

# Modification of Stress-Strain Properties of OCC

JONG MYOUNG WON\* and SI YOUNG KIM†

\*Professor and †Graduate student

Dept. of Paper Science & Engineering, Kangwon National University, Chuncheon 200-701, Korea

wjm@kangwon.ac.kr

## ABSTRACT

---

The stress and strain properties of KOCC were modified to improve the performance of KOCC as a packaging raw material. The refining consistency, refining degree and the grammage of handsheet were varied. The stress strain properties, tensile energy absorption were measured for prepared handsheets. The refining improved significantly the stress and strain properties of paper, especially at lower refining consistency. The increase of grammage also had contributed to improve the stress and strain of paper. It was also found that both refining and grammage contributed to the improvement of tensile energy absorption. However, it is strongly recommended to introduce the combination of refining consistency, refining degree and mechanical treatment.

---

## INTRODUCTION

Industrial papers have very close relation with industrial and economical situation. All products should be packed to protect safely during transportation and the extension of packaging concept increased the importance of packaging significantly. Korean industrial paper manufacturers have been imported lots of OCC from American, etc. and used it as the important raw material to reduce the production cost. However, as the global environment is getting worse rapidly, there are various types of campaigns to protect and preserve the global environment. The regulations are established to reduce the greenhouse gas and demanded forcibly to participate the environmental preservation campaign. Many developing countries and underdeveloped countries are facing the serious problems. Even some advanced countries like America, Australia, etc that consume the enormous energy also try to find another way which can reduce the burden in the greenhouse gas reduction.

Such trends caused to increase the reuse of wastepaper, thus the quality of OCC was deteriorated significantly, while the price OCC was rose. Eventually, the Korean industrial paper manufacturers have to increase KOCC in order to overcome this difficult situation. Unfortunately, KOCC had recycled several times, thus there is serious problems in quality. The weakening of pulp fiber especially could not meet the requirements from industrial packaging paper and boxboard. Furthermore, many modern Chinese paper mills and paperboard mills with larger capacities are constructed recently. Therefore, the export to china is impossible if the quality and price competitiveness are not improved. Therefore, it is urgently required to develop the technology which can overcome such kinds of difficulties. Researches on the utilization technology of OCC were carried out by Korean Research Institute of Chemical Technology<sup>1-4)</sup> and Lee, etc.<sup>5)</sup>. Our research team also carried out the study to maximize the utilization of KOCC by the

improvement of physical properties of KOCC<sup>7-8)</sup>. Most important thing is the development of environmentally friendly technology which can minimize the use of chemicals and energy consumption. Thus, the study is carried out to find out the solutions that can improve fiber bonding ability and stretch of paper.

**EXPERIMENTALS**

KOCC obtained wholesale mart is used as a raw material. The adhesive tape is removed manually, and torn out KOCC into small pieces and soaked in water for 24 hrs. The soaked KOCC was disintegrated with laboratory pulper, and then thickened and stored in cold room for the future experimental uses. The disintegrated KOCC was refined to 550, 400, and 450 ml CSF at 0.5% and 1.0% consistencies. Mechanical treatment with Hobart mixer was also applied to the refined KOCC at 30% consistency in order to increase the stretch of the sheet. The grammage of handsheet was controlled to 80, 90, and 105 g/m<sup>2</sup> for both refined KOCC and refined KOCC with mechanical treatment. Stress strain characteristics and tensile energy absorption were measured for the handsheet prepared from treated KOCC.

**RESULTS AND DISCUSSION**

There are lots of parameters affecting stress strain properties of paper. Of such parameters, the furnishes, refining and papermaking parameters such as wet pressing and drying conditions, etc. are very affective on stress and strain properties. The study was focused on the effect of refining and other mechanical treatment. Although Htun<sup>8)</sup> mentioned that the yield strain is 0.16% in ordinary handsheets dried under full restraint independent of furnish type, wet pressing, and beating, but different furnishes, refining conditions and degrees, wet pressing conditions, and drying conditions are usually applied to the different paper grades. The response of paper is also strongly depend on the pulp fiber properties such as surface chemical properties, fiber

dimension(i.e. coarseness), fiber bonding ability, refining, and other papermaking conditions including wet pressing and drying.

