

Advisor Report on Dissertation

of

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Title of Dissertation: Chemical and Chemical-mechanical Pulping of Rapeseed Straw

The dissertation on 223 pages (213 tables,73 images) deals with the processing of rapeseed straw (stalks and valves of siliques) to pulp. It is logically organised into chapters, successively into the theoretical, experimental part and lastly the part discussing the results.

Because of expanding usage of rapeseed in the production of bio-diesel fuel, the straw after the oily parts have been processed remains as a by-product suitable for further processing for the pulp and paper industry. Currently, the processing of straw gets lately higher prominence. Therefore the candidate's interest and his decision to follow the rapeseed straw processing, which has attracted lesser attention so far compared with other non-wood raw materials, should be highly appreciated. The dissertation is significant and is fully in line with the trends of the use of non-wood raw materials for applications in the pulp and paper industry. The use of any kind of straw is one of the most promising areas of research funded by the EU.

The experimental was carried out in laboratory conditions at the training Department of Wood, Pulp and Paper, Faculty of Chemical Technology, University of Pardubice. The PhD student used the technological processes of chemical delignification a combination of chemical and mechanical processing of rapeseed straw before disintegration into the papermaking fibres. To evaluate the processing of the raw material and to assess the obtained pulp , the student used appropriate laboratory methods and procedures. To determine the basic physical and mechanical properties and to evaluate the obtained results, the student used the procedures described and recommended in the applicable standards (TAPPI, ISO, DIN, CSN).

It should be underlined that in evaluating the results the PhD student used also an unconventional evaluation method of curve curvatures.

However, the author in his effort to get maximum information about the process of rapeseed straw did not pay enough attention to the dissolved material. It is true that this area was not the topic of the work but because of the volume of the liquid portion from the delignification of rapeseed straw this contains a large proportion of dissolved organic and inorganic substances. According to the information quoted in the work, the yields are sometimes about 60%. The data on the composition of the liquid portion with the identification of chemical compounds would be significant information that would even more importantly supported processing of this raw material. Despite the aforementioned comments it can be concluded that the set aim of the dissertation have been met.

From the submitted work the most significant results should be regarded the applications of enzymes in pre-treatment of oilseed rape before the chemical-mechanical processing.

Regarding the contribution of the submitted work to theoretical knowledge, the author significantly contributes to the information on the processing of non-traditional materials of rapeseed straw and on transformation to fibres. The dissertation brings about novel results that have been obtained and certain functional dependencies that have been described, for example, qualitative parameters of fibres as dependent on conditions of rapeseed straw processing.

On the basis of the obtained results the PhD student has correctly evaluated the options for further utilisation of the obtained fibre in sucking cartonnage to be used for packaging materials.

Questions to be answered by the PhD student:

1. When studying the dissertation text I stumbled over the usage of the terminology "grinding, beating and chemical mechanical pulp". How am I to understand the chapter "2.4.3.1 Grinding of Straw"? The paper states that „a chemical-mechanical pulp was prepared from rapeseed straw“. However, from the data stated in the experimental work, I understand that the PhD student describes the beating conditions under the use of chemicals. The chemical-mechanical pulps as one representative out of the category of mechanical pulps are prepared

by isolating the fibres from logs in grinders or preparing them from chips processed in disc defibrators, with or without heat or chemical treatment, at a consistency of about 30%.

2. A comment to introducing the H factor: In general, the H-factor is given as a non-dimensional number representing the area under the curve as a function of k versus time, even though the calculation is made with a non-dimension coefficient and the time in hours.

