

ANNUAL PSST CONVENTION SEPTEMBER 3 - 4, 2012 KARACHI



CAPACITY - ENHANCEMENT OF BAGASSE - FIRED BOILERS A CASE STUDY OF FCB DESIGN AT FARAN SUGAR MILLS

By,

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INTRODUCTION

1. Faran Sugar Mills commissioned during 1983 with two bagasse-fired boilers of FCB design had initial evaporation capacity of 34 TPH @ 24Kg/cm², 330⁰ C as designed working parameters.
2. Initially both boilers were supplied with economizers as sole heat recovery units without air-heater and ash collecting arrangement.
3. In order to attain efficiency and further capacity enhancement, a well designed road map has been prepared to ascertain desired modifications/implementations at FCB boiler # 2 during off - season 2011 .
4. However, we had raised the generation capacity of Boiler # 1 from 34 - 38 TPH in a first phase during off - season 2009 and further to 40 TPH along with boiler # 2 in the second phase.

WHY THE NEED ARISE FOR MODIFYING?

- Certain parts like economizer (Sole -heat recovery unit) needed to be replaced due to its under rated efficiency. , As a result the temperature of out going gases was increased in stack between 300 - 310 °C Inspite of design 254 °C.
- Poor thermal efficiency due to higher stack loss.

Operational inconsistencies

- Operating the boiler was a difficult exercise, because of heap firing of bagasse in the furnace instead of suspended combustion due to non-availability of air heater hot air.
- Furnace backing was also a problem for boiler and was a safety hazard for the operators on site.
- Persisting ID Fan after the season's campaign reflects badly wearing of impeller parts.

WHY THE NEED ARISE FOR MODIFYING?

- ◉ Due to non -availability of Ash - collecting system, particles were discharging from the stack and creating environmental problem.
- ◉ Besides eroding the areas including, Economizer tubes, Ducting, this caused an involuntary violation of local EPA rules as well.
- ◉ Assessment regarding metal loss due to non-availability of ash collecting system on economizer tube surfaces, ducting, Fans integrals proportional to 2.5th exponent of linear velocity of gases really in the hazardous zone.
- ◉ Plant requirement seeks for capacity enhancement to meets the steam needs regarding higher crushing rates.

CHOICES FROM PROPOSALS FOR ENHANCEMENT

- Steam generation capacity of any solid fuel boiler mainly depends upon its heating surface, grate area, furnace volume and draft system
- There were number of proposals which remained under discussion for capacity enhancement are as follows,
- Extension of tube height through relocation of drums for additional heating surface.
- Furnace wall relocation to increase furnace area and volume as well.
- After, certain discussions, home work & ground realities we had choice expansion without disturbing the drum height and furnace wall due to Furnace area/volume assessment, were sufficient to generate 40 TPH capacity.
- (Furnace Area 21.9 M^2 , Furnace Volume 148 M^3)

ACTIVITIES PERFORMED

In this connection, we have incorporated additional designed pressure parts and allied accessories to ascertain the capacity enhancement such as,

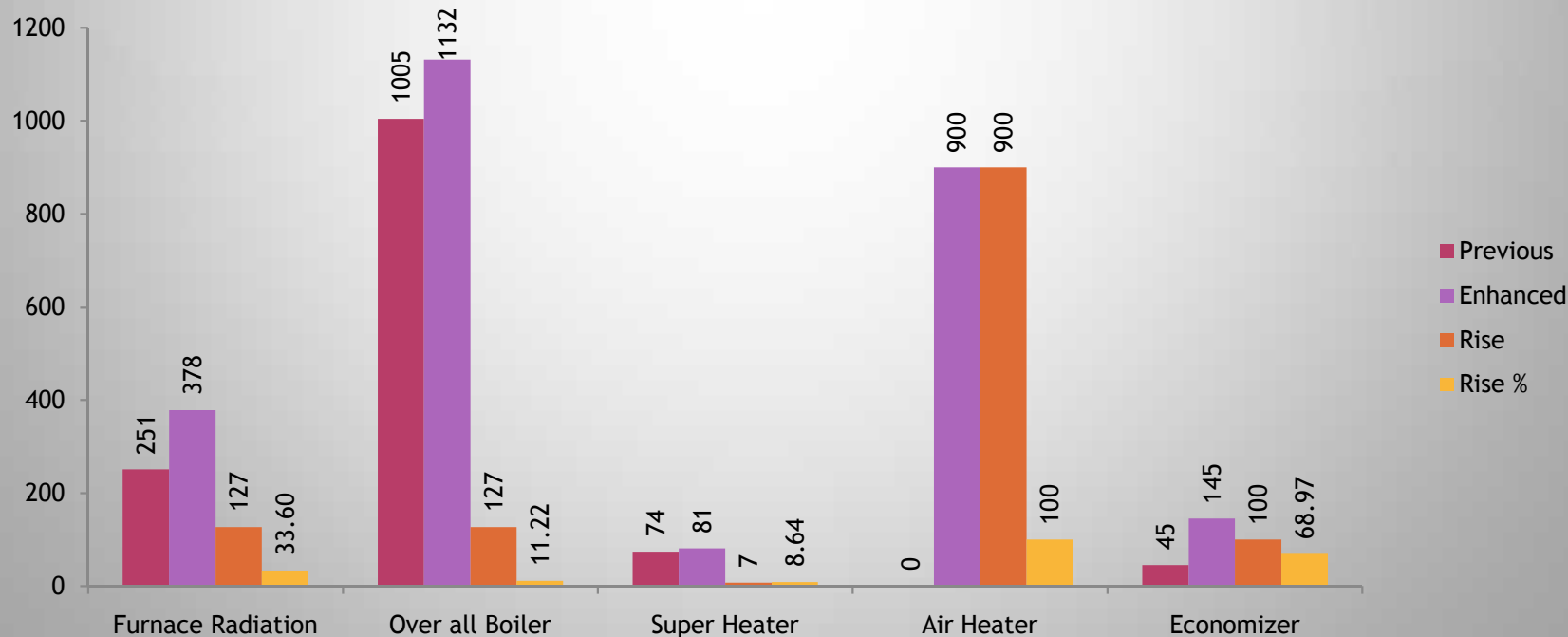
- ◉ Additional Roof header of 273 diameter X 25.4 (T) X 5790 (L) MM
- ◉ Additional 30 numbers of generation tubes of 76.1 MM diameter which connected between steam drum & Front header through incorporated roof header along with previous 31 tubes (Total 61 numbers)
- ◉ Additional 40 numbers of generation tubes of 76.1 MM diameter at both locations (20 Each) of side headers.
- ◉ Additional 02 numbers of Upper Risers of 76.1 MM diameter which connected between steam drum & side headers from top.
- ◉ Five newly fabricated super heater coils were installed to raise its quantity from 55 to 60 of 38.1 diameter X 3.2 (thickness) X 15000 MM length.

