



Hybrid Design of High Pressure Biomass Boiler to Burn Spent Wash

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ABSTRACT

Under the ever changing scenario of sugar and distillery industry in India, there have been number of factors emerging with an aim to minimize the operating cost of boilers, still meeting the restrictions imposed by government of India with respect to pollution norms. One of such factors in molasses based distilleries operating on syrup as their feed stock is to consume very low amount of spent wash in convention low pressure incineration boilers. In such cases, the ratio of spent wash quantity and bagasse would be 10:90. In such cases, bagasse becomes the main fuel and total energy potential of bagasse is not utilized while firing in low pressure boiler. Isgec have taken an initiative to design a high pressure boiler which can fire spent wash up to 10% (on heat basis) in high pressure boiler, thus with the same quantity of bagasse, more power can be extracted. This boiler is under construction and will be functional in upcoming crushing season in October 2024. This hybrid design boiler can produce steam to run your digester plant and distillery thereby reducing the overall capex.

Keywords: Spent wash, high pressure, efficiency, biomass

INTRODUCTION

For a distillery which is operated on syrup base feed stock, the conventional incineration boiler burn slop 10% and bagasse 90% on weight basis with efficiency of 60-62 % only. Thus operating incineration boilers only on bagasse, with less slop quantity is not economical. To meet such demand, Isgec worked on development to design a boiler to fire 8% slop (weight basis) in specially designed high pressure traveling grate boilers. Isgec is currently executing one such high pressure boiler which can fire slop and support fuel bagasse Pith.

Type of feed stocks

For making sugar in India, the mills crush sugarcane which typically has total fermentable sugars (TFS) contents of about 14%. The TFS component consists of sucrose along with the reducing sugars glucose and fructose. Most of this TFS component gets crystallized into sugar, and the remaining part is called molasses.

following recent changes to the National policy on biofuels, three conventional feedstocks to distilleries can be utilized. These include juice or syrup, B heavy molasses and C heavy molasses. Change in government policy, distilleries operated in cane syrup mode only. Then sugar complexes, compromising sugar production and aiming for high ethanol production. Mills can now also produce only ethanol from sugarcane, without producing sugar at all. In this case, the entire 14% TFS in the cane is fermented. Here, a mill can make 84 litres of ethanol and zero kg of sugar. It can be seen from (Table 1) that the quantity of vinasse generated from distilleries with cane syrup feedstock.

An incineration boiler which is designed for high slop firing on same ethanol generation now it fire only 1.4 TPH on syrup feed stock.

Previous incineration units were operating mostly on C and B heavy molasses. The boiler was designed with the quantity and quality of vinasse produced from these

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**Table 1 : Syrup based feed stocks vinasse generation 100 KLD ethanol productions
(by process calculations)**

Molasses Grade	% TFS content in feedstock	%TFS content in cane	Ethanol produced L/t per ton of cane	Sugar produced kg per ton of cane	Vinasse production at inlet TPH @ 17 % solids	Vinasse fired in boiler TPH @ 60 % solids
Syrup	100	14	84	0	5.1	1.4

distilleries and all the auxiliaries were sized with the proportion of vinasse and support fuel.

Isgec Heavy Engineering Limited has been working in these incineration boilers since 2010 and first bagasse based incineration boiler was installed by them at M/s Balrampur Chini Mills in Uttar Pradesh in India.

Since then, Isgec has supplied or is presently supplying more than 50 incineration boilers including the world's largest capacity 84 TPH incineration boilers for DCM Shriram group at their Ajbapur plant. This boiler has a 34 TPH vinasse firing capacity with bagasse as support fuel and has been in operation for the last 4 years.

Isgec has also successfully commissioned a 75TPH capacity incineration boiler exclusively designed to fire slop from cane syrup at Maizapur unit of Balrampur group.

In the course of last 10 years, Isgec have been modulating design of such incineration boilers based on learning from the operating units and as of now they have their 5th generation of incineration boilers. Operations of such boilers have crossed more than 250 days of continuous operation.

Salient features of Isgec 5th generation slopfired boilers

- Adjusted heating surface area for the furnace first and second pass to improve gas cooling and maximize combustion.
- Location of placement of vinasse firing nozzles and secondary air.
- Adequate wall blowers in furnace first pass and second pass and their usage.

- Pitching of secondary and primary super heater to have the optimum velocity.
- Approach profile of gas entering in super heater sections.
- Stainless steel hoppers for high temperature zone with adequate vibrators and mouth opening.
- Highly reliable wall blowers in furnace 1st and 2nd pass and long retractable soot blower in super heater section.

