BOILER UPGRADATION AND PERFORMANCE EVALUATION.

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ABSTRACT:

1. **Several high pressure boilers are installed up to now in Pakistan. What are the experiences so far?**

2. **The systems built are all of 60/65 bar(a) pressure. Most likely the future systems to be built are of 110 bar(a). What are the reasons for this trend?**

3. **Coal firing is an alternative fuel to be fired in the off-season. What are the advantages and disadvantages.**

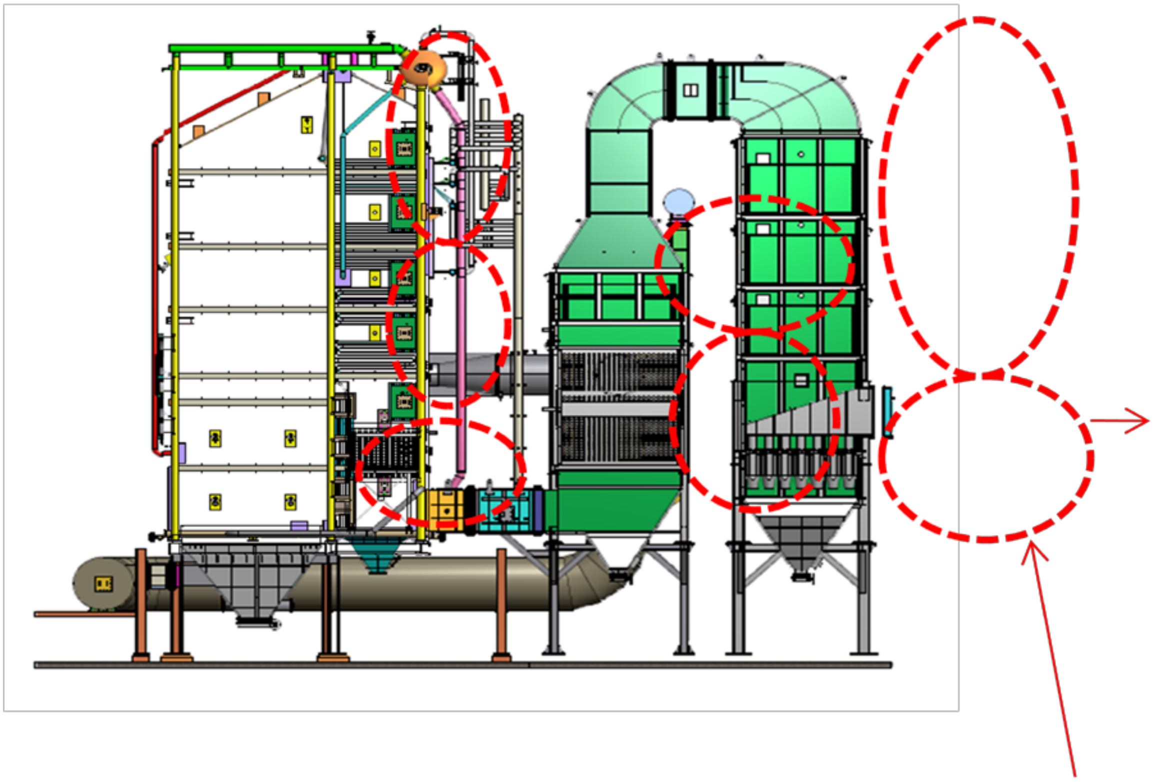
4.

1. **<u>Several high pressure boilers are installed up to now in Pakistan. What are the experiences</u>** .

Bottom supported single drum boilers, bagasse and biogas fired, have been mainly installed and operated so far:

Positive experiences are:

- Limited height and space
- Easy accessible.
- Fast start up (steam delivery)
- Fast responding
- Efficiencies are met: 87% on LCV basis
- Power consumptions electric drives are lower than anticipated



HP bagasse fired boiler
140 tph 65,7 barg 485 C

Some problems are experienced:

A. Conveyors

Dump the wet bagasse after a stop of crusher otherwise the fire will go out.

