VINASSE INCINERATION WITH BAGASSE AS SUPPORTING FUEL

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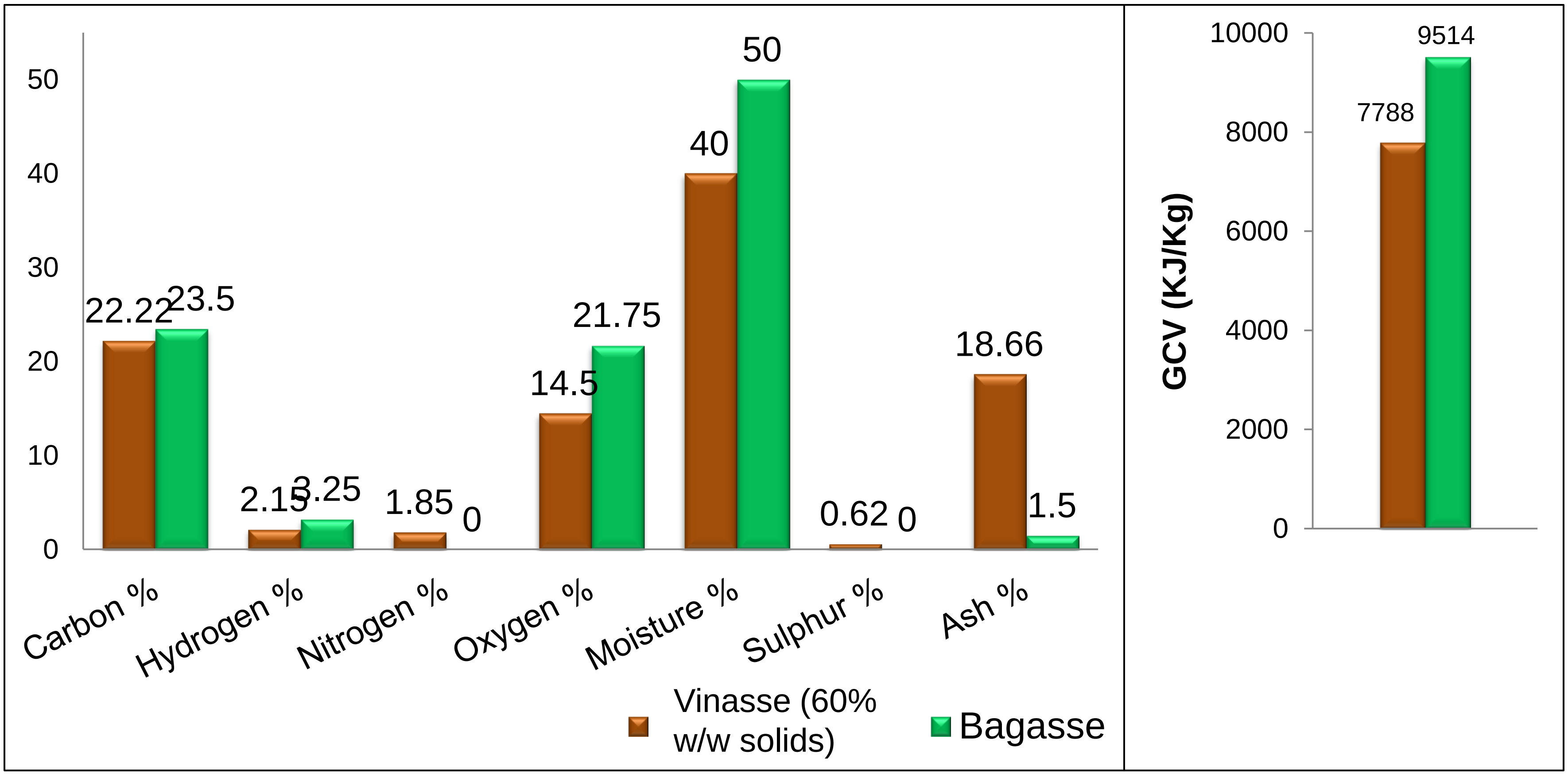
INTRODUCTION

- The present day concern of the scientific and technological innovation is the abatement of pollution and environmental degradation.
- Efforts are being put to minimise industrial pollution worldwide.
- One of the most polluting process industry is the alcohol industry.
- Molasses based distillery effluent (vinasse) is high in BOD, COD, TDS and low in pH.
- It is an extremely potential water pollutant and has an adverse effect on the aquatic environment.

