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Properties of Bleached Pulps from Low and High Kappa Number Old Corrugated Containers (OCC)

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Abstract
The strength, structural, optical and water absorption properties of bleached pulps from unprinted, low and high kappa number old corrugated containers (OCC) were determined. The results were compared with the properties of bleached birch pulp and pine pulp. It was found that old corrugated containers pulps show higher Shopper-Riegler freeness, distinctly lower tensile strength, and lower maximum short-span compressive strength (SCT) than birch and pine pulps. However, they also show quite good tear resistance, optical properties, bulk and water absorption. In order to explain the differences in the properties of bleached OCC pulps and birch and pine pulps, they were evaluated using image analysis. This study showed that OCC pulps contain both long softwood and short hardwood fibres, with a predominance of the former. An analysis of the lower tensile strength of OCC pulps was also made. It was established that it is mainly caused by the lower degree of polymerisation (DP) of cellulose and the higher degree of damage of OCC fibres.

Key words: *bleached OCC pulps, beating, handsheet properties, fibre properties, hemicelluloses content, fibre defects.*

T – *tensile strength of paper handsheets*
Z – *zero-span tensile strength*
L – *average fibre length*
P – *average value of the circumference of fibres of the pulp*
A – *average cross-sectional area of cell walls of fibres*
ρ – *density of the cell wall of fibres*
RBA – *Relative Bonded Area of fibres*
b – *shear bond strength*

■ Introduction

Bleached kraft pulps obtained from wood are mainly used in the production of white writing and printing papers, tissues and boxboard covering papers. Alternative sources of fibre, ideally more ecologically justifiable than wood, are increasingly sought after. In this respect, waste paper from old corrugated containers (OCC) has a certain potential. However, the use of this material to produce bleachable pulps is not straightforward due to the growing share of waste paper pulps in the furnishes of liners and fluting, and the gradual deterioration of their quality. The main problem is the presence of various chemical additives in OCC waste paper, such as printing inks, glues, fillers, polymer binders and waxes, which are used to give boards their end properties required. Thus it is necessary to upgrade OCC pulps before reusing them: removing contaminants, brightening the pulp and improving the papermaking properties of the fibres. This problem has already been the sub-

ject of research. For example, De Ruvo *et al.* [1], Jackson *et al.* [2] and Nardi [3, 4] reported that oxygen delignification is suitable for this purpose. Markham and Courchene [5] stated that the combination of forward cleaning and oxygen delignification removed 86 – 88% of dirt from screened OCC pulp. Dionne and Hoyos [6] indicated that hydrogen peroxide bleaching can be an effective chemical treatment aimed at the brightening of OCC pulps, while Zanuttini and McDonough [7] reported that the treatment of OCC pulps with ozone has a beneficial influence on some of the strength properties of sheets made from OCC pulps.

There have also been attempts to obtain easily bleached pulps from pulped OCC waste paper in the oxygen delignification process with the additional treatment of OCC pulps with peroxy acids [8, 9]. Another way to upgrade OCC pulps involved their physical treatment in such devices as kneaders and refiners [10]; the latter to improve the properties of sheets made from OCC pulps [11].

The upgrading of OCC also comprises their processing into fully such pulps. The first who suggested this idea were Nguyen *et al.* [12] and Bisner *et al.* [13], who processed OCC into bleached pulps. Research on the processing of OCC into bleached pulps of high brightness was also done by Wandelt [14]. The author focussed on the optimisation of OCC delignification with the use of the polysulfide-anthraquinone (PS-AQ), neutral-

Abbreviations

PS-AQ – *polysulfide-anthraquinone method of pulping*
NS-AQ – *neutral-sulfite-anthraquinone method of pulping*
o.d. – *oven-dried*
d – *initial disintegration of OCC boards*
A – *pre-treatment of pulp with diluted sulphuric acid*
Sa – *kraft pulping*
D – *disintegration of OCC or wood chips after its pulping*
Q – *pre-treatment of pulp using EDTA*
O – *alkali-oxygen delignification of pulps*
B – *bleaching of pulps*
BH – *bleaching of pulps with its subsequent hyperwashing*
DP – *degree of polymerisation of cellulose*
rel. % – *relative percent*

sulfite-anthraquinone (NS-AQ) and alkali-oxygen methods. Studies were further continued by Danielewicz and Surma-Ślusarska, who performed research into the processing of different kinds of currently produced OCC into bleached pulps [15 - 18]. The main aim of this work was the comparison of papermaking properties of bleached cellulosic pulps from low and high kappa number OCC with bleached cellulosic pulps from birch and pine wood, which have not been sufficiently explored so far, and which may be relevant to take a decision of starting the production of this type of pulps.

Experimental

Pulps

Dried bleached pulps of 87 - 90% ISO brightness were used to study their properties. These pulps were produced from kappa number 52.6 and 103 unprinted old corrugated containers (marked as OCC50 and OCC100), respectively, according to the sequence of processes $d + A + Sa + D + Q + O + BH$. In the research, conventional bleached birch and pine pulps produced from wood chips were also used according to the process sequence $Sa + D + O + B$.

Methods

Processing of OCC

Initial disintegration (d)
Initial disintegration of "dry" OCC samples was conducted in a beaker using a Zelmer Robi kitchen mixer (produced in Poland) at a 0.5% consistency of the pulp for 2 min.

Removal of metal ions (acid and chelation stages)
The acid (A) and chelation (Q) stages were performed at 10% consistency for one hour at 75 °C, followed by thorough washing with deionised water. The pH of stage A was adjusted to 2.5 - 3 using H_2SO_4. At stage Q, a 0.5% charge of EDTA was applied to the pulp, and the pH was adjusted to 5 with H_2SO_4. After 60 min of treatment, the pulp was washed in the same way as in the oxygen delignification process.

