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The Oldest Newsprint Paper Mill Redesign and Rebuild for Energy-saving and Water-reducing in China

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Abstract. Guangzhou paper was the first newsprint producer in China which achieved an circular economy and decreased the cost of production by increasing the energy conversion efficiency, increasing energy use and recovery efficiency, enhancing reuse of fresh water and reducing the quantity of fresh water for getting better economic and social benefits in both ways. The successful energy saving experience will be not only benefit of Guangzhou paper but also excellent example of other similar Chinese paper mills facing same problem.

Key words: Energy-saving, water-reducing, paper mill redesign, paper mill rebulid

1. Introduction

China has been the biggest paper maker in the world after twenty years continuous development. Guangzhou Paper Mill (GPM) was established in 1936, it was the first big newsprint producer in China. During the development of more than 70 years, GPM has been expanded from 30,000t/a. to a big scale of 450,000t/a. Meanwhile, it was an enterprise of huge energy consumption also, about 500 million Kwh, 1 million tons steam would be used per year.

The main facilities in GPM

Pulp Lines	Capacity	Year	Water Cons.	PMs	Capacity	Year	Water Cons.
SP	100 t/d	1931	70 m^3/t	PM5	65,000 t/a	1956	27 m^3/t
GP	150 t/d	1982	20 m^3/t	PM6	45,000 t/a	1982	40 m^3/t
CTMP	150 t/d	1997	26 m^3/t	PM7	45,000 t/a	1982	40 m^3/t
DIP1	120 t/d	1992	22 m^3/t	PM8	145,000 t/a	2000	22 m^3/t
DIP2	250 t/d	1999	21 m^3/t	PM1	150,000 t/a	2006	8 m^3/t
DIP3	650 t/d	2006	5 m^3/t				

*the data of water consumption except PM1 is based on the average value in 2000.

The technical level of the above systems is quite different due to the time putting into stream in various historical periods, the energy and water consumption in each system was in big difference too. The energy and water consumption was considerable as high as the normal Chinese paper mill. Therefore, finding out right ways to reduce energy and water consumption of the papermaking process in whole mill for saving manufacturing cost and improving economic benefits are urgent.

In the past ten years, GPM invested 2.7 billion RMB to bring in new and advanced technology, constantly to rebuild original old production system. The scale of production was increased from 0.14million tons to 0.42million tons. At the same time, the comprehensive unit energy consumption of the product had been decreased from 0.567 to 0.332 ton standard coal per ton of paper, the consumption of fresh water had been also decreased from 160 to 17

https://doi.org/10.24084/repqj08.642 1268 RE&PQJ, Vol.1, No.8, April 2010

cubic meter per ton of paper. We have got good economic benefiting from energy saving.
Base on the analysis of existing product line and comparing it with the modern new technology, we focused on the three-links method to improve the results of energy and water utilizing:

2. Increasing the energy conversion efficiency: The technology innovation improved the overall efficiency in power station

A. Use the multi-pressure steam pipe net instead of single high pressure system for different steam pressure requirement, reduce the throttle losing.

In the past, we used one-stage extraction process in our steam turbine system, which means we only extract 1.0MPa medium pressure steam from the main steam turbine, and then by the respective temperature and pressure reduction devices we supplied different pressure steam to every end user, it cause lots of energy loss. We modified the steam pipe net into three different pressure systems according to the actual requirement of steam pressure of end user. There were several back pressure turbines instead of throttle valves between the different pressure steam pipe net (see Fig.1).

B. Back pressure steam turbine replace electric motor for big boiler feeding water pump

We invested more than 20 million RMB to build a back pressure steam turbine replace electric motor for big feeding water pump via the pressure and temperature difference between the secondary steam net and the third steam net of end user, transforming energy loss due to temperature and pressure reduction into electric power. The annual power output got increased 48 million Kwh which creating extra profit of over 20million RMB, and the payback period was only one-year. Meanwhile, as the extraction volume increased, the capacity of the main steam turbine increased from the previous 50MW up to 60MW because of enough extract steam, and the annual output got 160 million Kwh more which gaining extra profit of 16 million RMB.

