INCREASING PLANT AVAILABILITY AND OPTIMISING FUEL OIL CONSUMPTION AT ADANI POWERPLANT MAHARASHTRA LTD

BY

NAME: RAVADA V S MURALISRINIVAS
SAP NO/REGN NO: 500024874

GUIDED BY
VIKAS VERMA
ASSOCIATE MANAGER
ADANI POWER MAHARASHTRA LTD

DISSERTATION REPORT SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR

EXECUTIVE MBA (POWER MANAGEMENT)

OF

UNIVERSITY OF PETROLEUM & ENERGY STUDIES, INDIA

CENTRE FOR CONTINUING EDUCATION
UNIVERSITY OF PETROLEUM & ENERGY STUDIES, DEHRADUN

Acknowledgement

This is to acknowledge with thanks the help, guidance and support that I have received during the Dissertation.

I have no words to express a deep sense of gratitude to the management of ADANI POWER MAHARASHTRA LTD. for giving me an opportunity to pursue my Dissertation, and in particular VIKAS VERMA , for his able guidance and support.

I must also thank VIKAS RANJAN for his valuable support.

Signature

Name of the Student : V S MURALI SRINIVAS R

Residential Address : Adani Power Maharashtra Ltd
Plot A-1,Tirora Growth Centre
MIDC Area, Tirora
Dist Gondia 441911
Maharashtra, India

Telephone/Mobile : 9951445557

e-mail : vsms.ravada@gmail.com

Date : 22/10/2015

Place : Gondia

adani

Declaration by the Guide

This is to certify that the **Mr RAVADA V S MURALI SRINIVAS**, a student of **Executive MBA(POWER MANAGEMENT),** Roll No **500024874** of UPES has successfully completed this dissertation report on "**INCREASING PLANT AVAILABILITY AND OPTIMIZING FUEL OIL CONSUMPTION AT ADANI POWER PLANT MAHARASHTRA LTD.**" under my supervision.

Further, I certify that the work is based on the investigation made, data collected and analyzed by him and it has not been submitted in any other University or Institution for award of any degree. In my opinion it is fully adequate, in scope and utility, as a dissertation towards partial fulfillment for the award of degree of Executive MBA.

Signature

Name & Designation : VIKAS VERMA, Associate Manager

Address : Adani Power Maharashtra Ltd
Plot A-1,Tirora Growth Centre
MIDC Area, Tirora
Dist Gondia 441911
Maharashtra, India

Mobile : 9764314139

e-mail : vikasy.verma1@adani.com

Date : 22/10/2015

Place : Tirora

Adani Power Maharashtra Ltd
Plot A-1,Tirora Growth Centre
MIDC Area, Tirora
Dist Gondia 441911
Maharashtra, India

Tel +91 7198 25 3961
Fax +91 7198 253971
info@adani.com
www.adani.com

TABLE OF CONTENTS

ABSTRACT

Adani Power Maharashtra Ltd. Thirora is a coal based thermal power plant which has completed COD of 5 Units by 2014, Looking forward it is aimed to make all the units available by 100% with reduced fuel oil consumption during startups and emergencies. This Dissertion is about installation of Micro Oil Gun and Operational changes for meeting the Goals.

Installation Of Micro Oil Gun:

In a coal based power plant, coal is available at minimum cost. Using coal during start up is always a better idea. Micro Oil Gun uses coal & little oil for light up / startup of boiler. This fuel system has to be installed in unit#1. This dissertation is to verify whether the payback period & feasibility of the system is according to the manufacturer during start up (both hot and cold). Based on the results, establishing the same to unit#2,3,4&5.

Operational Changes To Decrease The Number Of Shut Downs Due To Exfoliation:

Operating plant at rated temperatures provide maximum efficiency but this is causing Exfoliation in Thirora boilers, reducing the plant availability, Generation Loss and increasing the number of shut downs. A suggestion from SANGHAI Boiler Manufacturer is to have operational changes(Main Steam & Hot Re-Heat Steam Temperature Reduction by 10 degree Celsius), this dissertation is to study the feasibility as it involves both plant efficiency reduction and rise in plant availability in unit#1,2,3,4&5 at thirora site.

PURPOSE OF DISSERTATION

The present situation of each unit in **Adani Power Maharashtra Ltd.** Thirora:

a. Average shut down of each unit in a year due to exfoliation is 6/year.
b. Specific oil consumption of plant is 0.240 ml per Kwh generated.

The purpose of this dissertation is to:

a. Decrease the shutdown of unit due to exfoliation which eventually raise the availability and PLF of unit.
b. Decrease the specific oil consumption of plant by installation of Micro Oil Gun.