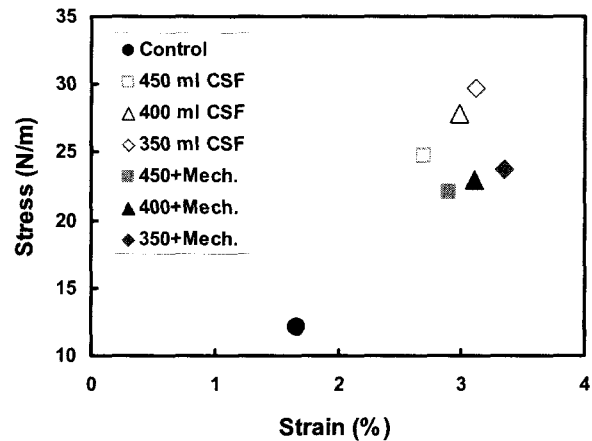


Fig. 1. The stress strain properties of handsheet(80 g/m<sup>2</sup>) made from KOCC refined at 0.5% and mechanical treated with Hobart mixer at 30%.

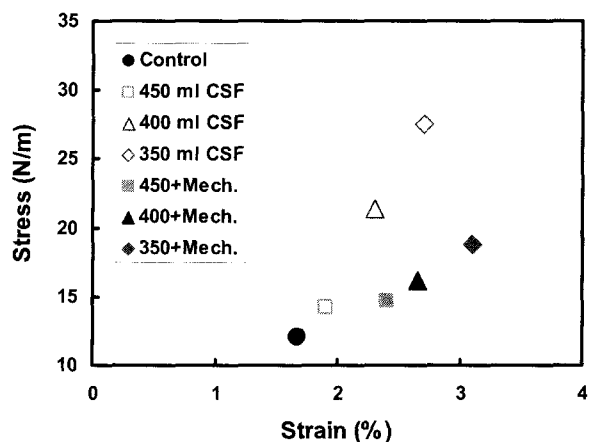


Fig. 2. The stress strain properties of handsheet(80 g/m<sup>2</sup>) made from KOCC refined at 1.0% and mechanical treated with Hobart mixer at 30%.

Figs. 1-6 showed that the refining consistency, refining degree and grammage had affected greatly the stress and strain properties of paper. The increase of refining degree and grammage improved both the stress and strain performance. Higher stress and strain were especially obtained at lower refining consistency. When the mechanical treatment is applied, little bit higher strains

**Modification of Stress-Strain Properties of OCC**

were obtained at higher refining consistency(0.1%), but the improvement of strain in the lower grammage handsheet(80 g/m<sup>2</sup>) was not observed. The mechanical treatment with Hobart mixer improved the strain significantly, although some scarification of stresses was accompanied. Such improvement in strain was remarkable at higher refining consistency. The effects of mechanical treatment with Hobart mixer on the stress and strain properties were affected by the refining consistency and grammage of handsheet.

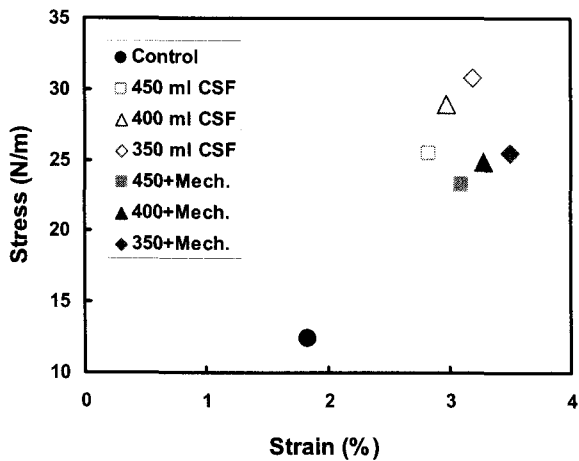


Fig. 3. The stress strain properties of handsheet(90 g/m<sup>2</sup>) made from KOCC refined at 0.5% and mechanical treated with Hobart mixer at 30%.

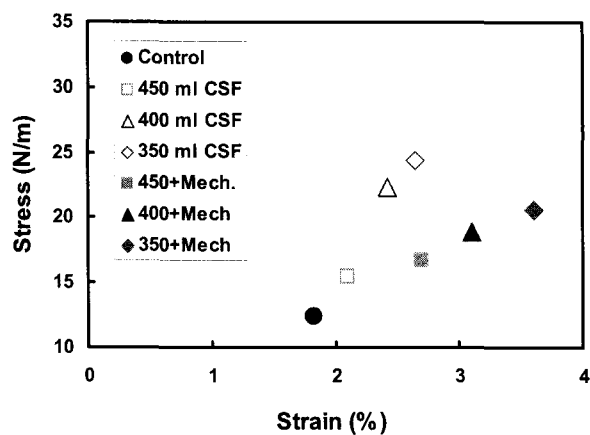


Fig. 4. The stress strain properties of handsheet(90 g/m<sup>2</sup>) made from KOCC refined at 1.0% and mechanical treated with Hobart mixer at 30%.

