Chemical recovery system for small bagasse based paper units

Panduranga A.*

Introduction

While Big Sized Recovery Boilers for Kraft Liquor are succesfull in operation, small sized units for Bagasse Soda Liquor are not yet in operation in India. The author discusses in this article the considerations he had and problems encountered while designing a small sized unit to give trouble free operation and still to make the unit economically viable.

About 2 decades back, when further growth of paper production was threatened due to non availability of forest raw materials, mini paper mills entered into the production field with waste paper and agricultural residues as raw materials.

Inspite of innumerable initial problems, mini paper mills came to stay and infact have taken a lead over major paper mills.

The stream pollution and rising chemicals cost have become a major problem for mini paper mills and unless Technically feasible and economically viable solution is not found immediatety their very existence is threatened. Needless to say that paper production in India is inter linked with this development and hence is the most burning issue as on date.

Bagasse, Rice Straw, Wheat Straw, Kenaf etc are some of the major agricultural residues available in India.

Bagasse is relatively easy raw material to plan a Recovery System compared with Rice Straw and the same is discussed here.

All over the world, many big sized Recovery smelting type units are in operation; While the search is on for exotic technologies, many are not field tested, field proven and not yet found to be economically viable. At this juncture smelting type of furnace appears to be the only answer, at least for some time to come.

Some problems encountered with bagasse liquor and specific problems with reference to small sized units and philosophy and approach with specific reference to the recovery system being supplied to pulp and paper project of Sri Satpuda Tapi Shakari Sakhar Karkhana Ltd., Satpuda, by Tungabhadra Machinery & Tools Ltd., Hyderabad (TMT) are briefly discussed herein :

About Satpuda Paper Mills :

The paper mill is coming up in the campus of the existing sugar mills. The capacity of the paper plant as planned at persent is about 18,500 MTPA (About 56 TPD paper considering 330 working days). The pulping process is based on the Soda process.

The operational experience of this unit can be considered as a guiding factor for further Recovery Systems in similar units.

TMT is supplying five effects evaporators with forced circulation for a capacity of 27.5 Tonnes water evaporation per hour; Recovery Boiler for firing 65 Tonnes of Black liquor Solids per day. Recausticisers for 130 Cubic Meters of white liquor at 100 gpl

* Tungabhadra Machinery and Tools Ltd.
1001, Kaushal Towers, Khairatabad
HYDERABAD-500 004

TTA and effluent treatment plant based on the activated sludge process.

Brief specifications of the plant are given in the Annexure—I

While designing Recovery system the following important points are to be kept in view :

a) Bagasse Black Liquor is having higher viscosity compared with wood or bamboo black liquor. The viscosity of Bagasse liquor increases steeply as the concentration increases. It is difficult to get higher concentration liquor from direct contact evaporators. While all efforts should be made to get thick liquor at high concentration, the furnace should be suitably designed for firing liquor at lower concentration.

   The viscosity problem is more severe with Soda liquor compared with kraft Liquor or Sulphite Liquor.

b) The swelling volume index of bagasse black liquor is lower. If the same spray techniques as for wood or Bamboo Black Liquor are adopted blackening of furnace could happen.

c) Inview of lower concentration of liquor as fired coupled with relatively lower calorific value of fuel, autogenous combustion is affected. To maintain the combustion, supplementary fuel is needed. Where as, oil firing is a costly affair and hence to be avoided.

d) Melting temperature of smelt is higher than for wood & wood Bamboo liquor.

Besides the above specific needs, Recovery Boilers should be designed for :

a) Safe Operation

b) Continuous operation without forced stoppages to clean the boiler passages.

c) High Recovery efficiency.

d) High Thermal efficiency.

e) Ease of Operation.

As the units become smaller and smaller the problem becomes more and more complicated. It is similar to an American with his luxurious car trying to drive in the narrow and populated streets of India.

While supplying Recovery Boiler to Satpuda TMT incorporated the following features :

To give trouble free and continuous operation, the boiler passes should be free from chemical deposits and free from ledge formation in the furnace region.

