DECARBONIZATION THROUGH HYBRID BIOMASS DRYER WITH WESP – ENVIRO-FRIENDLY ENERGY SOLUTION FOR CAPTIVE POWER PLANTS

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INTRODUCTION

The need to comply with the Ministry of Environment, Forest, and Climate Change (MoEFCC) Gazette notification for ensuring pollutant emissions through CPP Boiler stack within the prescribed limits had led the industries to go in for advanced state of the art Air pollution Control (APC) technologies. Existing ESPs are not able to ensure the notified SPM in the flue gas stack to < 30 mg/Nm3. Apart from space being a constraint for add-on fields, preponderant micronic particulate fines in flue gas makes it difficult to contain SPM in discharge gas to < 30 mg/Nm3.

Innovators in India have successfully developed a Hybrid high moisture Flash Biomass dryer with Wet ESP (WESP) for ensuring a cleaner stack integrated with low-grade heat recovery.

PATENTED INNOVATION SCHEME

All Captive Cogeneration Power plants in Sugar mills invariably have ESP or Wet scrubber or Bag filter at the back end of the boiler to contain particulate emission from the flue gas discharge to stack within 150 mg/Nm3. With the stringent act from MoEFCC to limit the SPM in flue gas through the stack at 50 mg/Nm3, one of the innovators has successfully developed a Hybrid high moisture Flash Biomass dryer (FDB) with Wet ESP (WESP) for ensuring cleaner stack integrated with low - grade heat recovery. It has addressed all the **3Es** in one -**E**nergy Conservation, Cleaner **E**nvironment as well as **E**mission Reduction offset.

PATENTED HYBRID FDB -WESP IN BRIEF

Innovative Hybrid Flash Bagasse dryer unit is installed at the Boiler back-end, wherein flue gas leaving APH/Dust collector is being allowed to be scrubbed with fresh milled wet bagasse in co-current flow for effecting significant reduction in moisture in biomass (say by 20%) through exchange of waste heat available in flue gas. The dried bagasse is then fired in the Combustion chamber of the HP Boiler for enhanced HP steam generation. The dedusted flue gas leaving the Flash bagasse dryer is led to integrated Wet WESP for particulate reduction (SPM < 30 mg/Nm^3) before the cleaned gas is discharged through the connected stack. Warm dried bagasse with higher GCV, results in higher boiler thermal efficiency due to lowered stack heat losses, finally resulting in increased HP green steam generation from CPP boiler. Significant stack heat loss reduction to the tune of say 7 to 8% points had been achieved resulting in equivalent fuel savings. This innovative hybrid scheme leads to, not only increased green steam and power generation, but also to a cleaner environment by way of significant absolute emission reduction of pollutants.

CASE STUDY -DAURALA SUGAR WORKS

Daurala Sugar Works (DSW) is presently having a Battery of High-Pressure Boilers firing high moisture fuel. DSW, in its quest for increasing boiler productivity, converged on the stack heat losses to be targeted -with milled wet bagasse as the primary fuel, as considerable thermal energy available in the waste flue warm gas is being lost to the surrounding environment through the connected Boiler stack.

BOILER DESCRIPTION

Milled wet bagasse with 50% moisture content is being directly fed to the HP Boiler. The steaming conditions of the Cogen HP Boiler and other related parameters are elicited in Table -1.

TABLE -1
Bagasse fired HP Boiler

Parameter	Design Value	Units
Fuel	Milled Bagasse @50% moisture	
Steam Evaporation (MCR)	90	TPH
Steam outlet Pressure	67	kscg
Steam outlet temperature	515	ºC
Feed Water Temperature to Boiler Economizer	104	º C
APC	FDB integrated with WESP	

