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**THE ENGINEERING AND OPERATION OF  
ANOTHER STRAW RECOVERY BOILER IN CHINA**

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**Abstract**

Zhenjiang Pulp Mill is located in Zhenjiang city of Jiangsu province. It was put into production in 1968 with reeds as the raw material to produce kraft bleached market pulp. The annual capacity is about 37,000 tons.

In 1986 a new jet recovery boiler (the type of WGZ 14/13-I) combined with cascade and EP was set up and put into running in place of original three rotary furnaces each with subsidiary boiler.

In order to meet the special requirements for the combustion of reed black liquor (without desilication) and to get perfect results. Some efficient steps were considered and adopted, in geometric size of the furnace and boiler, spraying and drying of black liquor and the arrangement of air nozzles and heating surface. etc.

The boiler was manufactured by Wu-han Boiler Workshop. to see attached draw. 1

BCEL was responsible for the engineering of the complete combustion department. to see attached draw 2.

The main parameters of the boiler are as follows :

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Dry solids .....	110 t/24th
Concentration of BL from the evaporator Plant : .....	40% (D. S.)
Concentration of BL for jetting : .....	50% (D. S.)
Temperature of BL for jetting : .....	105-110°C
Temperature of steam : .....	360°C
Pressure of steam : .....	1.3 MPa (13kgf/CM <sup>2</sup> )
Steam production : .....	14 t/h
Temperature of feed water : .....	104°C
Temperature of air supply : .....	150°C

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After over two year's running all the design indices have been reached and the renovation has brought more benefit to the mill because of the reeovery of more heat and chemical than original rotary furnace.

At present, the price of the recovered alkali (as NaOH) is 133USD/ton (The market price of liquous NaOH about 400 USD/t).

The advantages of this boiler which have been shown are as follows :

1. High alkali production-average monthly production 795.89 tons this year.
2. Excellent drying of BL inside the furnace, no need add auxiliary fuel under the normal operation. Oil is Consumed only for the open and close fire as 83.85 kg/ton (as NaOH).
3. No ashes build up and foul on the heating surface and flue gas passage, thus longer operation period, much less maintenance and labour consumed.
4. Possible to make up certain amount of salt cake with BL into the boiler.

## INTRODUCTION

### 1. Background

It has been more than 20 years in some pulp mills of China to recovery the soda from straw BL. Zhenjiang Pulp Mill located in Zhenjiang city of Jiangu province is one of them.

It was put into production in 1968 with reeds as the raw material to produce kraft belached market pulp. The annual capacity is about 37,000 tons.

The main equipment of pulping and soda recovery system include 2 sets of 110 M<sup>3</sup> vartical batch digester, 4 sets of vaccum drum washer vaccum pumps, 6 sets of 750 M<sup>2</sup> rising film evaporator with long tube, 3 sets of rotary furnaces each with subsidiary steam boiler, recausticization plant of dorr type with 4 sets of 8m clarifiers. Due to economical reason, there is no lime kiln in the mill. All of the equipment were supplied and manufactured by China.

Before 1986, when the rotary furnaces were employed at the combustion department, the average monthly production of recovery alkali is less than 600 tons, the heat efficiency of its subsidiary boiler lower, therefore, the supply of steam production can't meet the demands of the whole mill. Besides the above short-comings, it took much more maintenance also and operation condition for the workers was too bad.

In order to increase the capacity of recovery alkali and overcome the above mentioned shortcomings of rotary furnaces, a new jet recovery boiler combined with cascade evaporator and EP. was set up at the mill in 1986 in place of three original rotary furnaces.

### 2. Brief description of the process

The reeds bundles to be used for pulping are cut by disc cutter with 4 knives. After screening and dry dust removing systems, the accepted reed chips are transported by conveyor to the top of the digesters of packing at the same time of cutting, ie, there are no chip bins above the digesters for batch packing due to the bridge problem. It takes about 60 minutes to fill up a batch in weight of 19 tons of reeds (air dried).

