Solid Waste High Efficient Treatment Methods of A Typical Pulp Mill

Yuganj Li[1]*, Keshun Ma[2], Shouguo Zhang[2] & Mei Lu[1]

ABSTRACT

Different kinds of solid waste were generated in the big pulp mills, which include fiber line plants, recovery plants and effluent treatment plant, etc. In this article, we introduce where and how the solid waste is produced and how the solid waste is disposed in a pulp mill whose annual production capacity is 1 million tons per year.

The solid waste of a pulp mill is usually sorted by their compositions. There are three kinds of solids waste. The first is from the fiber line plant, including chip fines and screen rejects. The second is inorganic solid which is mainly from the power and recovery plant, such as ash, dregs and grits. The last is the sludge form the effluent treatment plant.

In this study, the comprehensive utilization of solid waste is discussed. The solid waste is used efficiently in the mill or conjunctive use with other mills. It brings significant economic benefits (about 49 million $ one year) for the pulp mill.

Keywords: *solid waste; high effective and minimization treatment; discharge reducing; pulp mill*

Introduction

As the pulp and paper industry developed so rapidly in the past decades, more and more solid waste was produced. That is a serious problem for the environment. The researchers in China always focus on the solid waste that is produced in the papermaking process. That is mainly because there is less pulping mill is China and the production is very small in each mill. However, in recent years, some bigger pulp mills went into operation and their production is very large, some reaches more than 1 million tons per year[1].

The Kraft pulping process is very complex, especially for large mills. Lots of waste is produced during the pulping process, such as waste water, waste gas and solid waste. For waste water and gas the government has formulated some strict rules to protect the environment in China. But for solid waste, the pressure from the government is not so high and some solid waste treatment method is not reasonable. For example, landfill directly. Table 1 shows how some European pulp and paper mills deal with the solid waste[2]. We can see that most of the solid waste is recycled and only little percentage was land filled. There is also some dangerous waste produced in pulp mills.

Table 1 Solid waste in some European pulp and paper mills.

Pulp and Paper mills	Production /MT	Solid waste /kgt^{-1}	Recycled /kgt^{-1}	Landfill /kgt^{-1}	Dangerous waste/kgt^{-1}
Holmen	230	160	136	23	0.2
SCA	990	163	115	47	0.3
Norske Skog	480	155	138	16	1.5
Stora Enso	1510	23	----	22	0.3

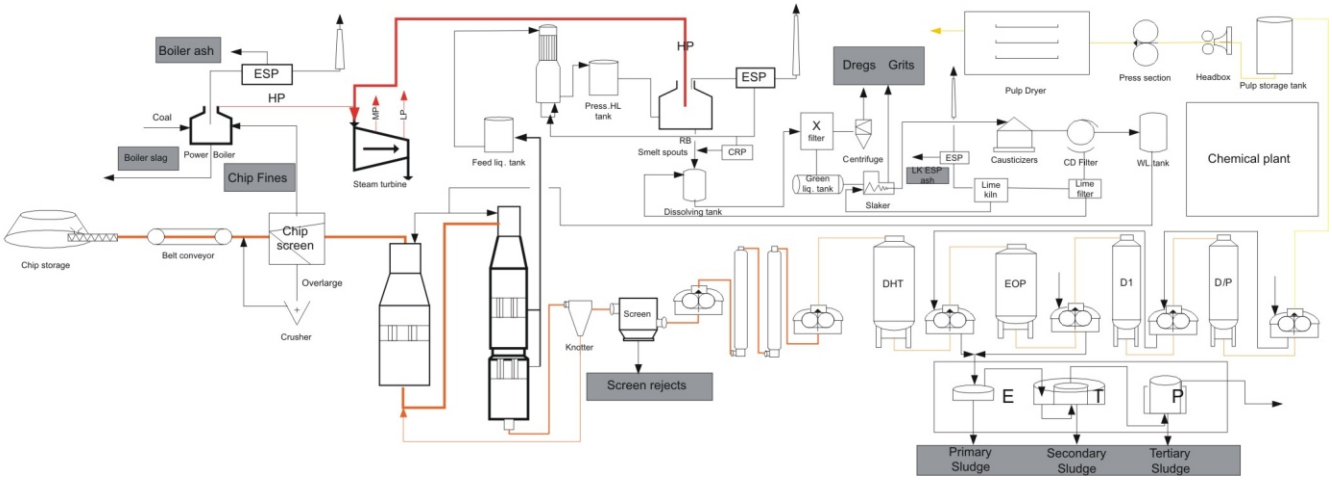

Fig.1 The Flow Diagram and Solid Waste Point of a Pulp Mill.