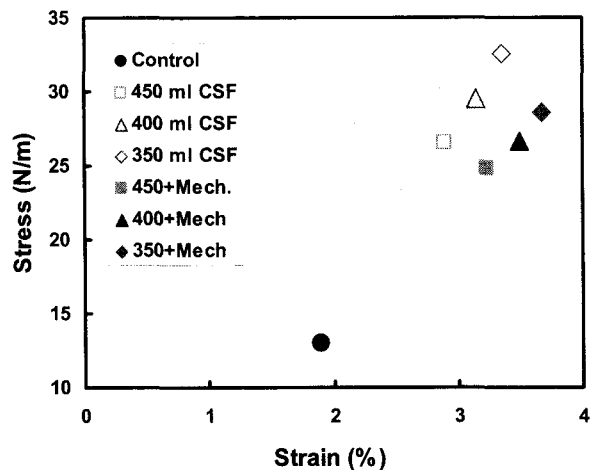


Fig. 5. The stress strain properties of handsheet(105 g/m<sup>2</sup>) made from KOCC refined at 0.5% and mechanical treated with Hobart mixer at 30%.

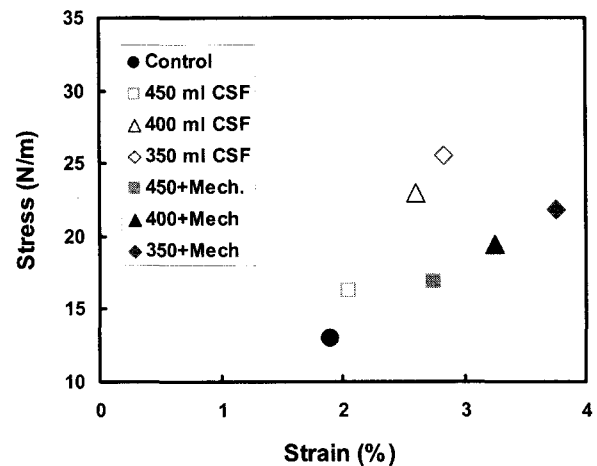


Fig. 6. The stress strain properties of handsheet(105 g/m<sup>2</sup>) made from KOCC refined at 1.0% and mechanical treated with Hobart mixer at 30%.

We found that the degree and type of improvement in the strain by the mechanical treatment depended on refining consistency(Figs. 7-8). When KOCC refined at 1.0% was treated mechanically, the decrease of stress was lower, but the increase of strain was higher than those of KOCC refined at 0.5% consistency. Thus, proper combination of refining degree, refining consistency and mechanical treatment is beneficial in improvement of stress and strain performance.

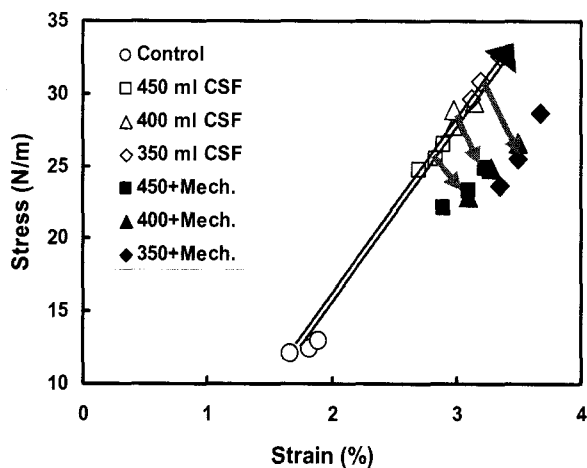


Fig. 7. Effect of refining and mechanical treatment on the stress strain properties of KOCC handsheet(refining consistency 0.5%)

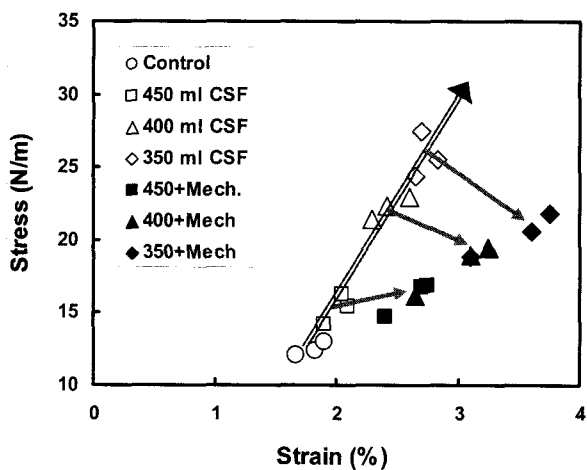


Fig. 8. Effect of refining and mechanical treatment on the stress strain properties of KOCC handsheet(refining consistency 1.0%)