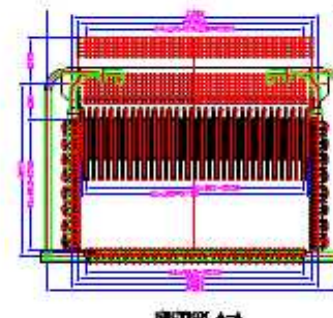
ACTIVITIES PERFORMED

- ◉ Economizer redesigned with additional heating surface from 45 to 145 M^2 . This additional heating surface possibility facilitated by larger air heater space.
- ◉ Air Heater induction of 900 M^2 heating surface
- ◉ Well designed Ash Collecting system to meets 40 TPH boiler producing ash.
- ◉ All draft fans changed with new fans to bear the additional load due to addition of air heater, economizer and dust collector . Additionally, ducting replaced to suit the new fans.
- ◉ Chimney height increased up to 100 feet from 70 feet to facilitate draft.

COMPARISON OF ADDITIONAL HEATING SURFACES AT PROJECTED LOCATIONS IN (M²) WITH PERCENTAGE IMPACT

Description	Previous	Enhanced	Rise	Rise %	Status
Furnace Radiation	251	378	127	33.60	Furnace/Riser
Over all Boiler	1005	1132	127	11.22	Total
Super Heater	74	81	7	8.64	Elements
Air Heater	NA	900	900	100	Heat Recovery
Economizer	45	145	100	68.97	Heat Recovery



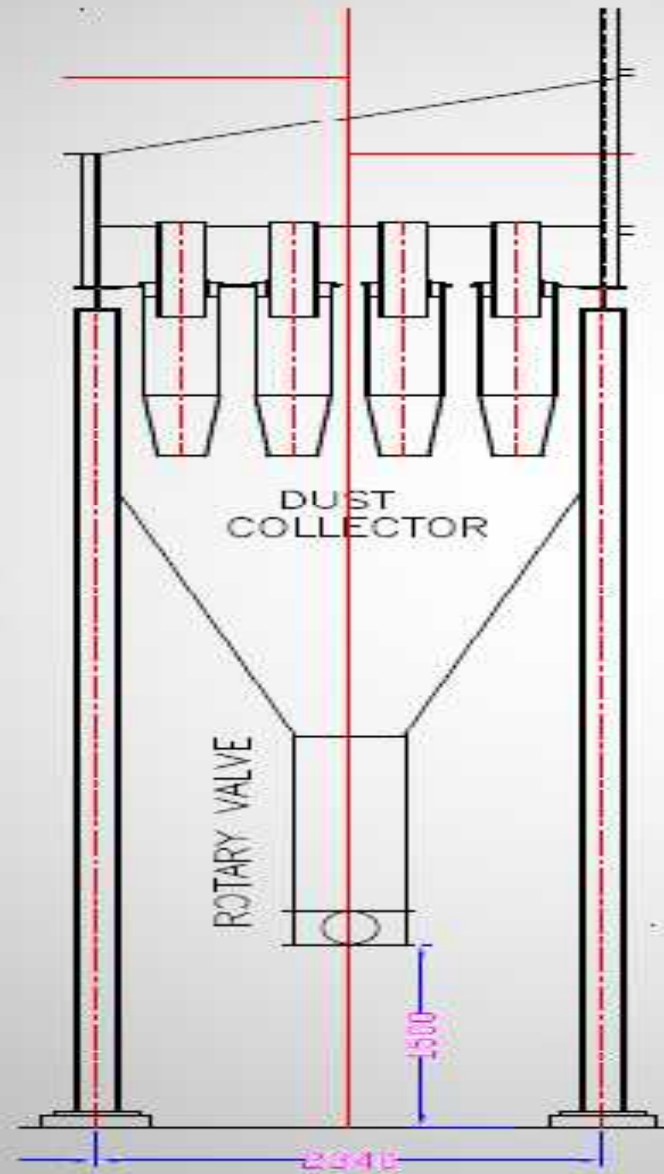


FARAN SUGAR MILLS SHAHEH BIKRU			
ITEM NAME		BOILER MODIFICATION	
CHARGE		ARRANGEMENT (40 T/Hr)	
APPRO			
SCALE	10.00		
AMOUNT		DRG. NO.	PG. 2
DATE	2003.01.01	FOR BLK. NO. 20-02-00	

DESIGNED AND COMMISSIONING CHARACTERISTICS OF ASH COLLECTING SYSTEM

- Dust collector arrangement designed, fabricated and erected to meets the ash production disposal on 5 % based of fuel consumption at MCR.
- However, it is further translates to 909 Kg/hr of ash @ 18181Kg/hr of bagasse consumption.
- 44 numbers of cyclones installed to capture the ash.
- Two numbers rotary valves use to handle the producing ash.

ASH COLLECTING SYSTEM



RE-DESIGNING AND COMMISSIONING CHARACTERISTICS OF ECONOMIZER HAVING ENHANCED HEATING SURFACE FROM 45 TO 145 M²

i. Original boiler economizer replaced with a **newly designed economizer** of greater heating surface, Characteristics are as under,

○ Heating Surface	145 M ²
○ Design of application	Vertical
○ Design working Parameters	34 - 40 Bar, 250 °C
○ Header size	220 X 7.11 X 6000 MM
○ Tube size	50.8 X 3.2 (T)
○ Temperature of gases before Economizer	330 - 340 °C
○ Temperature of gases after Economizer	280 - 285 °C
○ Temperature of gases captured	50 - 55 °C
○ Temperature of water before Economizer	95 - 98 °C
○ Temperature of water after Economizer	115 - 120 °C
○ Temperature Rise	20 - 22 °C
○ Cost of Economizer	Rs.6000 / M ² H.S
○ Unit Cost (Material Plus Labour)	Rs . 0.870 Millions
○ Pay Back	One Season

ECONOMIZER

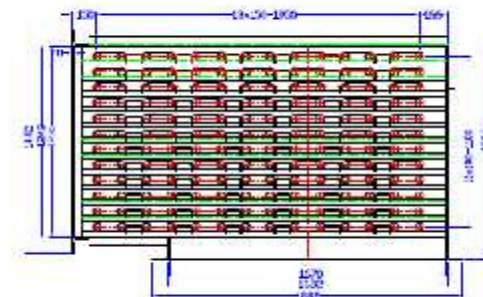
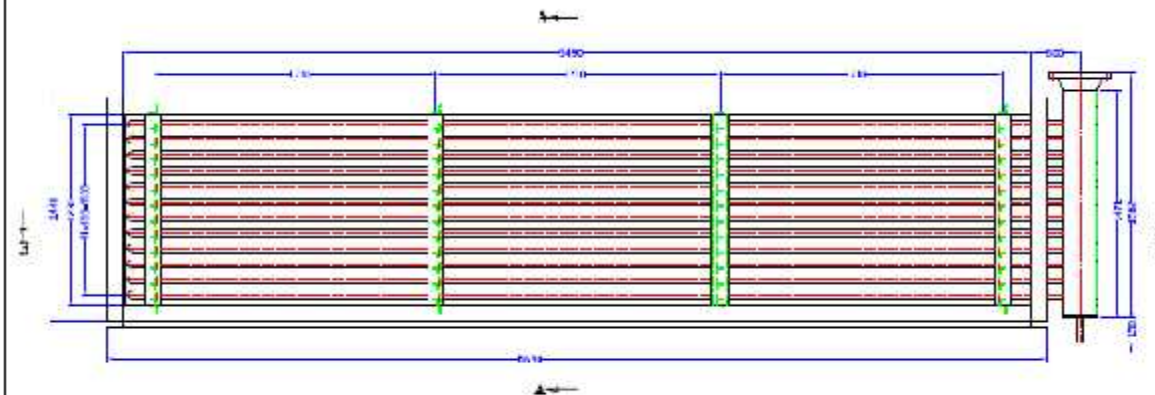
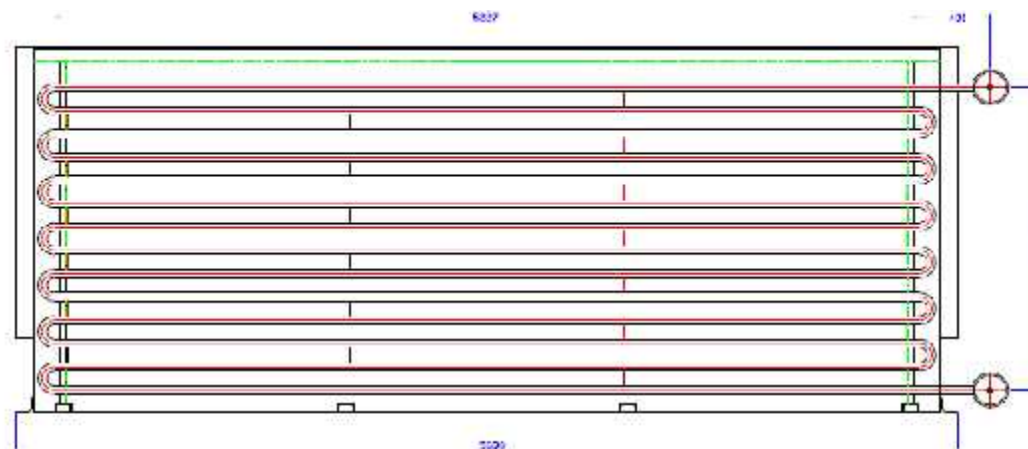
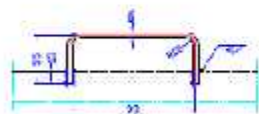


