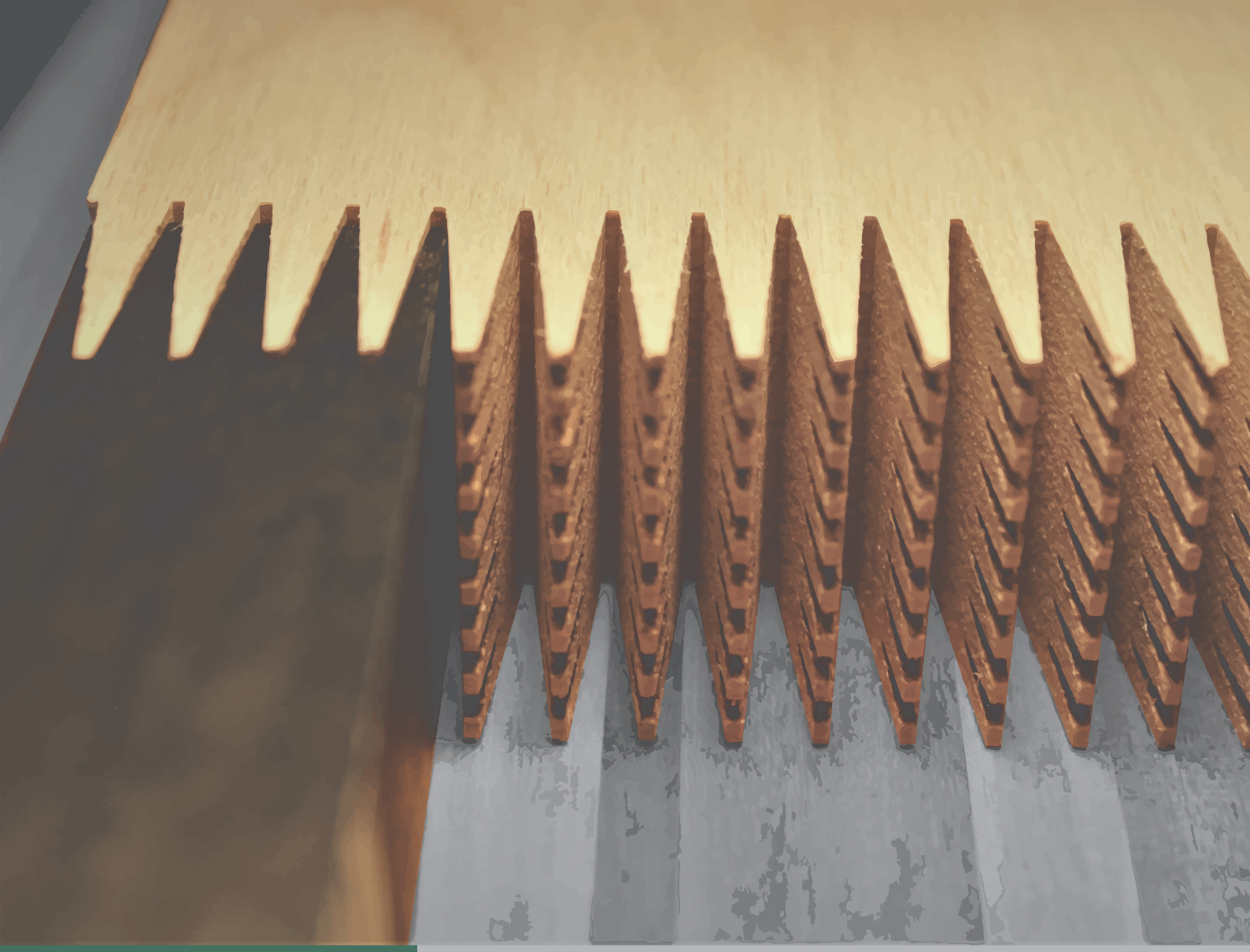

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A fast method of modified fibrous composites preparation