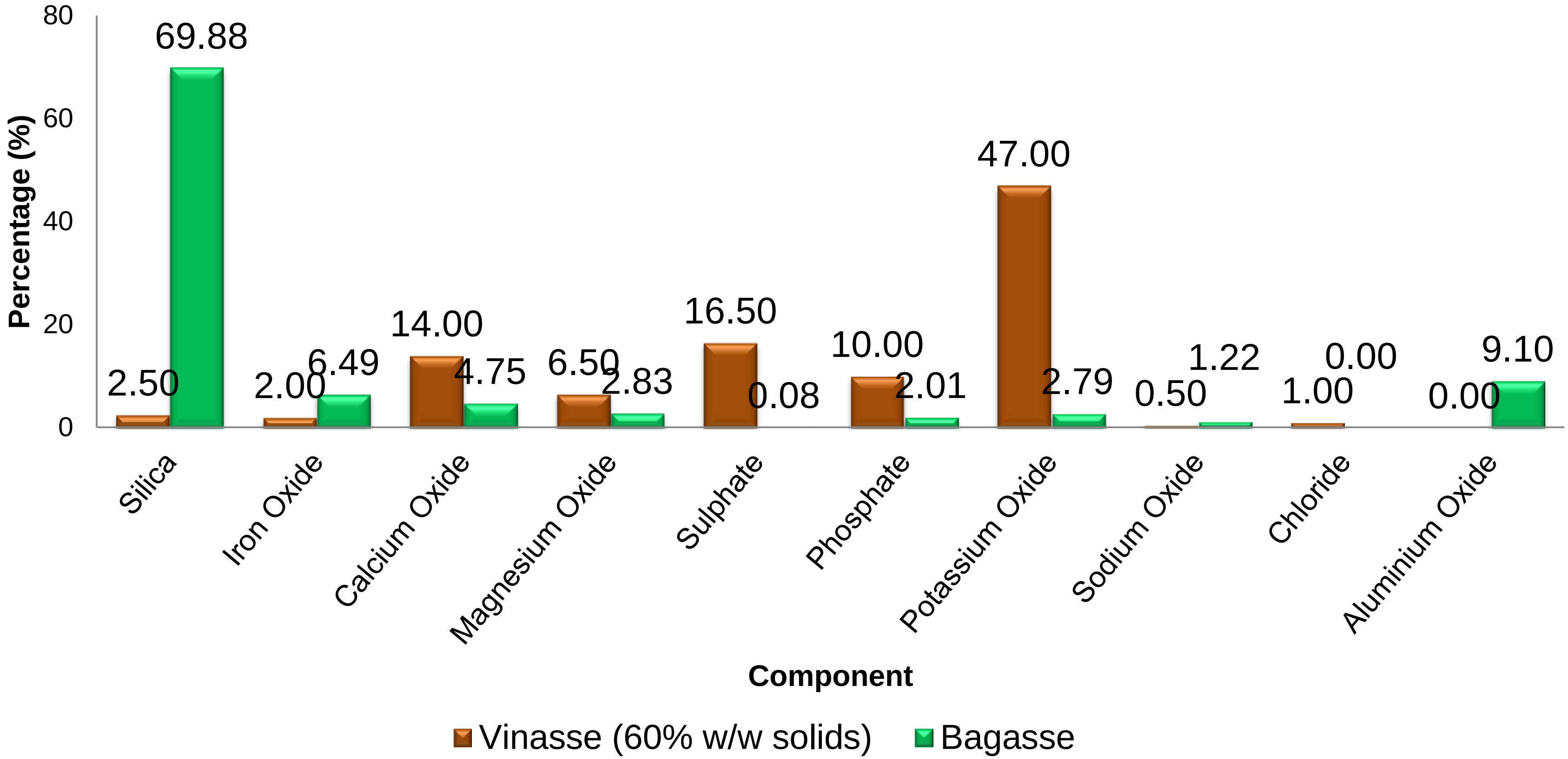
Typical characteristics of Vinasse :