1. REVIEW OF LITERATURE

ADANI POWER MAHARASHTRA LTD. 3300MW (2*660MW Phase-1 + 1*660MW Phase-2 + 2*660 MW Phase-3) , Thirora is a coal based super-critical power plant producing power for Maharashtra state utilization. The Boiler, Turbine and Generator specifications are as follows:

GENERATOR SPECIFICATIONS

Rating : 776.5 MVA
Active Power : 660 MW
Stator Voltage : 22 kV
Stator Current : 20377 A
Power Factor : 0.85(lagging)
Hydrogen Pressure : 0.45 MPa
Number of phase : 3
Stator winding connection : Y Y
Short Circuit Ratio : 0.518
Dew point at Hydrogen : 25 °C to 0 °C

Weight

Stator : 337 T
Rotor : 71 T
Each end bracket : 5.5 T
Each set of Hydrogen cooler : 4.3 T
Each set cooler cooling : 12.4 T
Seating Plates : 4.6 T
Gland seal/ Bearing weight of each : 0.02/0/87 T
Lead box : 6.3 T
Total weight of Generator : 502 T

EXCITER

No load field current : 1497 A
No load field Voltage : 150 V
Rated field current : 4669 A
Rated field voltage : 491 V

VENTILATION PARAMETERS

Fans : Axial fan on each end of rotor shaft
Fan total pressure : 45.08 Pa (Equivalent in air)
Total volume : 40.5 m^3/s
Hydrogen inlet temperature : ≤ 16 °C

HYDROGEN COOLER

Rated Hydrogen cooler capacity : 5000 kW
Water inlet temperature : 35 °C
Water outlet temperature : ≤ 46 °C
Hydrogen pressure drop : 750 Pa
Volume of cooling water required : 900 m^3/h
Cooling water pressure drop : 0.2~ 0.23 MPa
Maximum cooling water inlet Temperature : 50°C

BOILER SPECIFICATIONS

General Description:

Super-critical, once through intermediate single reheat
Single furnace, double pass, outdoor, fully steel structure
Four corner tangential firing
3 layers of HFO, 1 layers of LDO
Eight HP coal mills
SH temperature control by coal/water ratio and attemperation
RH temperature control by flue gas damper at rear pass and excess air coefficiency
Model : SG-2111/25.4 - M986
2111 t/h supercritical pressure once through boiler
Serial Number: 986-1-8608
Manufacturer: Shanghai Boiler Works

2.6.21.1). BOILER DESIGN PARAMETER							
Sl. No.	Description	Unit	BMCR	BRL	60%BMCR	40% BMCR	HPO
			Constant Pressure		Sliding Pressure		Constant Pressure
1	Main Steam Flow	t/h	2111	1991	1267	845	1740
2	Main Steam Outlet Pressure	MPa.g	25.40	25.28	18.87	17.10	25.02
3	Main Steam Outlet Temperature	°C	571	571	571	571	571
4	Reheat Steam Flow	t/h	1749.1	1661.8	1091.8	739.8	1708.2
5	Reheat Steam Inlet Pressure	MPa.g	4.70	4.43	2.93	1.96	4.68
6	Reheat Steam Outlet Pressure	MPa.g	4.45	4.19	2.76	1.85	4.44
7	Reheat Steam Inlet Temperature	°C	324	318	313	293	327
8	Reheat Steam Outlet Temperature	°C	569	569	569	553	569
9	Feed-water Temperature	°C	283	279	254	231	191
10	Economizer Inlet Pressure	MPa.g	29.40	28.93	20.88	18.10	27.83

Start-up time and allowable start-up in 30 years:

Start	**Start-up time**	**Shut Down time**	**Allowed No.**
Cold start	5~6 hrs	> 72 hrs	300
Normal Start	2~3 hrs	< 72 hrs	1200
Hot Start	1~1.5 hrs	< 8 hrs	4500
Extreme Hot Start	< 1 hr	< 1 hr	300