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Background

EN ISO 5269-2: 2005 - Pulps - Preparation of laboratory sheets for physical testing - Part 2: Rapid-Köthen (R-K) method (ISO 5269-2: 2004) is the primary production method on a laboratory scale, model paper sheets in the paper industry. In the literature on the subject, there was little information on using an apparatus to form sheets of paper to produce model research materials on a laboratory scale. Sehaqui et al. (2010) proposed using the R-K apparatus for manufacturing flat cellulose materials containing inorganic nanoparticles. The research showed that obtained nano-paper was characterized by high strength (232 MPa), modulus (13.4 GPa), significant optics transparency (T600 42%), and surface smoothness (surface roughness 21.9 nm). Researchers suggested that the proposed procedure can be used to prepare nano-paper structures with cellulose nanofibers in combination with inorganic nanoparticles. Castro et al. (2018) used the R-K apparatus as a pilot-scale discontinuous paper process for fire retardant cellulose-kaolinite nanocomposites. The work resulted in inorganic hybrid composites with high in-plane-oriented nanocellulose, nanoclays, and wood fibers. Researchers concluded that potential applications could include fire retardant cardboard for semi-structural applications and as reinforcement mats in molded thermosetting biocomposites.
This study aimed to modify the widely known Rapid-Köthen method and apparatus so that it was possible to produce composites using biomass and substances containing a high concentration of elemental carbon under reproducible conditions. The R-K apparatus was equipped with a module for automatic and manual control of the product forming process, and the sieves were strengthened to reduce the risk of their destruction. In this paper, three types of modified composites will be presented, including modified starch, forest biomass, and graphite. Manufactured composites were appropriately characterized by increased resistance to water and microscopic methods. For the produced composites, the uniformity of distribution of the substrates included in

the composite was examined by analyzing significant differences in water absorption.
The superior goal of the work is to present the possibility of fast obtaining new products aimed at inviting partners associated with the Northern European Network for Wood Science and Engineering to cooperate using the proposed method.

Keywords: paper sheet, composites, cellulosic materials, Rapid Köthen sheet former

Experimental

Materials

Bleached softwood Kraft fibers (Södra Black R) were used as raw materials. Wheat starch (C*Flex 20002, Minneapolis, MN, USA) with Protectosile SC Concentrate® (daw Corning) was used as a hydrophobic agent. Wood waste (MDF) was used as a cellulose filler, and graphite (ES 100, Krapfmu GmbH) was used as an inorganic carbon component.

Cellulose sheets production

Before paper manufacturing, either as native or as modified form, cellulosic fibers were immersed in deionized water for 24h for better defibrillation during cellulose sheets production. A lubricity of diluted suspension of pulp was measured by the Schopper-Riegler apparatus (Labormex, Poland) acc. to ISO 5267. Pulp suspension in water in terms of the Schopper-Riegler (SR) number was 14 ± 0,8. Rapid-Köthen sheet former (Labomex, Poland) was applied to prepare paper sheets with 200±0,1 mm diameter. All additives were added during sheet production for treated samples, individually or as a mixture. Key parameters controlled in the R-K apparatus were: the number and amount of additives and cellulosic fibers, stirring time, the volume of water, composite stirring time (by air pressure), floating time, vacuum time, and vacuum drying time of the final product. In figure 1, the picture of the R-K sheet former is presented.

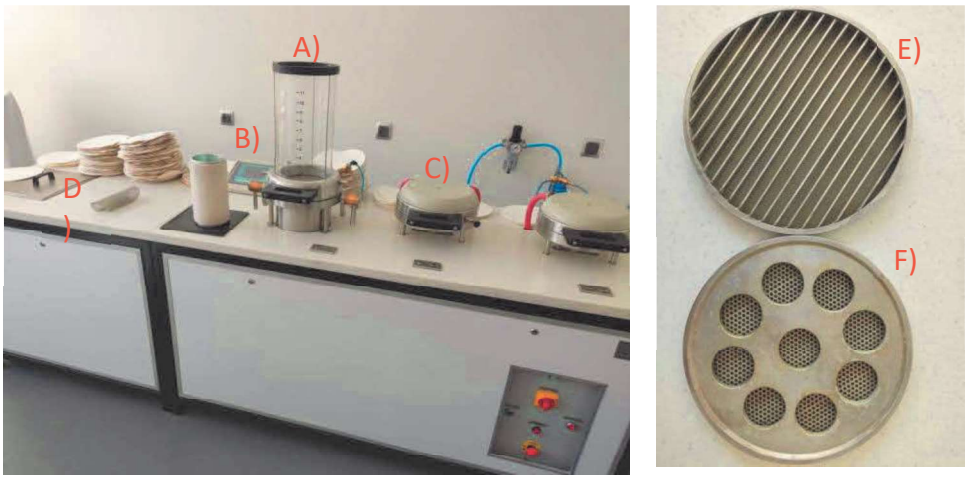

Figure 1. R-K sheet former – A) sheet forming area; B) control panel; C) Vacuum drying area; D) container of post-process water; E) standard net for sheet paper forming; F) Modified net for composite forming.