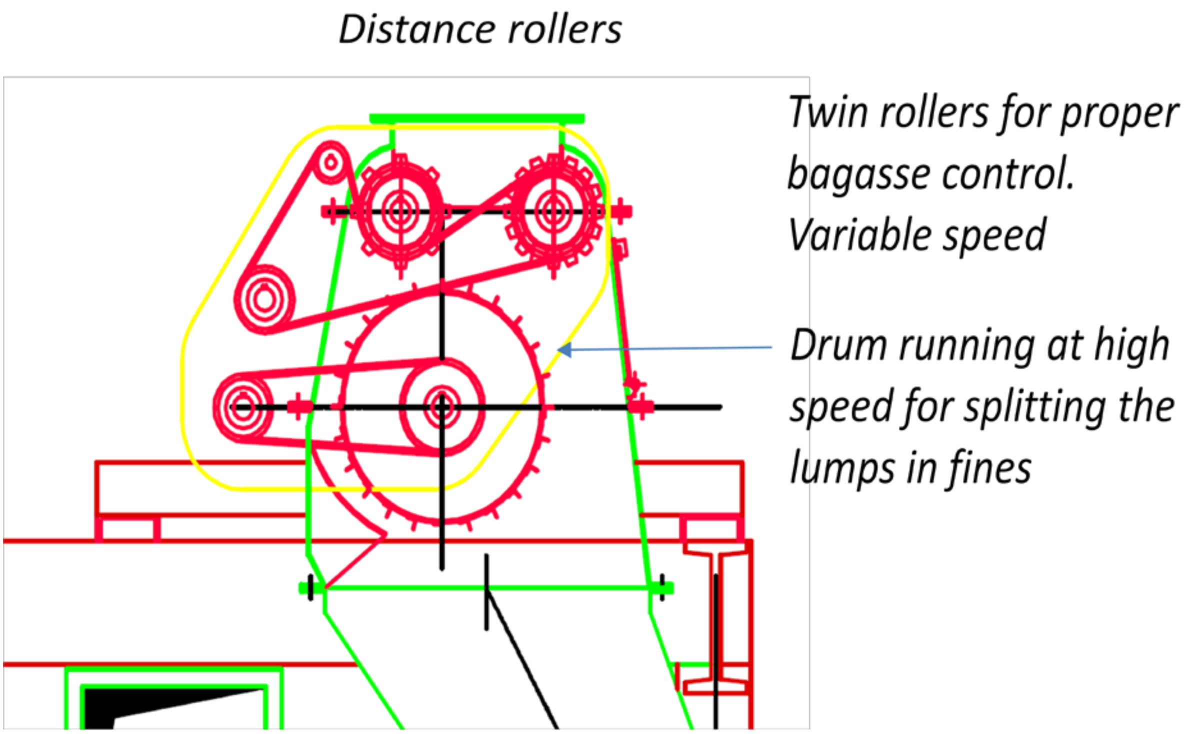
B. Multi drum Feeders:

Multi drum feeders are used and it is experienced that the bagasse amounts can be controlled accurately with this type.

However, important is to keep the centerline of the twin rollers such that the bagasse will not cause a high pressure on the rollers.

The speed of the electromotor of the twin rollers needs to be high enough for proper cooling

The slide valves at inlet of chute needs to have proper rollers for guiding the sliding plate



