Chemical Recovery Boilers for Pulp Mills using Agricultural Residues as Raw Materials

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SUMMARY

After tracing reasons why agricultural raw materials which are important substitutes to wood and bamboo, have not become main source of raw materials for paper and pulp industry as yet, special operational features required to be taken into consideration are described. They show that Modern Babcock-Tomlinson type recovery boiler is quite suitable for handling black liquor solids from agricultural raw materials. This fact and familiarity of Indian technical personnel with Babcock Tomlinson units hold a promise which will give flexibility to existing paper mill operation and pave a way to rapid expansion of industry.

Low cost chemical recovery boiler suitable for small mills is described. It is essentially a smaller version of Modern Recovery Furnace with venturi scrubber evaporator handling low concentration incoming solids. These features and omission of boiler bank save capital cost of evaporator plants and boiler without compromising on chemical recovery.

INTRODUCTION

Need for speedy adoption of agricultural raw materials arises out of task of meeting domestic demand of 15 million tonnes/year (Mt/y) of forest raw materials and secondary fibres for paper and pulp production by year 2000 from present supply level of 5.25 Mt/y to increase paper and board production at a modest rate of 5·6% per year to 4.25 Mt/y from present level of 1.5 Mt/y.

The two most important factors which would enable us to adopt quickly to the growing need of using agricultural residues as raw materials for paper and pulp making and which would enable us to embark upon rapid expansion of pulp and paper industry without undue worries about the supply of raw materials are the facts (1) that presently installed modern Babcock-Tomlinson chemical recovery boilers (without or with only minor additional features) can efficiently burn black liquor solids from agricultural raw materials and (2) that a large number of Indian technical personnel are thoroughly familiar with such units.

In what follows we would first overview the situation as at present and likely to be encountered in coming two decades and then our attention to description of special features in some details to increase familiarity with problem on hand which will help to dispel undue fears about the agricultural raw materials. This will be followed by brief description of large and small capacity recovery boilers suitable for agricultural raw materials.

I would consider our endeavours in taking part in this seminar fruitful if you take home the thoughts—

(1) that chemical recovery unit required for agricultural residue usage is essentially same as a modern Babcock-Tomlinson unit handling kraft process liquor from wood and bamboo,

(2) that we have in India well developed capabilities of designing and supplying recovery boilers to meet needs of large mills and low

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capital cost units' needed by small mills, using agricultural residues, that may come up in the vicinity of existing/new sugar mills,

(3) that coal can effectively replace bagasse and similar agricultural residues and coal fired units are available indigenously.

PRESENT AND FUTURE PROSPECTS OF AGRICULTURAL RESIDUE USAGE IN INDIA

One is tempted to ask as to why have agricultural residues not become main source of raw materials inspite of their apparent abundance and suitability and year after year discussions at various IPPTA Seminars urging their use.

Large paper mills (of over 20,000 t/year capacity) representing over 70% of installed capacity have process machinery suitable for bamboo and wood. Such mills have to some extent established ties, hold and long term assurance of supply of bamboo and wood from forests under various State Governments. Their commercial and technical personnel are familiar with procurement and processing problems of these conventional raw materials and are likely to look upon them as known devils rather than unknown ones. There is a good chance of improving very dismal productivity of forestry section occupying over 75 million hectares of land (almost 24% of total land in India) by planting fast growing trees and other modern methods not needing large funds. Marginal improvements have averted and can avert serious raw material crisis and under utilization of capacity. Such large mills are also looking into the possibility of introducing high pulp yield hardwood based processes inspite of their requiring considerable changes to the process equipment. All these factors have prevented agricultural residues from becoming most important source of raw materials for existing mills and for those which are likely to be commissioned in coming 3-4 years.

Although technical suitability of agricultural residues is already proved, the factors those come in the way of their use (1) less dependability of supply due to rain based agriculture, (2) high cost of transport due to their bulky nature and (3) likely deterioration in storage in absence of organised large scale bailing facility.

Straw has numerous alternative uses. It is used as cattle fodder, hut roofing material and domestic fuel in rural areas. Straw producers are very small, scattered and unorganised farm units. This increases uncertainty of its availability.