Results and Discussion

In Fig. 2, manufactured products were presented. Cellulose composite with starch modified with Protectosile SC Concentrate has characterized high water protection. The average contact angle of the composite was higher than 130°. No significant differences in the frame of contact angle result in the same types of products (Fig. 2a). Composite consists of cellulose and harvest waste substrate also were characterized by comparable contact angle results (Fig. 2b). Also, the distribution of inorganic carbon was satisfied. In Fig. 2c and 2d, composite incrusted with graphite and its microscopic picture can be observed, respectively.

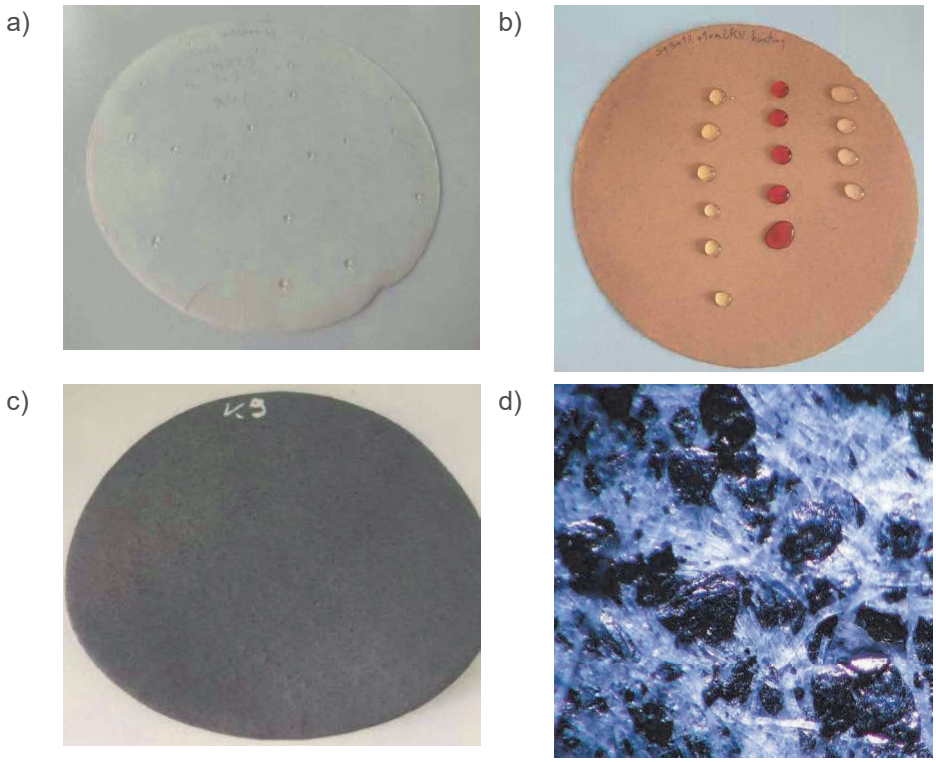

Figure 2. Picture of manufactured products and their selected properties: a) Hydrophobic properties of cellulose modified with starch and Protectosile SC Concentrate®; b) cellulose sheet incrusted with wood waste; c) cellulose sheet incrusted with graphite; d) microscopic picture of cellulose sheet incrusted with graphite.

Conclusions

The Rapid-Kothen apparatus is excellent for preparing a new or innovative composite based on cellulose or wood waste products. Repeatable structures and properties characterize the manufactured products. Moreover, the composite production process can last less than 10 minutes (excluding components preparation) per one sheet (20 cm diameter). The R-K apparatus is relatively easy to clean equipment, and it is possible to prepare many modification variants in a short period. The main disadvantages of this technic are the limitation of product thickness and small retention of the substrates when they are water-soluble.

References

Sehaqui H, Liu A, Zhou Q, Berglund LA (2010) Fast preparation procedure for large, flat cellulose and cellulose/inorganic nanopaper structures. Biomacromolecules11(9): 2195-2198.

Castro DO, Karim Z, Medina L, Häggström JO, Carosio F, Svedberg A, Wågberg L, Söderberg D, Berglund LA (2018) The use of a pilot-scale continuous paper process for fire retardant cellulose-kaolinite nanocomposites. Composites Science and Technology 162: 215-224.

ISO 5269-2:2004 Pulps — Preparation of laboratory sheets for physical testing — Part 2: Rapid-Köthen method.