HYBRID FLUE GAS BAGASSE DRYER FOR ENHANCED HP BOILER STEAM GENERATION

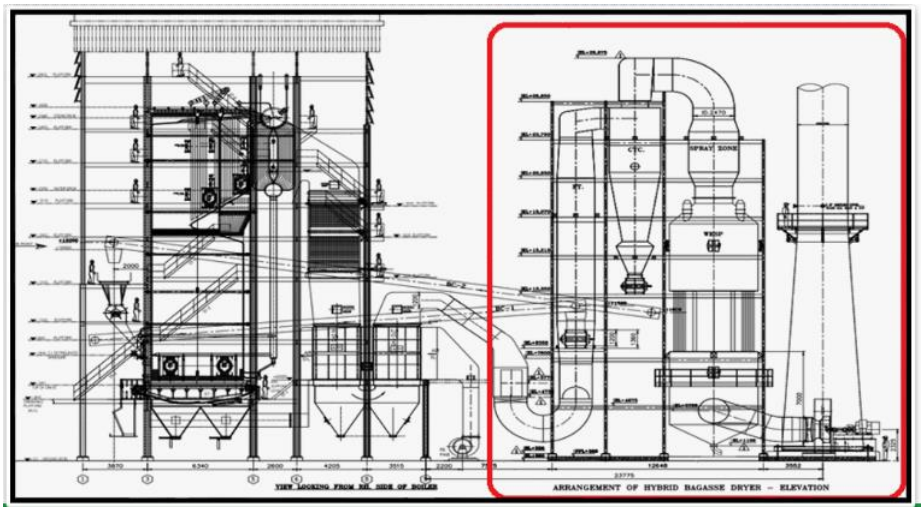

Fig 1 : G.A. Drawing of bagasse fired H.P. Boiler integrated with Hybrid Dryer

Warm flue gas leaving the economizer is passed through tubular APH wherein ambient air is preheated before the same is led as combustion air to the Combustion chamber [Fig.1]. The hot and dusty flue gas from the air pre-heater is first passed through a flash dryer [Fig.2] allowing the same to get mixed directly with wet bagasse. During the process of bagasse drying, the dust particles get entrapped in the dried bagasse. Photographs of milled wet bagasse and the dried bagasse leaving the Flash bagasse dryer are depicted alongside [Fig.3].

Fig.2. Hybrid Flash Bagasse Dryer integrated to HP Boiler at DSW

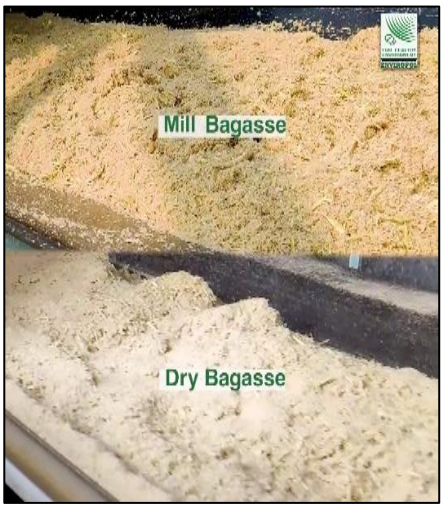

Fig.3: Photograph of wet and dried bagasse-FDB

The clean flue gas with remaining dust load of nearly 200 mg/Nm^3 is then made to pass through an integrated low- pressure drop WESP [Fig.4] for further cleaning down to as low as 30 mg/Nm^3 depending on the prevailing norms and target set by the end-user.

Fig 4: Flue gas flow path across energy scrubbing and Wet ESP

The clean dedusted flue gas is sent to the connected tall stack with the help of Booster ID fan.

PERFORMANCE SUMMARY RELATED TO ENERGY CONSERVATION CUM CLEANER ENVIRONMENT

Through scrubbing warm flue gas over the incoming wet bagasse at ambient, heat is directly transferred through the reduction of flue gas temperature for effecting reduction in moisture in incoming wet bagasse reduction to as high as 20% - leading to increase in thermal efficiency of 7 to 8% on GCV of fuel and finally resulting in enhancement in HP Boiler steam generation [Table – 2]. With WESP at the back end of the boiler stack particulate emissions of < 40 mg/Nm3 [Table - 2] were recorded with WESP particulate collection efficiency of 82%. Absolute emission brings out to the fore not only Boiler thermal efficiency status in general but also includes Net Heat rate of the CPP/Cogen. Absolute particulate and other pollutants in stack gas were reduced through lowered fuel firing in boiler. Reduction in bottom ash discharge of ~10% related to ~1TPD in the subject case study. All the above facets viz., Energy conservation, cleaner environment, and absolute stack gas pollutants control are summarized in the illustration related to case -study of Hybrid FDB-WESP scheme demonstrated in HP Bagasse fired Boiler in Daurala Sugar Works [Table-2].