Kraft pulping (Sa)
The pulping of OCC was carried out in a Hatoo rotary digester in autoclaves of 2 dm³ capacity. Liquor of 25% sulfidity and active alkali of 10 and 14% based on oven-dried (o.d.) OCC of kappa number 52.6 and 103 were used as pulping liquor, respectively. The liquor-to-solid ratio, heating time, pulping time and maximum processing temperature in all pulping experiments were the same, viz. 6:1, 90 min, 90 min and 165 °C, respectively. The stock after pulping was preliminary washed using distilled water (Büchner funnel, water-to-pulp ratio 20 : 1) and then washed by diffusion using this kind of water in plastic buckets for 24 hours. The Kappa number of pulps OCC50 and OCC100 after washing was 21.9 and 30.4, respectively.

Normal laboratory disintegration (D)
After kraft pulping and washing, the OCC pulps were subjected to disintegration in a laboratory disintegrator which is used e.g. for the disintegration of wood chips after kraft pulping. The process was performed at a concentration of 1% of OCC pulps in water, at 3000 r.p.m. for 3 min. The pulps were then centrifuged and stored in wet conditions in a refrigerator in closed polyethylene bags for further research. The kappa number of pulps OCC 50 and OCC 100 after pulping was 21.0 and 30.3, respectively.

Oxygen delignification (O)
A weighted portion of OCC pulp was placed in a foil bag. 0.1% of magnesium sulfate in relation to oven-dry pulp (in the form of a 1% solution) and 0.1% of sodium hydroxide per kappa number unit were added to the pulp suspension. The content was mixed together in a bag by kneading and then was quantitatively taken to a Parr 5112 reactor. The autoclave was closed and filled with oxygen to a pressure of 0.6 MPa; the mixing mechanism was then switched on, and the contents were heated to 100 °C over 30 min. This temperature was maintained for 60 min. The experiments were carried out at a consistency of 8%. After the preset time elapsed, the oxygen reactor was degassed and emptied. After oxygen delignification, the pulp was discharged, filtered, washed with three aliquots of 1000 cm³ deionised water, and stored in a plastic bag for further treatment.

Bleaching and hyperwashing (BH)
The OCC pulps were bleached according to the D_0ED_1 sequence. A weighted portion of pulp was placed in a double polyethylene bag together with deionised water. The chlorine dioxide charge was 3% based on o.d. pulp. Sixty-five percent of this charge was added at the D_0 stage and the rest at the D_1 stage. Bleaching was carried out at 8% consistency. No adjustment of the pH of the pulp suspension was made. After 1 min of further kneading, the pulp was placed in a constant temperature water bath at 75 °C. The bag was kneaded again after 5 and 30 min. After 60 min of bleaching in D_0 and 90 min in D_1, the bag was opened. Next the pulp was washed in the same way as in the oxygen delignification process, and then it was placed in a new plastic bag for further treatment.

After the D_0 stage, the pulp was treated in the alkaline extraction stage (E). Deionised water and sodium hydroxide (1.5% on o.d. basis) were added to the bag with the pulp (10% pulp consistency). After kneading, the bag was placed in a water bath (75 °C) and kneaded again after 10 and 30 min. After 90 min of treatment, the pulp was washed in the same way as after the oxygen delignification process.

After bleaching, the OCC pulps were additionally washed with a strong stream of tap water in a Büchner funnel with a dense metal net with a 75 by 75 μm mesh (hyperwashing stage, marked as H). The wash water-to-pulp ratio was 40:1.

Processing of birch and pine
Birch and pine pulps were produced from birch and pine wood chips according to the process sequence $Sa + D + O + B$.

Kraft pulping process (Sa)
Industrials chips were used to obtain birch and pine kraft pulps. The time-temperature conditions of pulping were the same as in the processing of OCC. The amount of active alkali charged of birch and pine wood was 18 and 22% on o.d. wood, respectively, while the liquor-to-wood ratio was 4 : 1. After pulping and further treatment of cooked chips (pre-washing, diffusion washing, disintegration), the pulps were screened on a laboratory screen sorter - Weverk using a screen plate with slots of 0.2 mm. The kappa number of birch and pine pulps after screening was 29.7 and 20.2, respectively.

Oxygen delignification and bleaching (O and B)
Birch and pine kraft pulps were oxygen delignified and bleached in similar conditions to those for OCC pulps.
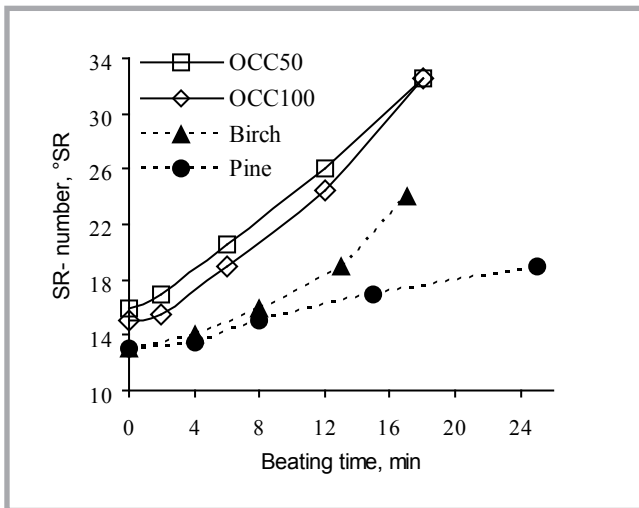
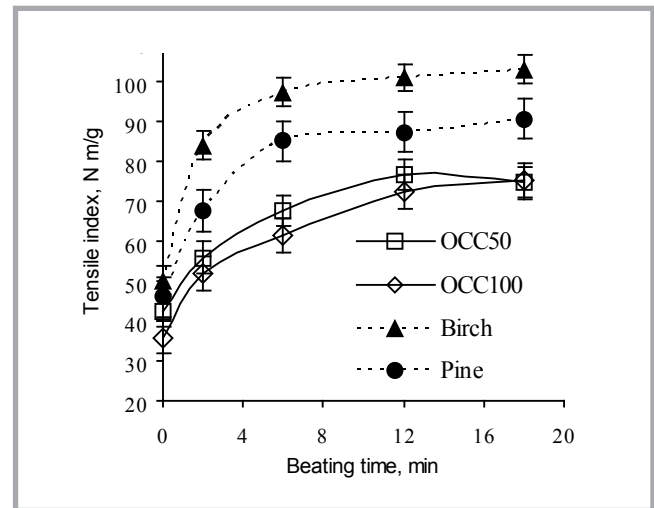Figure 1. *Beating curves of pulps.*