**The cooking conditions and results--** alkali charge 15% (as NaOH), sulphidity 15% max. cooking temperature 150°C, cooking time (from 90°C to 150°C only) 60 min, yield of coarse pulp 48%, residual alkali in BL. 7-9 g/l (A. A as NaOH).

The conc. of BL. extracted from washing room is 10% (DS), 70-75°C, it is continuousy concentrated up to 40% (DS) at evaporator plant, then led to cascade evaporator located at combustion department and directly evaporated with flue gases up to 50% (DS), finally for jetting into the furnace mixed with boiler ashes and salt cake.

### 3. Properties of reeds BL.

Sampling from jetting BL, the conc. 49.85% (DS), ashes content 33.04% (as NaOH), calorific value of Ds 14.27 MJ/kg (3408 kcal/kg) with oxygen bomb calorimeter.

Element analysis (%) of DS. C-35.39, H-3.69, S-2.35, N-0.03, Na-16, Si-0.94. Function between viscosity (CP) and temp. (°C)

Be'(20°C)	30°C	60°C	90°C
10	2.62	1.80	1.01
20	20.5	7.9	4.15
24	55.5	18.8	10.6
28.5	530	73	24.5
33.64	7050	435	87

### 4. Design characteristics of the boiler

The design parameters of the boiler are as follows :

Dry solids .....	110t/24th
Concentration of BL from the evaporator Plant : .....	40% (D.S.)
Concentration of BL for jetting : .....	50% (D.S.)
Temperature of steam : .....	360°C
Pressure of steam : .....	1.3 MPa (13kgf/CM <sup>2</sup> )
Steam production : .....	14t/h
Temperature of feed water : .....	105°C
Temperature of air supply : .....	150°C

Before engineering this boiler, there were more than 10 recovery boilers used to combust the BL. such as reeds, bagasse, wheat straw, bamboo etc. in China, The amount of treated dry solid range is 40-80 tons per day. Based on the running experiences and practice of above noted boilers, some efficient steps were considered and adopted in geometric size of furnace and boiler. spraying and drying of BL and arrangements of air nozzle and heating surface etc.

1). The temp. of flue gases at exit of top furnace or at entrance of bank tube was designed at 550°C, it is a bit lower than the deformation point of the boiler ashes. According to the temp. the height of whole furnace can be decided naturally. The temp. of flue gases at economizer exit was designed at 250°C.

2). Two fixed vortex nozzles are installed at sides of the furnace wall, spraying downward to the bottom, it is 6.5m from nozzle location down to the bottom of furnace.

3). The temp. of air supply was considered at 150°C by steam heater, it's not necessary to increase the air temp. up to 200°C with flue gases heating.

4). For the arrangement of air supply, it is necessary to install two purposes air nozzle below the liquor gun, the primary air led to the center of charbed the secondary to the space above charbed, so as to form the oxidizing and drying zone. Above the spraying gun, the tertiary air nozzle is needed for burning up the dried BL. fine granules which are carried upward with flue gases. The proportion of the primary air is 40-45%, both of second and tertiary air 60-55%.

5). Due to too smaller size of straw BL. granules and much more carried boiler ashes up, the angle with horizontal line of the buffer inside of the furnace was designed 60 degree, it's precipitous than normal furnace of wood pulp BL. so that the ashes built up on the nose can be eliminated and easy self-sliding down back to the smelt furnace.

6). 12 mechanical retractable sootblowers are installed in different position of the top furnace and bank tube, economizers, at important place where the flue gases changing the direction, some opening hole for manual sootblowing must be opened.

7). The membrane water wall with prefabricated fin tube ( $\Phi$  60 x 5mm) is adopted in furnace structure, the pitch of 80mm. The column stud ( $\Phi$  10 x 25mm) coated with chromiumbase refractory is adopted too in the smelt furnace zone. It's much more economical than using composite tube for smelt furnace structure and very advantageous to burn lower calorific value of BL.