Development of high pressure co-generation boilers

Previous operational and maintenance experiences of such incineration boilers and type of issues faced, it gave Isgec the required confidence to fire limited quantity of slop in high pressure boilers too.

Distilleries operating in syrup mode; the quantity of vinasse/slop generation will be considerably reduced so a design has been developed to utilize the small quantity of vinasse in specially designed high-pressure traveling grate boilers. Sugar Industries have adopted high pressure cogen boilers and plant since early years of 21st century to get maximum output for power and process from unit quantity of bagasse. Since then the pressure of boilers rose from 32 ata to 125 ata.

Table 3 depicts the gain in key factors of power plants with respect to high pressure and temperature of steam.

Calculations shown above are based on a 100 TPH travelling grate boiler with 69% efficiency (on GCV 2270 kcal / kg Basis) and turbine exhaust at 0.1 Kg/cm² (a)

Table 2 : Advantage of boiler with high pressure and temperature

Parameters	Unit	45 Kg/cm ²		66 Kg/cm ² (a)		87 Kg/cm ² (a)		110	125
		440 °C	515 °C	485 °C	515 °C	515 °C	540 °C	Kg/cm ² (a) 540 °C	Kg/cm ² (a) 540 °C
Feed Water temp to boiler	°C	105 (without HP Heater)		150 (with 1 HP Heater)		170 (with 1 HP Heater)		220 (with 2 HP Heater)	230 (with 2/3 HP Heaters)
Bagasse Quantity	TPH	43.51	46.18	41.78	42.89	41.2	42.2	38.6	37.5
Steam/Fuel ratio	-	2.29	2.16	2.39	2.33	2.42	2.36	2.59	2.67
Gross Power output	MW	24.8	28.8	26.5	28.9	28.5	29.3	29.4	29.8
Net Power Output	MW	22	25.2	23.4	25.3	25.1	25.7	25.9	26.1
Specific Steam consumption	Kg/KW-hr	4.03	3.46	3.77	3.46	3.51	3.41	3.4	3.36
Power Generation per ton of Bagasse	KW/Ton	Base	9.50%	11.40%	18.30%	21.40%	22.00%	33.60%	39%
Heat Rate	Kcals / KW-hr	3983	3640	3579	3370	3281	3258	3000	2875
Plant Efficiency	%	21.6	23.6	24	25.5	26.2	26.4	28.7	29.9

Distillery which is operated on syrup base feed stock, the conventional incineration boiler will burn slop 8 - 10% and bagasse 90% on weight basis with efficiency

of 60 - 62 % only. Thus operating incineration boilers only on bagasse with less slop quantity is not economical (Table 3).

Table 3 : Gain in efficiency as per design calculation

Parameter	Units	Typical Incineration boiler (with Syrup)	High Pressure TG boiler (With Syrup)
Fuel ratio for boiler on weight basis	%	8% slop+ 92 % bagasse	8% slop+ 92 % bagasse
Slop generation	TPH	3	3
Backend Temperature (APH Outlet)	Deg C	190	150
Unburn carbon loss	%	4.5	1.9
Steam to Mix Fuel ratio		2	2.35
steam generated (Ton) Per ton of fuel (Slop+ Bagasse fuel mixture)			
Boiler efficiency	%	62.5	70 - 71

