Fractionation of KOCC for Better Utilization-Effect of Screen Design Parameter and Reject Flow Rate on Flocculation Efficiency

Hye Jung Youn, Seong Min Chin, Ik Sun Choi, and Ji Yong Kim

Utilization rate of recycled fibers has been continuously increased for economical and environmental reasons. Recycled papers are major fiber resources for brown grades and newsprints. Since the recycled fibers have disadvantages of high fines content and fiber hornification, it is of great importance to optimize the use of these recycled fibers. OCC (Old Corrugated Containers) is the major fiber source for linerboards and corrugating mediums that require high strength properties. Diverse studies have been carried out to overcome the problems of strength reduction of brown grades when recycled fibers are used as raw materials. Fractionation technology could be considered as one of the available approaches for recycled fibers. In this study, effect of screen basket parameter and operation variable like reject flow rate on fractionation efficiency of KOCC was investigated. Hole-type basket showed higher fractionation index than slot-type and fractionation efficiency of OCC was better using screen with the smaller hole size.

Keywords: OCC, recycled fiber, fractionation, screen, multifractor, basket type

INTRODUCTION

Use of recycled fibers which are major resources for linerboard and newsprint has been continuously increased for economical and environmental reasons. Utilization rate of recycled fibers in Korea was 74% and recovery rate was over 80% on 2005. Linerboard and corrugating medium are mostly produced using OCC (Old Corrugated Containers), but they are faced with quality and process troubles because of low quality of OCC. The problem of strength loss for papers made from recycled fibers is closely associated with the increased amount of fines in recycled fibers and hornification of fibers. Fines contained in the recycled fiber resources cause problems not only in paper properties but also in process runnability. The collapsibility and conformability of fibers were reduced by repeated drying and wetting, and bonds between fibers could not be developed easily. This shows that the optimal treatment of recycled fibers is critical to get the benefits of using recycled fibers.

Many studies to make best use of OCC have been proceeded. Great improvement in our understanding on recycled fibers has been made during last several decades and successfully applied to improve the technological processes for effective and efficient use of fiber resources. But there is much to be learned to improve the recycling potential of these fibers since the quality of recycled fibers keeps deteriorating these days because of repeated recycling of fibers. For instance, the amount of fines contained in OCC has been increased up to 35%. And it is not rare to find 50% of fines in headbox stocks for corrugating medium. This indicates that optimum treatment strategies for these fibers should be developed to improve physical properties of paper products made from the recycled fibers. For this, fractionation technology could be considered as an alternative. Fractionation is a separation technology of the stock into two fractions with different properties like fiber length. One fraction contains predominantly long fibers and the other contains mainly short fibers and fines. According to Musslemann, fractionation and selective mechanical treatment of long fiber fraction produced a stronger paper with a little drop in freeness. Since fractionation technology was introduced to papermaking, it has been adopted by paper mills. Many linerboard mills in Korea are also using a multifractor or screen to fractionate OCC stocks into two fractions, short (accept) and long (reject) fraction. Most of them installed multifractor equipped with slot basket with aperture of 0.15-0.3 mm. They, however, use the fractionator generally in purpose of rather removal of the flakes than separation into two fractions. A proper fractionation should be achieved to make fractionation and selective treatment technology effective. We, therefore, investigated the effect of screen basket parameter and operation variable, reject flow rate on fractionation characteristics of OCC to find optimum condition for fractionation. And we intended to simulate mill fractionation in laboratory using Sweco screen.

EXPERIMENTAL

Fractionation in mill

Pilot multifractor (AFT Co., Fig. 1) which was followed by LD cleaner was installed in filler layer of a duplex carton board mill. Its specification and operating condition were shown in Table 1. Screen basket could be easily replaced with other type. To investigate effect of screen design parameter on fractionation performance, screen basket type and aperture size were controlled. In this study, we used four hole-type screens with different hole size of 1.0, 1.4, 1.7, and 2.0 mm and one slot-type screen with slot size of 0.15 mm. In addition, reject flow rate was controlled by 20, 40, and 80% to evaluate the effect of operating condition on fractionation.

