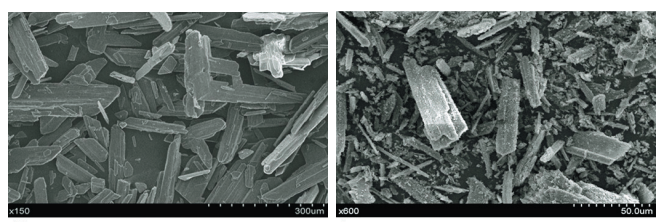
EMISSIONS

Can carbon capture be a new revenue opportunity for the pulp and paper sector?
Katja Kuparinen, Satu Lipäinen, and Esa Vakkilainen

OTHER RESEARCH APPEARING IN *TAPPI JOURNAL'S* SEPTEMBER 2021 ISSUE:

TECHNICAL BRIEF: PACKAGING

Commercially relevant water vapor barrier properties of high amylose starch acetates: Fact or fiction?
Chinmay Satam, Ashok Ghosh, and Peter W. Hart



a. b.

Scanning electron microscope (SEM) image comparison of whiskers before (a) and after (b) modification.

By combining the structural properties and characteristics of phosphogypsum whiskers, researchers carried out a preliminary study on the modification of phosphogypsum whiskers and their application in papermaking. Researchers explored the effects of reaction temperature, reaction time, and reaction concentration on the solubility and retention of modified phosphogypsum whiskers and the effects of phosphogypsum whiskers on the physical properties of paper under different modified conditions.

The research results show that, after the phosphogypsum whiskers are modified with calcium stearate, a coating layer will be formed on the surface of the whiskers, which effectively reduces their solubility. The best modification conditions are: the amount of calcium stearate relative to the absolute dry mass of the phosphogypsum whisker is 2.00 percent, the modification time is 30 min, and the modification temperature is 60°C.

The use of modified phosphogypsum whiskers for paper filling will slightly reduce the whiteness, folding resistance, burst resistance, and tensile strength of the paper, but the tearing degree and retention of the filler will be increased to some extent. From this research, phosphogypsum whiskers modified by calcium stearate show reduced solubility in water and enhanced application as a paper filler.