1. Qufu Normal University, College of Printing, No.80, Yantai Road, Rizhao, Shandong Province China - 276826
2. Shandong Asia Pacific Ssymb Pulp & Paper Co., Ltd. No. 369, Beijin Road, Rizhao Shandog Province, China - 276826

The main handling methods of solid waste are land filling, central incineration, manure mixture for fertilizing, recycle and reuse and other methods. In China, to land fill the solid waste directly is the

main disposal method, however that really has a deep impact to the surrounding environment and human health[3, 4].

In this article, we mainly introduce where and how the solid waste is produced in a large typical pulp line, and how the solid waste is treated. It also includes the advanced design concept and the technical and equipment improvement during the pulp line operating process. This article also gives a reference for domestic pulp mills to minimise the solid waste disposal.

Where the solid waste from in the pulping mil and the designing treatment methods

To deal with the solid waste, we should firstly know where the waste from and what the main components of the waste in a pulp mill. The component of the solid waste usually depends on the process, materials, production technique and equipment. The whole pulp mill here we discussed includes the following plant: the fiber line plant, chemical recovery plant, power plant, chemical plant, effluent treatment plant and the pulp dryer plant. For such a big pulp mill with so many plants, solid waste can produced almost in every plant. Fig. 1 show where the solid waste is from and what they are.

We can see that the solid waste can be made in almost every plant, the amount of the solid waste generated is decided by the pulp production. For this pulp line, the solid waste can be divided into the following three categories depending on their property.

(1) Chip fines and rejects

The chip fines and rejects are both from the fiber line plant. The chip fines are from the chip handling process. Before reaching the digester, the chips should be screened. The length of fines is shorter than 3mm and the content is less 2%. Rejects are also from after screen, and the main contents of the rejects are the chips which are not cooked completely.

(2) Inorganic mud and ash

Inorganic mud and ash are mainly from the chemical recovery plant and power plant, including ash from the boiler and lime kiln, lime mud, dregs and grits from the causticizing process.

(3) Sludge

Sludge is from the effluent treatment plant, including primary sludge, bio-sludge and chemical sludge. The primary sludge is from the primary clarifier and only gets by gravity settling. The bio-sludge is from the secondary clarifier after bio-treatment in the aeration tank. The chemical sludge is from physicochemical in the Tertiary treatment, such as using PFS to flocculation and flotation in the last stage.

Those three kinds of solid waste are so different and should be treated separately. Table 2 shows the daily amount of each solid waste and the treatment method in the design book and the actual solid waste amount of each plant.

From Table 2 we can see that, more than 26% solid waste are actually produced than design and the design of the solid waste, especially the inorganic mud and lime and sludge are send out of the mill for land filling. but we also see that the solid waste of the mill is so much and the cost for land filling increasing rapidly, that also increasing the cost of the pulp production. We have to find some more reasonable and less cost way to the solid waste.

Modified solid waste treatment method

The operating practice shows that design treatment method can be improved and only little solid waste is send out for land filling. But there is some defects in the design and the equipment and process. So, based on the traditional solid waste treatment method, we follow the principles “reused in plant, recycle between plants and mills, minimum the land filling amount” and give the four rules.

a) Reused in the same plant
b) Recycle and reused between plants
c) Recycle and reuse with other mills
d) Send out to land fill

Follow this four rules, with the practical experience, we do deeper treatment and recycle and reuse the solid waste more fully.

(1) For unqualified chips, fines and rejects, its main content is fiber. Firstly we should consider reusing in the plant. For example, the over-thick and over chips should be sent to the chip crusher to reuse in the digester. The knot which is not cooked very well will screen out by the knotter and sent to digester again. Chip fines can not be used

Table 2 The Quantity of Solid Waste and Disposal ways.