Figure 2. *Beatablity of bleached OCC, birch and pine pulps.*

Determinations of pulp properties

- the intrinsic viscosity as a measure of the degree of polymerisation of cellulose (DP) - in accordance with PN-92/P-50101/01,
- the content of hemicelluloses in the pulps - method described by Beélik *et al.* [19],
- dimensions of the fibres and their degree of deformation - computer image analysis with MorFi apparatus (Techpap) according to the instruction manual,
- brightness, light scattering coefficient and printing opacity - according to ISO 2470:1999 and with Spektrocolor 01 apparatus (Spectrocolor, Poland),
- the beating of pulps in a Jokro beater - in accordance with PN-61/P-50062,
- preparation of handsheets to study their physical properties - in accordance with PN-EN ISO 5259-2:2001,
- conditioning of handsheets - in accordance with PN-EN 20187:2000,
- Schopper-Riegler number (SR-number) – with Schopper-Riegler apparatus according to PN-EN ISO 5267-1:2002,
- apparent specific volume - according to DIN EN ISO 534,
- tensile strength - in accordance with Standards ISO 1924-1 and 2:1998 in Zwick/Roel BZ2.5/TN1S apparatus,
- tear resistance - according to DIN EN 21974:2002 with ProTear (Thwing-Albert, USA) apparatus,
- short-span compression strength (SCT) - in accordance with Standard ISO 9895:2002 in Zwick/Roel BZ2.5/TN1S apparatus (Germany),
- zero-span tensile strength - with Troubleshooter TS-100 (Pulmac, USA) after the beating of pulps in a Jokro mill

for six min according to the owner's manual of the apparatus,
- zeta potential of the fibres – with FPA (Emtec, Germany) apparatus,
- water absorption of pulps in the form of handsheets prepared using Rapid-Koethen apparatus and dried without restrain prepared from unbeaten pulps - according to PN-65/P-50153 and expressed as a multiple indicator, showing how many times more water is able to absorb pulp in the form of handsheet compared to its o.d. weight,
- water absorption of fluff pulps – according to PN-89/P-04781.12 as a multiple indicator, expressing the number of grams of water absorbed by 1 gram of pulp in the form compared to its o.d. weight,
- the fines content in pulps - after their beating in a Jokro mill for 10 min according the method described in publication [20],
- ash content in pulps – in accordance with PN-92/P-50092.

■ Results and discussion

#### Drainage and handsheet properties of OCC pulps after beating

Beating is important operation in paper technology because it affects the dewatering performance of pulps and the number of their properties. The influence of the beating of bleached pulps from low and high kappa number OCC on its SR-number, which is very sensitive to the presence of fibril material and fines in pulps, is presented in *Figure 1*.

The data plotted in *Figure 1* show that the SR-number of bleached pulp from OCC before beating is higher than that

of bleached birch and pine pulps only by 2 - 3 °SR. However, after beating, the difference in the SR-number between the pulps increased. For example, after 12 min of beating, the SR-number of birch and pine pulps was 18 and 16 °SR, respectively, whereas in the case of OCC50 and OCC100 it was 24 and 26 °SR (*Figure 1*). Thus the average SR-number of OCC pulps after this beating time was higher than that of birch and pine pulps by 8 °SR.

The tensile strength of pulps is determined primarily by inter-fibre bonding and fibre strength. The former being dependent on fibre flexibility and external fibrillation, while the later – on the DP of cellulose and small-scale deformations (dislocations, slip-planes, bucklings, cracklings, wrinkles, folds). Changes in the values of the tensile index of bleached OCC and birch and pine pulps during the beating process are illustrated in *Figure 2*.