3. The results taken from literature that are quoted in tables and figures are not cited.

Despite the abovementioned misperfections that I consider not serious, I have the opinion that the dissertation “Chemical and Chemical-mechanical Pulping of Rapeseed Straw” is of satisfactory quality and it complies with the requirements of the Zákon o vysokých školách č. 111/1998 Sb. (Higher Education Act no. 111/1998 Coll.). I recommend that the dissertation is accepted for defence. In the case of successful defence I recommend that

Ing. Bijay Gurung

is awarded the academic degree

Doctor of Philosophy (PhD)



In Bratislava, 30th September, 2015

**Review of Doctoral Thesis of Ing. Bijay Gurung
"Chemical and chemi-mechanical pulping of rapeseed straw"**

For many years it has been possible to observe problems in the production of paper products on the basis of recycled fibres. Continued recycling of waste paper reduces quality of fibres, their runnability in paper machine and at the same time increases costs of their development. Effective and ecological production of pulp from agriculturally grown energy crops and agricultural crop residues, and their applicability in paper, is worldwide trend at present.

Growing of rapeseed has increased significantly in the past few years, since EU legislation requires use of bio ingredients in fuels. Rapeseed oil, which is obtained by moulding of rapeseed oil-rich seeds, is processed into biodiesel and this is then added into diesel fuel. In the period of 2012/2013 the rapeseed was grown on an area of 400 000 hectares in the Czech Republic alone, that is 16 % of all arable land in the country. As a result of this, each year about 1.5 million tons of rapeseed straw, which can't be used as animal food or as bedding, and can't be decomposed easily by ploughing, is left to farmers. It is used as cheap fuel, moulded in bales like straw or moulded in the form of pellets and serves as an additional source of income for farmers.

The thesis deals with the possibility of using rapeseed straw in the pulp and paper industry and is in line with the current worldwide trend. It is important to highlight complex utilization of various methods of pulps production from rapeseed and their properties with regard on the possibility of the use and replacement of recycled fibres in paper. Optimum conditions of soda pulping, stalk and straw regarding the alkali charge and liquor-to-raw material ratio were defined. Higher yield was obtained by soda pulping of stalks, than of straw, and that was confirmed by cooking with AQ (anthraquinone). With increasing AQ charge, the rate of delignification significantly increased and the reject content was decreasing especially in the area of low H-factor. Measurements of rheosedimentation characteristics of beaten pulps are in accordance with the results of strength properties for pulps from the same raw materials (stalks or straw), prepared by soda pulping with and without addition of AQ. Soda pulps had demonstrated comparable strength properties, when they were prepared from rapeseed straw in our laboratory. Use of AQ is restricted according to the reference of BfR (Bundesinstitut für Risikobewertung) Nr. 005/2013. It is only allowed for production of pulp when absolutely necessary. There are indications of carcinogenic impact of AQ, and it is assumed, that its use will be banned.

I am interested, whether new additives, which could replace AQ, were already tested with the same results?

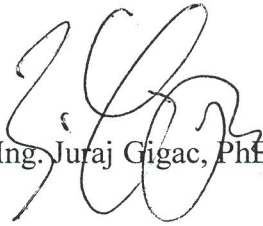
I appreciate the goal of processing of rapeseed straw into chemi-mechanical pulp, at very mild conditions (cold pulping process). Chemi-mechanical pulps, prepared this way, had lower strength properties. I assume that with the modification of this method, it would be possible to use chemi-mechanical pulps of rapeseed straw in the production of paper from recycled fibres, without using expensive pulp manufacturing technologies. Enzymes were used in this work, with the goal of improving the strength properties of chemi-mechanical fibres. This reduced energy consumption for beating and better strength properties were reached.

Why was grinding of dried rapeseed straw used before the leaching with solution of chemicals with and without application of enzymes? It would be interesting to compare properties of chemi-mechanical pulps prepared from unground rapeseed straw.

Regarding the range of reported results, my assumption is, that the author has already published some of them.

Finally, my conclusion is that the graduate has shown capability and creativity for writing a scientific thesis. A large number of experiments was carried out and valuable results were reached, and they can be used in pulp and paper industry as well. This thesis certainly meets all the criteria for doctoral dissertation thesis and I thus recommend accepting Mr. Gurung's dissertation work for further actions for awarding the doctoral degree PhD.

Bratislava, 2 September 2015



Ing. Juraj Gigac, PhD.