C. Drum Feeders plus screw conveyor:

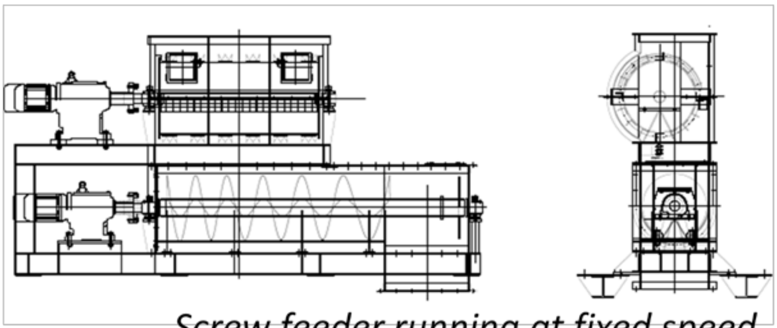
Used in case of requirement for high bagasse storage quantity i.e. 10 minutes.
Silo needs to be polished inside to lower resistance to avoid roof forming. Also opening angle should be sufficient.

The drum needs to be more to the outer side to reduce the pressure from the bagasse column

The teeth on the drum needs to be stronger due to the high friction caused by the weight of the bagasse.

Stones and metals needs to be avoided

Drum feeder with variable speed to control the bagasse flow



Screw feeder running at fixed speed

D. Spreader system:

Usage of cold spreader air supplied by separate fans and rotary valves.
Commissioning needs to be done proper during cold testing.
Observe and optimize the spreading patron of bagasse over the grate section by standing in the furnace.

E. Dumping grate

Some Grate stoker bars and its support shafts broken due to high forces on frame from boiler expansions

Ceramic wool of sufficient thickness should be installed uncompressed around the grate

The grate stoker bars are installed loose on support bars. Can fall out during dumping when clinker is formed.

Clinker needs to be avoided by proper spreading and feeding. If so it should be broken in small pieces before dumping

F. sootblowing:

In between superheaters the soot layer was hard and difficult to remove.

The other heating surfaces had also more fouling then expected.

Commissioning of sootblowers was not done proper.

The pressure downstream poppet valve needs to be set by manually adjusting the disc in the poppet valve.

G. Full closing of dampers at inlet or outlet of fans

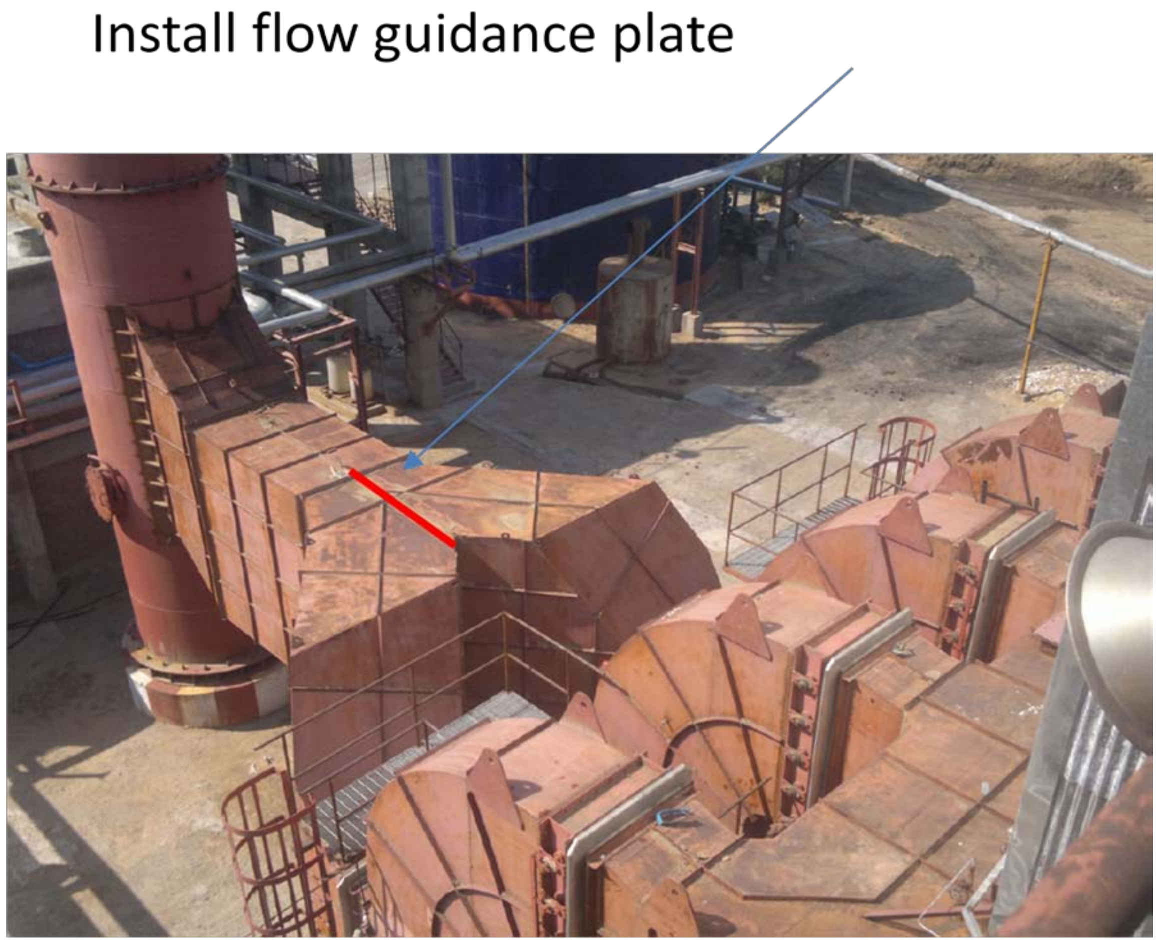
When one fan (2 * 50% fans) stops the damper should close fully in order to prevent anti-rotation.