Characteristic		Effect
pH	4 - 4.5	• Acidic • Corrodes the surroundings and contaminates the soil
BOD	10,000 - 60,000 mg/kg	• Will pollute rivers and ground water
COD	110,000 - 135,000 mg/kg	• Water will become unfit for human consumption and for general use
High moisture and solid content	9 - 20% w/w depending on plant configuration	• Difficult to handle and store. • Requires large area to store and then removal of settled solids and its disposal is of concern.
Odour	Pungent	• Unbearable

Comparison of vinasse and bagasse



Comparison of ash from vinasse and bagasse



INTRODUCTION

Vinasse as a fuel

- Raw vinasse from distillery has very low calorific value.
- 60 % concentrated vinasse has calorific value, but lower than bagasse.
- Its Heating value is not enough to sustain self-combustion, hence a support fuel is required.
- Ash from vinasse incineration has a higher alkali and chloride content.
- This creates post-combustion issues like fouling and corrosion.
- Vinasse is concentrated to 60 % solids in a separate evaporator system.
- The condensate of evaporator is used in plant after treatment in a condensate polishing unit (CPU).

EARLIER DESIGN & SHORTCOMINGS

- In India, several designs of vinasse incinerator have been developed in past:
  - spraying vinasse on fuel outside incinerator
  - twin furnace design
  - varying pressure part arrangements
- Due to fouling nature of ash, the heating surfaces of evaporators, superheater coils, economiser coils and air preheaters get covered with ash and flue gas paths get blocked. They had to be stopped every 8 – 10 days for cleaning.
- Incinerators used coal as supporting fuel using atmospheric fluidised bed combustion (AFBC) technology.
- The cost of support fuel, High carbon emission , High cost of operation was a concern.

EARLIER DESIGN & SHORTCOMINGS

- Distilleries and Incineration Boilers are generally located inside or near to the sugar plants.
- This enables easy availability of bagasse as a support fuel with low or no cost
- Thus bagasse would have been an ideal choice of support fuel over coal.
- It was initially thought that Vinasse incineration with Bagasse will not be possible as both fuels have low calorific value.
- After indepth study of combustion of biomass fuels and trials, It emerged that for any fuel, volatile matter is an important factor beside calorific value.

EARLIER DESIGN & SHORTCOMINGS

- Bagasse has lower calorific value than coal, but, higher volatile matter. This enables rapid combustion of bagasse.
- Different combinations of vinasse, bagasse and coal results in high volatile matter and enough heat to sustain combustion.
- Thousands of boilers are in operation with Bagasse as a fuel, hence Isgec never doubted it.

INTRODUCTION

Volatile matter and minimum heat requirement for different fuels to sustain combustion:

Fuel	Volatile matter (% dry and ash free basis)	Minimum NCV to sustain combustion (KJ/Kg)
Blast furnace gas	99 – 100	2261 – 2303
Biomass	77 – 85	3768 – 5025
Municipal solid waste	65 – 75	5025 – 5445
Sub bituminous/ Bituminous coal	35 – 40	5445 – 6281
Anthracite coal	< 10	7327 – 7537
Petroleum coke	< 5	16747 – 25121
Bagasse	85 – 87	3768 – 4181
Vinasse	75	5025 – 5862

Fuel	Volatile matter (% dry and ash free basis)	Minimum NCV to sustain combustion (KJ/Kg)
Bagasse + Vinasse (30:70)	78 – 80	5066
Coal + Vinasse (30:70)	64 – 65	6028
Bagasse+Coal+Vinasse (15:15:70)	71 – 72	5526

Vinas

MAJOR CHALLENGES IN FIRING VINASSE

- Major drawbacks of the existing vinasse incineration technology were:
  - Unstable combustion
  - Scaling of heat exchanging surfaces of the boiler
  - Handling vinasse of varying solids concentration
  - Deposition of potassium salts on boiler tubes and reaction with refractory material
  - Clinker formation and shut down for cleaning
  - High down time
  - Evacuation and handling of high temperature ash

MAJOR CHALLENGES IN FIRING VINASSE

✓ Extensive studies have revealed that travelling grate is the most appropriate for vinasse incineration.