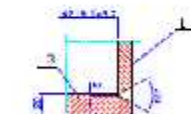
EXHIBIT A A



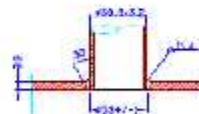
SECTION B-D



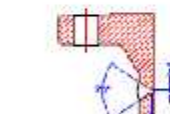
DETAIL FOR ITEM 3



-E&DP T- END FL DETAIL



- BE TO -EADER #ELS DETAIL

NECK & FENN
ALLIANCE

DESIGN DATA

DESIGNED CODE	ASME SECTION 1
OPERATING PRESSURE	28 BAR
OPERATING TEMP	< 250 °C
DESIGNED PRESSURE	34 BAR
DESIGNED TEMP	250 °C
HYDRAULIC TEST PR	51 BAR
MATERIAL	A105-B
HEATING SURFACE	145 SQM

13	100x100x5 L=24H	1	A36	6.2
15	4" C CHANNEL	288	A36	12.8
17	3/8x3/8 L=220H	40	A36	55.0
11	100x50x6 L=100H	4	A36	46.3
10	100x100x12 L=100H	3	A36	47.4
9	PLATE 3/4x157x225H	2	A36	261.3
8	4" XTF 3/4x157x44H	1	A36	34.1
7	PLATE 3/8x100x140H	1	A36	100.0
6	4" XTF 3/4x100x200H	1	A36	562.0
5	4" XTF 3/4x100x270H	1	A36	546.4
4	2" XTF 1/2x92x104Hx12	2	A36	0.6
3	BOTTOM PLATE 100x250H	1	A36	10.1
2	PLATE 3/8x157x150Hx100H	2	A36	82.7
1	TOP PLATE 3/8x157x150H	2	A36	123.7
5.0	DESIGNER	CT	REF	DATE

FARAN SUGAR MILLS SHAIKH BIRKU

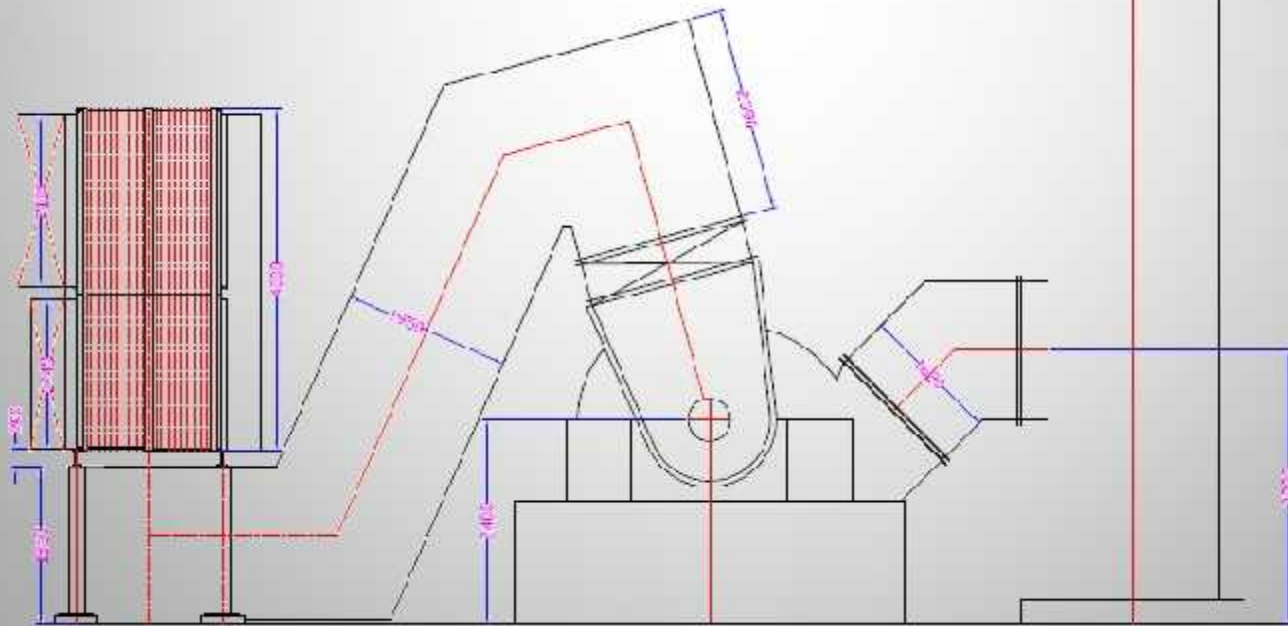
DESIGNED		BOILER MODIFICATION ECONOMIZER	
CHECKED			
APPROVED			
SOLD WEIGHT	5995		DRG. NO
DATE	12/26/01	F5M BLR 02 34-40-13	REV. 0

