What We Look in a New Chemical Recovery Boiler

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SUMMARY

The Chemical Recovery unit at West Coast Paper Mills had faced a variety of problems specially with the recovery boiler. This article deals with the summary of problems faced and suggests the points to be kept in view while planning and ordering a new recovery boiler.

INTRODUCTION

The importance of Chemical Recovery unit in a integrated pulp and paper mill is well known to every body from the economical as well as pollution control point of view. The needs of the Chemical Recovery unit in an integrated pulp and paper industry are many, complex and ever growing in nature. In the past much importance was not given to recovery boiler as a steam (power) generating unit, as it was felt that the prime function of the recovery boiler was to recover chemicals and steam generation was incidental or secondary function, but in recent years, due to shortage of electric energy in many parts of the world, it has become necessary to design recovery boilers for maximum thermal efficiency with minimum down time like any other power boilers. So now-a-days recovery unit can be considered as a back bone of any modern pulp and paper mill.

During the start up of the mill, the recovery unit was running with more or less at its rated capacity, but slowly as the paper production increased higher and higher, recovery boiler was correspondingly overloaded, resulting in variety of problems. In the year 1972-73 when the crash programme was implemented in the mill, to augment capacity in the recovery unit as a stop-gap arrangement, smelter units were installed. But because of lower chemical and thermal efficiency of the smelters the mill is currently planning for a suitable higher capacity chemical recovery boiler which can take care of the present production and small increases of production in next five years.

The design condition of the recovery boiler should be such as to operate the same with maximum efficiency (chemical as well as thermal) even at the load of 75% of the rated capacity and also at 20-25% overload condition.

The second recovery boiler should also take care of existing pollution control problems keeping in view the local and Central Government pollution control regulations. This system should also eliminate foul gases, hazardous dust and vapours from the stack gases. This is essential because of the social responsibility of the industry towards the community and country as a whole.

BLACK LIQUOR COMBUSTION PROBLEMS

In the present recovery boiler there used to be constant problems because furnace was always unstable due to low calorific value of bamboo black liquor solids, because the boiler was designed for higher calorific value softwood black liquor solids of 6600 BTU/lb, and also due to dilution of firing liquor by taking white liquor in direct contact evaporator for increasing active alkali content of black liquor to avoid lignin separation. New recovery boiler should be designed on the ultimate analysis of black liquor solids of the mill so that sustained combustion will be maintained to keep the furnace stable. The furnace chamber should have a proper design to accommodate the changes in the calorific value of black liquor solids due to the processing of different types of pulping raw materials used from time to time.

PROBLEM OF "LEDGE OR HONEYCOMB" FORMATION

There used to be smelt ledge formation on the rear wall of the furnace and these hard deposits were so much increasing that after 4 to 5 days run only these formations were obstructing the liquor spray and creating unstable furnace operation. After so many trials and errors this problem could be reduced to some extent. So we expect that the new boiler designers should take care of this aspect to avoid this.

PROBLEMS OF "SMELT HOLD UPS" IN THE FURNACE

Freezing of smelt near smelt spout was a very common feature. There used to be heavy accumulation of smelt in furnace near all primary air ports

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and sometimes smelt used to enter primary wind boxes also. Due to smelt accumulation burning at ports was not good and primary air ports used to get blocked due to smelt coating. After putting two smelt spouts this problem is solved in the present furnace. In new recovery boiler manufacturer should keep this point in view.

FOULING OF BOILER PASSES

Due to unstable condition of furnace, supplimentary fuel was used most of the time, for increasing furnace temperature and this supplimentary fuel along with overloading of furnace has increased fouling of screen tubes, nose baffle area and superheater passages due to sublimation of sodium chemicals and carried over material because of narrow spacings of superheater tubes.