Sugar mills in India producing bagasse are relatively small. A typical 1250 TPD seasonal cane crushing mill can only support 9000 TPY paper production necessitating a moderately sized 50,000 TPY mill to depend on 5 or 6 such sugar mills. Workable model contracts binding such sugar mills to provide assured raw material to a paper mill undertaking large investment will have to be developed. Equally vigorous efforts will have to be made to provide such sugar mills with assured coal supply and coalfired boilers. In absence of such an arrangement, large hydraulic press bailing and storage units owned by Vendors operating in free market and who could meet fluctuations of supply and demand at a small price have to be developed and nurtured.

Small pulp mills set up under a common management of 'sugar and pulp mill' is yet another possible alternative economic vehicle. Smaller paper mill units have a bigger steak in undertaking use of agricultural residues.

ADVANTAGES OF USE OF AGRICULTURAL RESIDUES

The main advantages would be those of (1) removing short and long term raw material constraints on realising fuller utilization of paper mills and on rapid expansion of pulp and paper industry and (2) adding flexibility in operation due to insignificant process equipment changes to the existing equipment.

Special considerations given while designing chemical recovery boilers and associated auxiliary equipment for large mills.

(1) CYCLONE EVAPORATOR/VENTURI SCRUBBER—CYCLONE SEPARATOR SYSTEM: Due to high viscosity of B.L. and a sociated pumping problem an endeavour is made to keep B.L. concentration at the outlet of direct contact evaporators on lower side (say 60-61% level rather than attempting to concentrate liquor to 63-64% as with standard Kraft liquors). This design philosophy stems from our belief that it is preferable to fire the recovery furnace at slightly lower but consistant concentration commensurate with figures mentioned above rather than attempting very high concentrations to start with and subjecting the furnace to fluctuations in concentration and B.L. quantity due to clogging/precipitation problem.

We normally provide free alkali injection connections on cyclone evaporator/separator sumps for pH controlling and avoiding precipitation problems.

Where it is possible to obtain 58 to 60% concentration from M.E.E., we do not propose direct contact evaporators.

(2) BLACK LIQUOR PUMPS : While designing B. L. Boilers for agricultural residues we request that customer to properly ascertain viscosity of B.L. at say 90°C, 95°C, 100°C, 105°C and solids concentration 50%, 55%, 60% and 63% so that the designer can use this data to the best advantage of the Customer by choosing proper concentrations at direct contact evaporators outlets and mixing tank outlet and by choosing proper types of pumps and their drive motor power. It may be worth noting that Bagasse/straw liquor pumps can demand 2 to 3 times standard Kraft B.L. pumping power.

(3) MIXING TANK : It is essentially of the same kind as for wood liquor fired boiler. If very viscous liquor is encountered it may become necessary to increase the horse power of Agitator drive motor.

(4) STEAM AIRHEATER : With high silica solids exhibiting somewhat difficult drying character, we normally recommend higher air temperature (nearly 205°C). To provide sufficient differential to keep airheater size and air pressure drop across it at reasonable level we prefer to use steam having saturation temperature of 235°C. 175°C air temperature and 205°C saturation temperatures may be considered as less preferred temperatures.

(5) CHEMICAL RECOVERY BOILERS : We believe that Tomlinson principle of spraying liquor on the wall is the best method to handle Black liquors from agricultural residues concentrated to relatively low percentage solids for reasons mentioned above as it offers extra time for drying and assists in trouble free burning of dried char on the bed without need of auxiliary fuel oil support.

For mills handling agricultural residues, we suggest that customers Engineers should properly evaluate the solids firing rate and resist temptation of specifying inflated solids firing capacity to cover contingencies. This will ensure that unit chosen is not required to run at very low loads. Adverse combination of low load operation, low GCV solids and low concentration require auxiliary fuel firing which otherwise could have been avoided.

Black liquors from agricultural residues from Kraft or NCSC process do not differ much in their burning characteristics from normal hardwood and bamboo liquors, except that they exhibit about 20% lower GCV and burn somewhat slowly. Difficulty due to slow burning rates is partly overcome by lower solid rates.

As compared to normal 1.5 tonnes of black liquor solids per tonne of pulp, bagasse is reported to give 1.1—1.2 tonnes of dry solids per tonne of pulp and wheat straw 1.3—1.4 tonne dry solids per tonne of pulp. These values vary to some extent depending on yield, amount of chemicals used for pulping and on free alkali maintained to avoid encrustration and precipitation problem in multi-effect evaporators and preciptation problems in other B.L. system.

