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Case Study: Increasing Recovery Boiler Power Output by introducing MP Soot Blowing

ABSRACT

Kraft Pulp Mills generate huge amounts of organic as well as inorganic effluents from its washing section which poses a very big challenge to treat them to eliminate pollution load. Since the organics are having huge amount of heat value in them, this allowed us to explore the possibility of getting energy from it by processing it through the Soda Recovery Plant from ages. As many of the processes this process also went on lots of changes starting from its earlier days and reached a stage where the 50 to 55% of the energy requirement of the Kraft Pulp and Paper Mill is met through this route.

Due to the change in lifestyle and huge industrialization, the energy need as well as cost, never seen a downtrend and increasing day by day. Human always innovates new ways to meet this challenge through improving the efficiency of equipment and processes. Our process is also not an exception. One such initiative done by ITC PSPD is described in this paper.

Introduction

Kraft pulp mills use white liquor which is a combination of Sodium Hydroxide, Sodium Sulfide and Sodium Carbonate to remove the lignin from wood by cooking it in digesters. After cooking the pulp is washed with hot water to remove the dissolved lignin along with the chemicals used in the cooking process. In this process around 48-50% of the wood is recovered as pulp and sent for further processes to make various grades of paper. The remaining 50–52% wood dissolved in chemical is sent to the Soda Recovery Plant to recover the chemicals back for next batch of cooking and generating green energy from the organics by burning it in a boiler.

Soda Recovery Plant consists of four stages of operation namely Evaporation of Weak Black Liquor, Burning of Heavy Black Liquor, Causticizing to get white liquor and Lime Mud re burning to get lime for Causticizing.

Weak Black Liquor of 16-18% solids is concentrated in the multiple Evaporator to +70% solids. The heavy Black Liquor is then burned in a Recovery Boiler which is designed specially to handle a fuel having very high moisture (30%). The organics are burned in the water cooled furnace and the inorganics melted is drawn from the bottom of the furnace through special spouts. This is dissolved in weak Wash liquor from the Causticizing plant mud washing section to form Green Liquor which is treated with burnt Lime (Cao) to get the white liquor.

The organics burned in the furnace, release lots of energy which is absorbed by the water circulated inside the boiler furnace tubes to produce High Pressure steam which is sent to Turbines for power generation.

The flue gas generated from the recovery boiler furnace also carries some chemical fumes which re precipitates on the heat transfer surfaces of the boiler in various locations like Super Heaters, Generating Bank and Economizers. This reduces the heat transfer efficiency of the boiler in turn increases the losses.

Also the sticky nature of this fumes, plugging of the flue gas passage also happens which will bring the boiler to a standstill after some period of time if these deposits are not removed periodically.

So to avoid the plugging and unforeseen outages of the boiler, traditionally the HP Steam produced from the boiler is used after reduction of pressure through a pressure control valve to about 25 kg/cm², and used to blow out the deposits which we call soot blowing. This amounts to about 3-5% of the steam generated from any Recovery Boiler. Since the high pressure steam is reduced to Medium Pressure there is a huge loss of energy in this operation.

ITC has implemented a new technology called Medium Pressure Soot Blowing which uses the steam at 11.5 kg/cm² from the turbine extraction to gain the power generation from the HP steam to MP steam without affecting the cleaning efficiency, and to improve the overall power generation efficiency of the Recovery Boiler.

Soot Blowing System In Recovery Boilers

In ITC at its Bhadrachalam unit, three Recovery Boilers are there with 625,950 and 400 TPD dry solids firing capacities. The 625 TPD boiler uses the final HP steam after tertiary super heaters outlet to soot blowers with a pressure reducing valve to reduce the pressure from 64 kg/cm² to 25 kg/cm² and de super heater to reduce the temperature from 460°C to 320°C. The other two boilers use the primary super heater outlet steam reduced to a pressure of 25 kg/cm² from 64 kg/cm². Here there is no de superheating applied as the temperature of steam after reduction of pressure is 330°C.

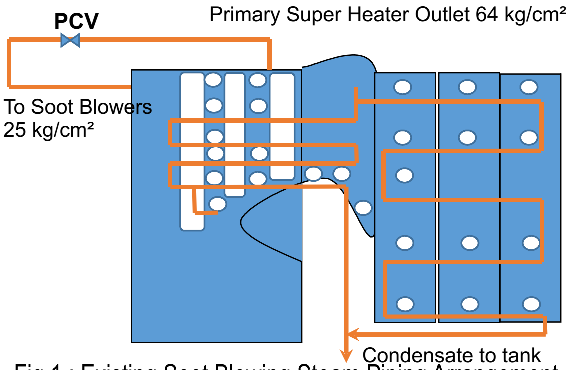


Fig.1 : Existing Soot Blowing Steam Piping Arrangement

We found an opportunity in this system to reduce the losses of power due to reduction of pressure where we are losing lots of energy. We came across a technology available with Clyde Burgmenn, USA. We consulted them for a suitable solution where they are the experts in this area. They came up with the application of Low Pressure (12 kg/cm²) Soot Blowing.

Challenges And Solutions

There were some challenges before us since the High pressure soot blowing system is well established and effective since decades. Mainly the Indian Black Liquor is very different from other European and American Black liquor. Following challenges were before us to do any upgradations…

1. Higher chlorides content in Black Liquor and sticky nature of dust.
2. Effectiveness of MP Sootblowing on Hard depositions and runnability of boilers.
3. If the effort fails we cannot revert back as it is a permanent change.
4. Availability of Medium Pressure Steam at that pressure.
5. Implementation constraints like long boiler shutdowns.

We put all our concerns to the supplier and worked with them closely to overcome these concerns one by one with minimal risk.