Unlike our present boiler, new boiler should have sufficiently large furnace chamber to cool down the gases before they enter screen tubes and superheater tubes. The fusion temperature of condensing fumes and salt cake carry over from the furnace varies from 1350°F to 1500°F (732°C to 871°C), depending on the eutectic mixture of chemical ash. The superheater must operate in a fusion temperature transition zone where deposits are sure to form. The design arrangement of super heater surface must consider operation over a wide range of flue gas temperature and ash condition (Ref. IPPTA Jan.-Feb. & March 1975, Volume XII, No. 1). So to keep up these conditions in any new boiler properly spaced screen tubes, super heater (panel type screens and super heater) and boiler passes to avoid accumulation and build up of chemical dust which can be easily dislodged by a system of soot blowers.

PROBLEMS FACED WITH "REFRACTORY BAFFLE" IN THE FURNACE

In the earlier designs of Tomlinson boilers, there are refractory baffles which are getting damaged very frequently resulting in unplanned shut downs for repairs affecting the whole mill production programme. To avoid this concrete refractory baffle in a new recovery boiler is a must.

SMELT LEAKAGES FROM FURNACE HEARTH AND LEAKAGES OF GASES FROM BOILER CASING

Due to overloading of boiler and sometimes due to misalignment of furnace health tubes, there used to be frequent smelt leakages from furnace hearth which required freezing of smelt by taking boiler off range. To avoid this trouble of smelt and flue gas leakages from furnace and boiler sing, new boiler should have properly designed membrane wall construction to get maximum thermal efficiency.

DESIGN OF LIQUOR SPRAY GUN MECHANISM

Liquor firing gun in the present boiler is connected by high pressure, high temperature rubber hose pipe from the main liquor header to keep the flexibility for the free movement of spray gun on the saddle but there are too many interruptions in liquor firing due to either puncturing or bursting of the rubber hose pipes which may sometimes lead to serious accidents and spraying of liquor in the boiler walls and other places. In addition to these troubles, hose pipes are quite costly and increases operation cost. To avoid all these things new recovery boilers must be provided with hoseless sturdy type spray gun mechanism.

BOILER ASH COLLECTION SYSTEM

The earlier Chemical Recovery boilers are provided with wet bottom ash hoppers where water was circulated in the hopper and after obtaining desired concentration this circulated ash dissolved water was slowly dozed to direct contact evaporator and thus diluting the firing liquor so new boiler should have hoppers where dry ash can be collected and with suitably designed conveying system ash can be transferred to salt cake mixing tank.

THE SECONDARY RECOVERY SYSTEM

Another two more places from where firing liquor gets diluted are direct steam injection firing liquor heaters and Venturi scrubbers. This direct injection of steam in firing liquor can be avoided by using steam jacketed salt cake mixing vessles and indirect liquor heaters. Even smallest amount of water addition in firing liquor affects the thermal efficiency of boiler so as far as possible we should try to avoid any dilution of firing liquor. Second source of dilution is the brine solution collected from Venturi scrubber from secondary recovery of chemicals from flue gases, which is constantly mixed with the liquor at direct contact evaporator.

To avoid all this equipment needed for secondary recovery system should include a well designed Electrostatic precipitator (dry bottom type) in order to have maximum chemical recovery efficiency, to the extent of 98–99%. The venturi scribber system is bound to be less efficient (about 75%) and consumes more power per tonne of chemical recovered. Though the initial cost of Venturi Scrubber is low but running cost is high whereas in electrostatic precipitator initial investement is very high but day to day operation cost is lower due to less power consumption and high chemical collection efficiency which can meet demands of tomorrow's more stringent air pollution codes. This electrostatic precipitator should also include a well designed conveying system for conveying salt cake dust to salt cake mixing vessel.