The above factors psimarily affect the steam output expected from the boiler rather than the type of equipment required.

Recovery boiler is essentially of the same type as used with Kraft liquor.

Special extra features with agricultural residues will be to provide oil guns mounted on primary air ports in the side wall near the front wall, so as to assist in smelting down somewhat sluggish flow of smelt resulting from black liquors having high percentage of silica.

To smelt down ledge that can form on the rear wall, we provide ports near the rear wall nose on which oil firing guns can be mounted.

Screen tubes, widely spaced shallow superheater banks and use of retractable soot blowers are necessary to keep the boiler passes and tube surfaces clean.

Horizontal or finned tube economiser is considered unsatisfactory and vertical plain tube mild steel economiser is generally proposed.

Above features are generally incorporated in modern Babcock-Tomlinson boiler for burning Kraft liquor from hardwood cooking and therefore, such units can burn agricultural residue liquors successfully.

(6) RECOVERY BOILERS FOR SODA PROCESS LIQUORS FROM AGRICULTURAL RAW MATERIALS : Due to very different and impervious nature of black liquor char it becomes necessary to burn such liquors in finely atomised state with the help of steam atomisers as in the case of soda liquors obtained from wood cooking. Higher concentrations are attempted with the help of direct contact evaporator.

The hard gritty precipitates which are formed in black liquor with higher percentage of silica when its pH falls, necessitate closer control of pH

and corrective introduction of free alkali. Due to different burning principle adopted, slight excess of free alkali than strictly necessary can be tolerated by recovery unit. However need for using oil support at low load operation should not be ruled out.

SPECIAL SHELTER TYPE DESIGN FOR SMALLER UNITS

As mentioned before, typical sugar mills in India are small in size and have sugarcane crushing capacity of around 1250 tonnes/day and crushing season of 180 days. Assuming that sugar cane contains around 12% bone dry bagasse, depithing process removes 25% of bagasse pith and fines which would have consumed cooking chemicals without any benefit to pulp yield, cooking yield of 50%, screening losses approx. 5%, bleaching loss of 8% and approximately 300 days of pulp mill operation, such a 1250 TPD mill can support

$$1250 \times \frac{180}{300} \times .12(1-.25) \times (1-0.50) \times (1-.08) =$$

29 5 tonnes/day of bleached pulp of 32 T/day of unbleached pulp. Thus such a mill can support around 9000 Tonnes of pulp capacity per year.

For such smaller mills, we have a Babcock-Tomlinson smelter type recovery boilers upto 66 TPD pulp capacity which is especially designed for the low capital costs without compromising on chemical recovery efficiency. It is basically a smaller edition of an efficient larger Kraft type recovery furnace, with costly bi-drum bank and costly retractable sootblowers omitted.

The tubes are generally 63.5mm O/D on 127mm pitch finned so that they do not require bending for rodding ports and primary and secondary air ports.

The liquor is sprayed in the normal manner with the help of oscillating spray gun spraying B.L. on walls in a paint brush action and combustion takes place in primary and secondary zones located in the hearth of the furnace.

Combustion gases at furnace exit are tempered to 480—530°C with either recirculated flue gas or additional cooling air before they enter venturi scrubber evaporator, serving a dual purpose of chemical fume collection and concentration of incoming B.L. Costly ESP used for collecting chemical particles on bigger unit is thus not required.

The unit of this design receives liquor from a comparative very small muiti effect evaporator at approximately 30% solids and thus offers further savings on capital costs. Flue gas concentrates liquor to about 60—62% solids for burning in the furnace.

Mini pulp mills can be very effective in making use of bagasse and similar agricultural raw materials near their source of generation. They can make best use of 'Low capital cost' chemical recovery plant described above. Most effective way for such small users would be to make use of forums like IPPTA to come together, choose and standardise on one or two Black liquor solid burning capacities to enable equipment suppliers to offer pre engineered standardized units in large number at reasonable costs with an added advance of short delivery periods and limited engineering effort on users as well as suppliers side,

Needless to say, we at A-V-B are fully geared to design and supply coal fired boilers as well, that would be required by sugar mills where replacement of bagasse as a fuel by coal is considered and also for such mini pulp mills where additional steam raising capacity will be required to meet steam and power demand.

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