The data plotted in *Figure 2* shows that the tensile strength of bleached low and high kappa number OCC pulps achieved its maximum value after approximately the same time of beating as in the case of birch and pine pulps (12 min). There was almost no difference between the tensile strength of low and high kappa number OCC pulps. Comparing this property of bleached OCC and birch and pine pulps after 12 min of beating, one can state that in the case OCC it is lower by approximately 26% and 15 relative % (rel.%) than in the case of pulps from birch and pine, respectively.
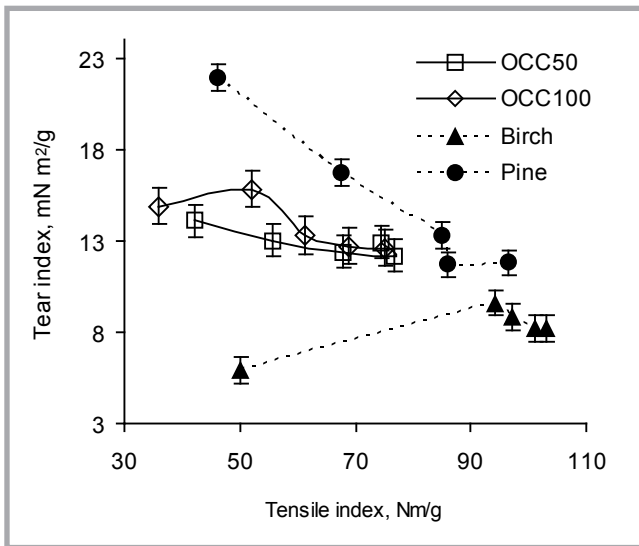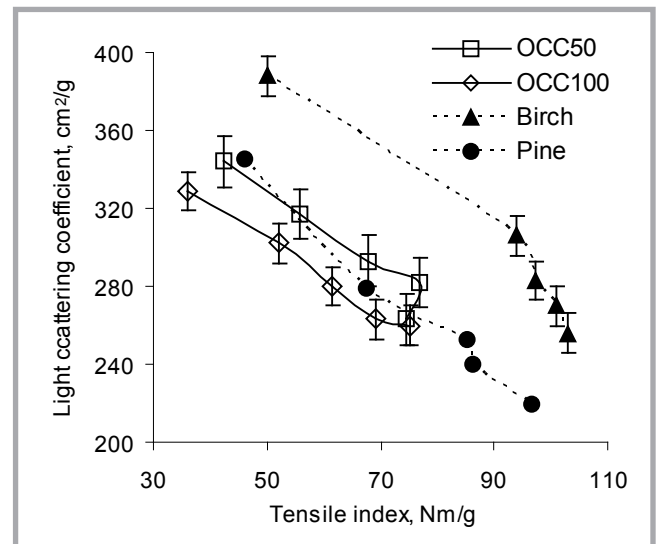
Figure 3. *Tear-tensile strength relationship of bleached OCC, birch and pine pulps.*
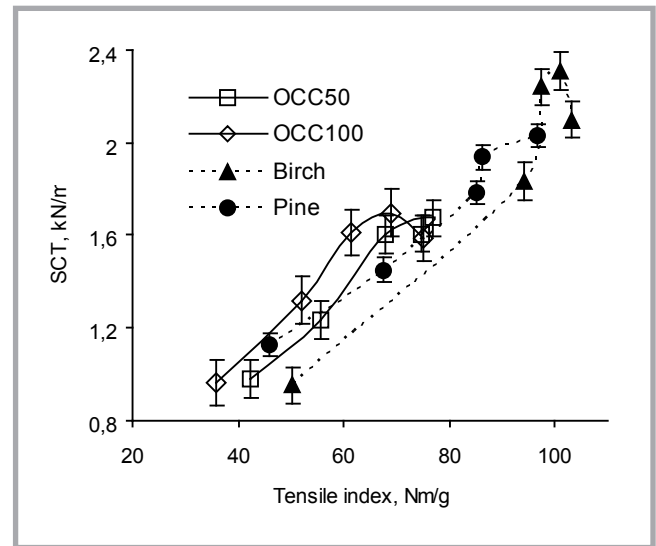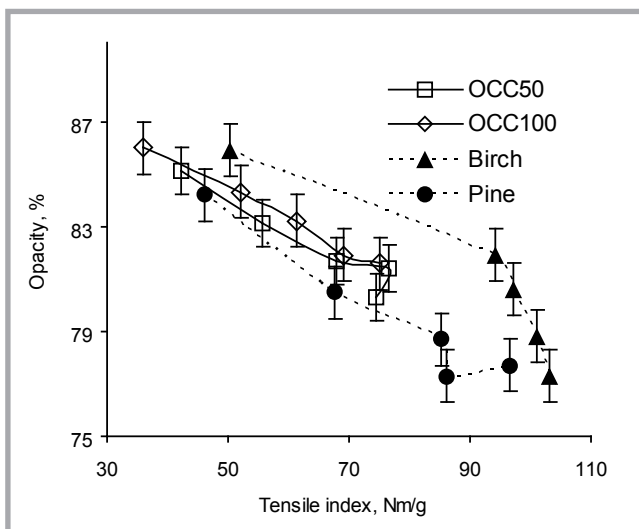

Figure 4. *SCT-tensile strength relationship of bleached OCC, birch and pine pulps.*
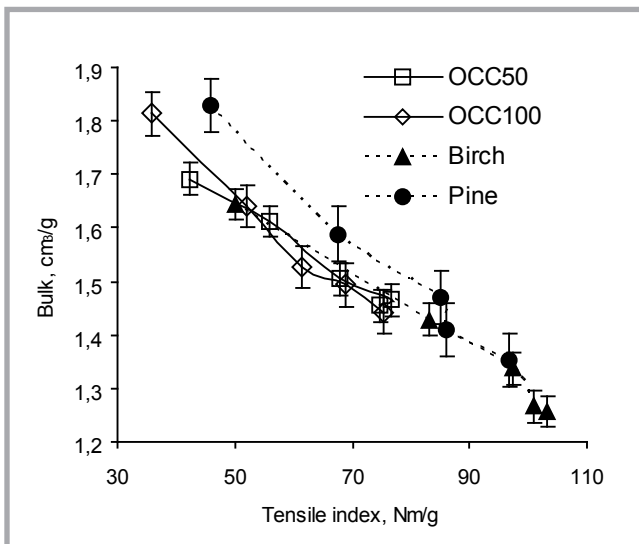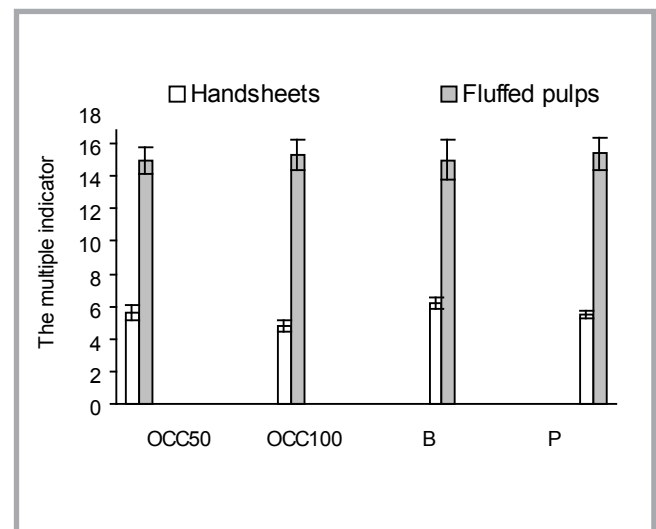