High pressure boiler with syrup slop firing

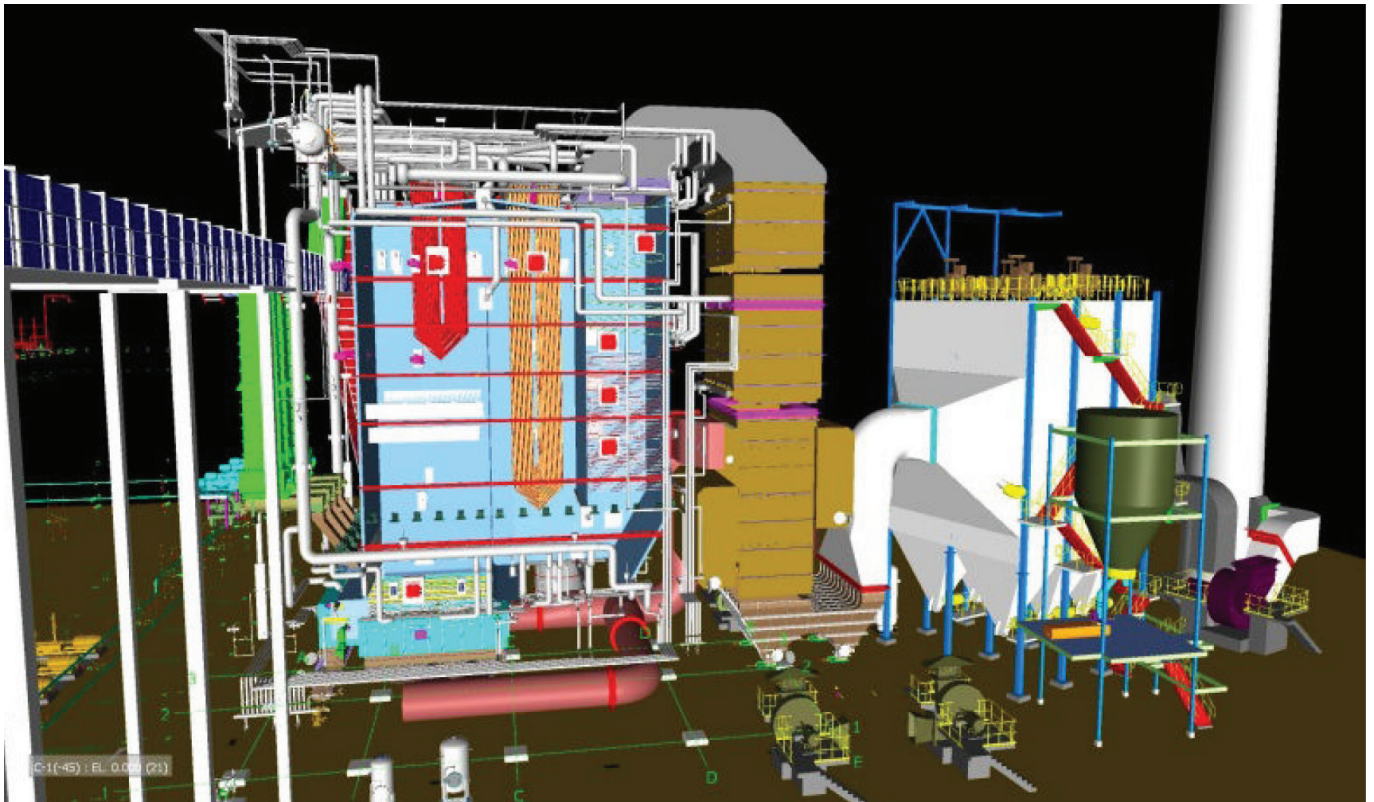
Isgec has designed a boiler for JGN Sugar and Biofuels (P) Limited at Sitarganj in Uttarkhand. This boiler is presently under erection and is expected to get commissioned in October 2024.

Details of JGN Biofuel's high pressure cogen boiler designed with syrup based slop firing

Specific features of high pressure traveling grate boiler for firing spent wash.

Table 4 : Details of boiler

MCR Evaporation (TPH)	120
Steam Pressure at MSSV (Kg/Cm ² G)	87
Steam temperature at MSSV (Deg C)	515+5
Feed water Temperature at Eco Inlet (Deg C)	160
Feed water at Deaerator outlet (Deg C)	130
Feed water at HP Heater outlet (Deg C)	160

**Figure 1 : Schematic view of hybrid design high pressure boiler designed for firing slop**

- Boiler is a continuous ash discharge traveling grate boiler with bagasse being spread pneumatically in the furnace and spent wash with pressure jet firing nozzles. It is girth supported, single drum boiler.
- Furnace height of this boiler is kept considerably higher than convention high pressure TG boiler.
- This is a three-pass design boiler provided with adequate heating surface areas to cool down the flue gases.
- Special designed superheater with three pass arrangement. First few loops of secondary super heater coils are with superior grade material to protect coils from high temperature corrosion.
- Spacing of superheater coils are kept higher than conventional.
- Considering possible furnace pressure fluctuations, welded type roof sealing are considered
- For the same reason, furnace bottom sealing has been improved and is with continuous high temperature withstanding fabric.

- To keep furnace surfaces clean wall blowers are provided on roof section of water wall furnace and also at goose neck panel as well as on straight water wall.
- Special designed slop nozzle at strategic location on front wall of furnace.
- Long retractable soot blowers are installed to have proper cleaning of the heating surface areas.

CONCLUSION

Specific design features adopted for vinasse firing produced from syrup feedstocks now ensure high availability and good efficiencies of vinasse fired boilers. Distilleries are now considering continuous operation throughout the year. Hybrid design high pressure boiler is now available for firing small quantity of slop generated from syrup based distilleries along with other biomass fuels.