8). There is a rapid draining system of recovery boiler and the explosion relievers called weak corners at the upper part of furnace is installed.

## **5. Process design characteristics of combustion department**

1). According to local condition of the wether, the boiler was designed to install in semi-open so as to save the capital investment of the building and speed up the construction of the project. to see draw, 2.

2). The conc. of jetting BL. was fixed at 50-52% (DS), the reason is that if the conc. is much higher than 50-52% the viscosity increses violently, resulting bad atomization of BL.

The black liquor for jetting is directly heated up to 105°C.

3). There is a tube filter designed with self-cleaning function on the BL. pipe which is connected with nozzle for jetting. The dimension of round hole of the filter is 6mm.

It's very useful to prevent the plugging problem causing by oversize matter contained in Bl. and to often keep good atomization result as well as reducing the times of changing the nozzle.

4). For the dust removing system, a cascade and two lines of EP set with flat bottom and dry ashes conveyor are combined, the flue gases temp. at inlet of EP set is 150°C and at outlet 140°C.

5). Considering to use powder salt cake with 95% purity of  $\text{Na}_2\text{SO}_4$  to minimize shut down times due to purging some tanks.

6). All of instrumentation for measuring and controlling were designed except measuring for conc. of BL. in line, it's not successful at present.

7). For piping engineering, we paid attention to preventing leakage problem of the valves installed between both of the pipes of water and BL, steam and oil, for the safety reason.

## **6. Operation and its results**

After the erection of combustion department, the test running went off without a hitch in a very short period, but at the begining of production, for lack of experiences of jetting, air supply and control of the charbed, in general, the drying efficiency was not so good and very often resulted in the charbed wetted and primary air nozzle blocking, the smelt spout blinding. Under this situation, the auxiliary fuel had to be added for burning with BL. Through practice for two months, the operation and process conditions were adjusted further, then the running of the boiler turned to smoothly nd stable. At present, the advantages of this boiler which have shown are as follows.

1). High alkli production, the treated dry solid daily has been come up to 120 tons, the average monthly production of alkali 795.89 tons (as NaOH) in 1988, it is 200 tons more than before. For the spraying conditions, normally two nozzles with 12mm dia. are used, the pressure of spraying ranges from 0.15 to 0.18 Mpa (1.5 -- 1.8 kgf/CM<sup>2</sup>), the volume of jetting BL is 8 -- 8.5 M<sup>3</sup>/h (conc. 50% Ds).

2). Excellent drying of BL inside the furnace, no auxiliary fuel is needed under the normal operation, oil is consumed only for open and close fire as 83.85 kg per ton recovered NaOH.

3). No ashes build up and foul on the heating surface and flue gases passage thus longer operation period, much less maintenance and labour consumption. Under normal conditions the boiler can be run continuously for three months without shutting down for ashes cleaning.

4). Higher heat efficiency of the boiler, the steam production ranges from 13 to 14t/h; it efficiently solved and unbalance problem of steam supply of the mill before the renovation.

5). After direct evaporating in cascade, the black liquor can be efficiently concentrated from 40% up to 50% (DS). For the efficiency of dust removing, after cascade it can be reached to 25%, after EP set 97.35%, the residual dust content in flue gases at outlet of EP set is only 0.378g/NM<sup>3</sup>. It is useful to minimize the air pollution and recovery more alkali.

6). It is the first time to make up salt cake into straw BL so smoothly in China. Under normal operation, 50-80kg of salt cake to per ton recovered alkali (as NaOH) can be made up. Of course, if added too much salt cake, the nozzle plugging will take place frequently and the temp. of char-bed will drop down as well as smelt spout easy to be blinded.

After over two year's running, all the design indices have been reached and the renovation has brought more benefit to the mill because of the recovery of more heat and chemical than original rotary furnaces.

At present, the price of the recovered alkali (as NaOH) is 133 USD/ton (the market price of liguous NaOH about 400 USD/ton).