Figure 5. *Bulk-tensile strength relationship of bleached OCC, birch and pine pulps.*

Figure 6. *Light scattering ability of bleached OCC, birch and pine pulps at a specific tensile strength.*

Figure 7. *Printing opacity-tensile strength relationship of bleached OCC, birch and pine pulps.*

Figure 8. *Water absorption ability of bleached OCC, birch and pine pulps.*

Figure 3 shows that there was no fundamental difference in the tear resistance of bleached pulps from high and low kappa numbers OCC pulps. Besides this, one can state that they had high tear strength both before and after beating. At the maximum tensile index (75 N·m/g), the tear strength of bleached OCC pulps was by 70 rel.% higher than that of birch pulp and only 18 rel.% lower than that of pine pulp (Figure 3).

It was found that the short-span compression strength (SCT) of pulps is strongly dependent on their tensile index (Figure 4). Because the maximum tensile index of bleached OCC pulps was significantly lower than the tensile index of birch and pine pulps, the maximum SCT for OCC pulps is also lower by 15 to 25 rel.%, respectively, than that for pulps from birch and pine.

Bulk is an important structural property of pulps destined for the production of fine printing papers and tissue and fluff products. Figure 5 shows that the bulk of bleached OCC handsheets diminishes with the development of tensile strength. At a comparable tensile strength this property of OCC handsheets is lower than that of pine pulp ones, but comparable with the bulk of birch pulp handsheets, as is illustrated in Figure 5.

The light scattering and opacity of pulps are determined by the amount of the unbound surface of fibres and their lumens. Increased bonding between the fibres and their collapse reduces the amount of this surface, decreasing the light scattering ability of pulps and its opacity. As shown by the curves plotted in Figures 6 and 7, OCC pulps showed a light scattering ability similar to that of pine pulp and a slightly higher opacity.

Water absorption ability is an important property of pulps designed for the manufacture of tissues and fluff layers of other hygienic products. Its ability to absorb water depends on the fractional composition of fibrous pulps used for its manufacture, as well as on the properties of fibrous cells and the volume of pores, the later being dependant on the way of disintegration of the pulp and its forming. The results of the research show that the average water absorption of bulky handsheets prepared from unbeaten bleached OCC pulps was lower by 16.1% and 5.4% than that of birch and pine pulps, respectively (Figure 8). As
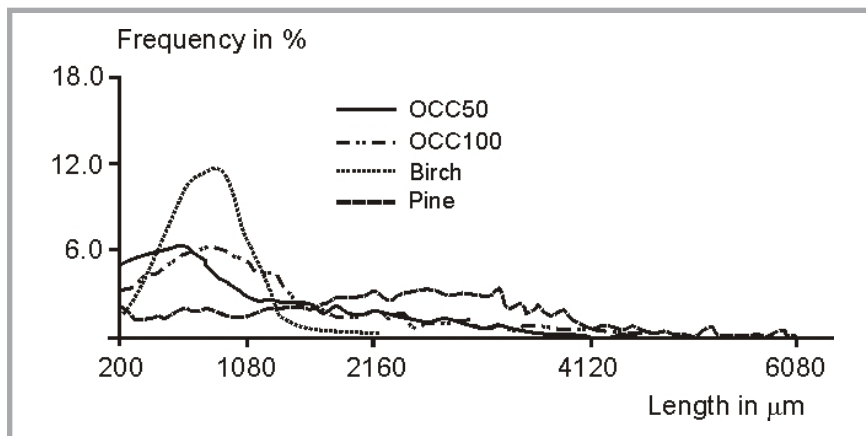
Figure 9. Distribution of the fibre length of bleached OCC, birch and pine pulps.

Table 1. Properties of bleached OCC, birch and pine pulp, and their fibres

Index, unit	Pulp	OCC50	OCC100	Birch	Pine
Length weighted fibre length, mm		1.296	1.348	0.92	2.34
Fibre width, µm		26.5	25.5	21.3	30.9
Coarseness, mg/m		0.163	0.189	0.117	0.192
Number of fibres per one gram of pulp, million/g		7.83	6.08	11.07	3.84
Fines, wt. %		5.1	6.3	3.2	2.9

Table 2. Other properties of bleached OCC, birch and pine pulps.

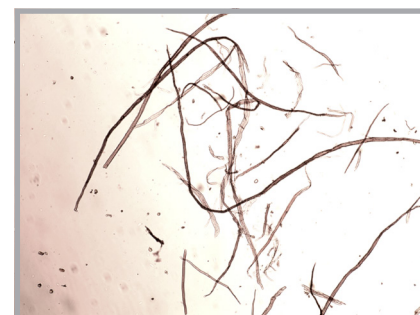| Index, unit	Pulp	OCC50	OCC100	Birch	Pine
Hemicelluloses content, %		11.3	9.1	14.2	10.7
Ash content, %		0.92	0.61	0.25	0.29
Zeta potential, (ξ), mV		22.7	24.2	36.4	32.6

for bleached OCC pulps in a fluffed form, the observation to be made is that its water absorption is high and comparable to that of bleached birch and pine pulps.