DESIGNED & COMMISSIONING CHARACTERISTICS OF AIR HEATER

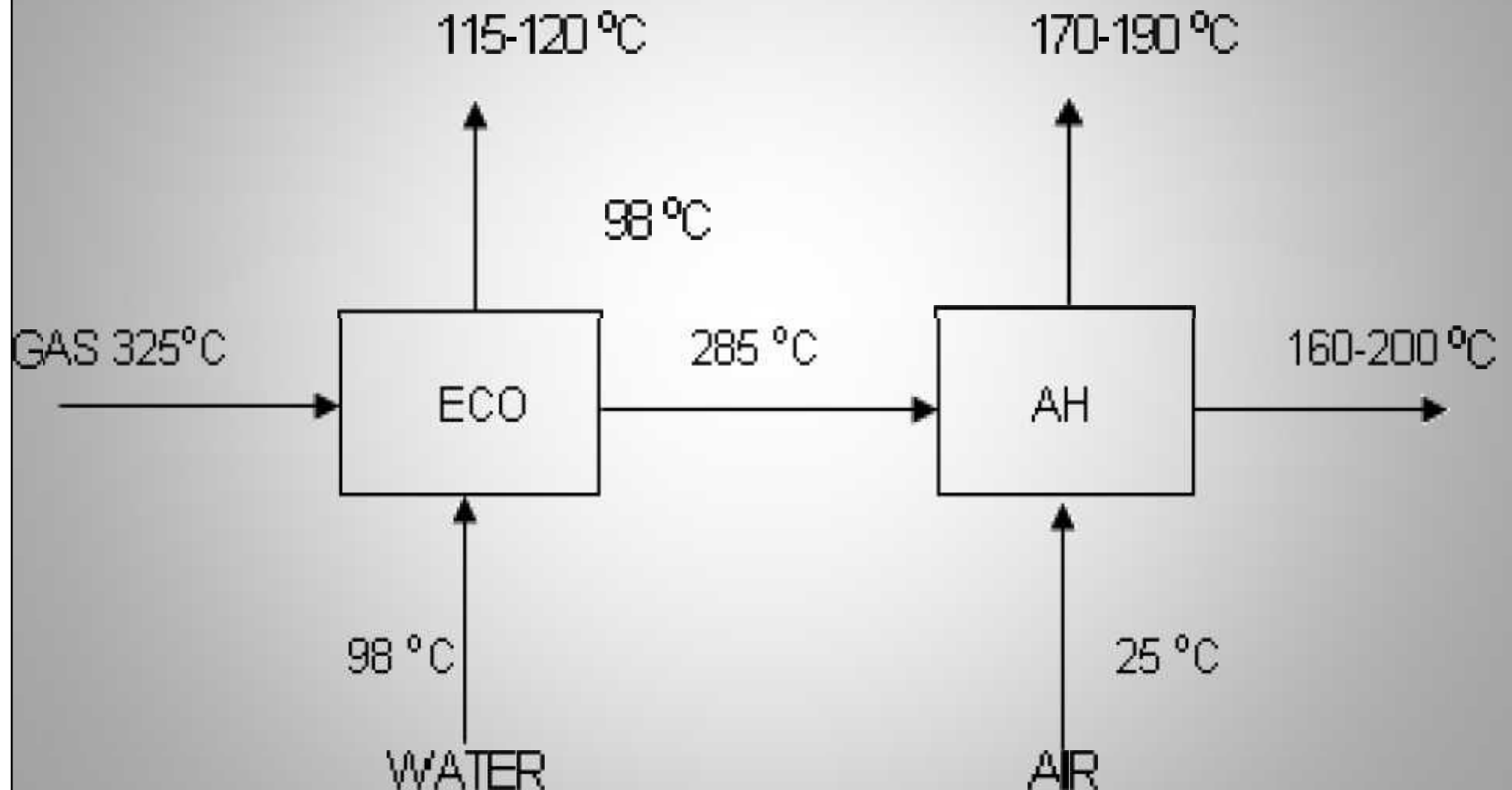
ii. A new FCB- design air heater of appropriate specification has been designed and installed. Their characteristics are as follows,

◉ Heating Surface	900 M ²
◉ Stack out going gas temperature before Air-heater	280 - 285 °C
◉ Stack out going gas temperature after Air-heater	196 - 220 °C
◉ Air heater out let air temperature	135 -151 °C
◉ Ambient air temperature	20 - 30 °C

AIR HEATER



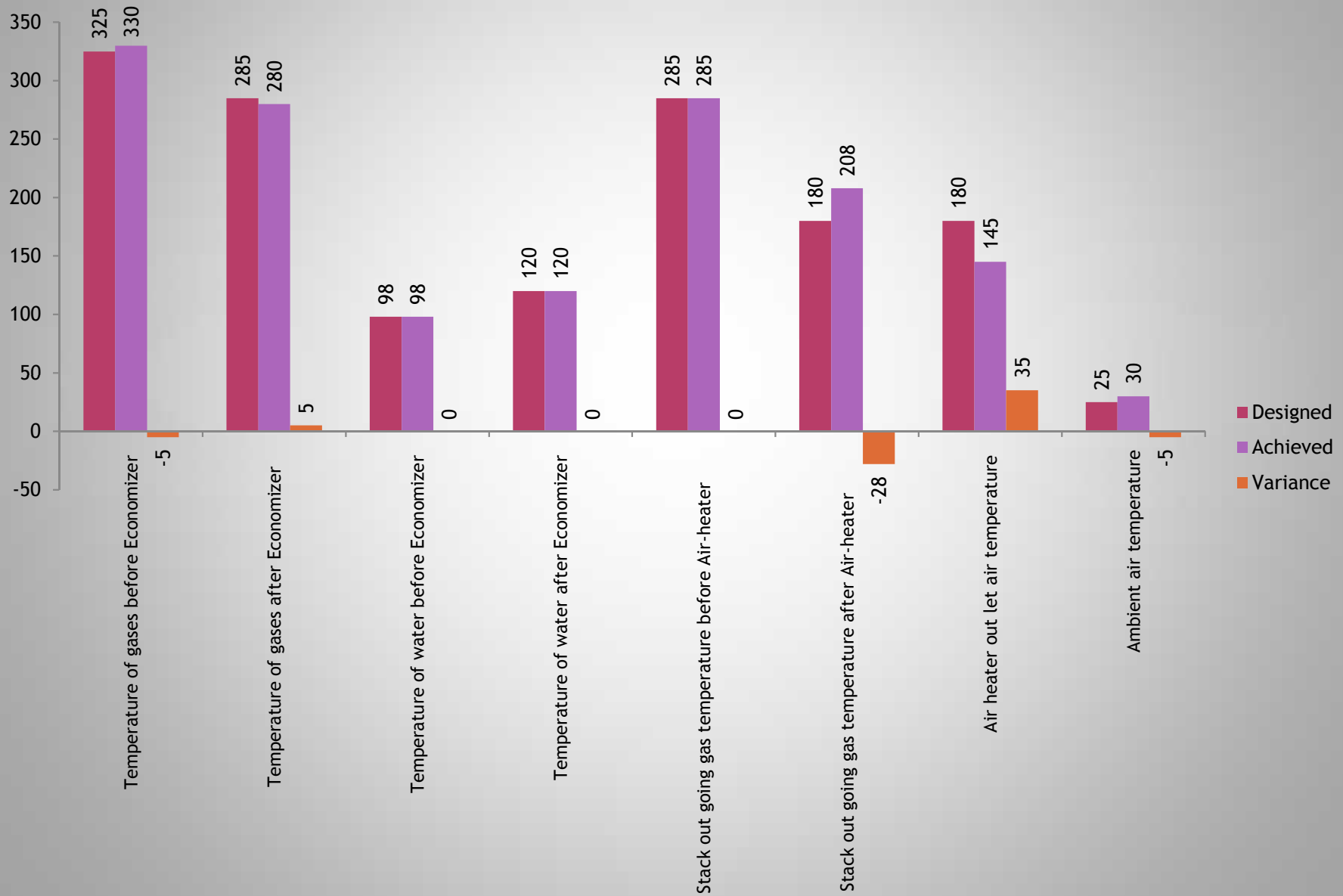
COMBINED DESIGNED TEMPERATURE CHARACTERISTICS FOR ECONOMIZER & AIR HEATER



COMPARISON OF TARGETED AND ACHIEVED TEMPERATURES AT PROJECTED LOCATIONS REGARDING AIR, GASES & FEED WATER IN °C

○ Description	Achieved	Designed
○ Temperature of gases before Economizer	330 - 340 °C	325
○ Temperature of gases after Economizer	280 - 285 °C	285
○ Temperature of water before Economizer	95 - 98 °C	98
○ Temperature of water after Economizer	115 - 120 °C	115-120
○ Stack out going gas temperature before Air-heater	280 - 285 °C	285
○ Stack out going gas temperature after Air-heater	196 - 220 °C	160 -200
○ Air heater out let air temperature	135 -151 °C	170 -190
○ Ambient air temperature	20 - 30 °C	25