TABLE -2
Performance Data with Hybrid Bagasse Dryer

Parameter		**BD -in**	**BD-out**	**Hybrid FDB-WESP**
Flue gas temperature	ºC	135	75	68
Moisture in Bagasse	%	50	39	-
Increase in HP steam generation	TPH			~5
Emission reduction -off-set	tCO2e/yr			1350
Draught loss across	mmWC		130	20
SPM Concentration in Stack flue gas	mg/Nm3	4000	195	35
Absolute Particulate emission reduction discharge to Stack	kg/h	-		4.5
Reduction in bottom ash discharge	TPD			~ 1

REPLICATION

Hybrid FDB -WESP scheme can now be effortlessly replicated in all Sugar mills having Captive Cogeneration Boilers with significant energy gains apart from cleaner stack with very low SPM in the discharge flue gas.

OPPORTUNITIES IN OTHER SECTORS

It is proposed to extend (explore) this concept of FDB to highly moisture Bagasse pith derived from the Depithing of Bagasse as milled from Cane crushing in adjoining/closely located Paper mills. Bagasse Pith not only has very high moisture content (55% to 63%), but also is high in fines. However, unlike Bagasse, Bagasse pith is of finer-sized particulates as compared to bagasse (Moisture: 48% to 50%) -as also with lower heat content. Efforts are on to fire this high moisture biowaste fuel along with coal in the multifuel fired boilers of the Paper plants. EEPL is proposing Hybrid FDB -WESP for high moisture Bagasse pith drying and firing in the HP Boiler along with wood dust and imported coal.

Decarbonization through coal off -set is accomplished with multi-fuel fired boilers with Hybrid FDB - WESP in place at the boiler back-end. GHG emission reduction (through lowered CO2 & N_2O) would be of a high order (7% to 8%).

ENERGY GAINS AND ANALYSIS

- Flue gas from the combined fuel mix is having sufficient heat content so as to effect significant reduction. The dried bagasse and exit flue gas temperature leaving FDB shall be over 70°C.
- Though green energy input is low, by reducing moisture in Bagasse from 50% to 39%, resultant thermal efficiency of HP boiler is increased to a significant extent (7% to 8%).
- Increase in HP Green steam generation is over 5 TPH realizing the same amount of additional LP steam along with 0.15 MW Green Power.
- GHG Emission reduction is significant; more so due to lowering of N_2O (high potent GHG) formation in HP boiler due to increase in Combustion gas temperatures.
- In addition, the stack gas particulate emission shall be lowered by WESP apart from flue gas scrubbing with Bagasse.
- Absolute emission reduction of all stack pollutants over and above that of Specific pollutants emission is being achieved with the patented innovative scheme.

CONCLUSIONS

The Patented Hybrid Model of the bagasse dryer is a way forward to view investments in Air Pollution control devices as revenue-generating projects through enhanced green steam and power generation. The Integrated Wet Electrostatic Precipitator, being the most advanced emission control technology in the world as of today, and its presence as last equipment before stack makes the Hybrid FDB model a perfect device to maintain cleaner environment even during varying operating conditions of Bagasse dryer. To cap it all, through increased boiler thermal efficiency, indirectly it contributes to Absolute stack pollutants emission reduction (MoEFCC notification – Green Credit Programme - June 2023) & Decarbonization through Coal offset elsewhere.

(Note: For more details, please contact pv@enviropolengineers.in)
