Studies on Environmental Impact of Pulp and Addtives in Liner Papermaking

Jin Ho Seo*, **Hyoung-Jin Kim**†

*Graduate student, † Professor
Dept. of Forest Products, Kookmin University
861-1 Jeongneung-dong, Seongbuk-ku, Seoul, Korea
hyjikim@kookmin.ac.kr

ABSTRACT

A lot of water is using in the paper mill for dilution, washing, sealing, and other process operation. As the regulation of water environment has been more tightened than ever before, water management in the paper mill becomes the most important task. Topics on reducing fresh water and increasing recycling water have been studied. Further, an interest in zero-effluent system has been increased. The pH of waste water in paper mill is usually weak acidic or neutral. The waste water in the paper mill includes water insoluble organic materials that are not easy to be dissolved in the water, inorganic materials that never react with water and chemical additives that are used to recycled fiber. This study investigated on the effect of various materials used in paper mill on COD. This data could be used to control the environmental load in paper mill. COD caused by raw materials and NBDCOD (Non Bio Degradable COD) after the activated sludge process are investigated in this study. Results obtained in this study can be used in a simulation program designed to control environmental load in the paper mill.

INTRODUCTION

Environmental pollution issues, a global issue, associated with industrialization and urbanization have attracted everybody's attention in every sect of our society every year. The concern of water quality has been rapidly increased with a water price hike as our standard of life improved and our concern of environmental issues increased (1-11).

It is very important that water management should be controlled in a right and correct manner in the paper making industries where mass consumption of water has taken place. There have been many researches in this area (12-14). Water recycling technologies that could help decrease the pollution load of discharging water has been developed. Technologies that could identify process problems associated with increasing water recycling and execute trouble shouting have been also developed. Researches on new technologies for more closed white water system are under way.

The objective of this study is to investigate environmental impact of pulp and additives, model the waste water process of a liner paper making mill, and provide related engineers with useful data for environmental load control.

MATERIAL AND METHODS

Materials

Fibrous materials
UKP and BKP virgin pulps were provided from Korean K Paper Company. Sack wasted pulp, KOCC, AOCC, ONP, and OMG of recycled pulp were also provided from Korean K Paper Company and used in this study.

Non-fibrous materials
Starch and PAM, dry-strength additives were provided from chemical suppliers. Wet-strength additives such as PAE (Polyamide epichlorohydrin), UREA - formaldehyde resin, Melamin-formaldehyde resin were provided from S Paper Company. Direct dye, acid dye, and fluorescent dye were used in this study. Rosin and ASA size that are using widely in the paper industry were used to evaluate the size effect on the environmental impact. PEI, PAC, and PAM provided from H Paper Company were used in order to investigate any effect of retention aids on the environmental effect.

Methods

Sample preparation
Since the environmental effect of fibrous material itself could not be evaluated directly, after disintegrating GF/C filtrate was used in this study. The condition of the disintegrating is shown in Table 1.

Table 1. The condition of disintegrating

Sample	disintegrating concentration (BDT,%)	disintegrating time(min)	M. C. (%)	Oven dry weight
Fibrous material	1	30	5.2	30

Non-fibrous materials were diluted to make each concentration adjusted to evaluate the environmental impact of each component.

Table 2. The dilution condition of chemical additives

Classification			chemical	Dilution water(ml)	Dilution condition
Dry Strth Additives	starch	corn	20 ml	1980 ml	1:100
	PAM	cationic	20 g	1980 ml	1:100
Wet strth add.	UREA		20 g	1980 ml	1:100
	PAE		20 ml	1980 ml	1:100
Dye	direct dye		2 ml	1998 ml	1:1000
	acid dye		2 ml	1998 ml	1:1000
	Fluorescent brightening dye		2 ml	1998 ml	1:1000
size	alum		20 ml	1980 ml	1:100
	rosin		20 ml	1980 ml	1:100
	ASA		2 ml	1998 ml	1:1000
retention aids	PEI		20 ml	1980 ml	1:100
	PAC		20 ml	1980 ml	1:100

Biological treatment

The concentration of the activated sludge was adjusted to 4,000 ppm in the reaction vessel and nitrogen and phosphorus gas were injected into the reaction vessel. DO of reaction vessel was maintained to 5 ppm using aerator. Table 3 shows the condition of activated sludge in treatment place.

Table 3. The condition of activated sludge in treatment place

	Concentration	SCOD Cr	Conductivity	calcium Hardness
sludge	55,400ppm	557ppm	35400 µS/cm	9200 $mgCaCO_3/\ell$

Fenton oxidation treatment

Sample was put into a reaction vessel and adjusted to pH 3.0. Agitate the sample for 30 minutes after mixing $FeCl_2$ and H_2O_2. Adjust pH to neutral and add anionic polymers. After injecting anionic polymers agitate the sample in a high rotating speed and then reduce the agitating speed and stop the reaction.