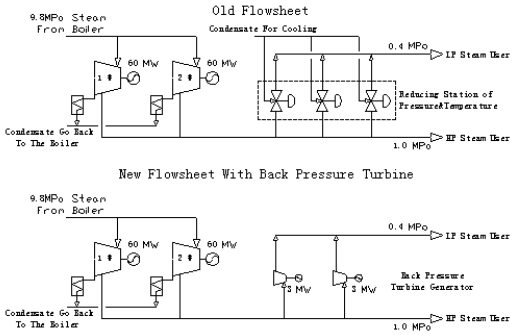

Fig. 1. The Flowsheet of There stages steam System

C. Optimizing boiler and ball grinding machine parameter to increase operating efficiency.

With a series of technology innovation in the thermal power plant such as the modification of the impeller of circulating water pump, using simulation logic technology on coal grinders, reuse of milling's hot exhaust air, boiler combustion with low oxygen consistency, steam supply network operation with lower pressure, recycle the sewage energy of the boiler etc., the integrated efficiency of the power plant exceeded 52%.

3. Increasing the energy use and recovery efficiency: optimized the process, adjusted running parameters, maximized the output of equipments to reduce the energy consumption

A. Optimizing technical process to reduce the electricity consumption of Bleach Chemical Thermal Mechanical Pulp Line

In the past, there were only two-stage refining in our BCTMP line, there were no extra reject treatment system, the reject of screen was fed back to the second refiner for refining. To keep good pulp quality, lots of reject had to be fed back to the interim tank which limited the capacity of second refiner and led to higher power consumption. Therefore, we made certain optimization to the process correspondingly (see Fig.2). By using the existing low consistency refiner in the pulping line for market pulp, we divided the refining into coarse refining and fine refining, the feed back of screen reject was just half of before, then the capacity of main line was increased without causing sacrifice to the pulp quality. Thus, the daily output of the pulp line had been increased from 147 to 172 tons(Table 1), 17% higher than before and the unit power consumption decreased from 2607 to 2379 Kwh/T pulp accordingly.

B. Adjust the compressed air system to reduce air compressors' running time.

The compressor air station works for whole mill. We always run the compressed air station at the highest pressure of 0.66 MPa before, no matter how much pressure requirement of each consumption point. Hence, we divided the compressed air system into

https://doi.org/10.24084/repqj08.642 1269 RE&PQJ, Vol.1, No.8, April 2010

instrument air system and mill air system, run two different pressure systems according to the production status now. At past, we had to run 9 air compressors while right now 7 compressors was enough. By doing this, we can save 10 thousand Kwh every day. Now the system might be not so stable as before, but we still can keep operating smoothly by making fine management according to the practical situation.

Table I. - BCTMP line quality and electricity consumption

	DAILY PRODUCTION (T/D)	UNIT CONSUMPTION (kWh/T)	BEATING DEGREE (°SR)	TENSILE INDEX (N.m/g)	TEAR INDEX ($mN.m^2/g$)
Average on Y2003	147	2607	59.5	25.1	7.12
First half year on Y2004	156.2	2655	53.2	24.2	6.84
Second half year on Y2004	170.7	2475	57.8	27.6	6.85
Average on Y2005	171.6	2379	59.4	26.5	6.43

C. Reduce the energy consumption of boiler's water feeding pump.

There are two water feeding pumps with 2000 KW motor for the boiler in power plant, the energy consumption is 96 thousand Kwh per day. The outlet design pressure of these pumps was 15 MPa while the requirement to the boiler inlet pressure is only 12 Mpa, which made a lot of energy-loss at the throttle valve. Hence, we convoked our related technicians to make comprehensive analyses and calculate performance parameters under different conditions, and consulted with the supplier and the experts in other power station. We gradually decreased the water pumps' outlet pressure from 15 MPa to 12.5 Mpa by cutting down the impeller diameter of pump under the condition of safe operating. In this case, we can save 20 thousand Kwh every day.

D. Increased the capacity of pulp line to save energy consumption.

Along with the implement of some innovations on paper machines during recent years, our paper quality got improved and machine speed got gradually increased as well, which made the output of our pulp lines cannot conform to the capacity of paper machines and we had to purchase 30 thousand tons pulp from the market per year which increased the cost a lot. By analyzing all the equipments on the pulp lines comprehensively, we carried out a series of optimization and rebuilt to break through all bottlenecks and increase the output of pulp lines outstandingly. Now it had been conformed to the requirement of paper machines basically and in turn we can save over 20million RMB per year.
The output of our 250T/D DIP line was always keeping around 240T /D since it had been put into operation. After observation we found that the main problem was because of shortage of screening and dewatering capacity. We carried out plenty of optimization and modification works on this line based on those conditions (see Table. 2) and increased the daily output form 240 upto 330 tons. The unit power consumption had been reduced from 331 to 290 kwh as well.