✓ It provides flexibility in support fuel:

- ❖ Bagasse
- ❖ Coal
- ❖ Wood chips
- ❖ Other biomass

Bagasse

Coal

Wood Chips

Rice Husk

✓ Other technology can not offer such Fuel flexibility

Vinasse incineration with bagasse as supporting fuel

OBJECTIVE FOR DESIGN OF BAGASSE BASED VINASSE INCINERATOR

Following Objectives were kept in mind for going ahead with this technology:

- Ability to fire a variety of support fuel and even at 100 % when vinasse is not available.
- Sustained boiler operation with varying vinasse concentration and support fuel moisture
- Reliable and effective on load cleaning of heat transfer sections
- Reliable ash handling system to ensure continuous ash discharge
- Minimum operating cost
- Longer operation days of distillery

CASE STUDY

Isgec's First Bagasse Based Incinerator

Factory name	Balrampur Chini Mills Ltd.
Location	Balrampur, Uttar Pradesh, India
Distillery capacity	160 KLPD^
Boiler capacity	40 t/h
Support fuel	Bagasse
Power plant capacity	6 MW
Type of turbine	Extraction cum condensing

40 TPH Incineration Boiler at distillery of Balrampur Chini Mills Ltd., Balrampur, India

(* Boiler was designed for 13 TPH Vinasse initially)