Environmental load measurement of each waste water treatment stage

After reacting with fibrous and non-fibrous materials sample was filtered using Whatman GF/C filter paper. Filtrate was used to measure COD for evaluating environmental impact of each waste water treatment stage.

RESULT AND DISCUSSION

Change of CODcr in fibrous material after waste water treatment

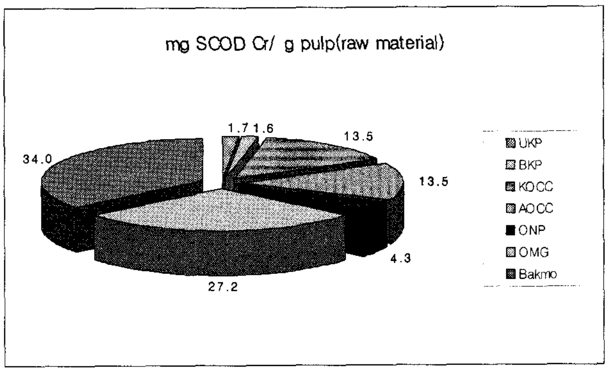

Fig. 1. COD portions of fibrous material.

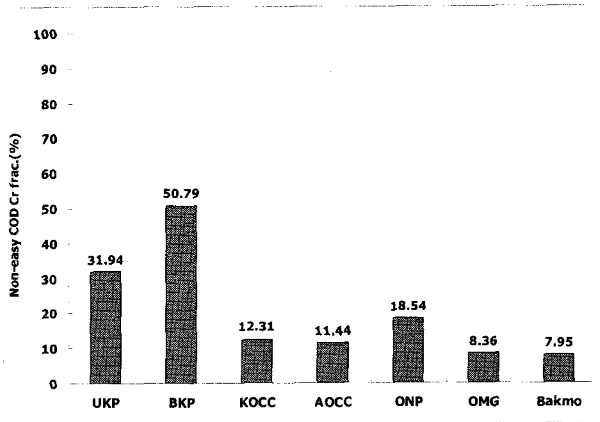

Fig. 2. Non-biodegradable COD portions of fibrous material.

Before and after biological treatment, ratios of COD were obtained in order to investigate the residual non biodegradable COD. COD value was SCODcr value per gram pulp. Original SCODcr value per gram pulp is seen in Fig. 1. Fig. 2 represents the NBDCOD ratio to original SCODcr value after tertiary treatment.

The original COD value of material itself was decreased with the following order: Sack wasted pulp > OMG > KOCC > AOCC > ONP > UKP > BKP. After tertiary Fenton treatment the same result was achieved. Regardless of material type, SCOD cr was near 30 ppm after tertiary Fenton acidic treatment. In case of UKP, BKP, and ONP secondary Fenton acidic treatment was not efficient. Even though NBDCOD values were high before secondary Fenton treatment, actual COD load was relatively low after secondary Fenton treatment.

Even though NBDCOD values of UKP, BKP, or other natural pulp were relatively high, such as 30-50% actually only 0.6 mg SCODcr per g pulp have an effect on COD load. Sack wasted pulp that had the highest original COD value showed 7.9% NBDCOD percentage which might be a negligible. Given original COD value of sack wasted pulp itself was 510 ppm, there might be need control its input for whole environmental load impact.

Change of CODcr in non-fibrous material after waste water treatment

The same methodology was applied to obtain CODcr values as in fibrous material itself. SCODcr value was mg SCODcr per ml solution.

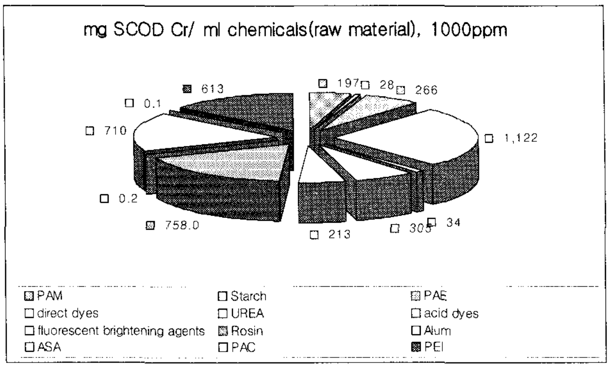

Fig.3. COD portion of chemical additives.