Table II - Main modification measures on 250T/D DIP line

ITEM	PROBLEMS	MAIN REASON	IMPROVEMENT MEASURE
1	drum pulper reject with fiber	Broken or plug in screening stage	change completely
2	shortage of screening capacity	Screen basket wearing, out-of-data technology	Change to new equipment and optimize process
3	shortage of PDF capacity	Too small filtration area	Increase filtration area by using spare sectors
4	shortage of Twin wire roll press capacity	The inlet consistency was low	Optimize PDF and feed pump, Increase inlet consistency
5	Some of pumps' capacity were not enough	Wearing or capacity not enough	Repair or change
6	Serious loss on post Flotation	Unreasonable process	Optimize process and reduce loss
7	Cleaner lost too much	Structure of cleaner, Unreasonable process	Add one more final cleaner stage with fiber recovery

https://doi.org/10.24084/repqj08.642 1270 RE&PQJ, Vol.1, No.8, April 2010

8	Too much loss on air floatation system(DAF)	Unreasonable water system design	Optimize water system, clear filtrate instead of cloudy filtrate

E. Shoe press application for improving the dryness of wet sheet

As the shoe nip press technology become more and more popular in press section for higher dryness and better quality of web, we utilize economic technical solution of shoe press for our PM8 to replace the second roll nip in press section without big structure changing of machine frame. It means no need of big investment and long shutdown time for existing machine. We could get same effect as new machine. The configuration of PM8 press section was like Fig 3:

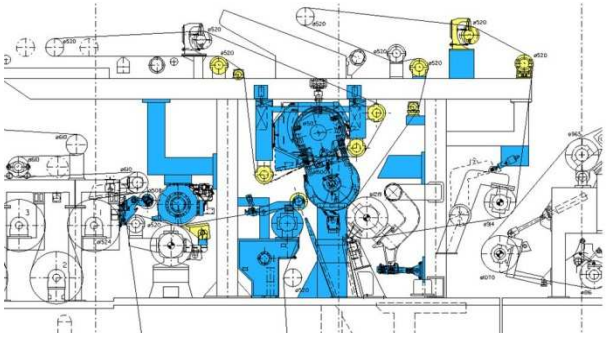

Fig. 3. Shoe press replaced roll press in second nip

After rebuilding, the dryness of web before dry section increased from 42% to 46%, and the steam consumption reduced from 1.856t/t to 1.485t/t.

F. Using de-ink pulp instead of ground wood pulp for newsprint furnish

During our new PM1 project, we learned the modern technology of de-inking process and paper machine, via abundant investigation and trial, we decided to use the 100% DIP for newsprint, it was the first traditional Chinese enterprise which introduced this process technology. In order to maintain the good quality of paper and the good runnability of paper machine, we built full two loops system for cleaning, screening, flotation, thickening and washing, bleaching and one dispersion in de-inking line, we integrated the all new technology for locally supplied paper machine with high efficiency deculator, dilution headbox, economical gap former and shoe nip press, single nip soft calender, etc.

The project was quite successful, paper machine reached at the 1400m/min design speed only one week after starting up and had operated at 1550m/min stably just three months later. The paper quality was same as the competitor's and welcome by the customer. The energy and water consumption include pulp and paper were 980Kwh/T and 13m^3/T, it was greatly lower than the consumption of the other existing paper making lines. GPM also transfer the acid wet end process to alkaline by recycle fiber.

4. Enhance the reuse of fresh water, and reduce the quantity of fresh water

In the past, GPM was one of the biggest factories who polluted the environment heavily for discharge of industrial waste water in Guangzhou city. It used to spend around 100 thousand cubic meter of fresh water per day with the annual capacity was just over 100 thousand tons due to the out-of-date process as well as obsolete equipments. Based on this fact, we carried out lots of technology innovations in each pulp and paper making lines as well as auxiliary systems to save water for clean production. As a result, the fresh water consumption got decreased outstandingly and the contamination discharge of waste water was reduced obviously.

A. Optimized technical process, enhance the reuse of fresh water, and reduce the quantity of first water.

--- Introduced high consistency screening process in chemical pulp line to replace previous low consistency CX screening, in which way we decreased the water consumption from 150 to 50 cubic meter per ton in screening stage and reduced the waste water discharge amount and pollution load to environment.

--- Introduced high efficiency PDF system for treatment of the white water in papermaking plant, to recover the fiber in the white water, decrease the discharge amount of suspended solids in the sewage and reduce unit fiber consumption.

