The Classical Approach to Chemical Recovery and Pollution Abatement for a Large Scale Bagasse Based Mill - TNPL allays fears

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ABSTRACT

Most of the large sized bagasse based mills in international scene operate with limited or no chemical recovery and pollution abatement systems due to apprehension regarding technical feasibility and commercial recovery system on account of problems associated with high silica, high viscosity high scaling characteristics of spent liquors from bagasse pulping. Factual data on operating chemical recovery systems for bagasse spent liquors indicates a marked dependency on auxiliary fuel oil/gas support for black liquor burning. Reported levels of overall chemical recovery efficiency have always been low the highest being around 86-87%. Scale formation on black liquor evaporation plant has plagued the chemical recovery operations in the past.

Early development of large scale bagasse based mills in Latin America were mostly located on the coastal lines and hence effluent disposal did not impose constraints requiring detailed applications of pollution control measures. Disposal of pith (both moist as well as wet) until now has been a disposal problem.

This paper explains the measures taken during project planning, design, manufacture and implementation to counter the problems associated with chemical recovery operations of spent black liquors from bagasse pulping to demonstrate the technical and commercial viability of conventional chemical recovery systems with effective pollution control measures to meet the prescribed standards.

Introduction—

TNPL is an integrated Pulp and Paper/Newsprint Mill operating since 1985. The primary raw material to produce pulp is sugar cane bagasse obtained from five nearby sugar mills. The average production output of the mill is 300 tpd newsprint or 240 tpd printing and writing paper with one Bel-Baie II paper machine using 75–85% bagasse pulp in the furnish. The chemical recovery plant is designed to handle 285 tonnes of black liquor solids per day and is in continuous operation.

Planning of the Chemical Recovery Section

During basic planning of the chemical recovery section, the following points were considered :

— Poor drainage characteristics of bagasse pulp which tends to carry more chemicals, hence requiring more water for washing. The weak black liquor from bagasse washing system is consequently dilute (in the order of 6–8% solids) compared to the weak black liquor from the pulping of conventional raw materials (14% solids).

— Weak black liquor from bagasse washing system carries more fibre (200 ppm) due to presence of more fines and this escalates the scaling problems in evaporation plant.

— Silica content in bagasse weak black liquor is high and is in the order of 3–5% on dry basis. However this can be reduced to a minimum by proper bagasse handling prior to pulping.

— Viscosity of bagasse black liquor is considerably higher compared to black liquor from conventional raw materials. Handling such highly viscose liquor is difficult and also increases scaling of evaporator tubes.

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It was with this background, a field study was undertaken by SPB–PC by visiting large size bagasse based mills in Latin American countries to properly plan to counter the problems. Based on the data collected during the field study and discussions with the executives of the operating mills and machinery suppliers, certain features were incorporated during project planning and implementation.

Black Liquor Evaporation Plant

To improve the efficiency of the black liquor evaporation plant, it was considered imperative to have :

— a very effective screening arrangement for weak black liquor prior to evaporation.

— pH of the weak black liquor to be maintained above 10.0 to avoid lignin precipitation in the evaporators.

Black liquor screening is being effectively achieved by using a battery of single deck vibrating screens of Pennwalt make and the pH of the weak black liquor is being maintained by using an automatic caustic dosing instrument control.

The system design for black liquor evaporation plant is incorporated with the following features to suit the practical requirement of a highly scaling liquor but achieving a better steam economy.

— Six effect evaporation system with a standby body for first effect to facilitate descaling.

— Forced circulation unit with two heater bodies (one as stand by) and one common vapour separator unit.

— External pre-heaters were provided to facilitate easy cleaning in vew of the high scaling tendency of bagasse black liquor.

— Two-street installation to have maximum efficiency of operation by running nearly at rated water evaporation capacity and also to facilitate water boiling/cleaning of any one street during low loads.

The weak black liquor evaporation plant is supplied by M/s Larsen & Toubro Limited. The total water evaporation capacity of the plant is 130 t/h with a guaranteed steam economy of 4.96. The weak black liquor is concentrated from 8% solids to 45% solids. Vacuum system is provided with surface condenser and two-stage ejector for regular running plus a starting ejector. The system incorporates an effective entrainment separator at low concentration bodies to limit the alkali loss in combined condensate to 100 ppm. The system is also equipped with a boil-out tank with pumps, piping, valves etc. to boil-out the total system for one/more bodies as and when required.

Chemical Recovery Boiler

During basic planning of the chemical recovery boiler requirements, the following characteristics of the black liquor were considered :

— High viscosity

— Sludge formation

— Poor smelt flow

Detailed discussions were held with the recovery boiler manufacturers and the following features were incorporated in the recovery boiler design to counter the anticipated problems.

Counter measure to High Viscosity

— Black liquor concentration is limited at 65% at the outlet of direct contact evaporator.

— Dilution system by using weak black liquor/dilute caustic is provided at direct contact evaporator to cope with possibls high concentration than designd

— Motors for direct contact evaporator, black liquor pumps and mixing tank agitators are suitably sized for handling high viscosity liquor.

— Block liquor heater is designed to have ample capacity to raise the black liquor temperature upto 125°C

— Steam heating/mixing features are provided in flow boxand mixing tank to raise black liquor temperature to the required levels

— Screw type pumps are provided to fire highly viscous liquor in the furnace

— Enough insulation is provided to all equipment handling black liquor.