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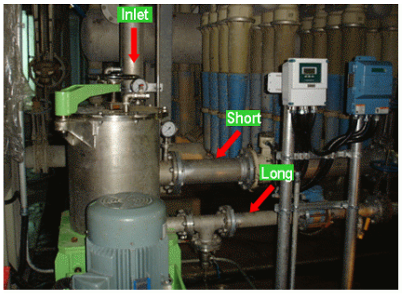


Fig. 1. Pilot multifractor

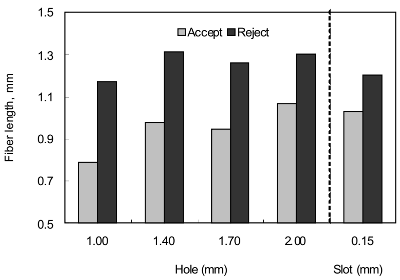
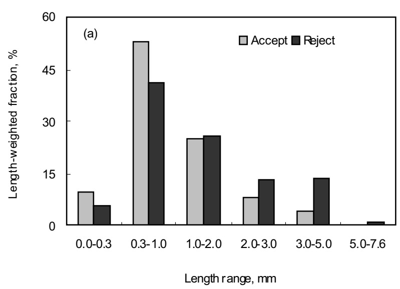


Fig. 2. Fiber length of accept and reject fractions.



The filler layer stock which consisted of KOCC (Korean Old Corrugated Container) was fractionated using this multifractor, and two stocks, accept and reject fraction was obtained. Stock properties including consistency, fiber length, and fines content were determined. The inlet consistency of the stock is 0.9%, and average fiber length of stock was 1.23 mm. Its fines content was 30.9%.

Fractionation in laboratory

Material

We used KOCC (Korean Old Corrugated Container) stock which is obtained from machine chest of filler layer in duplex board mill to simulate fractionation in laboratory.

Fractionation

Laboratory fractionation was carried out using Sweco screen equipped with different wires of 40 and 100 meshes. Fractionation time was controlled by accept flow volume. Properties of fractionated stocks were evaluated.

Table 1. Specification and operation condition of pilot multifractor

Type	8 PS S/M
Motor	1700 rpm
Motor load	22A
Line speed	21.5 m/sec (rotor rpm : 1020)
Inlet flow rate	About 1000 L/min

Table 2. Weight fraction ratio in pilot multifractor

		8:2		6:4		2:8	
		Accept(%)	Reject(%)	Accept(%)	Reject(%)	Accept(%)	Reject(%)
Hole (mm)	1.0	71.5	28.5	51.5	48.5	16.7	83.3
	1.4	74.4	25.6	54.3	45.7	18.8	83.2
	1.7	76.2	23.8	55.2	44.8	17.8	82.2
	2.0	74.9	25.1	54.8	45.2	17.5	82.5
Slot (mm)	0.15	74.9	25.1	54.9	45.1	16.6	83.4

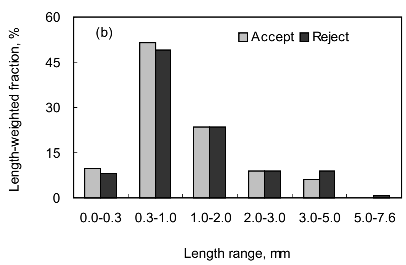


Fig. 3. Fiber length distribution of each stock. ((a) hole 1.0 mm, (b) slot 0.15mm)

Evaluation of fractionation efficiency

Fractionation efficiency was determined as fractionation index (FI) that was defined by Karnis.

$$FI = 1 - \frac{X_a}{X_r}$$

Where, Xa and Xr are the average values of property X in accept and reject fractions. Length weighted average fiber length of stock was used as X in this study. That FI = 0 means there is no separation.

RESULTS AND DISCUSSION

Evaluation of mill multifractor

KOCC stock was fractionated at the various conditions. Fractionation was controlled by flow rate in reject stream, but the mass rate of each stream was different from flow rate. Table 2 showed weight fraction ratio depending on basket type and reject flow. Because the reject stream was thickened after fractionation or screening, mass rate in reject stream was higher than flow rate. 8:2 flow rate ratio of accept and reject streams showed approximately 7:3 of mass rate ratio for hole basket of 1.0 mm.

Fig. 2 represented length weighted average fiber length of each fraction depending on screen basket design. Reject rate was adjusted on 20%. Generally, the difference in fiber length between accept and reject fractions was bigger in hole-type multifractor than slot-type one. Fig. 3 depicted fiber length distribution of each stock. In the case of screen equipped with 1.0 mm hole basket, accept fraction had predominantly short fibers and reject fraction contained mainly long fibers over 1.0 mm (Fig. 3-(a)). On the other hand, two fractions fractionated using screen with slot basket showed similar distributions in fiber length (Fig. 3-(b)). Fines content in each fraction also had similar tendency.