They are achieved by the following features :

a) Furnace cross sectional area is provided liberally to reduce the gas velocities thereby chemical carry over is reduced.

b) Tower type furnace design is adopted to give more dwell time and thereby to complete the combustion in the furnace region only and to cool the flue gas sufficiently before entering boiler bank tubes. The chemical deposits are Soft when the flue gas is cooled.

c) Platen type screen tubes are provided in the furnace to facilitate easy dislodgement of chemical deposits. Spaced tubes provide hold for the chemicals and when once chemicals envelope the tubes it is difficult to dislodge. Platen type screen tubes without clearance between the tubes don't offer any hold.

d) Efficient secondary and tangential tertiary air systems are provided for completing the combustion in the lower furnace region, before entering Screen Tubes.

e) Rotary cum Retractable Soot Blowers are provided in critical zones and sonic soot blowers are provided in non problematic convection zones.

f) Large open passages are maintained between screen tubes panels, and convection tubes at the entry zone of boiler banks.

g) The generating section consists of Baffle-less single pass tube bank reducing the incidence of chemical deposits and elimination of problematic ash hopper.

To achieve higher thermal efficiency the combustion should be complete with low excess air with no air infiltration and with minimum radiation losses :

a) The leakage of air into the Boiler is avoided by adopting membrane wall construction which is a costly process and generally adopted only by bigger units.

b) Effective primary, secondary, air systems with controls are provided, to facilitate complete combustion in the hearth zone. Due to high turbulance in Secondary and tertiary zones.

Volatiles are burnt completely and carbon monoxide formation is contained while operating the unit with low excess air.

c) Good insulation is provided to reduce radiation losses.

The following special features are incorporated to facilitate burning Bagasse black liquor :

a) The liquor spray gun is located at a higher level to give higher dwell time for the black liquor droplet from the time it leaves the nozzle and falls on to the furnace hearth. This is to facilitate evaporation of the higher moisture in Black Liquor and to compensate for the lower swelling volume index of bagasse liquor.

b) The Tertiary air ports and screen tubes are located at safe elevation from spray gun to facilitate adopting JMW type of spray system for space firing if required which increases the dwell time further.

c) The wall spray nozzles also can be adopted in this. If ledge formation is not serious this can be adopted profitably in the unit. The dried liquor mass only will fall into hearth and hearth will not be influenced by low concentration liquor. Furnace stability will be better.

d) Spray nozzles similar to that of combustion Engineering system also are provided. With due field trails what is best for the unit may be adopted advantageously.

e) Restricted quantities of air at high velocity is fed through primary air ports. This allows proper maintenance of char bed level for stabilizing furnace operations.

f) The thick liquor to furnace is provided with indirect and direct heating arrangement to maintain required temperature and thereby regulating the viscosity for proper atomisation.

To maintain Autogenous combustion :

1. Wet liquor incidence into hearth is greatly reduced. by locating the Spray gun at a higher level and facilitating varieties of spray nozzles as detailed above.

2. Hot air at 150° C. is fed in to furnace to give stability to combustion.

3. Properly designed primary air ports are provided to maintain a good char bed which acts as a buffer and allows stable operation of furnace.

4. To avoid cooling of bed, refractory surface is provided in the furnace up to spray gun level over the water walls of the furnace.

The thick liquor storage tank is designed to add salt cake in case the client wishes to convert the system from soda to kraft process, to reduce viscosity of the liquor and to have better operational results.

Problems peculiar to smaller units :

The coefficient of heat emissivity, the coefficient of heat absorption in the furnace zone of small uuits is not same as in the bigger units. Generally bigger cross sections, higher volume in furnace are provided. With increased furnace volume and furnace surface the heat absorption to heat input ratio becomes higher in smaller unit compared with bigger units, creating conditions for BLACKOUT unless supported by supplementary fuel. To counter it; the furnace is to be completely covered with Rafractory. Conventional Bailey studs on water walls are not effective since it conducts away some heat.

If the fouling gets reduced as a result of providing generous cross section of furnace and platen screen tubes, the heat absorption in the tower portion of furnace and convection zones can improve. This reduces the gas temperature at the outlet of the boiler. If the flue gas temperature entering direct contact evaporator falls, the concentration of Black Liquor gets affected which in turn causes instability in the furnace.