THERMAL EFFICIENCY OF THE BOILER WITH RELATION TO THE DIRECT CONTACT LIQUOR EVAPORATORS

Direct contact evaporators attached to the earlier designed boilers are one of the biggest source of air pollution hence as far as possible black liquor

should be concentrated in the multiple effect evaporators up to 65% total solids (using forced circulation system) suitable for directly firing into recovery boilers for getting maximum thermal efficiency. But in cases where varieties of pulping raw materials are used and it is not possible to concentrate black liquor to 65% total solids in multiple effect evaporator than direct contact evaporators like cascade or cyclone evaporator should be of air contact type. In this air contact type system, hot air is used for evaporation of liquor in the cascade and this air after evaporation is blown into the recovery furnace for combustion purposes. Small amount of gases that separate out from black liquor are completely burnt in the furnace and hence its complete combustion avoids air pollution.

DESIGN OF BOILER TUBES FOR CONNECTION WITH HEADERS AND DRUMS

In old boilers there are unscheduled shut downs due to leakages of water from tubes from the expansion joints either at the drums or headers whenever undue stress and strains are given to boiler while boiler cleaning. This type of shut downs can be avoided in new boilers if tubes are provided with welded construction wherever they are connected to drums and headers.

EMERGENCY WATER DRAIN SYSTEM (IN COMPLIANCE WITH BLRBAC)

From the safety point of view, boiler should be provided with the emergency water draining system with automatic controls to desired level to protect the pressure parts in case of any water leakage from pressure parts where water can enter the furnace to avoid explosion due to smelt water reaction.

CRITICAL EQUIPMENTS OF RECOVERY BOILER

Many a times there are troubles due to induced draft fan vibrations where chemical dust is deposited in closed impeller fans and to avoid this type of troubles induced draft fans must be designed with radial blades instead of curved ones and automatic washing arrangement should be provided on induced draft fans.

Some critical equipments like induced draft fan, forced draft fan, liquor spray pumps, fuel oil pump, dissolver green liquor extraction pump, boiler feed water pump etc. must be provided in duplicate in order to ensure continnous running of boiler unit.

CONTROL OF SUPER HEATER STEAM TEMPERATURE

Recovery boilers are always operated at varying loads depending on the mills production programme and black liquor solids available from different pulping raw materials available. In such conditions, it is very difficult to control the outlet temperature of steam from super heater. To avoid this problem, new recovery boiler must be provided with an atemperator for proper control of super heater steam temperature with automatic controls.

SOOT BLOWING SYSTEM

Boiler availability should be throughout the year and that can be kept up by properly designed and adequate number of soot blower system with sequencial control panel which will dislodge all the chemical deposits as and when formed from time to time.

DEMISTER FOR DISSOLVER VENT

From dissolver vent gases chemical fumes and dust can be arrested by installing a properly designed demister system with proper by-pass arrangement.

AUXILIARY FUEL BURNERS AND IGNITION SYSTEM

The burner system should be arranged to produce a heat that will satisfy the special requirement of the auxiliary fuel system on a black liquor recovery boiler. The ignition system shall be properly sized and arranged to positively and smoothly ignite the auxiliary fuel. Each burner shall be provided with an integrally moulded ignitor utilising a spark of similar device that is automatically energised with the admission of fuel to the ignitors. The ignitor and its control equipment shall be designed for its environment with convenient access for maintenance.

SAFETY AND FIRE PROTECTION SYSTEM

In Recovery boilers there should be a fire protection system in case exit temperature at either evaporators or precipitators should rise to 100°F above design temperature at rated capacity the fire protection system shall be automatically activated and alarmed. If the temperature continues to rise to 200°F above design, the protective system shall operate. The fire protection system shall be designed so that once it is activated it will remain in service until reset manually.

INSTRUMENTATION AND CONTROLS

Now all the new modern recovery boilers must have all latest instruments and controls like automatic boiler feed water controller, boiler drum level indicator and recorder, automatic furnace draught controller, magnetic flow meter with injector for black liquor firing, green liquor and black liquor density and level controls, firing liquor temperature controller, automatic proportional ratio controller for primary and secondary air control with total air flow, steam flow meter with indicator and integrator automatic air control for liquor and air ratio etc.