Fractionation efficiencies at the different design of basket were compared in Fig. 4. Reject flow rate was kept on 20% (a) and 40% (b). Fractionation indices ranged from 0.08 to 0.39. These figures are not low compared with other researches' results. Screen with hole-type basket was better fractionators. Fractionation efficiency was dependent on hole or slot size as shown in Fig. 3. When screen basket with 1.0 mm hole was used, fractionation index was the highest, irrespectively of reject flow rate. Because the fiber length of inlet stock was 1.23 mm, screen equipped with 1.0 mm hole seemed to be superior to the other types. As reject flow rate was 40%, the dependence of fractionation index on basket design was clearer. The smaller size of aperture was used, the higher fractionation efficiency was obtained.

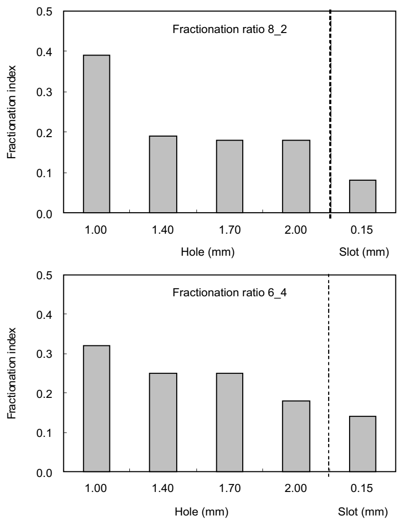


Fig. 4. Effect of screen basket design on fractionation index

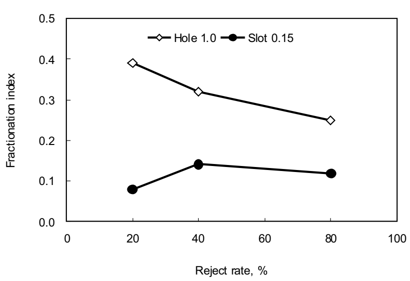


Fig. 5. Effect of reject rate on fractionation index

Fig. 5 represented the effect of reject rate on fractionation index when screens with 1.0 mm hole and 0.15 mm slot were used. For 1.0 mm hole-type screen, low reject rate showed a more efficient fractionation.

Evaluation of laboratory fractionation

Laboratory fractionation was carried out using Sweco screen, and the effect of wire mesh and accept flow volume on fractionation was examined. A high accept flow volume means a long fractionation time. Fig. 6 showed fines content of each fraction obtained from fractionation. In the case of 100 mesh wire, accept fraction had fines content over 90%. It means that perfect fractionation seemed to be possible when 100-mesh wire was used. Fractionation index was shown in Fig. 7. Effect of accept volume on fractionation was not significant, but wire mesh had a great influence on fractionation. The smaller wire mesh size was suitable for complete

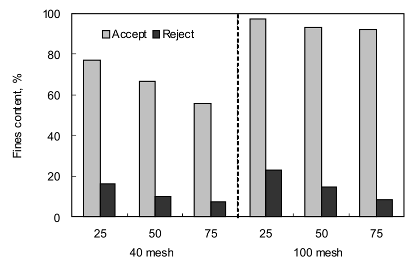


Fig. 6. Fines content of each fraction after laboratory fractionation.

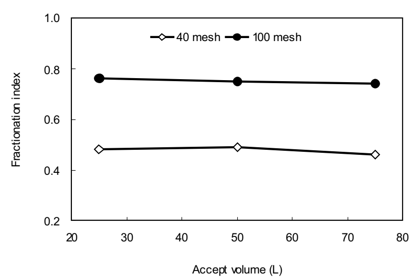


Fig. 7. Fractionation index after laboratory fractionation.

separation. If 40-mesh wire was used, we can obtain the fractionated stock that showed similar properties with mill stock.

CONCLUSIONS

In this study, effect of screen basket parameter and operation variable like reject flow rate on fractionation efficiency of KOCC was investigated. Hole-type basket showed higher fractionation index than slot-type. And fractionation efficiency of OCC was better using screen with the smaller hole size and lower reject rate. In laboratory fractionation, effect of accept volume on fractionation was not significant, but wire mesh had a great influence on fractionation. The smaller wire mesh size was suitable for complete separation. If 40-mesh wire was used, we can obtain the fractionated stock that showed similar properties with mill stock.

ACKNOWLEDGEMENT

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