Turbine Specifications

01. TURBINE TECHNICAL SPECIFICATIONS & PARAMETERS		
SR. NO	DESCRIPTIONS	VALUE / SPECIFICATIONS
1	TYPE	SUPERCRITICAL PRESSURE SINGLE SHAFT, TANDEM COMPOUND THREE CYLINDERS, FOUR FLOW EXHAUSTS, REHEAT CONDENSING TURBINE
2	Manufacturer	STC (SHANGHAI TURBINE CO., LTD)
3	MODEL	N660-24.2/566/566
4	Design	Westinghouse Electric Corporation USA
5	Rotate speed	3000 rpm
6	Rotate direction (from steam turbine to generator	Clockwise
7	Rated Power	660 Mw (TMCR Working Condition)
8	Maximum Power	698 Mw (VWO Working Condition)
9	Rated main steam pressure	24.2 MPa (a)
10	Rated main steam temperature	566 °C
11	Rated main steam input quantity	1959 t/h
12	Rated pressure at exhaust outlet of high pressure cylinder	4.401 MPa (a)
13	Rated temperature at exhaust outlet of high pressure cylinder	315.3 °C
14	Rated pressure at reheating steam inlet	3.961 MPa (a)
15	Rated temperature at reheating steam inlet	566 °C
16	Rated reheating steam input quantity	1649 t/h
17	Rated exhaust pressure	10.13 MPa (a)
18	Designed cooling water temperature	32 °C
19	Final water supply temperature (working condition on nameplate)	279.3 °C
20	Heat rate (Steam turbine heat consumption checks TMCR working condition)	7960 kJ/kW.h
21	Max. back pressure value allowed by the steam turbine	18.6 kPa (a)
22	Grade of steam extraction	Grade 8 (3 high, 4 low, 1 deoxidization)
23	Time cost from no load to full load during cold startup	157 min
24	Outline dimension of the steam turbine (L×W×H)	27.7×11.5×7.93 m
25	Total length of the unit (including the shell)	27.7 m
26	Max. width of the unit (including the shell)	11.5 m
27	Height of highest dot pitch operation floor of the equipment	7930 mm
28	Total internal efficiency of steam turbine	88.60%
	Efficiency of high pressure cylinder	86.00%
	Efficiency of intermediate pressure cylinder	90.80%
	Efficiency of low pressure cylinder	87.90%
29	Final Stage Blade Height	905.5mm

STAGE's OF SHANGHAI TURBINE		
SR. NO	DESCRIPTIONS	VALUE / SPECIFICATIONS
1	High pressure Cylinder	1 (one) Single row governing stage + 11 (eleven) pressure stages
2	Intermediate pressure Cylinder	8 (eight) pressure Stages
3	Low pressure Cylinder	2 (two-LP Turbine) X (2X7) pressure Stages

CHARACTERISTIC DATA OF STEAM TURBINE				
SR. NO	Working condition Items	Unit	TMCR 100 %	VWO CONDITIONS
1	Power	MW	660	698
2	Heat rate	kJ/kWh	7960	7891
3	Main steam pressure	MPa(a)	24 2	24.2
4	Reheat steam pressure	MPa(a)	3.961	4.239
5	Temperature of main steam	•C	566	566
6	Exhaust temperature of high pressure cylinder	•C	315 3	323.1
7	Temperature of reheat steam	•C	566	566
8	Flow of main steam	kg/h	1959257	2101774
9	Flow of reheat steam	kg/h	1649063	1761190
10	Exhausting pressure of high pressure cylinder	MPa(a)	4.401	4.71
11	Exhausting pressure of intermediate pressure cylinder	MPa(a)	1.12	1.196
12	Exhausting pressure of low pressure cylinder	MPa(a)	10 13	10.13
13	Exhausting flow of low pressure cylinder	kg/h	1148011	1215018
14	Water supply rate	%	0	0
15	Water supply temperature in the outlet of last stage high pressure heater	•C	278.3	283 2

BACK GROUND

MICRO OIL GUN PRINCIPLE

The Micro-oil Ignition technology is the application of **Enhanced Oil Firing Technology** which uses small quantity of fuel oil, high compressed air for atomization & gasification of oil releasing sufficient high heat flame (1600~1800 °C) .

The pulverised coal passes through specially designed coal burner, the high heat oil flame & absorbs the heat (staged Combustion), releases volatile matter & quickly burns. Thus enabling the combustion of coal particles in the very beginning of boiler ignition (i.e Cold State of Boiler)

After the light-up & Normal Operation the new coal burner will act as the original burner with the same performance.

WHAT IS ENHANCED OIL FIRING TECHNOLOGY

The Enhanced Oil Firing technology consists of a small quantity of fuel oil is atomized into oil mist with high compressed air & ignited by spark ignition device in a very short time.The wall temperature of the oil combustor will increased rapidly & due to its heat absorbing & storing property of the material, rapid gasification of oil takes place & accelerate oil firing & produce high temperature oil flame.

