INFLUENCE OF THE PROCESSING METHOD ON BASIC PHYSICAL AND MECHANICAL CHARACTERISTICS OF THE FIBROUS MATERIAL

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The article presents a brief analysis of various processing methods for fibrous materials.

Key words: knifeless grinding, fibrous materials, jet-barrier unit, grinding, knife grinding tooling.

Knifeless processing of fibrous plant materials is significantly different from knife grinding both in the way of fiber treatment and in various technological and economic factors [1].

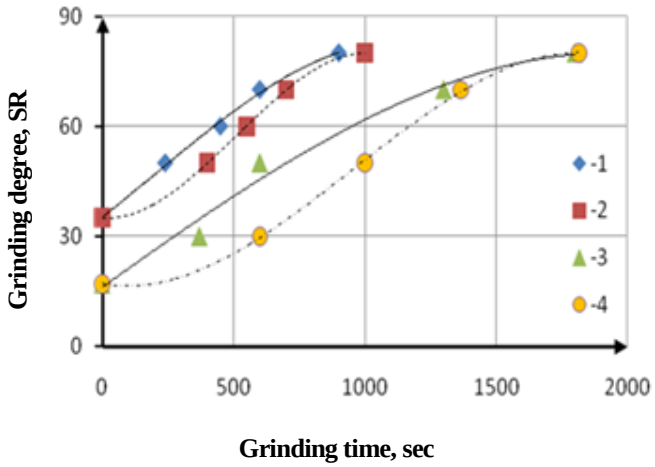
Grinding process affects mechanical strength of the produced paper in several ways with opposite effects. At the beginning, the factors with positive effect on mechanical strength of the paper prevail (flexibility of the fibers increases due to swelling, fiber bonding forces increase) increasing main indicators of the mechanical strength.

But at some stage of the grinding process, the negative factor increases greatly (in particular, the fibers become shorter, this is especially true for recycled fibrous materials). The resulting quantitative changes in the fiber length cause qualitative changes in the development of the main mechanical strength indicators. The indicators begin to decrease under predominant influence of the negative factor.

In this regard, we decided to investigate how grinding methods affect efficiency of fibrous material treatment. We used a jet-barrier unit for the knifeless grinding and a semi-industrial disk mill for the knife grinding [2, 3, 4].

The experimental data show that the type of fibrous plant materials (unbleached cellulose or broke) and the way of fiber treatment greatly influence duration of grinding.

Based on the experimental data, we created a graphical dependence of the grinding degree increase (the Schopper-Riegler scale) on the grinding time of the fibrous plant materials using various grinding methods (Fig. 1).



1 – recycled material grinding in the knife unit;
2 – recycled material grinding in the knifeless unit;
3 – raw fibrous material grinding in the knife unit;
4 – raw fibrous material grinding in the knifeless unit.

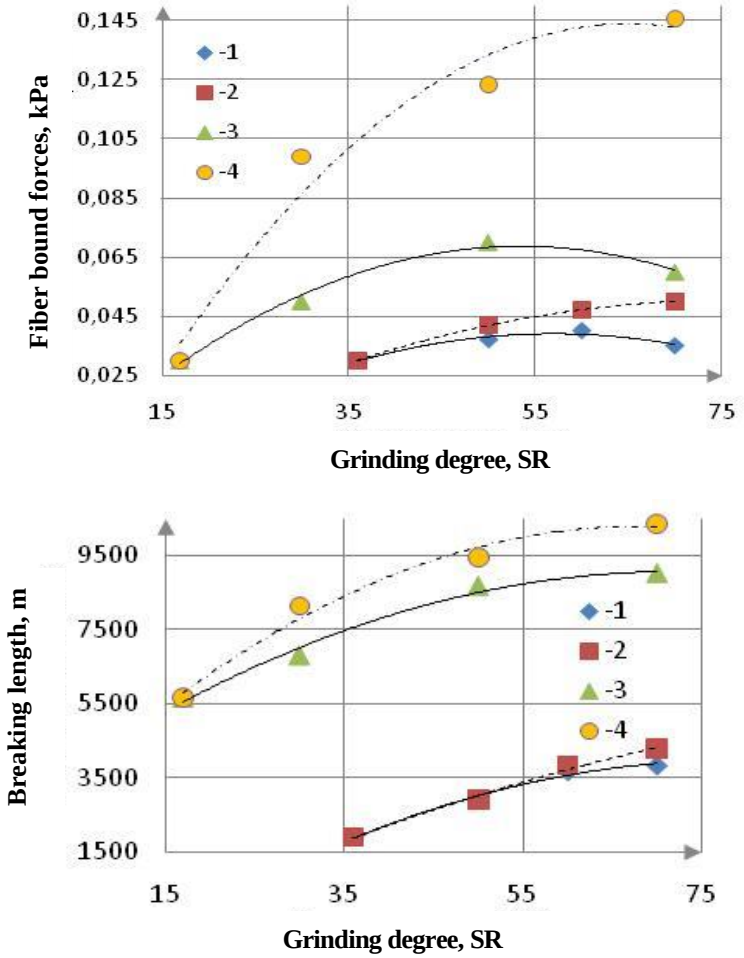
Figure 1 - Dependence of the grinding degree on the grinding time

The figure shows that the qualitative parameters of the grinding degree increase depend on the type of treatment and do not significantly depend on the type of the fibrous plant material. The quantitative indicators of the grinding degree change depend more on the type of the processed material and less on the type of fiber treatment (knife or knifeless grinding).

This is a positive effect, as we know that usually knife grinding is faster than knifeless grinding. We achieved this effect selecting appropriate operation modes of the knifeless unit (jet flow rate, distance from the nozzle to the barrier, etc.) that made it possible to approach knife units in terms of productivity and the grinding degree increase.

Under otherwise equal conditions, duration of the recycled material grinding by the knifeless way is comparable to the time needed for the knife grinding. We achieved the result selecting appropriate operation modes of the knifeless unit (jet flow rate, distance from the nozzle to the barrier, etc.) that made it possible to approach knife units in terms of productivity and the grinding degree increase [2].

Figure 2 shows the dynamics of main physical and mechanical characteristics of the finished product which allows to carry out a comparative analysis of various processing methods for fibrous materials.



1 – recycled material grinding in the knife unit;
2 – recycled material grinding in the knifeless unit;
3 – raw fibrous material grinding in the knife unit;
4 – raw fibrous material grinding in the knifeless unit.

Figure 2 - Dynamics of the main physical and mechanical characteristics

Figure 2 also shows that qualitative dependences of physical and mechanical parameters are of a similar nature. As for the quantitative dependences, it is apparent that the material

significantly affects their values. For example, if the fibrous material is processed in the knifeless unit, the physical and mechanical indicators of finished castings (fiber bonding forces and breaking length) are significantly higher than in the case of the knife unit treatment. The reason is that the physical and mechanical properties of finished castings mainly depend on plasticity and strength of individual fibers, as well as on the grinded fiber length, the external specific surface area and the bond forces. The mentioned paper-forming indicators are higher for the knifeless processing [4].

Thus, the grinding quality indicators of the knifeless grinding method are higher compared to knife grinding. In the knife grinders the fibers are subjected to strong chopping effect without significant fibrillation which ultimately leads to a decrease in strength of the finished product.

Acknowledgments: The authors express their gratitude to the Center for Collective Use of KSC SB RAS for supporting the research.

Funding: The research was carried out under the governmental task issued by the Ministry of Education and Science of Russia for the "Technology and Equipment for the Chemical Processing of the Plant Biomass Material" project by the Deep Plant Material Processing Laboratory (FEFE-2020-0016).

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