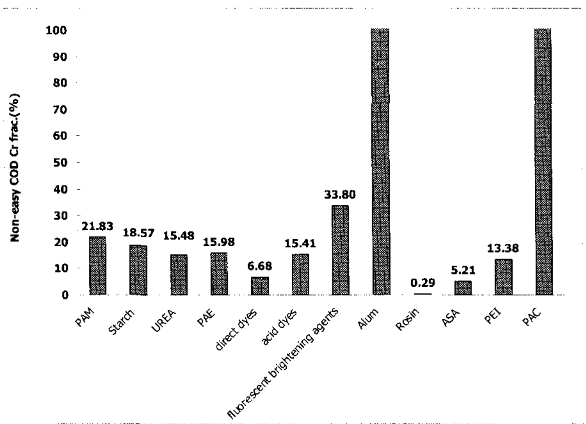

Fig. 4. Non-biodegradable COD portion of chemical additives

Fig.3 represents original SCODcr values of non-fibrous material before any treatment. The ratios of NBDCOD to original SCODcr after tertiary treatment can be seen in Fig. 4.

Except for alum and PAC, non-fibrous material showed far higher COD load than fibrous material. NBDCOD values were also very high compared to fibrous material. In case of direct dye, original COD value was the highest but total NBDCOD percentage turned out to be relatively low (6.7%). Even though original SCODcr values of alum and PAC were low, its values were increased with biological treatment and Fenton acidic treatment, pushing NBDCOD percentage over 100%. Rosin's COD values were low after secondary treatment. Only 0.4% COD load out of original COD value was obtained after secondary treatment. NBDCOD percentage was only 0.3%, the lowest percentage among non-fibrous materials. However, in case of fluorescent brightening dye the ratios of NBDCOD to original SCODcr after second and tertiary treatments were about 67% and 33.8% respectively. It turned out that the control of fluorescent brightening dye is essential to achieve optimum environmental load.

CONCULSION

NBDCOD percentage of fibrous material turned out to be less than 3 mg per g pulp. It might be negligible when evaluating its environmental load impact. The effect of fibrous material itself on COD load should be incorporated for future study in this area.

Conductivity and hardness of activated sludge were increased as biological treatment time was increased. It might indicate that activated sludge can induce environmental load and affect adversely the efficiencies of various additives with high conductivity and hardness.

Among non-fibrous materials dye stuffs seem have the highest impact on environmental load where the ratio of NBDCOD to original SCODcr after tertiary treatment was about 33.8%. In case of rosin and ASA, the ratios of NBDCOD to original SCODcr after tertiary treatment were 0.3% and 5.2% respectively.

REFERENCE

1. The Ministry of Environment. "Water quality and Environmental Protection Law" (1999).

2. Knudsen L., Pedersen Ja., Munck J., "Advanced treatment of paper mil effluents by a two-stage activated sludge process.", Water Science and Technology 30(3), pp. 173-181, (1994).

3. Perez M., Torrades F., Garcia-Hortal JA., Domenech X., Peral J., "Removal of organic contaminants in paper pulp treatment effluents under fenton and photo-fenton conditions.", Appl Catal 36(1), pp. 63-74, (2002b).

4. Dong M. Kim *et al.* "Waste Water Treatment Engineering" (2003).

5. F Wang, D W Smith, M Gamal El-Din, "Application of advanced oxidation methods for landfill leachate treatment – A review", Journal of Environmental Engineering and Science 2, pp. 413-427, (2003).

6. Hyun J. Ha *et al.* "PCE, TCE, Fenton acidic treatment process", Korean Solid Wastes Engineering Society, Vol. 1. (2003).

7. Chandra R., "Microbial decolourisation of pulp mill effluent in presence of nitrogen and phosphorous by activated sludge process.", J Eviron Biol 22(1), pp. 23-27, (2001)

8. Junna J., Ruonala S., "Trends and guidelines in water pollution control in the Finnish pulp and paper industry.", Tappi J 74(7), pp. 105-111, (1991)

9. Stuthridge TR. *et al.*, "Absorbable organic halide removal mechanisms in pulp and paper mill aerated lagoon treatment system.", Water Sci. & tech. 29 (5-6), pp. 195-208, (1994)

10. Welander T., Lofqvist A., Selmer A., "Upgrading aerated lagoons at pulp and paper mills.", Water Science Technology 35(2-3), pp. 117-122, (1997).

11. Helble A., Schalyer W., Liechti PA., Jenny R., Christian MH., "Advanced effluent treatment in the pulp and paper industry with a combined process of ozonation and fixed bed biofilm reactors.", Water Science Technology 40(11-12), pp. 343-350, (1999).

12. Schmidt T., Lange S., "Treatment of paper mill effluent by the use of ozone and biological systems: large scale application at lang paper.", Ettringen (Germany), Tappi International Environmental Conference and Exhibit, Denver, CO, vol.2, pp. 765-775, (2000)

13. Malmquist A., Temstrom A., Welander T., "In mill biological treatment for paper mill closure.", Water Science Technology 40(11-12), pp. 43-50, (1999).

14. Badar TA., "Wastewater treatment at pulp and paper mills effluent compliance improvements at a newsprint facility.", Asia Pac Tech Monit 13(6), pp. 8-13, (1996).