Counter measure to Sludge Formation

— Two cascade evaporators each with 70% of MCR capacity are provided to enable periodic water washing of any one at a given time.

— Black liquor circulating pump is provided for cascade evaporators to agitate the liquor inside the evaporators and eliminate dead-spots.

— Steam purge nozzle is provided inside the cascade evaporators to break sludge accumulation.

— Continuous return of black liquor is adopted to avoid stagnation of black liquor pipelines.

Counter measure to Poor Smelt Flow

— By maintaining high char bed temperature smelt is kept sufficiently fluid

— Effective and strong steam shattering system is provided to break viscous smelt

— Inlet of spout cooling water is maintained at 75°C to avoid excessive cooling of smelt.

Also, air pre-heat temperature is raised upto 165°C to improve combustion.

Chemical Recovery Boiler

The chemical recovery boiler is supplied by M/s Mitsubishi Heavy Industries Limited, Japan and is designed to handle 285 tonnes of dry solids per day and produce superheated steam at 44 kg/cm²g, 440°C. The recovery boiler is of conventional design incorporating the above extra features to handle bagasse black liquor.

The boiler in general is provided with

— Black liquor system consisting of a twin cascade evaporator (working in series), flow box, salt cake /ash mixing tank, black liquor heater, black liquor burners etc.

— Smelt and green liquor system consisting of two decanting type spouts, smelt dissolving tank with circulating and transfer pumps.

— Water and steam system consisting of feed water heater, economiser, boiler tank with lower and upper drums, screen tubes, 2 stage superheaters with spray type desuperheater in between etc.

— A well designed completely automatic instrument control system for effective operation of the boiler.

The overall chemical recovery efficiency achieved is consistently upwards of 90% with a very minimum oil consumption of approximately 500–1000 litres per month for operation without stoppage. If a shut and restart is envisaged, the consumption is around 7/8 kl which is additional.

The unit is coupled with a twin chamber Electrostatic Precipitator supplied by M/s Bharat Heavy Electricals Limited, which is operating with a collected efficiency at upwards of 98%.

Recausticizing

The recausticizing plant is a conventional one consisting of rotary drum slaker, causticizers, clarifier, 3-stage mud washing system aud a pre-coat filter. The layout of the plant is designed to accommodate a rotary lime kiln at a later date. For the time being, the plant is operating with purchased lime.

Effluent Treatment Plant

During basic planning of the effluent treatment plant, the following points were considered :

— Liquid Waste Treatment :

* High silica/grits/foreign materials in the drain from bagasse handling and washing

* pH control neutralising the acidic effluent from bagasse washing.

* High solids load, BOD, COD when compared to conventional pulp and paper mill effluents.

Detailed discussions were held with the equipment manufacturers and the following features were incorporated in the system design to counter the anticipated problems.

— Effective grit removal station prior to the primary clarifier to reduce the load on the primary clarifier mechanism and also to remove the over-size contraries which will facilitate smooth operation of the primary clarifier under flow pumps.

— pH correction station with milk of lime dosing to raise the pH above 7 whenever required.

— Heavy duty clarifier mechanism to handle the higher solids load.

The effluent treatment plant is supplied by M/s. Hindustan Dorr-Oliver Limited and consists of a pH control station, degriting detritor, primary clarifier, belt filters with accessories, floating surface aerators followed by a polishing pond.

As a tightening-up measure, dump/collection pits have been provided for recycling/recovery of chemical spills, particularly the black liquor spills, boil-outs and wash-outs. Avoidance of high/erratic colour levels and a proportionate reduction in BOD/COD levels is thus ensured A comprehensive programme to evaluate the possible use of bio-technics for effluent colour removal is underway and the progress so far has shown promise.

Solid Waste Treatment

— Pith from the bagasse depithing station and the wet cleaning stages generally consitutes, in a bagasse mill, a major solid disposal problem. In the past, pith fired boilers have been tried with limited success and requiring the usage of prohibitive quantities of furnace oil. Project planning for TNPL therefore dictated adoption of new routes. A comprehensive survey of the state-of-art and a few pilot-plant trials established beyond reasonable doubt that a multi-fuel boiler could be designed capable of handling pith and solid combustible wastes besides a variety of solid fuels like high ash coals, carbonised lignite (leco), raw lignite, coke etc. The multifuel capability also reduces TNPL's dependency on long lead procurement and movement of coal from up-country pit heads.

The multifuel boilers have been supplied by M/s Fives Cail Babcock of France and the performance of its multifuel capability has been convincingly demonstarted.

— Lime mud from recausticizing plant is being consumed by nearby cement factories for their use in their process.

— The effluent sludge coming out of the belt filters is being lifted by local people for its fuel value. Should, however, at some later point in time, disposal of effluent sludge pose any problems, the same can be effectively burnt in the multifuel boiler after open-yard drying. Boiler ash is also being lifted by local people for some use.
Hence the mill does not face any solid disposal problem.

Flue Gas Emission Treatment

— The flue gas emission from recovery boiler is effectively controlled by the electrostatic precipitator.

— The flue gas emission from multifuel power boilers is controlled by multiple cyclones and by baffle dust collector. The total quantum of particulate emission further stands reduced since the multifuel boilers generally operate with coal in admixture with raw lignite and pith which are both extremely low-ash fuels.