Hence innovative devices are to be considered such as blanking off of some portion of convection zone providing by passes to the convection zone and delivering hot flue gases from furnace into the direct contact evaporator, if required during operation to be planned and provided in the designs and the same has been done.

There are many more such considerations :

With these additional features the cost of a smaller unit becomes prohibitively high. Whereas, costs are to be contained as otherwise small mills cannot afford to have such Recovery unit.

Safety of Boilers :

The pressure parts are very carefully designed and good safety factors are adopted. Seamless Tubes only are used in the construction. All weld joints in the furnace are subjected to 100% X-ray tests even though the code does not specify so ;

The boiler is manufactured in a well equipped workshop under careful supervision and inspection.

Emergency Blow down system is provided in the Recovery Boiler to contain the hazards of explosion. This is in line with BLRBAC recommendations Such a system is absent in many Recovery Boilers in operation.

Other Points to mention :

Self cleaning type impellers are provided for ID fans to avoid unbalancing.

Availability of experienced hands is essential :

Many likely problems may be predicted in advance by the experienced personnel and corrective measures can be incorporated during design stage itself. Such a step will reduce the problems to be encountered while in operation. Inspite of this, still some spill over problems peculiar with each unit should be expected. Such problems as they come to surface should be diagonised and corrective measures taken without delay.

This needs ready availability of personnel having knowledge, experience and skills in operation. Maintenance, trouble shooting, designing, innovating, manufacturing. If any one of these skills lag, the solution gets delayed and the unit may suffer.

Shortly the Satpuda unit will be in operation and the out come of these considerations can be known paving way for more Recovery units in small sector.

**ANNEXURE-1

Brief Information of Recovery System Being Supplied to Satpuda Paper Mills

Evaporators :

— LTV Type with five effects with two forced circulation evaporators one as a stand by.
— Inlet concentration 9.5% and out let 45% solids.
— Water evaporation 27.5 Tonnes per Hour.
— Heating surfaces provided are :

245, 245, 295, 295, 295 and 2×65 squre meters respectively for multiple effects and forced circulation evaporators.

— Steam economy guaranteed after considering Radiation and Venting losses is +3.84.

Recovery Boiler :

— Dry BLS to be fired per day —65 Tonnes.
— Operating pressure and temperature 20 Kgs/Sq. Cm and at 199 deg. C.
— Steam generation about 7.5 Tonnes per hour.
— Furnace cross section :

Without Refractory	—2 54 m × 2.34 m
With Refractory	—2.3 m × 2.1 m (Apporox.)

— Levels : Ground level as base :

Bottom of hearth	— 5.25 m
Spout	— 5.47 m
Primary air ports	— 6.65 m
Secondary air ports	— 7.6 m
Burner	— 7.17 m
Spray Gun	—10.3 m
Tertiary air	—13.3 m
Screen tubes lower most level	—15.11 m
Water Drum	—18.97 m
Steam Drum	—24.47 m
Roof Level	—28.25 m

— Type of furnace —Decanting
— Type of construction : Membrane walls with Replaceable Refractory Blocks in the furnace Zone upto spray gun level.
— No. of Screen Tube Rows. : 22 × 4 Rows.
— No. of Boiler bank tubes : 22 × 24 Row
— Spacing of Boiler bank tubes at entry of flue gas. : 246
— Spacing of the Boiler Bank tubes at the rear side : 123

Superheater	—	Not Provided.
Economiser	—	Not Provided.
Direct contact evaporator	—	Cyclone evaporator.
Secondary Recovery	—	Venturi scrubber.

Causticisers :

Capacity : 130 Cu.M per day white liquor at 100 gpl TTA as NaOH.
Lime purity : 60% Cao

Slaker size	—1.6 m dia × 6 85 m long	—1 No.
Rake classifier	—1.2 m wide 6.1 m long	—1 No.
Causticisers	—1.8 m dia × 2.1 m height	—3 Nos.
White liquor clarifier	—9.2 m dia × 4.3 m height	
Primary mud washer	—9.2 m dia × 4.3 m height	
Secondary mud washer	—9 2 m dia × 4 3 m height	
Vacuum filter	—1.83 m dia × 1.22 m long	
Vacuum pump	—1140 Cu.M per hour	