Needs to be ensured during commissioning

H. Guiding of 2 flue gas streams in one common duct or stack

High pressure drop in case 2 flue gas streams are entering a common duct or stack.

Install guidance plate in case 2 flue gas flows are entering in one common duct or stacks so that they do not impinge.



I. **Fuel air ratio control**:

Air flow is measured in <u>venturi's.</u>

Those need to have no disturbance at inlet and outlet side.

The <u>accuracy</u> of the **air flows** should be ensured during the commissioning.

To <u>ensure correct measurement</u> it should be checked against:

- Steam water flows, pressures and temperatures
- Stack temperatures
- Water content in bagasse
- O_2 and CO_2 measurement at outlet boiler upstream the flue gas air preheater.

Also the <u>bagasse feeder speed</u> should be checked against the capacity.

When those 2 measurements are checked and correctly put in DCS then the <u>air flow ratio control can work properly in automatic mode.</u>

This is very important to guarantee that the operation will be always done at the <u>minimum required excess air in order to run at optimum efficiency.</u>

J. Excess air
The excess air was set at 5 vol% wet (n=1,45).

Smoke was white.

CO content 100 to 150 mg/Nm3

Design was based on excess air n=1,3 means an oxygen content of 3,5 vol% wet. CO content will then close to maximum allowable emission level of 800 mg/Nm3.

By running at excess air of n=1,35 the oxygen content is 4 vol% wet:

- The measured CO content is 350 mg/Nm3.
- Efficiency will improve with 0,7%
- Power consumption decrease with 141 KW.
- Stack temperature 6 C lower
- More margin in the fans

Lesson learned:
Do reduce excess air as far as possible

Reliable operation
The power supply contract require uninterrupted power supply.

Trip in power supply, not complying with power supply contract will results in high penalties.

To comply with power supply contract a power plant require:

- Reliable products which can be ensured by:
  * Proper specifications for enquiry
  * Proper review of quotations
  * design reviews during design stage
  * proper inspections during manufacturing and commissioning
  * proper commissioning and testing

- A very professional operating team which is experienced in power generation.

2. The systems built are all of 60/65 bara pressure. Most likely the future systems to be built will be of 110 bara. What are the reasons for this trend?