Vinasse incineration with bagasse as supporting fuel

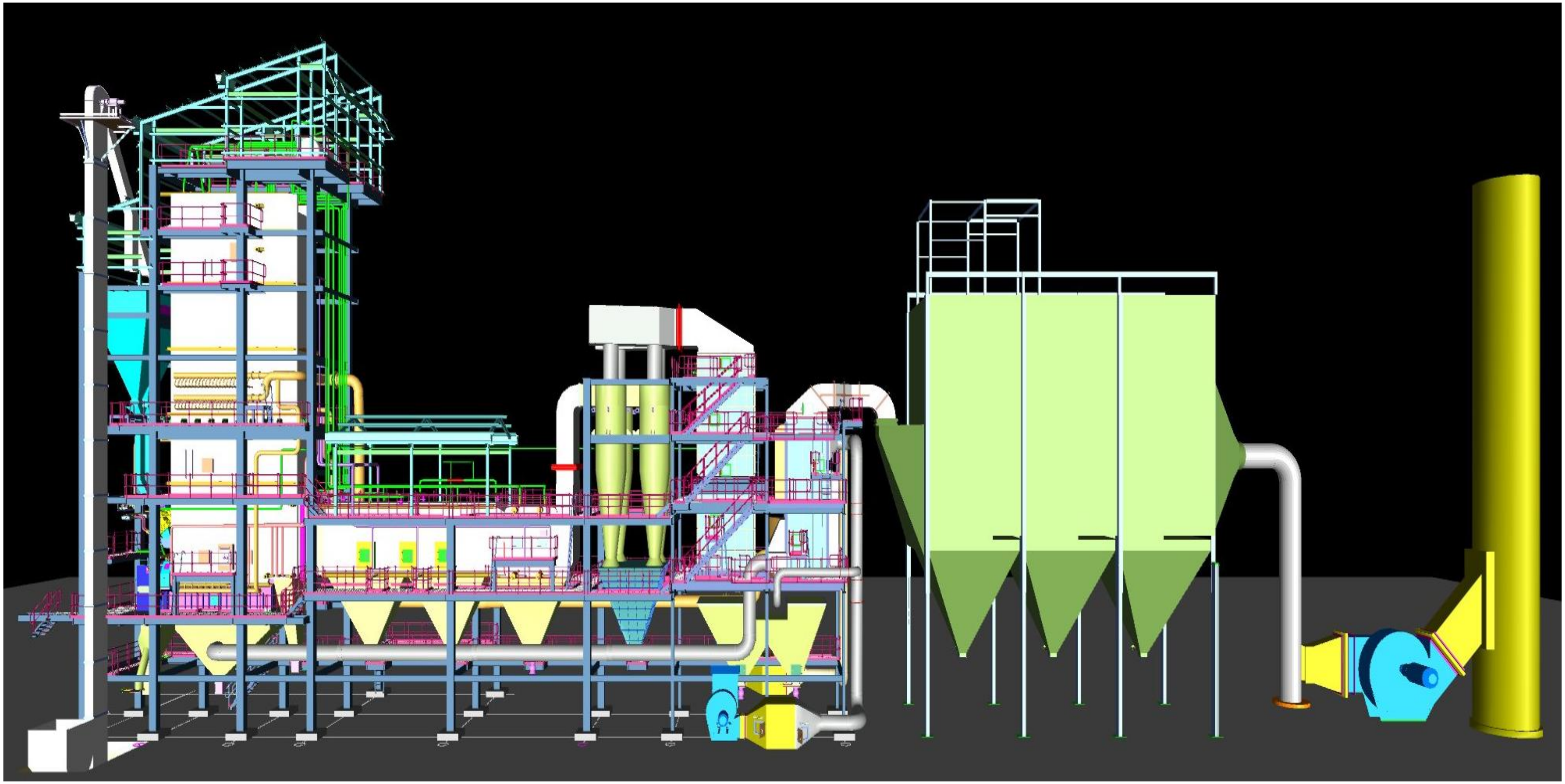
SPECIAL DESIGN FEATURES OF BOILER

Following Features were incorporated in the boiler

To minimize the effect of Fouling of Alkalies present in ash (K20, Na2O), corrosion of super heater due to chlorides, Low flue gas temperature at start of third pass is achieved by:

- Tall Furnace
- Three pass design .
- All three passes with water-cooled membrane-walled construction
- No Heating surface in furnace first two pass except Water walls.
- Wide clear openings for Gas to travel from 1^{st} to 2^{nd} and then to 3^{rd} pass.

CASE STUDY



3-D representation of a incineration boiler at Balrampur Chini Mills

Vinasse incineration with bagasse as supporting fuel

CASE STUDY

Specific featues of Vinasse & Bagasse Firing System

- High pressure atomization (spray) of vinasse by Pumps thru specially designed Nozzles.
- Located in such a way that the spray must not hit the side or rear wall of the incinerator..
- Slop nozzles are located at Strategic height on furnace water wall to ensure complete combustion and minimum carry over.
- Easy removal of gun for cleaning in case of nozzle chocking.
- Standby nozzle arrangement for uninterrupted operation.
- Bagasse feed was controlled by reducing the speed of 3 drag type bagasse feeders.

Specially designed vinasse nozzle

High pressure Vinasse Pump

CASE STUDY

SPECIAL DESIGN FEATURES FOR 3rd PASS PRESSURE PARTS

- Wide pitching of the superheater assembly to avoid fouling.
- This is a critical factor for this type of incinerator.
- Pitching of coils and velocity of gases selected for optimum heat transfer.
- This also minimizes fouling potential due to settling of ash.
- Economiser assembly kept in Vertical Pass to avoid settling of ash.

CASE STUDY

SPECIAL DESIGN FEATURES FOR AIR PREHEATERS

- Air Preheater kept in separate Vertical pass.
- Separate steam coil air preheater (SCAPH) used to preheat combustion air (FD) and Secondary Air (SA)
- SCAPH ensures that temperature of air entering the APH is > 70 ˚C.
- The cold end block of the air heater was provided with corrosion resistant corton steel tubes.
- Inner Sleeves provided in Air Preheater tubes at Cold Air entry zone to avoid corrosion
- The APH was designed with air through tubes and flue gas outside.
- This eliminated choking of the tubes

CASE STUDY

SPECIAL DESIGN FEATURES FOR POLLUTION CONTROL SYSTEM

- Mechanical Dust Collector as Primary collection system
- This reduced Low temperature ash fouling potential on Economiser and Air Preheater
- Electrostatic precipitator (ESP) limits suspended particulate matter below 50 mg/Nm^3.
- The ESP specifically designed for this application:
  - ✓ has shorter collecting and emitting electrodes
  - ✓ wide pitching
  - ✓ bottom rapping through specifically designed hammers
  - ✓ higher ratings of transformer – rectifier.