COMPARISON OF TARGETED AND ACHIEVED TEMPERATURES AT PROJECTED LOCATIONS REGARDING AIR, GASES & FEED WATER IN °C

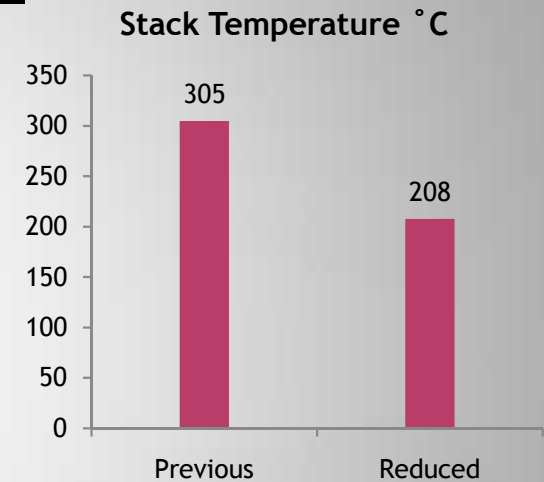


CHARACTERSTIC OF FAN & POWER ENHANCEMENT

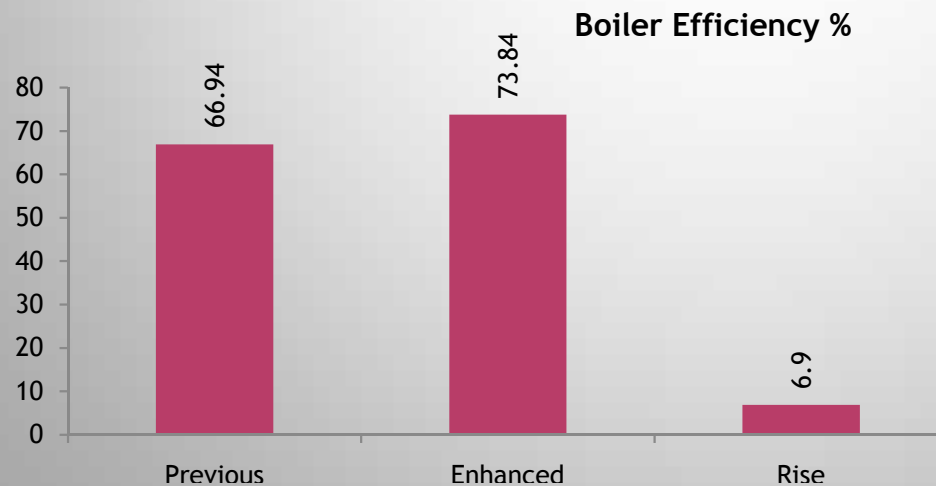
DESCRIPTION	BEFORE MODIFICATION (DESIGNED)	AFTER MODIFICATION INSTALLED WITH VFD
ID Fan motor power	110 KW	250 KW
FD Fan motor	25 KW	110 KW
SA Fan Motor	22 KW	45 KW
Total Power	157 KW	405 KW
Excess Power	248 KW	

RESULTS, DISCUSSION AND ACHIEVEMENTS

1. Temperature of out going Gases to stack restricted within range of 196 - 220 °C against 300-310 °C.



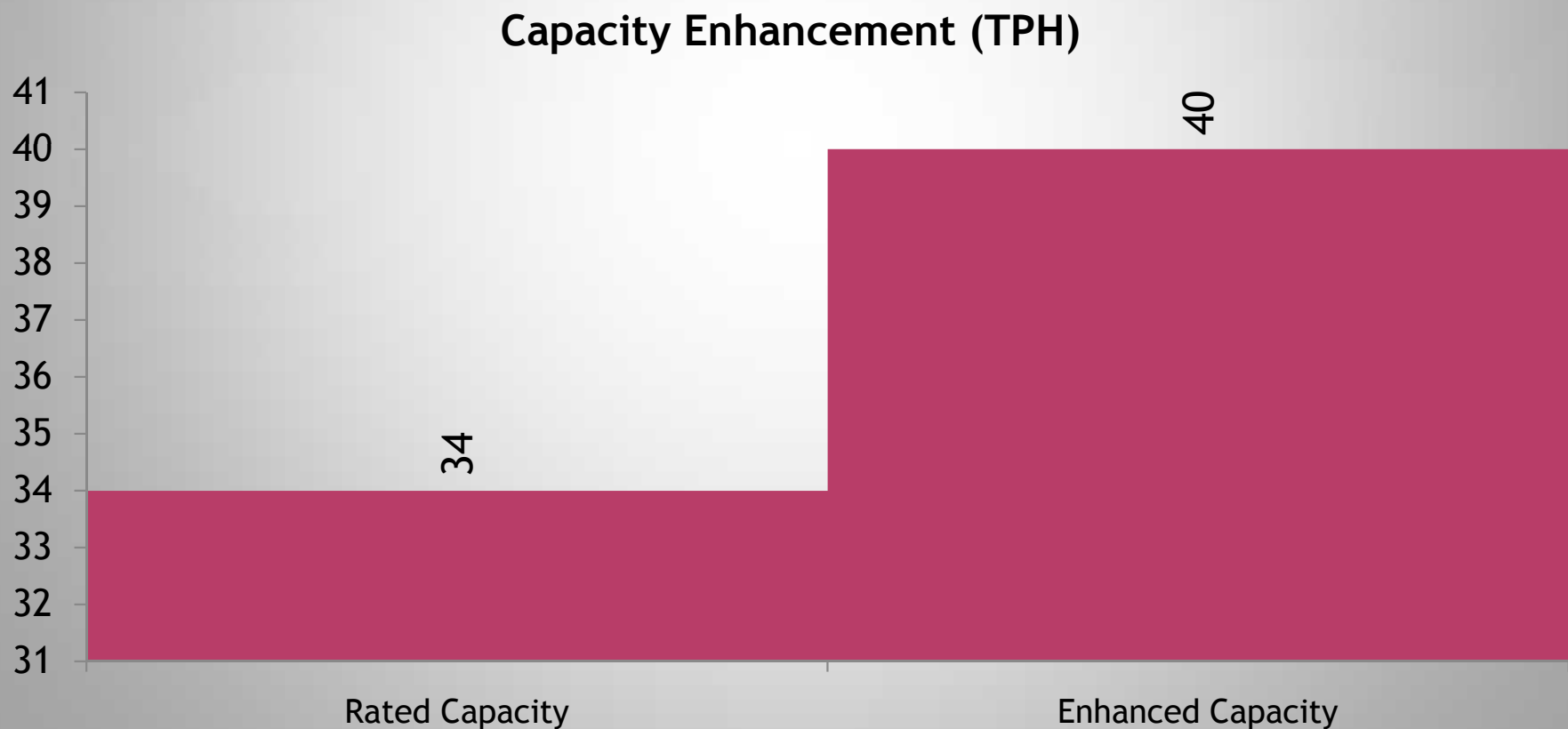
2. Boiler efficiency increased by 6.9 %



RESULTS, DISCUSSION AND ACHIEVEMENTS

1. Boiler capacity enhanced to 6 TPH from,

34  40TPH.

