Wastewater Treatment for the Recycled Pulp and Paper Industry

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Introduction

Before, when it came to industrial wastewater treatment, Malaysian corporations usually relied on foreign experts to design and build the treatment systems for them.

Now, our local wastewater treatment companies have gradually developed the technical expertise in this specialized field and they are capable of designing systems that are equally effective or even better than their foreign counterparts. In addition, Malaysian companies rely mostly on local fabrications, and hence, can maintain a low cost.

This article summarizes treatment processes for recycled paper mill effluent. They have been proven to work well for the three leading recycled paper mills in the country. The systems were installed by CG Environmental Systems Sdn. Bhd. (www.cges.com.my)

Treatment technology

Figure 1 shows the treatment technology used in these three factories.

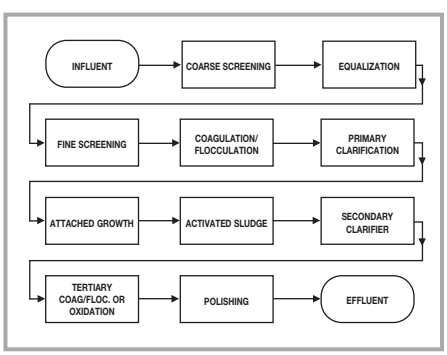


Figure 1 : Flow chart WWTP

Part I : Primary Treatment

Coarse solids (cans, paper) are removed using an automatic bar screen. Wastewater flow and contaminants are equalized in an equalisation tank that uses coarse bubble diffusers for mixing.

Fine solids (fibres) are removed using a static fine screen. Fibres can be recycled back to the factory for reuse.

Chemicals are added to condition the wastewater in the coagulation and flocculation processes. This aids in the removal of suspended solids before the next stage of biological treatment. Without the removal of solids, biological systems will not work well. This is because:

- Solids replace biomass and less will be available for contaminant removal.
- Solids need to be broken down by the biomass that is intended for removal of other contaminants (in dissolved form.)
- Some solids could be toxic to the biomass.

Figure 2 : Static screen

Solids separation from the wastewater is done with a dissolved air flotation clarifier. Solids, mostly in suspended form, are floated to the surface with the aid of small air bubbles. From the surface, they are skimmed off into a sludge holding tank.

Figure 3 : Dissolved Air Flotation Clarifier

Part II : Secondary Treatment

Secondary treatment is mainly intended for dissolved contaminant removal. A two-stage biological system is used in the secondary treatment. The first stage consists of a trickling filter tower (TFT). The second stage is an extended aeration system (EAS).

The advantages compared to a single stage biological system are:

- Higher COD removal efficiency.
- Greater shock-load resistance: TFT absorbs shock-load better than single EAS.
- Lower sludge production: TFT has low sludge production.
- Lower energy consumption: TFT uses energy more efficiently then EAS.

The trickling filter tower is an attached growth system using cross-flow plastic media to support the growth of a biomass slime layer. Different types of bacteria will grow on the layer:

- The inner layer consist of mainly anaerobic biomass.
- The outer layer is predominantly aerobic biomass.

Wastewater is pumped to the top of the tower from where it is sprayed down onto the media. It then trickles down the tower. The trickling filter tower will also assist in cooling down the wastewater to the temperature for optimum bacterial activity.

Figure 4 : Trickling Filter

The extended aeration tank is a suspended growth system. The aerobic biomass uses oxygen to break down the organic pollutants in the wastewater. The supply of this oxygen to the biomass requires the highest amount of energy in

Figure 5 : Aeration Tank with Diffused Aeration System

Figure 6 : MMF and Secondary Clarifier

the treatment plant. It is therefore important to carefully evaluate both capital and operating costs of available aeration systems (fine/coarse bubble diffuser, surface aerator, and jet aerator.)

Wastewater is then clarified in the secondary clarifier.

Part III : Tertiary System

Tertiary treatment is required in a more stringent discharge limit area (Standard A) or if there is high level of recalcitrant contaminants that cannot be removed in the secondary system. Tertiary coagulation or oxidation process is proven to work well for this type of wastewater.

Tertiary treatment is always exponentially more expensive to operate than biological treatment. Table 1 shows the cost for the biological systems and tertiary treatment processes. It is clear that TFT is the most energy efficient process. The cost to remove the refractory COD in the tertiary system is very high.

[RM/kg COD]	Mill 1	Mill 2	Mill 3	Ave.
TFT	0.14	0.12	0.17	0.14
EAT	0.18	0.25	0.28	0.24
Tertiary	6.6	-	-	6.6

Table 1 : Treatment cost comparison

Polishing with a multi media filter (MMF) can be used as a final step for removal of suspended solids from treated water. A multi media filter uses different sizes of sand and anthracite to remove these solids.

Part IV Sludge Management

Minimizing sludge generation in wastewater treatment systems should be considered, examples are:

- Recycling the fibre back to factory.
- Implementing a low sludge yield biological system (such as the two-stage system.)
- Optimizing aeration in aeration tank.
- Optimizing chemical usage.

Final dewatering of the sludge is commonly done with either belt or screw press type de-watering equipment.

An option to include in the system is recycling of treated wastewater. However, the total dissolved solids (TDS) in the treated water can be high and total recycling of treated water may not be practical due to increase of TDS overtime. Partial recycling, of treated water up to 50% of the volume, is being practiced in some of the mills.

System Design

The design of the system depends on several factors:

- Wastewater characteristics have to be checked and evaluated.
- Integration of existing components in the new system.
- Land availability.
- Site condition.

Recycled paper mills produce a variety of products like tissue, brown paper, liner, newspaper, etc. Various production techniques are used in the productions of these papers. Depending on the paper quality that is required, sometimes a bleaching process is used.

These variations result in a variation in the quantity and strength of the wastewater produced:

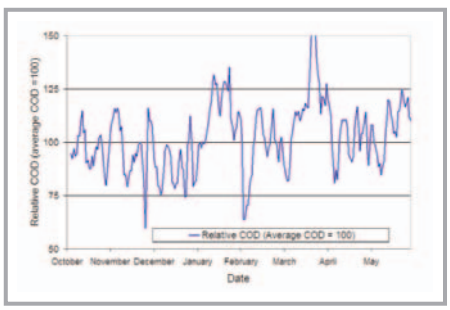
- Higher water consumption → lower strength (pollutants in wastewater are diluted.)
- Higher quality paper → higher strength (pollutants from paper end up in wastewater.)

This variation occurs between different mills as shown in Table 2.

The variation also occurs within one mill. Figure 7 shows the variation in COD of the incoming wastewater.

Table 2 : Parameters Paper Mills

Parameter	Unit	Mill 1	Mill 2	Mill 3
Water usage	m^3/ton	15	25	40
Flowrate	m^3/day	10,000	8,500	15,000
Raw COD	mg/l	5,000	3,500	3,000
Raw BOD	mg/l	1,500	1,200	1,000
Raw TSS	mg/l	4,000	1,500	1,200
COD after coag/floc	mg/l	2,000	1,200	900



Note: Trendline is the 4-day moving average

Figure 7 : Variation in raw COD Mill 1

Conclusions

- A two stage biological system can save costs due to reduced power consumption and sludge production. It can also reduce upsets to the treatment plant.
- Attention has to be paid to the option of recycling sludge and wastewater.
- Design of the system requires great attention. Even though the treatment concept for the three mills is the same, design parameters are different due to the variation in incoming wastewater strength. ■