It is well known that the strain property and toughness of paper have very close relation with its tensile energy absorption. As can be seen in Figs. 9-14, the higher tensile energy absorptions were obtained at the lower refining consistency, and improved by the mechanical treatment with Hobart mixer, although there are some sacrifice in the stress. These results were very well related with the result of stress and strain performances of KOCC refined. The increase in grammage contributed

to the improvement of the tensile energy absorption of paper. However, the increase in grammage can be the cause of the increase of transportation cost and thickness of packaging material. Thus, it is strongly recommended that the application of mechanical treatment for the refined KOCC to improve the stress strain performance of packaging paper.

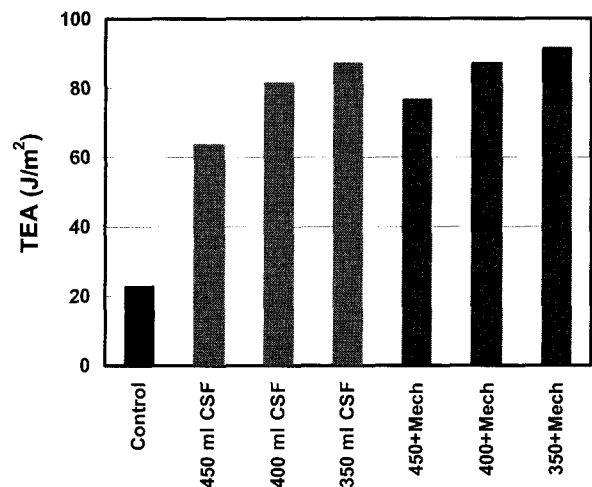


Fig. 9. Effect of refining and mechanical treatment on the tensile energy absorption of KOCC handsheet(refined at 0.5%, 80 g/m<sup>2</sup>).

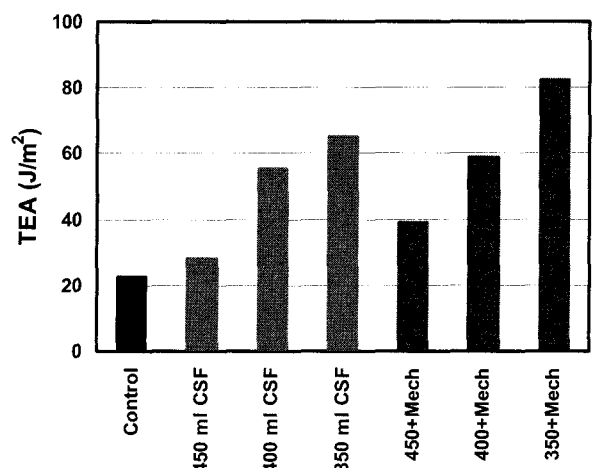


Fig.10. Effect of refining and mechanical treatment on the tensile energy absorption of KOCC handsheet(refined at 1.0%, 80 g/m<sup>2</sup>).

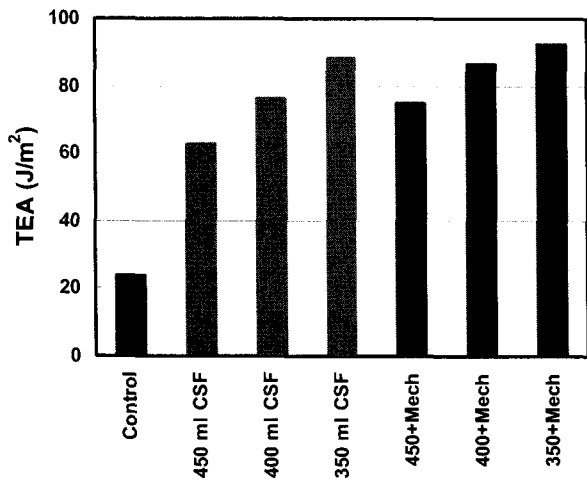


Fig. 11. Effect of refining and mechanical treatment on the tensile energy absorption of KOCC handsheet(refined at 0.5%, 90 g/m<sup>2</sup>).