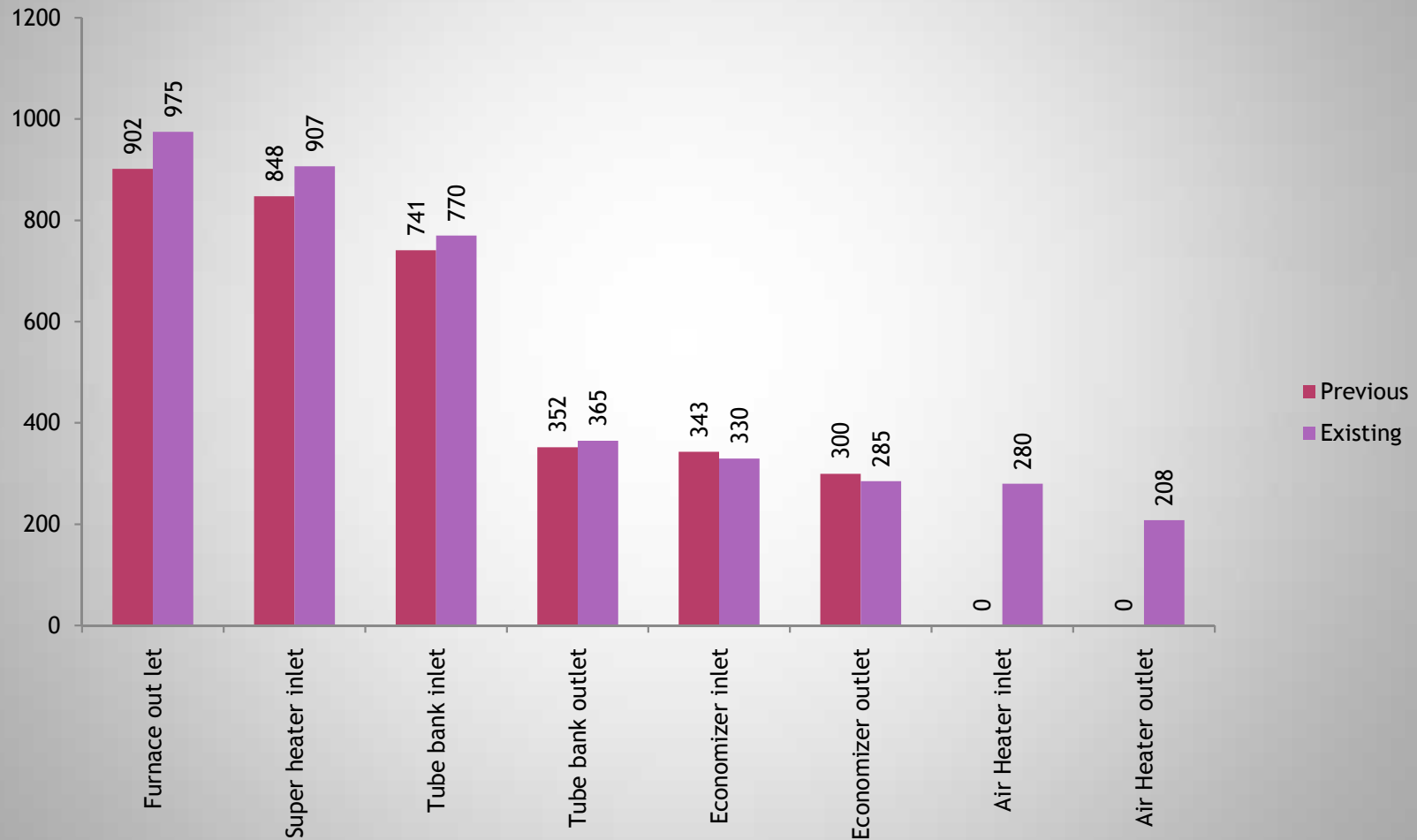


FURNACE FLAME STABILITY AND IMPROVED COMBUSTION

1. Operational difficulties have been overcome to certain extent. Boiler is operating smoothly, no backing and heap firing observed. Quality of flame remained satisfactory. Temperature around 950 - 1000°C achieved.



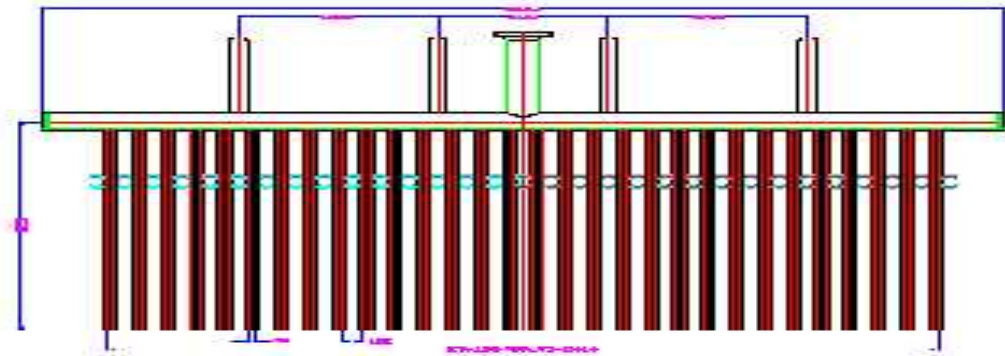
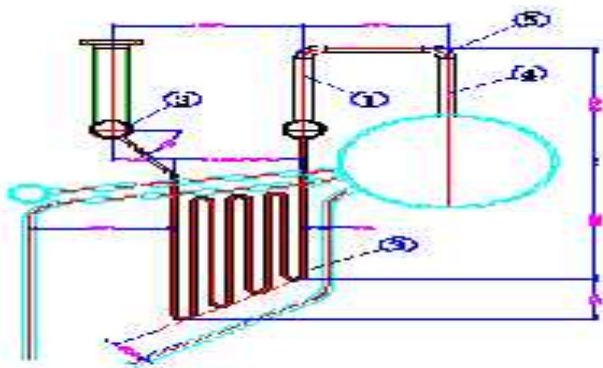
IMPACT OF HEATED AIR PROVISION DUE TO INDUCTION OF AIR HEATER IN TO THE FURNACE INSTEAD OF AMBIENT, COMBUSTION IMPROVED WITH FLUE GASES TEMPERATURES AT ENTIRE LOCATIONS OF HEAT TRANSFER. THIS FINALLY ENHANCE EFFICIENCY.THEIR COMPARISON FOR PREVIOUS & EXISTING GAS SHOWN



RESULTS, DISCUSSION AND ACHIEVEMENTS

1. Dust - collector is working excellently thereby proving the apex capacity of the installed equipment; one of the significant aspects observed was the quantity of ash carried over to stack also controlled ,which is termed as eco-friendly.
2. Inspite of 248 KW excess power consumption, we have attained an extra 6 TPH steam. Bagasse consumption has also reduced due to increase in boiler efficiency.
3. ID Fan installed with improved material of Hardox - 500 which have significantly wear resistance against erosion.
4. Bagasse to Steam ratio improved from 1.81  1.99
5. Bagasse Consumption reduce 1.69 TPH for unit TPH of Steam generation.
6. Pay back 3 - 4 Years @ 4056 Tons of bagasse saving per season.