Fibre and pulp properties versus paper properties

Figure 9 presents the fibre length distribution curves of birch, pine and OCC pulps. The fibre length distribution of the first two exhibit good agreement with literature data [21, 22], while in the case of the latter two one can observe that they may contain both hardwood and softwood fibres. Besides this, the curves in Figure 9 show that the OCC pulps contain a significantly larger number of fibres with a length of 0.2 - 0.4 mm (shortened fibre fraction) than bleached pine pulp.

The presence of a large number of softwood fibres in bleached pulps from OCC is also indicated by the average width and coarseness of fibres, which amounted to 25.5 - 26.5 µm and 0.163 - 0.189 mg/m, respectively (Table 1).

The fibre length distribution and value of the coarseness of bleached OCC pulps explain the relatively high values of tear strength of OCC pulps (Figure 3). Apart from this, the high tear index of these pulps can also result from the presence of long and narrow fibres, probably from the bast plant, which were evidently visible in photographs of OCC pulps, near the wide softwood tracheids and short, slender hardwood fibres (Figure 10). The presence of these fibres in bleached OCC pulps may result from the use of corrugated containers from Asia in

Figure 10. Photograph of OCC 50 bleached pulp (optical microscope, magn. ×40).

Table 3. *Fibre defect data (indices determined using computer image analysis method)*

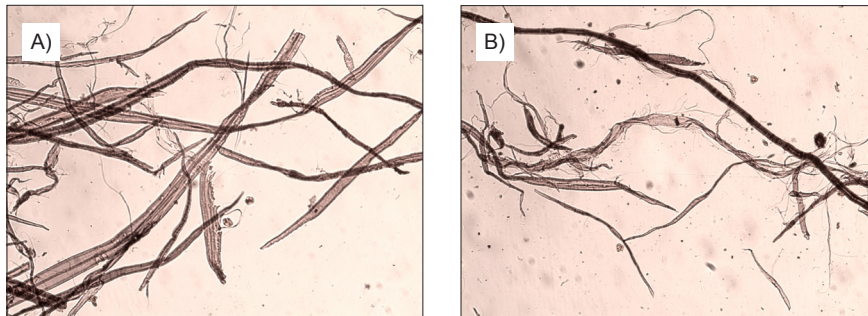| Index, unit / Pulp	OCC50	OCC100	Birch	Pine
Kinked fibres, %	57.5	61.9	56.5	53.4
Curl, %	18.2	16.4	11.0	15.3
Broken fibre ends, %	38.1	39.4	18.7	31.4
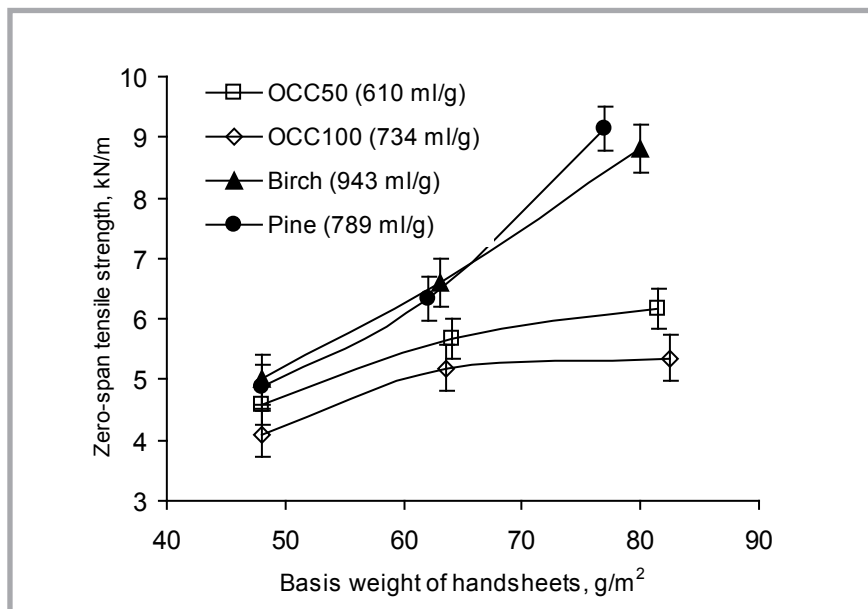
Figure 11. *Zero-span tensile strength of handsheets prepared from bleached OCC, birch and pine pulps, and the intrinsic viscosity of pulps (in legend).*

Figure 12. *Broken (A) and highly curled fibres (B) in bleached OCC 50 pulp (magn. ×100).*

the production of new corrugated boards, where non-woods plants are used for paper and paperboard manufacture in greater amounts than in Europe (e.g. in China it is about 20% of fibrous raw material) [23].

The results listed in **Tables 1** and **2** are useful in explaining significant differences in the tensile strength of bleached pulps from OCC and birch and pine pulps.

The tensile strength of paper handsheets (*T*), as shown in the following Page equation, depends on the zero-span tensile strength of paper as an index of the fibre strength (*Z*), the average fibre length (*L*), the average value of the circumference of fibres of the pulp (*P*), the average cross-sectional area of cell walls (*A*), the density of cell wall fibres (*ρ*) (which assumes a generally constant value of 1500 kg/m³), RBA (Relative Bonded Area) and the shear bond strength *b* [24, 25].

$$\frac{1}{T} = \frac{9}{8Z} + \frac{12 \cdot A \cdot \rho}{b \cdot L \cdot P \cdot (RBA)} \quad [24, 25] \ (1)$$

As regards RBA, Batchelor *et al.* reported it is proportional to the apparent density of handsheets provided the fibre shape is constant [26]. **Figure 5** shows that there was no significant difference between the density of the handsheets of paper made of bleached pulp from both OCC and birch pulp. Therefore this factor could not be the reason for the lower tensile strength of OCC pulps. Also the lower tensile strength of OCC pulps is probably not caused by the characteristics of the fibres. The fibre length of OCC pulps was in fact greater than the length of those of birch pulp, whereas differences in the *P*, *A* and *ρ* of OCC pulps are probably balanced. If it were not so, it would mean a significant difference in density between handsheets of OCC pulps and birch pulp, which was not observed.