## **7. Knowledge from experiences**

1. Strengthening the dust removing for the raw material of reeds and reasonable canceling or limiting the time at top cooking temp. (150°C). It's favorable to increase the efficiency of BL extraction and soda recovery as well.
2. To keep higher active residual alkali in BL, it's very useful to overcome the silica trouble, thus even without desilication plant in the mill, the soda recovery system can still be controlled under normal operation. As it should be, if recovery of lime mud to be needed, the desilication plant must be installed.
3. Available temp. and conc. of straw BL.
4. To well control the atomization (granularity), drying (capability), charbed (height and dryness).
5. Reasonable air supply.
6. Necessary to install the tube filter for straw BL.

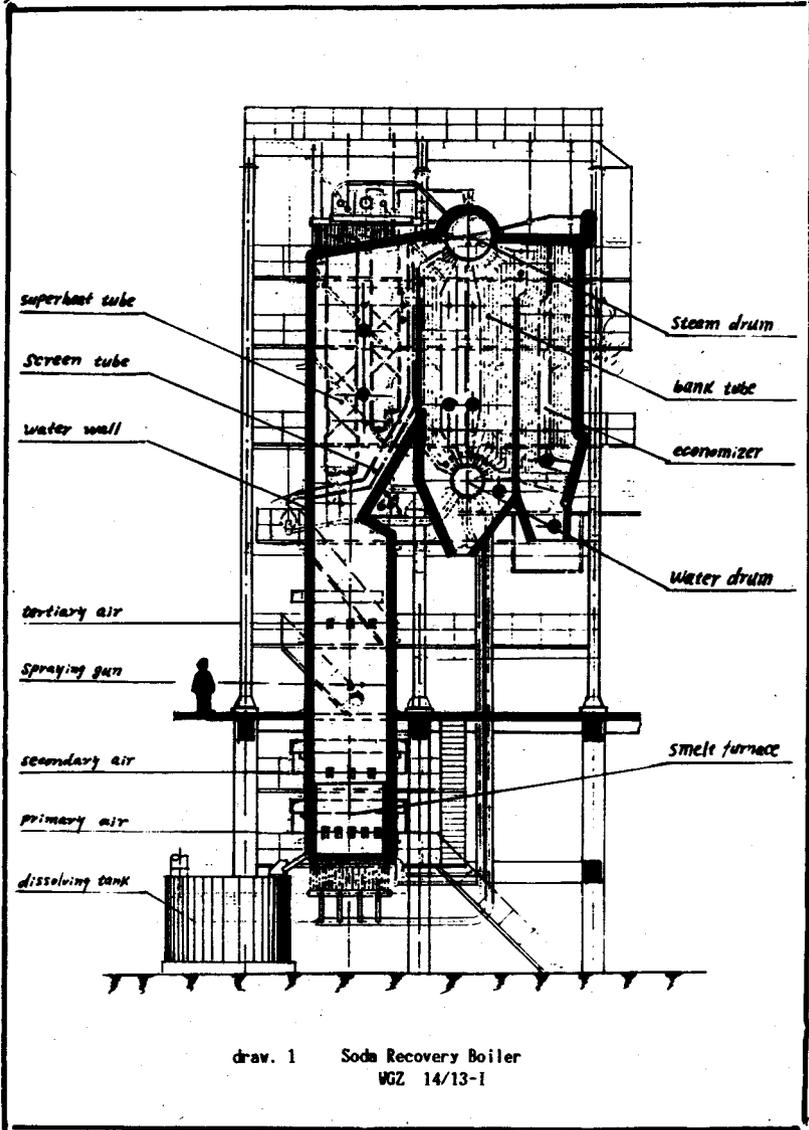
7. When auxiliary fuel is not sufficient or too costly, requiring as much less auxiliary fuel as possible for burning straw BL, the recovery boiler of straw BL should be used to generate the saturated steam for process rather than for produce of superheat steam for power generation, due to the poor quality of straw BL, lower calorific value, unstable operation and difficult control of the parameters of superheat steam.