TEMPERATURE OF SUPER HEATED STEAM RAISED 7 - 10°C. DUE TO ADDITION OF SUPER HEATER ELEMENTS ITS ENSURED 350°C



1	DESIGNER	DATE	10-10-11	1	APPROVED
2	BY	DATE	10-10-11	2	APPROVED
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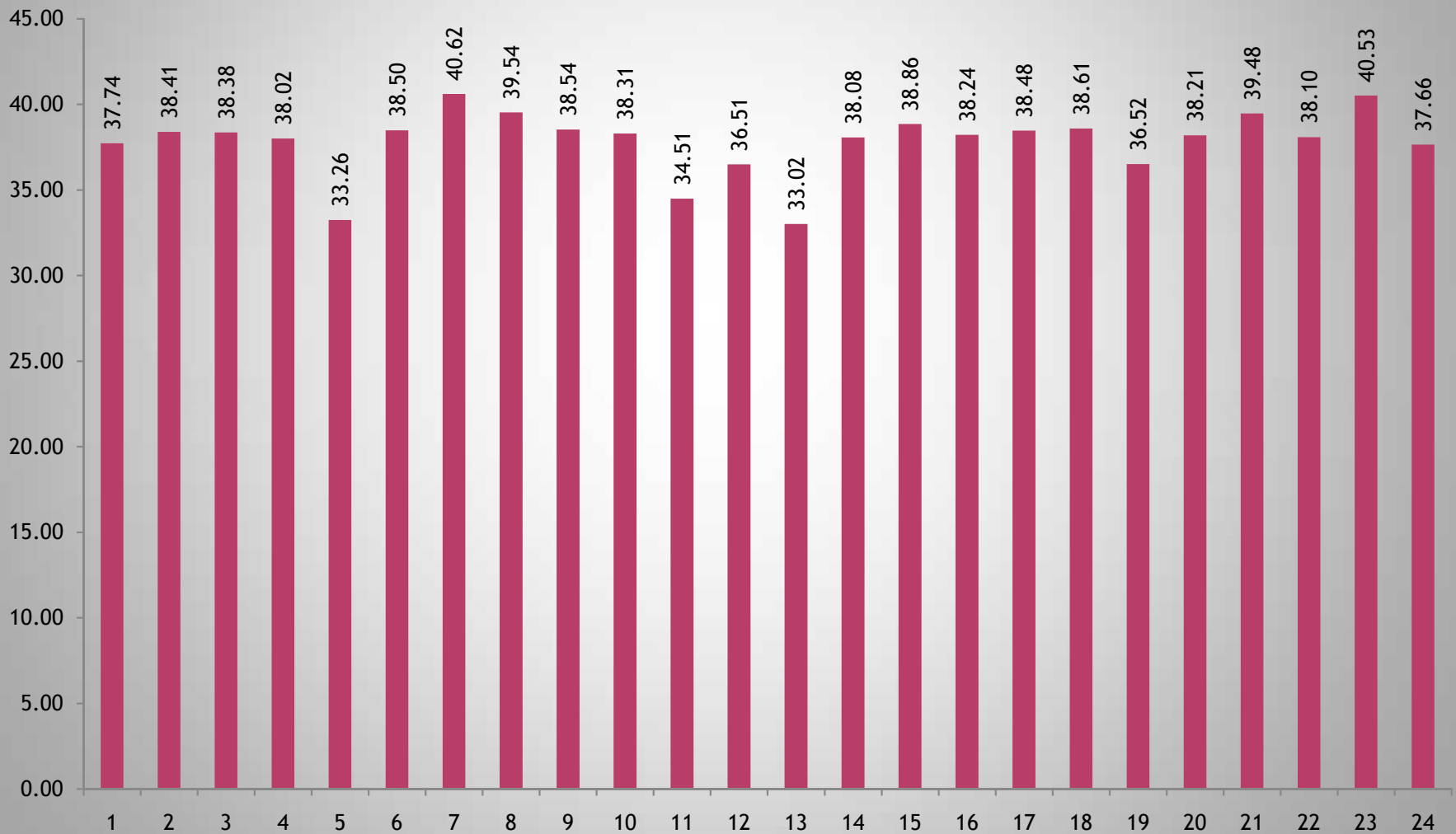
FARAN SUGAR MILLS SHAIKH BIRKU			
SUPER HEATER ADJUST			
DATE	BY	DATE	BY
10-10-11	10-10-11	10-10-11	10-10-11

IMPROVED COMBUSTION RESULTED DUE TO EFFICIENT DRAFT CONTROL PARTIALLY CONTRIBUTED BY EXTENSION IN CHIMNEY HEIGHT FROM 70 - 100 FEET.



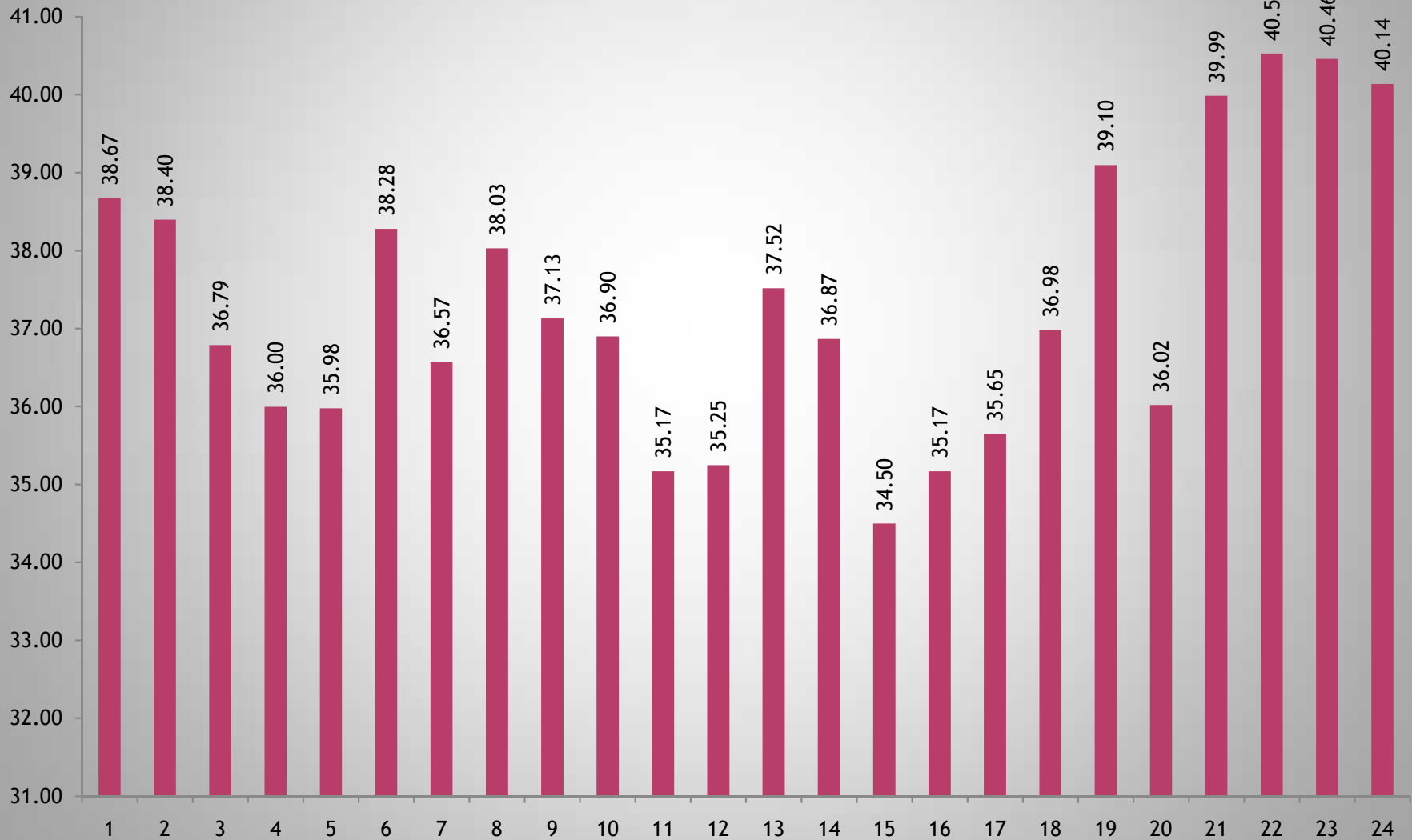
RECORDED DATA FOR STEAM FLOW DURING SEASON 2011 - 12 (SHEET 1)