Therefore the lower tensile strength of OCC pulps must be caused mainly by the lower tensile strength of fibres (*Z*), which is influenced by the degree of polymerisation of cellulose and fibre defects [27]. This was confirmed by the results of the determination of the zero-span tensile strength of handsheets, the intrinsic viscosity of pulps and fibre defect measurements (**Table 3, Figure 11**). These determinations revealed lower values of zero-span strength of bleached OCC pulps than for those from birch and pine, lower intrinsic viscosity of the former pulps (**Figure 11**), as well as higher defect indices (more fibres in which kinks were detected, less straight fibre and more broken ends) than in the case of pulps from birch and pine (**Table 3, Figure 11**).

Another observation that could be seen from the data of **Figure 11** is that differences in the strength of the fibres of different pulps measured using the zero-span tensile method are visibly better at a higher basic weight of paper handsheets.

The low tensile strength of the sheets of OCC pulps may also result from an insufficient number of bonds per unit area of fibres, which is characterised in Page's equation by the difficult-to-determine *b* ratio. This number depends on the content of hemicellulose in the pulps and the surface topography of fibres. As can be seen in **Table 2**, the content of hemicellulose in bleached pulps OCC50 and OCC100 was, however, comparable to that in bleached pine pulp. The reason for the smaller number of bonds between the fibres per unit of the bonded surface may therefore be the more uneven surface of fibres from OCC. In fact, OCC can contain horny, repeatedly processed recycled fibres and a higher content of mineral filler particles deposited on the fibres, which is indicated by their higher ash content (**Table 2**).

Table 2 also shows the value of the zeta potential of fibres of the pulps studied, which controls the deposition of fillers and chemicals used for paper modification on them (e.g. starch). As results from these data, this potential of OCC pulps was lower than that of pulps from birch and pine, which means that the amount of charge reducing chemicals that should be added in the papermaking process to decrease the zeta potential of these pulps should be somewhat lower than in the case of conventional pulps from wood. The lower values of the dzeta potential of OCC pulps can be due to the higher content of residual Al^{3+} ions in these pulps, which are used in papermaking as retention aids. Dionne & Hoyos [5] and Danielewicz & Surma-Ślusarska [15] reported a very high content of these ions in OCC boards.

The fractional composition of pulps can affect the ability of light scattering and opacity of the sheets. The data of *Table 1* indicate that the OCC pulps contain approximately twice the fibres than bleached pine pulp and from two to three times more fines in comparison with this pulp. This does not, however, translate into a significant increase in the ability of OCC pulps to scatter light or an increase in opacity, which were, respectively, comparable or only slightly higher than for pine pulp (*Figures 6* and *7*). The higher content of fines in OCC pulps than in birch and pine pulps explains the higher SR-number of the former pulps, both before and after beating (*Figure 1*). It also explains the somewhat lower water absorption of fluffed OCC pulps in comparison with bleached birch and pine pulps. In a such state fines generally deteriorates the ability of pulp to retain water because it does not create a porous structure like fibres; it decreases the share of fibres in the pulp and excessively felts it [28, 29].

■ Conclusions

Bleached pulps from unprinted low and high kappa number OCC have significantly higher tear strength and comparable bulk in comparison with birch pulp, comparable optical properties to pine pulp, and comparable or slightly lower water absorbability than birch and pine pulps. The favourable characteristic of these pulps is also their higher average fibre length than that of hardwood pulps, especially taking into consideration the application of these pulps to tissue and fluff grades.

Unfavourable features of bleached pulp from OCC are their higher SR-number, and lower tensile index and SCT compared with birch and pine pulps.

The differences in the properties of bleached pulps from OCC and birch and pine pulps can be well explained by variations in their fractional composition and the morphological properties of fibres. This study showed that the relatively high tear strength of OCC pulps results from the presence of a large amount of softwood fibres in them, while the lower tensile strength of these pulps is mainly caused by the lower DP of cellulose (lower intrinsic viscosity) and higher degree of damage of fibres.

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European Polysaccharide Network of Excellence

Institute of Biopolymers and Chemical Fibres

American Chemical Society

EPNOE 2015
4th EPNOE International Polysaccharide Conference

POLYSACCHARIDES AND POLYSACCHARIDE -BASED ADVANCED MATERIALS: FROM SCIENCE TO INDUSTRY

National Stadium in Warsaw, Poland
19 - 22 October 2015
organized by
the Institute of Biopolymers and Chemical Fibres (IBWCh), Łódź, Poland

EPNOE International Polysaccharide Conferences are now key features of the calendar of European scientific events. The conference has been organized biannually since 2009.

The conference aim is to bring together students, scientists and specialists working in industry, universities and research institutes to exchange experiences, present research results, develop a platform for mutual scientific contacts and intensify academic/industry cooperation.

Since 2013, the EPNOE International Polysaccharide Conference has been promoted and organised jointly by the European Polysaccharide Network of Excellence (**EPNOE**) and the Cellulose and Renewable Materials division of the American Chemical Society (**ACS**).