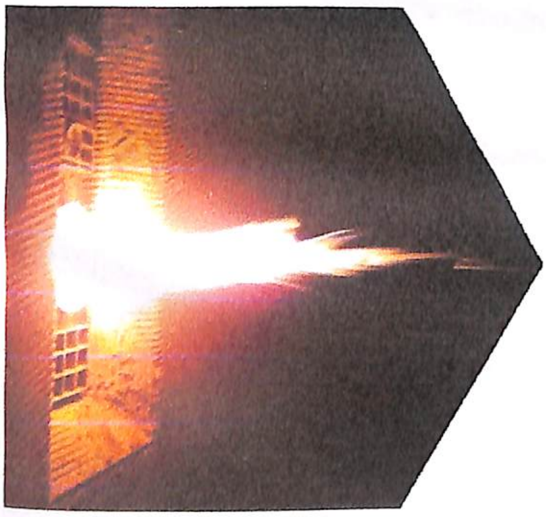
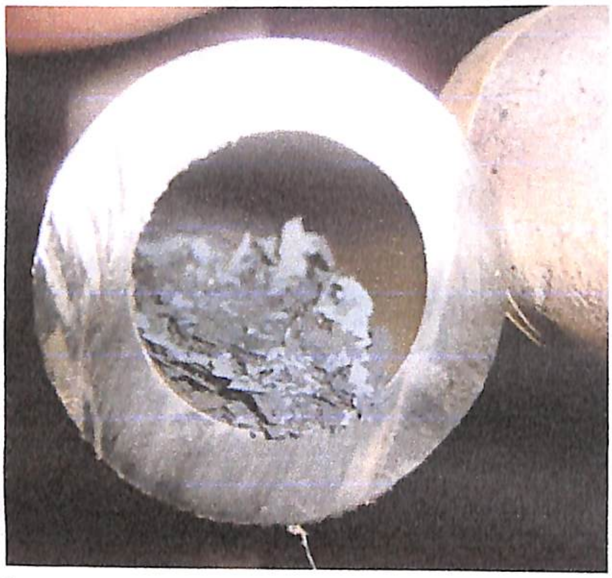


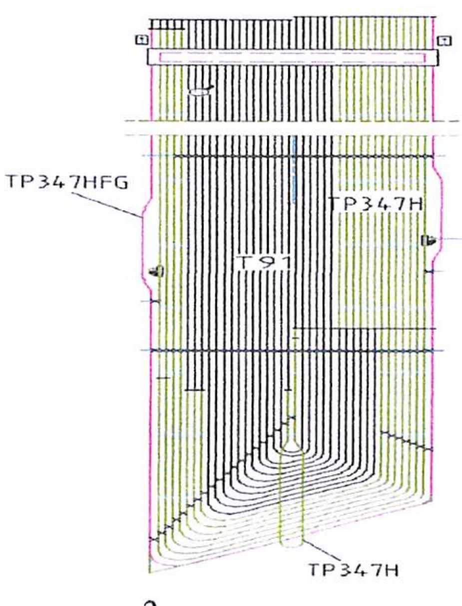
Figure Showing flame by Micro Oil gun used in Coal burner

WHAT IS EXFOLIATION IN BOILER

The new supercritical boilers are designed with austenitic stainless steel boiler tubes in the superheat (Final Super Heater) and reheat (Final Re-Heater) sections that operate at temperatures above 570°C. At these elevated temperatures, stainless steel boiler tubes will produce magnetite on the inside surface of the tube. A typical arrangement of these tubes is shown in the picture below. When the boiler is taken off-line and the boiler tubes cool, the internal magnetite scale can exfoliate and accumulate in the lower tube bends. Large amounts of loose scale in the tube bends can block steam flow resulting in overheating and, ultimately, rupture of the tubes.



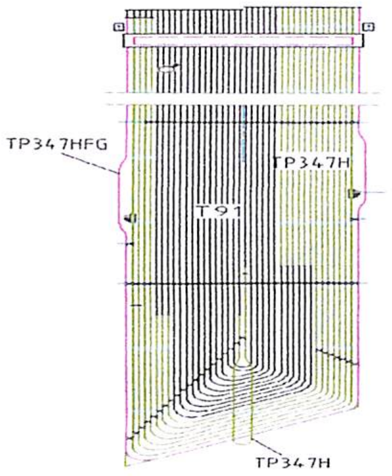
1.



2.

Figure1. showing accumulation of magnetite layer at bends Figure2. showing the arrangement of tubes in FSH& FRH

Material And Arrangement Of Tubes Used In FSH Of Thirora Boilers Are As Follows:



. Figure showing the arrangement & material of tubes in FSH of Thirora boiler

The Final Super Heater(FSH) design of Thirora boiler is the combination of following Tube Materials (T91+TP347H+TP347HFG):

(T91+TP347H+TP347HFG)

FSH Tube Material	Tiroda
SA213-TP347HFG	10 T
SA213-TP347H	58 T
SA213-T91	73T
TOTAL	141T

Designed Operation Parameters of Thirora Boiler:

Main Steam Pressure & Temperature = 24.2 MPa & 575 Degree Centigrade

Final Re-Heater Pressure & Temperature = 4.5 MPa & 575 Degree Centigrade.