In example a 9000 TCD sugar mill
Process steam requirement of 52,7% of cane crushing
Bagasse amount 30,5% of cane crushing
Crop season approx. 120 days

1st stage : one boiler approx. 140 tph plus extraction/condensing steam turbine 25 to 30 MW

2nd stage: duplicate of system plus process steam reduction plus all steam turbines replaced by electric drives

Power generation in case the steam turbine for 64 and 110 bara have the same efficiencies		1st stage	2nd stage 5% process steam saving 50% of cane	2nd stage 10% process steam saving 47,3% of cane	2nd stage 20% process steam saving 42,2% of cane	2nd stage 20%process steam saving min storage
HP system 64 bara	MWH	51900	80700	82800	84500	90000
HP system 110 bara	MWH	58900	99600	101000	102500	105100
Additional power 110 bara	MWH	7000	18900	18200	18000	15100
Additional power in %	%	13,5	23,4	22	21,3	16,8

However, standardized steam turbines models smaller then 50 MW are more efficient at 64 bara then 110 bara. Savings will be less.

Power generation as the steam turbine for 64 bara system is more efficient then for 110 bara		1st stage	2nd stage 5% process steam saving 50% of cane	2nd stage 10% process steam saving 47,3% of cane	2nd stage 20% process steam saving 42,2% of cane	2nd stage 20%process steam saving min storage
HP system 64 bara	MWH	51900	80700	82800	84500	90000
HP system 110 bara	MWH	56000	94600	95800	97200	100000
Additional power 110 bara	MWH	4100	13900	13000	12700	10000
Additional power in %	%	12,9	17,2	15,7	15	11,1
Annual additional revenue	milj PKR	43	146	136,5	133,3	105

We did see that with 10% process saving (result in 47,3 % of cane):

- Additional power with 110 bara system is 18200 MWH with high efficient steam turbine at 110 bara
- Additional annual revenue 191 milj PKR

- Additional power with 110 bara system is 13000 MWH with lower efficient steam turbine at 110 bara
- Additional annual revenue 136,5 milj PKR

Factor of **3** which is interesting as investment.

- The additional investment cost is approx. 400 milj PKR

Note: **The delivery time is approx. 2 months longer**
Purchase the power plant in time

3. Coal firing is an alternative fuel to be fired in the off-season. What are the advantages and disadvantages?

A. The efficiency:

The supercritical system of a power plant has an efficiency of approx. 40% at LHV value

The power plant of a sugar mill running at 110 bara maximum 30% on LHV value
Approx 500 kg coal per MWH required.
Based on 14 PKR per kg the coal costs 7000 PKR per MWH generated.

The fuel amount required for the sugar mill is 33% more then for a power plant

B. The quantity:

The coal quantity required for a large powerplant is 10 to 20 times more.
They can get more attractive prices due to the large quantities

C. The logistics:

The large power plant will be built at a location where coal can be transported with minimum costs to.

Sugar mill is difficult to reach for large coal transports.

For 25 MW approx. 300 tons per day coal is required.

Also the ash needs to be discharged to a safe area. Approx. 45 tons a day for a 25 MW plant.

d. The environment:

The sugar mill is located in the mid of agriculture environment.

The storage of coal and ash have to be done in a proper way in order to avoid fouling of the surface water around the mill.

e. Operation:

The sugar mill runs normally a 120 days a year. The power plant will run full year.

Operators and maintenance group needs to be full year engaged.

f. The investment and delivery time:

For coal firing the investment costs will be clearly higher:

- Storage yard for coal
- Coal crushers, screens and conveyors
- One day Storage silo at boiler
- Coal feeder system
- Travelling grate instead of dumping grate
- Increased height of furnace/boiler
- Thicker pressure part materials
- Larger superheater (additional de-superheater)
- Superheater and steam line of P91 material.
- Electric precipitators
- Ash handling and storage (silo) system

Advantage:

More likely is this option of coal firing when there is also other industry in neighborhood who need the power uninterrupted and suffer from power-cuts.

THANKS