Mechanical Dust collector

Electrostatic precipitator

CASE STUDY

SPECIAL DESIGN FEATURES FOR ASH REMOVAL

- On-load cleaning with steam soot blowers for all convective parts.
- Wall blowers for Water walls
- Long retractable soot blowers for superheaters.
- Short retractable soot blowers for evaporators, economisers and air heaters
- These have a wider area of cleaning than conventional rotary soot blowers.
- Electromagnetic vibrators for effective and continuous ash discharge from hoppers ,

CASE STUDY

SPECIAL DESIGN FEATURES FOR ASH DISPOSAL SYSTEM

• Previous experience of ash evacuation from Mild Steel Hopper with inside Refractory Lining was not good

• Hence for Effective Ash evacuation from Hoppers (handling high temperature ash) are of stainless steel.

• Stainless steel metallurgy was selected to provide smooth surface thus ensuring evacuation

•. Mechanical ash handling for high temperature ash and Pneumatic ash handling for low temperature ash.

▪To ensure positive ash discharge, a screw cooler is installed below the high temperature hopper.

▪ The outlet of the cooler is taken in front of submerged ash system.

CASE STUDY

OPERATING EXPERIENCE

- The boiler was commissioned in December 2015.
- It has been running satisfactorily with 80 days of continuous operation.
- It has achieved maximum continuous working of 90 days.
- It used vinasse with varying concentration of total solids.

Parameter	Designed	Achieved
Steam flow at MCR t/h)	40	39-42
Steam pressure at MSSV outlet kPa	42	42-44
Steam temperature at MSSV outlet °C	400	395-402
Feed water temp. at economizer inlet °C	140	135-140
Fuel fired (Vinasse + Bagasse)	100%	100%
Fuel parameters		
Vinasse quantity fired (55-60% TS) t/h	13.00	15.0-16.0
Bagasse fired t/h	8.0	6.0-7.0
Power consumption for auxiliaries kW	600	418
Dust concentration at the ESP	Less than 50	25-30

CASE STUDY

VINASSE FIRING CAPACITY AUGUMENTATION

- The boiler was originally designed to burn 13 t/h of vinasse.
- It has continuously processed vinasse at a rate of 16 – 17 t/h.
- Since the distillery had excess capacity and was generating 4 – 5 t/h of excess vinasse. Hence on customer's demand to sustain 18 t/h of vinasse firing, following modifications were done in boiler:

✓ Additional vinasse nozzle added to the front wall.

✓ Additional vinasse pump installed to provide flexibility.

✓ Openings of the ash hoppers increased from 250 mm X 250 mm to 450 mm × 450 mm.

✓ Wall blowers were installed on the furnace and second wall surface

CASE STUDY

- Post Capacity augmentation,, boiler performance has been exemplary.
- It has been running satisfactorily with 80-90 days of continuous operation.
- It used vinasse flow rate upto 19-20 tph..

BOILER PERFORMANCE AFTER MODIFICATION

Parameter	Designed	Achieved
Steam flow at MCR t/h)	40	40-42
Steam pressure at MSSV outlet kPa	42	42-44
Steam temperature at MSSV outlet °C	400	398-403
Feed water temp. at economizer inlet °C	140	136-140
Fuel fired (Vinasse + Bagasse)	100%	100%
Fuel parameters		
Vinasse quantity fired (55-60% TS) t/h	18.00	19.0-20.0
Bagasse fired t/h	6.0	4.0-5.0
Power consumption for auxiliaries kW	600	430
Dust concentration at the ESP outlet mg/Nm³	Less than 50	30-42

CASE STUDY

FLY ASH as K ASH

- The fly ash is rich in potassium.
- Fly ash generated is processed in a granulation plant.
- This product is sold as a fertiliser to generate additional revenue.

K ash generated from fly ash of incineration boiler at
Balrampur Chini Mills Ltd., Balrampur, India

CONCLUSION

- The success of travelling grate bagasse based vinasse boilers has solved a major problem of the distilleries.
- Bagasse is a cheap and easily available support fuel.
- The specific design adopted for vinasse firing ensures enhanced performance of the boiler.
- This leads to enhanced power generation – a source of revenue.
- Additional revenue from potassium rich fly ash.
- 12 nos. bagasse based incinerators are in operation in India and 10 nos are in execution stage.
- Largest capacity Bagasse based incineration boiler (80 TPH with 38 TPH vinasse firing) is in commissioning stage in India


Thank you