2.Hypotheses & Research Design, Methodology & Plan

PROBLEM

1. **MOIS SYSTEM**

Light up of Boiler is classified into two types:

1. Cold start up(if first stage metal temperature of turbine<150 c)
2. Warm start up(if first stage metal temperature of turbine>150 c)

CALCULATIONS:

Oil consumption in extreme cold start up:

Capacity of each oil gun(HFO/LDO) = 2.5 kl per hour

* [In below calculations it is evaluated as:

Capacity Of Each Oil Gun*No. Of Hours Gun In Service*No. Of Guns In Service]

During Boiler Hot Flushing = 2.5*3*1 = 7.5 Kl
During Boiler Parameter Rising = 2.5*4*4 = 48 Kl
During Turbine Rolling = 2.5*3*7 = 52.5 Kl
During Load(Mw) Rising Upto 300mw = 2.5*1.5*6= 22.5 Kl

TOTAL OIL CONSUMPTION => LDO= 7.5 KL
(LDO is used during flushing only)

HFO= 123 KL

Cost Of LDO/Litre = 60rs/Litre
Cost Of HFO/Litre = 52 Rs/Litre

Total Cost Of LDO Used = 60*(7.5*1000 Litre) = 4,50,000
Total Cost Of HFO Used = 52* (123 *1000 Litre) = 63,96,000

TOTAL COST OF OIL USED FOR START UP	= 68,46,000

Oil consumption in warm start up

During Boiler Hot Flushing	= 2.5*2*1=5
During Boiler Parameter Rising	= 2.5*3*4=30
During Turbine Rolling	= 2.5*1*7=17.5
During Load(Mw) Rising Upto 300mw	= 2.5*1.5*6=22.5

TOTAL OIL CONSUMPTION => LDO= 5 KL
(LDO is used during flushing only)

HFO= 70 KL

Cost Of LDO/Litre = 60Rs/Litre
Cost Of HFO/Litre = 52 Rs/Litre

Total Cost Of LDO Used = 60*5*1000	= 3,00,000
Total Cost Of HFO Used = 52* 70 *1000	= 36,40,000

TOTAL COST OF OIL USED FOR START UP	=39,40,000

CONCLUSION:

For light up of each unit, cost of oil used:

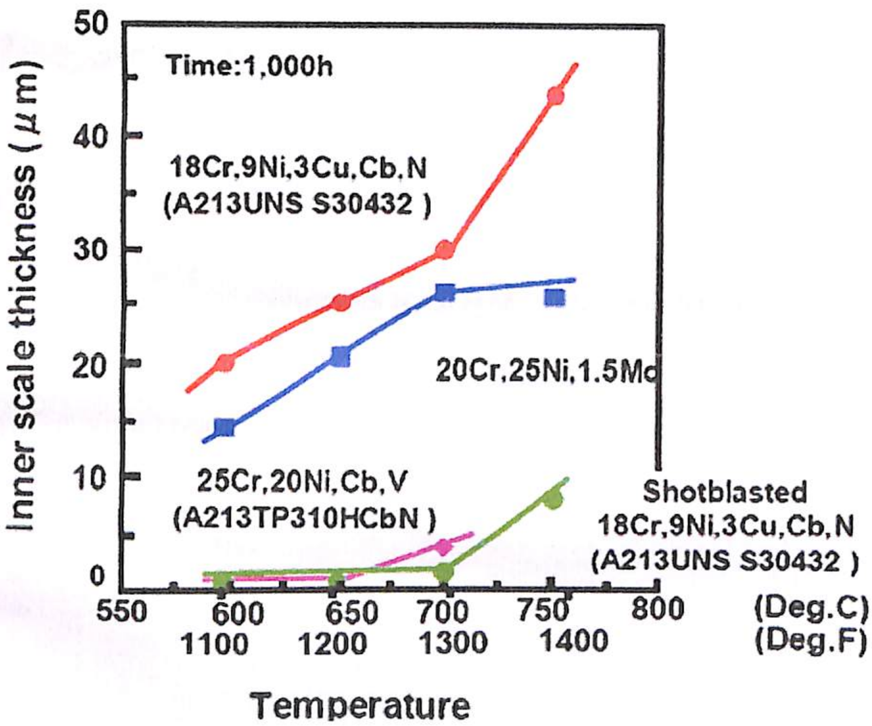
1. HOT START UP = 68,46,000 Rs
2. COLD START UP = 39, 40,000 Rs

2. PROBLEMS DURING OPERATION OF UNIT AT MAXIMUM or ABOVE RATED TEMPERATURE:

PROBLEM-1

Generation of Oxide layer:

Oxide layer is generated with operation of unit at maximum rated temperature or enormous temperature change rate during the start up and shut downs. over temperature will result in the exponential increase of the oxide layer/ inner scale sharply (for the material combination used in thirora boiler) as shown in the graph.



The generation and fall-off of the oxide layer of the high-temperature heating surface of the supercritical boiler are inevitable. It can be concluded from the below chart that all most every metal material generate oxide layer. They are different in anti-oxidizability.