Item		Design data		Actual data (3 months average)	
		Quantity (t/d)	Disposal Ways	Quantity (t/d)	Disposal Ways
Chip fines and rejects	Fines	323	To Power Boiler	385.3	Sell to other mills
	Screen rejects	30	To Power Boiler	72	Sell to other mills
Inorganic mud and ash	RC dregs and grits	35	To Power Boiler	54.3	Out the mill land fill
	lime mud	0		26.4	Out mill disposal
	LK ESP ash	75	leaving the mill	50	To power boiler as desulfurizer
	Boiler Ash	183	leaving the mill	40	Sell to other mills
	Boiler Slag	82	leaving the mill	17.1	Sell to other mills
Sludge	Primary	39	To Power Boiler	458.7	Out mill disposal
	Bio-sludge	23	To evaporator		
	Chemical sludge	21	To Power Boiler		

in the fiber line, but it can be used between plants, such as burned in the power boiler. Otherwise, if the selling price is very high, we can send them to other mills to make plywood.

(2) For Inorganic mud and ash. In chemical recovery process, the lime mud should be burned to produce CaO, but it also can be used between plants. For the power boiler as desulfurizing agent. The slag and ash in the recovery boiler are not useful in the mill; however they are good construction materials. Recycle and reuse with other local construction company can save the land fill cost and also protect the environment.

(3) To land fill the sludge will cause pollution problem. Also the heat value of the sludge is not very high, burning in the power boiler after mix with fines can reduce the cost of disposing, The deep dehydration technique of pup sludge is going well in the mill, that makes the sludge burning in the boiler feasible. The sludge can also be used between mills for some chemical mills to make fertilizer[5].

System and equipment improvement for the solid waste Comprehensive use

For chip fines to the boiler, we change the original design because the system has a feeding blocking problem. We did three important improvements. Firstly, we change the screw feeder to a large one. Second, the angle of the fines conveyor pipe was adjusted higher. Thirdly, the conveying screw is controlled by frequency converter which is easy to adjust. Figs. 2 and 3 show the difference before and after the improvement.

(1) We only know the amount of the rejects from the pulp screen, but there is no conveyor system to the power boiler. As we design and improve the fines conveyer system, the rejects can be sent to the power boiler directly by the system showed in figure 3 after mixed with the fines.

(2) The primary sludge from the ETP can also be burned in the power boiler or the recovery boiler. However we should press the sludge to a higher dryness more than 38% and a set of Frame filter press is necessary. If there is too much primary sludge and cannot be burned in the power boiler, it will be mixed with the bio-sludge (secondary sludge) and black liquor, and then sent to the evaporation system. After that, the concentration of the mixture will increase, and then the mixture of sludge and black liquor can be burned in the recovery boiler.

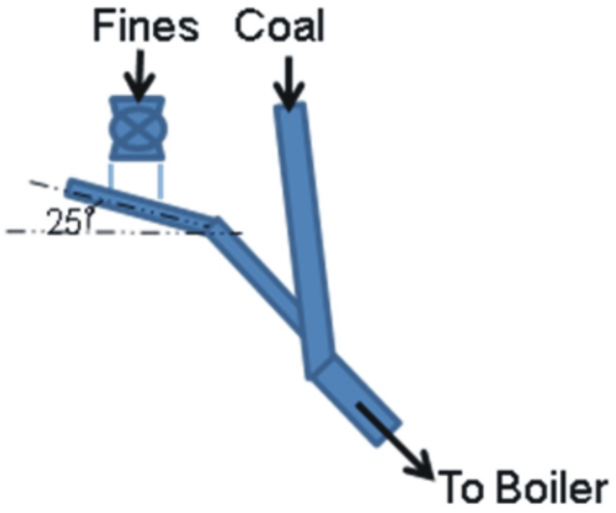

Fig. 2 The old fines convey system.