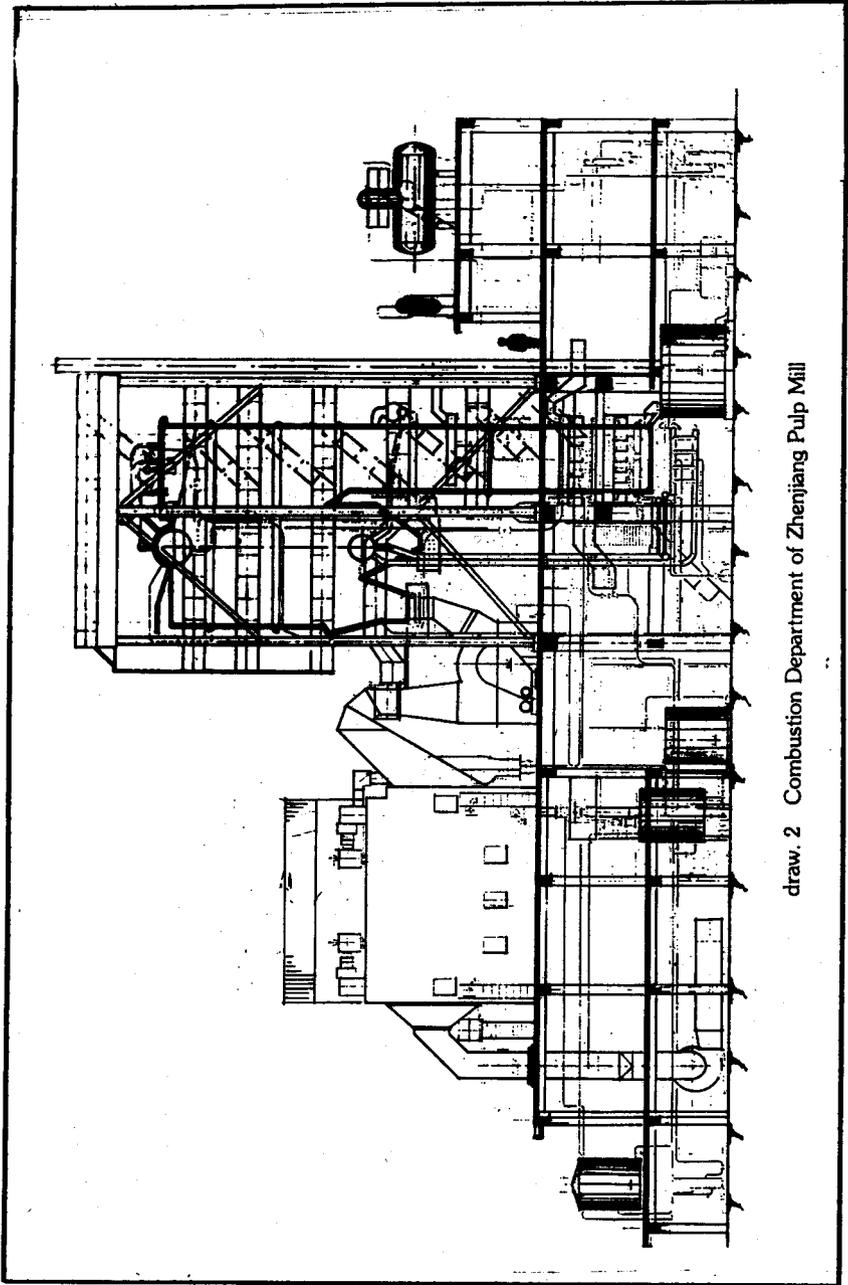
At present, the superheat steam generated at the boiler in the mill is led to temp. reducer to form saturated steam for process only.

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draw. 2 Combustion Department of Zhenjiang Pulp Mill