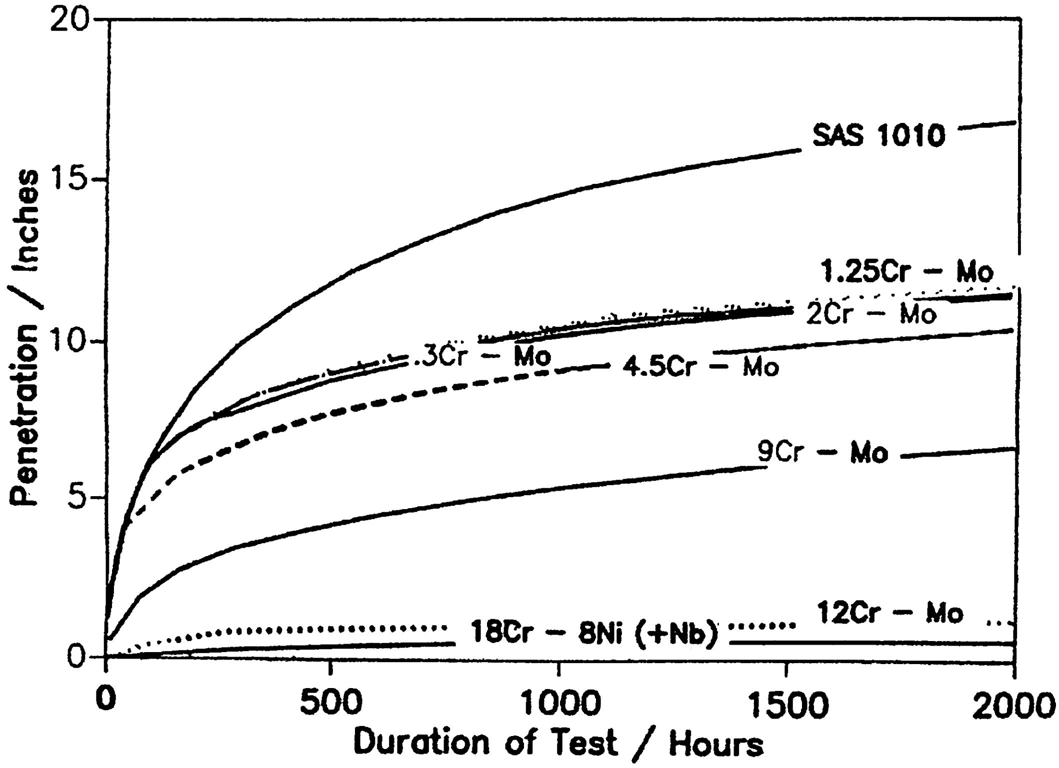
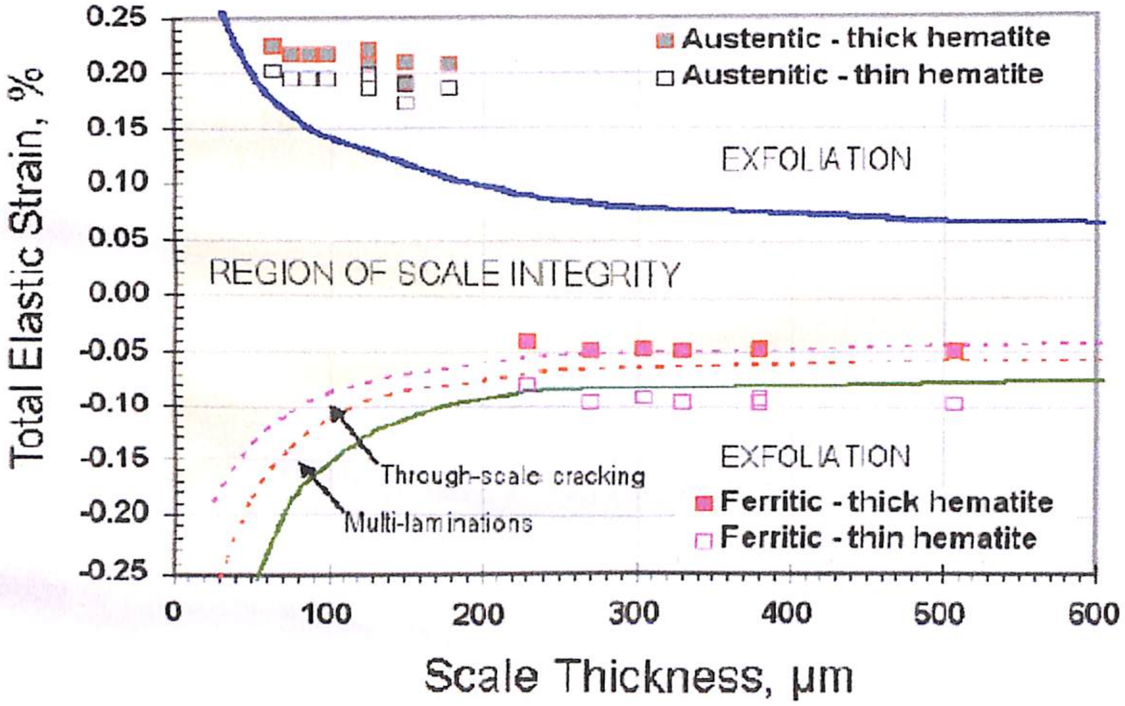


Figure 1 Corrosion of steel bars in contact with steam at 593 °C for 200, 500, 1000 and 2000 h (after Solberg *et al* [1])

PROBLEM-2

Fall of Oxide Layer at Tube Bents:

Frequent startup and shutdown, quick increase and decrease of the load, big fluctuation of the steam temperature, change of the feed water quality will be easy to lead to the intensive fall-off of the oxide layer.