---Rebuilt the LP shower system in PMs by installing automatic flushing filter and new type of nozzles and used clear filtrate of disc filters instead of fresh water for shower. In this way the fresh water consumption of PMs was reduced essentially.

--- Optimized wet end chemical system such as retention system in paper machine line, to reduce the waste water discharge during papermaking.

---Collect the sealing water of vacuum pumps, install new cooling tower and filter devices in PM5 and PM8. This circulation system saved fresh water more than 5,000 m^3/d.

---Collect all cooling water of mechanical drive, lubrication and hydraulic systems in PMs to use for showers. Fresh water is used by double times.

B. Built up a water balance system.

Due to the historical reasons, the material flow in GPM was single direction, fiber was carried by huge quantity of water to PMs, and then excessive water discharged directly out from PMs system. The deficient quantity of water in pulp lines was

https://doi.org/10.24084/repqj08.642 1271 RE&PQJ, Vol.1, No.8, April 2010

supplemented by fresh water. Most of the water was used one time and only for conveying fiber. In some case there was feed back of white water to pulp plant in single line, but the unstable source of white water can't suit for the big variation of pulp line and big quantity of fresh water had to be added.

Based on the analysis of the pulp-paper system situation in GPM and the principle of modern water recycling, we installed a white water balance system of 3,000 m^3 in the mill. The white water from PMs was treated and collected to a storage center and then dispatched to various pulp lines. Most of the harmful material was removed by DAF before feeding back to the storage center. Flowsheet of this circulation is as follow(Fig.4).

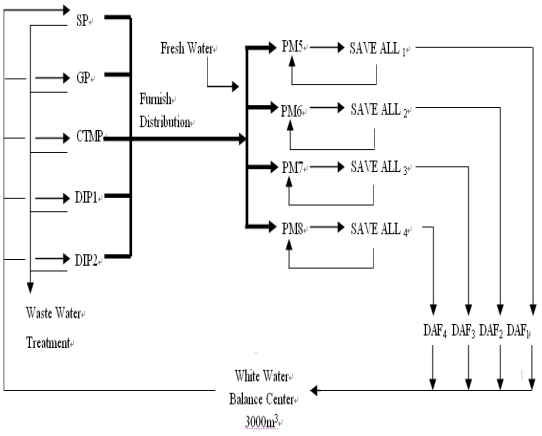

Fig. 4. New mill water balance system

Thank to the reuse of lots of clarified water, we can save over 5000 cubic meter fresh water every day after building up the new water balance system. Currently, even though our annual output had been doubled than before, the water consumption had been decreased to the one tenth of the past. The water recycling rate in whole company increased up to 90% which reducing the cost of fresh water remarkably. The annual production and unit water consumption during the past ten years is showed as Fig. 5.

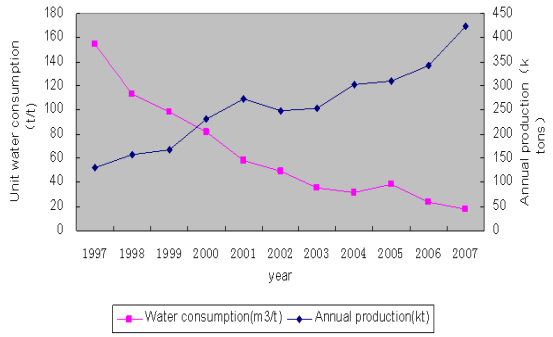

Fig. 5. The trend of water consumption and production in the past ten years

For the waste water treatment, we invested over 0.1billion RMB totally to set up EWP, HCR, IC, SBR systems, building up a complete network of waste water treatment by forming plant, interim and terminal three-stage protection system to ensure the discharged waste water can meet the national discharge standards. The discharged COD was lower than 90PPM and total amount COD was 1.8 Kg per ton product.

All of this made GPM improve utilization rate of the resources and the energy sources, come into a new path of industrialization with high technology, low resources consumption, less environmental pollution as well as better economic profitability.

GPM is building a new paper base with annual 2 million tons production in the field land now, the planning is to build several modern new paper lines and relocate two existing paper lines from the old mill. We will insist on the energy-saving and clean production continuously to promote the circular economy, the comprehensive unit energy consumption of the product is expected lower than 0.3 ton standard coal per ton of paper, the consumption of fresh water expected lower than 10 cubic meter. We hope we can achieve prosperous growth both in economical and social benefits.

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