29-Jan-12



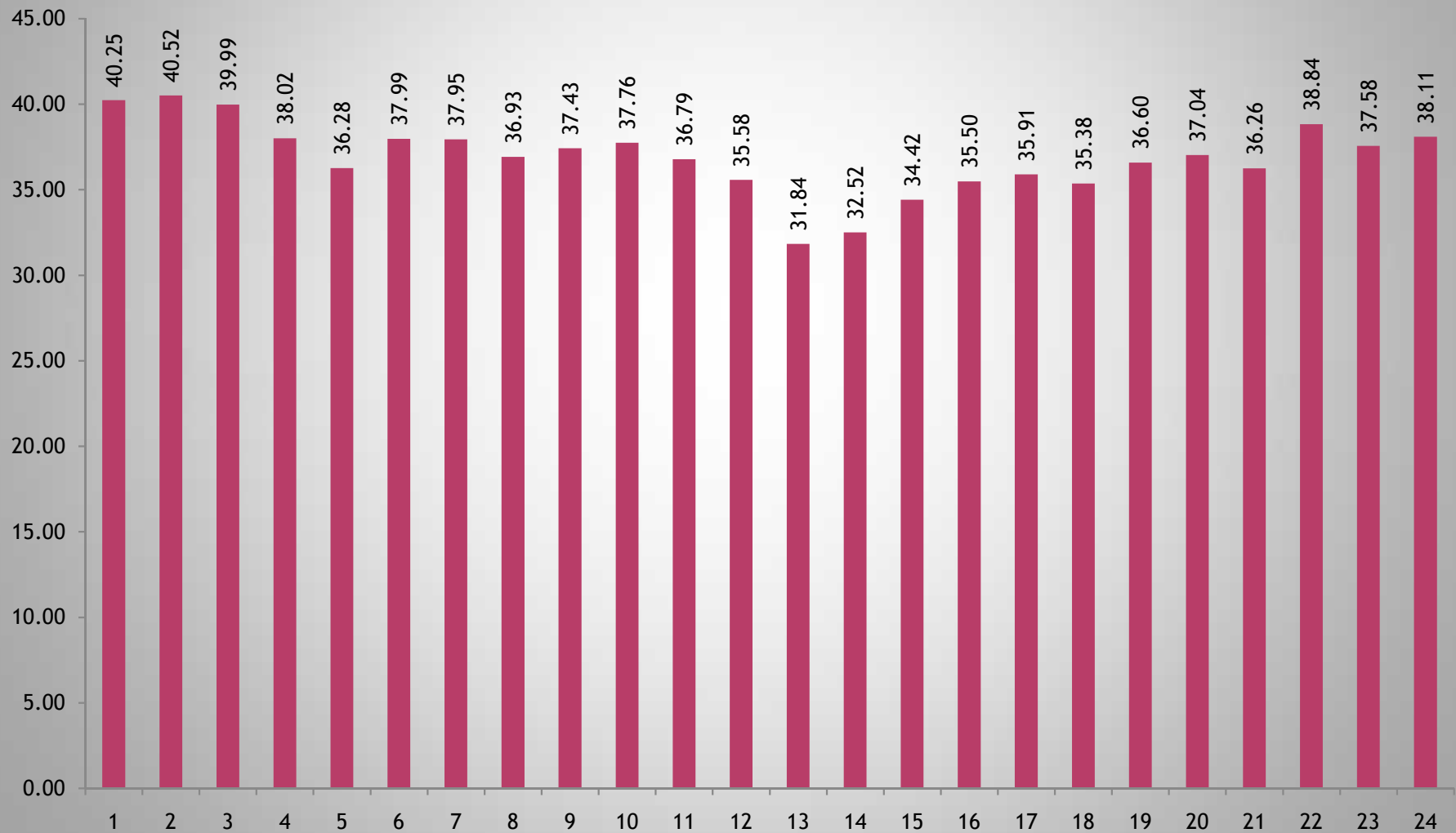
RECORDED DATA FOR STEAM FLOW DURING SEASON 2011 - 12 (SHEET -2)

30-Jan-12



RECORDED DATA FOR STEAM FLOW DURING SEASON 2011 - 12 (SHEET- 3)

31-Jan-12



CONCLUSION

Entire activities sum - up as follows,

1. Capacity Enhancement within safe working limits.
2. Improved Efficiency with operational consistency
3. Justified Environment measures.

ACKNOWLEDGEMENT

First of all I am thankful of Almighty Allah who gave us courage during the entire activity. Here, I cannot forget the role of Late Mr. Raza Ali Khan (Ex-Technical Adviser) & Mr. R.J. Suleri (General Manager) of Faran Sugar Mills, both of them supported us incredibly to make completion of massive BMRE activities & subsequent commissioning during season 2011-12. The author is also grateful for the Management support and confidence. In the last but not least, I am really appreciating the efforts & commitment of our technical team who always contributed from the front. Therefore, cumulative efforts facilitated us to reach towards targeted results.

REFERENCES

- ◉ FCB Manual for bagasse fired boilers 34 TPH Boilers)
- ◉ Design documents for up grading from 34 to 40 TPH FCB boiler
- ◉ FSML Operational data for boilers (Season 2011 – 12)
- ◉ Commissioning and season's recorded data FSML.
- ◉ Article entitled as Design & maintenance aspects for prevention of Pressure parts failure in sugar plant steam generators by S. Sridharan

*THANKS FOR PATIENCE
HEARING*