On behalf of EPNOE and ACS, we have the pleasure to invite you to participate in the 4th Conference EPNOE 2015 *"Polysaccharides and Polysaccharide - based advanced materials: From Science to Industry"*

Scope of the conference:
- Polysaccharide biosynthesis: structural and chemical aspects
- Polysaccharide dis-assembling, isolation and extraction
- Physical, structural, surface and chemical characterisation of polysaccharides
- Chemical and enzymatic degradation, functionalisation and modification of polysaccharides
- Nanopolysaccharide production, characterisation and uses, including nanocellulose and MFC
- Polysaccharides in food and feed
- Polysaccharides in health care, personal care, and cosmetics
- Materials for green engineering and building construction
- Biorefinery (pulp & paper, use of co-products and wastes)
- Bioplastics and fiber-reinforced composites
- Bio-resource and bio-product engineering
- Bio-based economy
- Bio-based textiles: eco-friendly design and technology

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PLENARY, INVITED AND KEY-NOTE LECTURES

	Plenary Lecturer	Title of presentation
P1	Stanisław Bielecki (Poland)	From bio-nanocellulose to bioeconomy
P2	Kevin Edgar (USA)	Ultramild, Selective, and Versatile – New Pathways to Polysaccharide Derivatives through Cross-Metathesis
P3	Orlando Rojas (Finland)	(Nano)cellulose as support for bio-interfaces and bioactive materials
P4	Artur Cavaco-Paulo (Portugal)	Enzymatic modification of carbohydrate fibres
P5	Vincent Bulone (France)	Structure and biosynthesis of essential Eukaryotic cell wall polysaccharides
	Invited Lecturer	**Title of presentation**
IL1	Janusz Kapuśniak (Poland)	Esterification of starch with fatty acids. New opportunities and challenges
IL2	Johannes Ganster (Germany)	Utilization of Lignocellulose in the Plastics Industry - Vision and Reality
IL3	Carmen Boeriu (the Netherlands)	Functional carbohydrates: Using enzymes for selectivity
Invited Lectures for Panel - 21 October		**Title of presentation**
IL1	Paweł Bielski - *Grupa Azoty S.A.* (Poland)	Grupa Azoty - The power creation for innovative, sustainable products
IL2	Silke Stüsgen - *Toho/Tenax* (Japan)	Development trends for carbon fibres
IL3	Gerd Unkelbach - *Fraunhofer Center for Chemical-Biotechnological Processes CBP* (Germany)	Shaping the future with bioeconomy - biogenic residues as raw materials for the chemical industry

Invited Lectures for Panel - 22 October		Title of presentation
IL1	Patrick Navard - *EPNOE Association* (France)	The role of research institute-industry relationships
IL2	Andreas Kuenkel - *BASF* (Germany)	Biodegradable and renewable polymers: How to contribute to a sustainable future?
IL3	Tomasz Zieliński - *PIPC* (Poland)	Chemical sector - or has a chance to become a leader of innovation in Poland
IL4	Krzysztof Jak Kurzydłowski - *NCBiR* (Poland)	Support for innovation and research - development, new chanenges for bussiness development for the period 2020
Key-note Lecturer		**Title of presentation**
KL1	Małgorzata Jaworska (Poland)	Ionic liquids, a new tool for modification of chitin and chitosan
KL2	Laurent Arnaud (France)	The use of bio based building materials: sustainability and technical performances
KL3	Tatiana Budtova (Russia)	Bio-aerogels
KL4	Birgit Classen (Germany)	Stimulation of somatic embryogenesis and plant regeneration by natural proteoglycans
KL5	Peter Williams (United Kingdom)	Modification of polysaccharides to form new functional materials
KL6	Sevda Senel (Turkey)	Chitosan for human and veterinary medicine: possibilities and limitations
KL7	Elizabete Frolini (Brazil)	Bio-based materials from electrospinning
KL8	Stefan Spirk (Austria)	Materials from Polysaccharides – New Tricks from Old Dogs
KL9	Bernard Cathala (France)	Nanocelluloses as versatile platform nanoparticles for advanced materials
KL10	*will be announced*	
KL11	Jay-Lin Jane (USA)	Resistant starch, health benefits and analysis
KL12	Izabella Krucińska (Poland)	Bio-based textiles as an element of bioindustry
KL13	Xiaoxi Li (China)	Design of starch-based controlled-release delivery carriers
KL14	Karin Stana-Kleinschek (Slovenia)	Polysaccharide surface structures for tailored biomolecule interactions
KL15	Danuta Ciechańska (Poland)	Biomass as a source of valuable polymer materials
KL16	*will be announced*	

ASIA APPAREL EXPO BERLIN

MESSE BERLIN, 24 - 26 FEBRUARY 2016
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EXPANSION FOR THE LARGEST APPAREL SOURCING SHOW IN EUROPE

Due to demand from both buyers and suppliers, **ASIA APPAREL EXPO** has opened its doors to apparel manufacturers based outside Asia to exhibit at the fifth edition in February 2016.

European clothing buyers from Germany, France, Italy, UK, Spain, Portugal, Czech Republic, Poland, The Netherlands, Denmark, Belgium, Norway and Russia attended the expo in 2015, meeting with new suppliers and discussing the most up-to-date sourcing and production information with the 220 apparel companies on show.

Garment and fabric manufacturers who are able to meet the changing demands and high standards of Europe's leading retailers, brands and importers can benefit from **ASIA APPAREL EXPO**, which offers direct access to these buyers, from large European retailers to smaller chains, clothing brands, importers and wholesalers. The 2015 expo attracted 1780 buyers and clothing companies.

For the fifth edition, **ASIA APPAREL EXPO** will once again take place at the BERLIN MESSE, opening on **WEDNESDAY 24 FEBRUARY** through to **FRIDAY 26 FEBRUARY 2016**. Over 250 companies are expected to participate in the 2016 expo. Apparel products on show cover mens, womens and childrenswear, fabrics and textiles, as well as trimmings and accessories from carefully-selected factories.

The 2015 show report is available at www.asiaapparelexpo.com

Notes to Editors

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