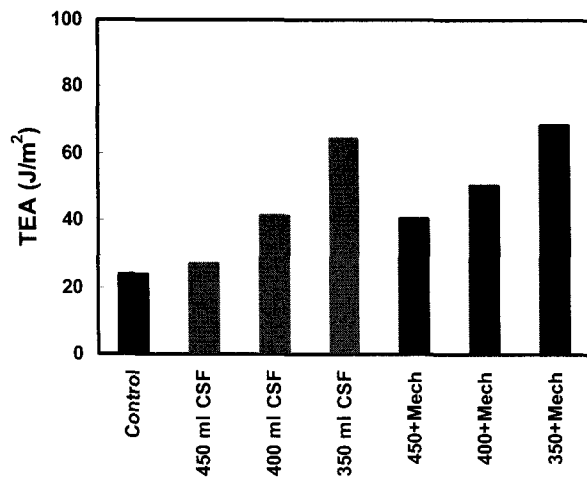


Fig.12. Effect of refining and mechanical treatment on the tensile energy absorption of KOCC handsheet(refined at 1.0%, 90 g/m<sup>2</sup>).

**CONCLUSION**

The modification of stress and strain performance KOCC was carried out by the refining and mechanical treatment. It was found that the stress and strain performance that is the main problem of KOCC can be overcome by the proper combination of refining consistency, refining degree, and mechanical treatment without the increase of grammage.

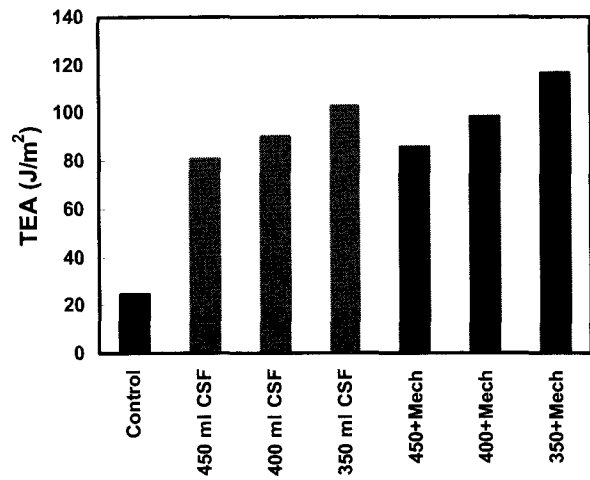


Fig. 13. Effect of refining and mechanical treatment on the tensile energy absorption of KOCC handsheet(refined at 0.5%, 105 g/m<sup>2</sup>).

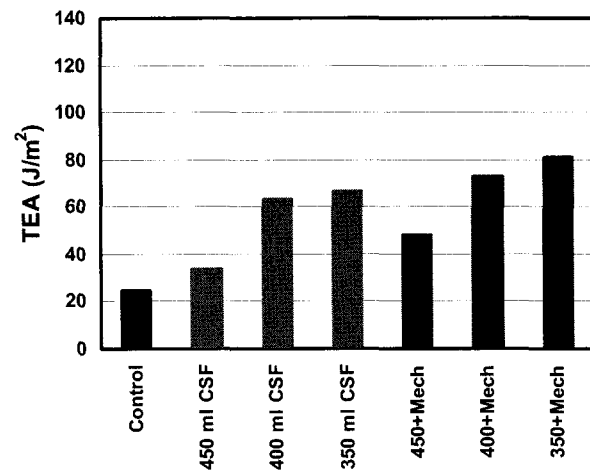


Fig.14. Effect of refining and mechanical treatment on the tensile energy absorption of KOCC handsheet(refined at 1.0%, 105 g/m<sup>2</sup>).

**REFERENCES**

- Ahn, B.J., Ryu, J.Y., Sung, Y.J., Kim, Y.W., Song, J.K. and Song, B.K. Proceedings of 2003 Korean TAPPI Fall Meeting. Pp. 65-75(2005).
- Ryu, J.Y., Sung, Y.J. and Song, B.K. Technical Meeting for the Establishment of Environmental Friendly Production Basis in Paper Industry(2004).

**Modification of Stress-Strain Properties of OCC**

3. Pang, M.H., Ryu, J.Y., Sung, Y.J. and Song, B.K. Proceedings of 2004 Korean TAPPI Spring Meeting, p. 154(2004).
4. Pang, M.H., Ryu, J.Y., Sung, Y.J. and Song, B.K. Proceedings of 2004 Korean TAPPI Fall Meeting, p. 169(2004).
5. Lee, H.L., Youn, H.J., Lee, S.G., Kang, T.Y. and Heo, Y.D. Journal of Korean TAPPI 36(4):1-8(2004).
6. Won, J.M. and Kim, S.Y. Proceedings of 2005 Korean TAPPI Spring Meeting. Pp. 76-82(2005).
7. Won, J.M. and Kim, S.Y. Proceedings of 2005 Korean TAPPI Fall Meeting. Pp. 279-284(2005).
8. Htun, M. and de Ruvo, A. Tappi 61(6):75(1978).