Above is the Amitt chart drawn by EPRI(U.S), which reflects the relation between the thickness and the total elastic strain of oxide layer. We can see from the chart that the critical thickness of exfoliation increase with the decrease of elastic strain.

TUBE FAILURE LIST DUE TO EXFOLIATION:

UNIT NO.	DATE	LOCATION	MATERIAL
1	16/09/2014	FSH-10 TUBE OF PANEL-12	T91+TP347H
2	11/09/2014	FSH-06 TUBE OF PANEL-24	T91+TP347H
3	11/09/2014	FSH-20 TUBE OF PANEL-33	T91+TP347H
4	16/10/2014	FSH-10 TUBE OF PANEL-17	T91+TP347H

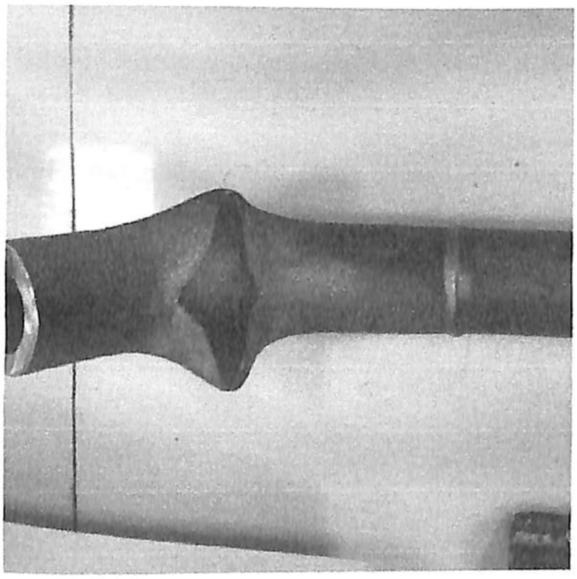


图 4.末过 24 屏 6 号管爆口

Oxide layer was found at the inlet and outlet of # 16 panel, # 14 tube by endoscopy.

OBJECTIVE

OBJECTIVE OF MICRO OIL GUN INSTALLATION:

The Objective of installation of Micro Oil Ignition System (MOIS) is to optimize the use of oil (LDO & HFO) to bring back the Unit on bar at stable load (@40% of BMCR) i.e 278 to 300 MW at which oil support can be removed in both Hot and Cold start up.

OBJECTIVE IN REDUCTION OF OPERATING TEMPERATURE:

Both the above problems are causing Exfoliation in boiler which in return causing the reduction in steam or coolant flow and causing boiler tube failure and leading to decrease in availability of unit or generation loss. Hence the objective is to reduce generation loss taking care of efficiency reduction due to operation changes.

Experimentally for thirora boiler:

1 unit shut down is costing upto 2 Crores which include Generation loss and boiler tube leakage arresting cost and start up cost.

Average shut downs of each unit in a year due to exfoliation is 6/year

TOTAL COST INVOLVED PER YEAR FOR EXFOILATION IS = 2*6 = 12 CRORES

SOLUTION

MICRO OIL GUN

Manufacturer details of micro oil gun

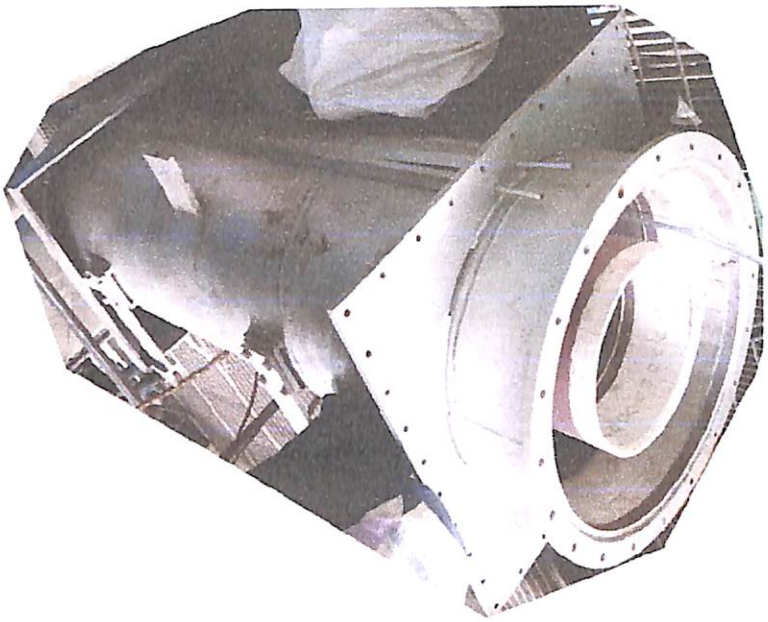
The MOIS Engineering, Design, Manufacturing & Supply is done by M/s Yantai Longyuan Power Technology Ltd, China