Our chlorides content in the ESP ash varies between 8 to 10% as chlorides. Clyde Burgemann was confident that this can be dealt with their specially designed nozzle. They also suggested a software called "SMART CLEAN" which uses a thermodynamic module of heat transfer efficiencies in different zones. This enables them to do soot blowing at required locations at appropriate timing before the deposits gets hardened on the tube surface. Also this will help us in optimizing the steam consumption than before where we do sootblowing on a pre determined interval of time. This will improve the runnability of the boiler atleast by 2 months than now. (From 6 months between water wash to 8 months between water wash).

The PIP (Peak Impact Pressure) of the steam jet will be slightly lesser than high pressure soot blowing. But the force acted on the deposits will be maintained high by increasing the impact area by designing the nozzle with a wider angle. The density increase in MP steam because it is just maintained at its saturation temperature also gives some added advantages for deposit removal.

To avoid risk of failure we have decided to implement this new technology in one of the boilers rather than implementing in all the three boilers. So we have moved forward with a boiler which is having comparatively less runnability between water wash.

Our turbines extraction MP steam pressure at our header is 10.2 kg/cm² only. To increase this pressure to 12 kg/cm² as required by the technology, we have proposed a thermo compressor to boost the pressure. This will use the HP Steam at 64 kg/cm² as motive. The motive will be about 20% of the total steam consumption in the soot blowers.

After all these solutions, the implementation of this technology posed a very big challenge since 50% of the hardware of our existing soot blowers are to be replaced with new. This will take around 16 hrs per blower and we are having 29 blowers in this boiler. Also the steam line sizing was changed from 80 NB to 150 NB to meet the flow requirement at reduced pressure. This is overcome by strategically following the sequence of operations…

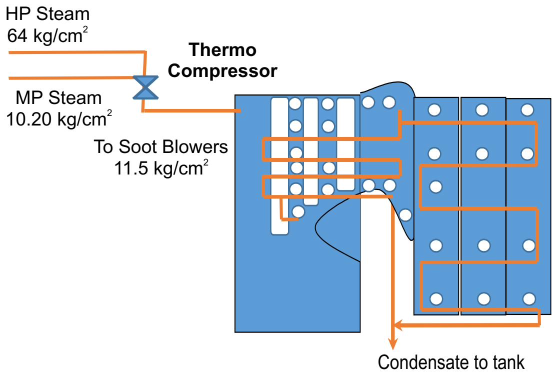


Fig.2 : Soot Blowing Steam Piping Arrangement after modification

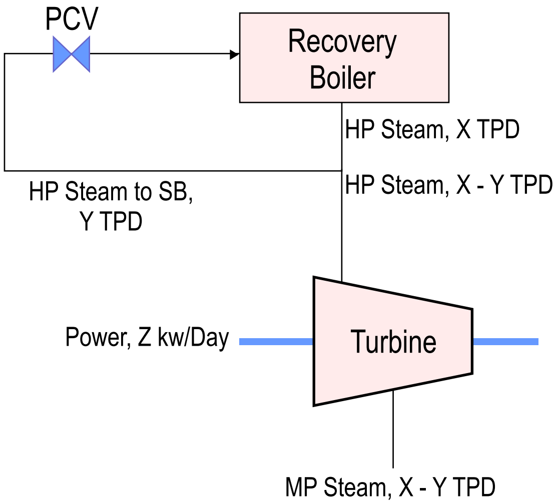
a. Laying the new steam line of 150 NB size parallel to the existing line.
b. Replacing of the parts of soot blower one per day along with the steam line connections.
c. Suitably modifying the DCS logics for the soot blowing system.
d. After conversion of all the blowers, changeover of total logics to the new software through DCS.

This has enabled us the very smooth transition from the existing system to the new system within a month and half time period. We have streamlined the MP soot blowers after totally commissioned in the month of Nov 2014. Our supplier is now studying the system through online data transfer, after which they will implement the SMART CLEAN software in the month of Jan 15 or Feb 15.

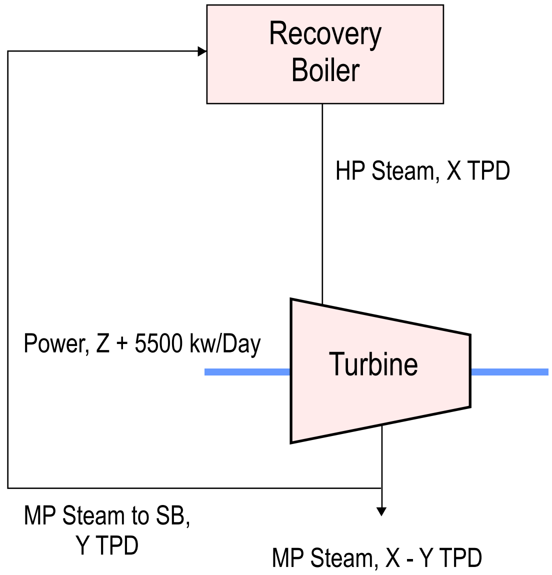
Results and Conclusions

Around 85 TPD of HP steam was being used for soot blowing in this boiler which is reduced to 10 TPD. Conversion of 1 Ton HP steam to MP in turbines produces a power of 80 kw. So we gained a power benefit of around 5500 kw per day.

Since two months we are operating this MP soot blowing system and we do not find any disadvantage over the existing system. After the SMART CLEAN software is implemented we will be gaining some more power by reduction in MP steam consumption as the software will optimize the number of soot blowers operated in a day.



HP Soot Blowing with PCV



MP Soot Blowing with Turbine Exraction

Acknowledgment

1. ITC PSPD, Bhadrachalam management for the opportunity given to present this case study.

References

1. Manual of Clyde Burgmenn, USA on Sootblowing Technolgy