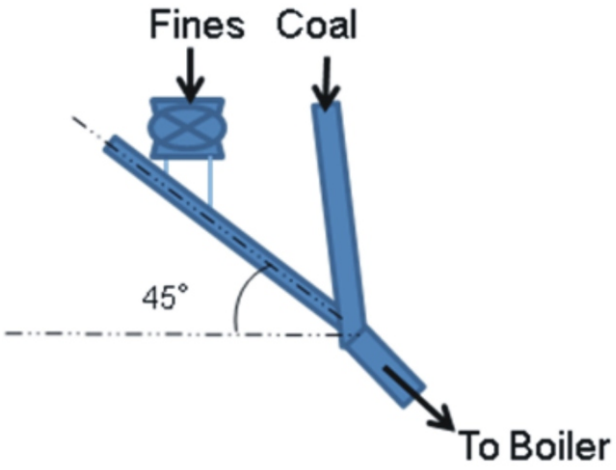

Fig. 3 New system after improvement.

Table 3 Benefit contrast after system improving.

Item	Current Disposal Fee			Get caloric in the furnace (PB&RB)			
	Weight (t/d)	Price ($/t)	Total ($/d)	Heat Value (kJ/kg)	Equivalent to standard coal (tce/t)	Equivalent ($/t)	Total ($/d)
Fines	385.3	30.6	1197.5	7582	0.259	47.2	18185.7
Screen & rejects	72	6.5	469.1	4523	0.154	28.2	2027.5
RC Dregs & Grits	54.3	-12.2	-663.3	-2179	-0.074*1	-13.6	-736.7
Lime mud	26	-7.3	-190.6	-1985	-0.068*1	-12.4	-321.4
LK ESP ash	50	0.0	0.0	0	0	0	0*3
ETP Sludge	75	-84.7	-6351.8	1972	0.067		-664.2*2
Boiler Ash	40	0.6	22.8	/	/	/	22.8
Boiler Slag	17.1	0.6	9.7	/	/	/	9.7
Profit ($/d)		5093.4			18523.5		
Saving ($/d)				13430.1			
Saving (M $Y)				49			

(3) The lime will be burned in the lime kiln to produce CaO which will be used to produce white liquor after causticization. The LK ESP ash can be sent to the power boiler as desulfurizer, but first we should add a storage silo.

Benefit contrast after system improving

Following the four principles the solid waste are maximum recycle and reused. Although large capital investment and equipment are the basic request, the Benefits are also very obvious. What is more, the less land filling solid waste would help to protect the environment, and good both for the mill and the social. Table 3 shows the benefits contrast after system improving.

From Table 3 we can see that as the solid waste are sufficiently reused in the mill, it has brought substantial economic benefits. It can bring more than 49 millions dollars per year for the company. Only little ash and slag that can not be used in the mill and are not harmful to the environment are sent out to landfill.

Conclusions

There are usually more solid waste produced actually than that was designed. For this pulp mill, it produces more than 26% solid waste than the design book. What is worse, there are less and less land in the city for the solid waste land filling. So it means that the equipment loading is not enough and some technical and equipment improvement should be made. More and more recycle and reuse the solid waste is the only way for a pulp mill.

The solid can also be treated in other method, such as thermal cracking and gasification. But till now, the feasible analysis report shows that burning in the power boiler is still the most effective and reliable approach.

The benefit is obvious when we do these improvement and totally about 49 million $/y is saved. That really not only decreases the cost and gets more profits for the mill, but also protects our living environment.

Acknowledgment

The authors gratefully acknowledge the financial support of this study by project bsdq2012057 and project xkj201322 supported by Innovation Foundation of Qufu Normal University, and project BS2012CL019, supported by Young Scientists Award Fund of Shandong Province.

References

1. Tang Z. Present situation and development trend of solid waste treatment in China. *China Pulp & Paper Industry* 2010, 31(18): 610.
2. Qi D, Gong G, Liu Y. Waste management from pulp and paper production in the European Union. *International Paper* 2010, 29(4): 4050.
3. Wu F, Zhou S, Chen Y. Current status and prospects in the reclamation for paper process sludge. *China Pulp & Paper Industry* 2009, 30(7): 97100.
4. Zhou Z, Xiong Z, Yang X, et al. Energy utilization of waste sludge from paper mill through gasification paper science & technology. *Guangdong Pulp & Paper* 2001, 20(6): 1821.
5. Li Y, Zhu H, Xu C, et al. Techniques of sludge treatment, disposal and application. *China Pulp & Paper* 2008, 27(11): 5962.