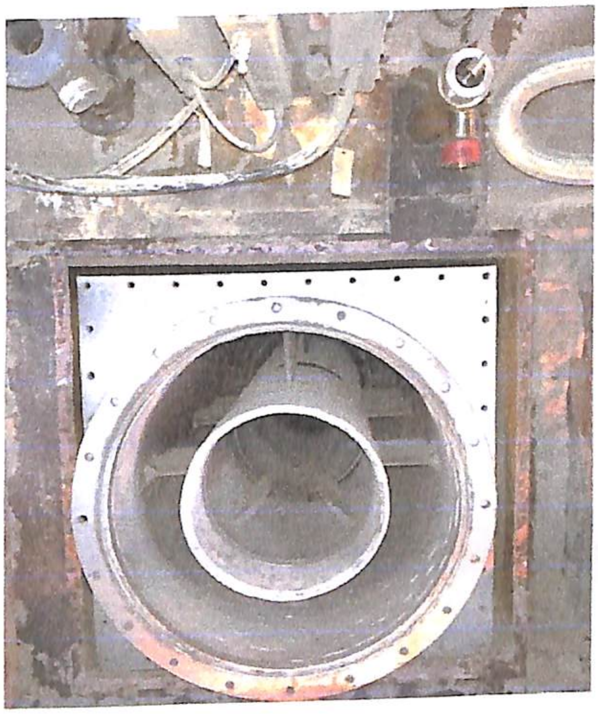
According to manufacturer:

The Cost of the Project including erection is @4.0 Cr
Pay back is @1.0 to 1.5 years
Extreme Cold Startup – 70% Oil saving is guaranteed
Cold Startup – 75% Oil saving is guaranteed
Warm Startup – 80% Oil saving is guaranteed
Hot Startup – 85% Oil Saving is guaranteed

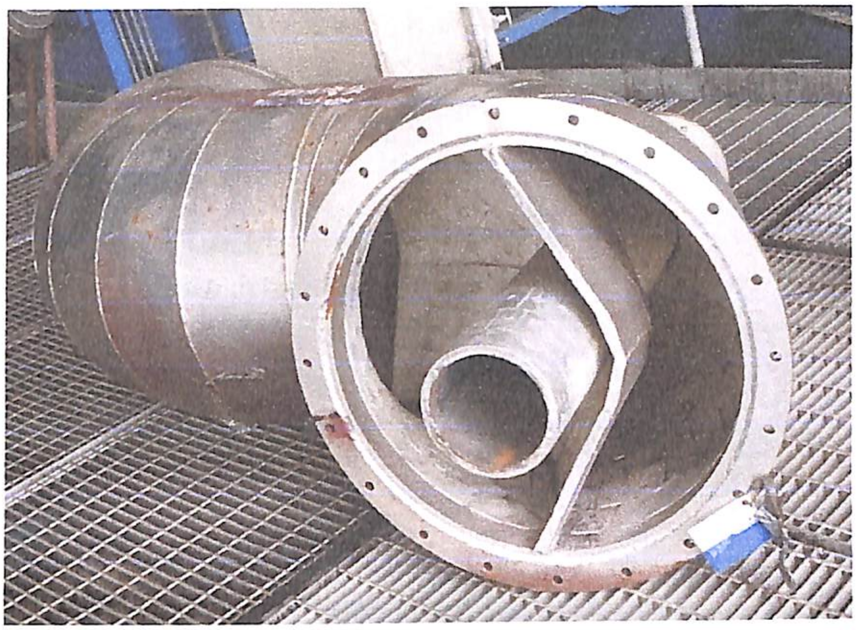
MOIS COMPONENTS TO BE INSTALLED:

1) Replacement of existing coal burner to newly designed coal burner. (location B1, B2, B3 & B4)
2) Steam Cooled Air Preheater(SCAPH) to be installed for initial heating of Primary Air to take the mill-B, it will take suction from hot Primary Air.
3) Steam line from Auxilary Header to SCAPH.
4) Replacement of existing coal burner elbow of B 1,B2,B3& B4 with newly designed elbow with arrangement to install the Micro Oil Gun
5) Scanner Flame fan for cooling of flame cameras installed at B1, B2, B3 & B4 inside wind box
6) Service Air for LDO Atomization
7) LDO supply & return line tapings
8) Igniter cooling fan.





Above pictures showing the Burner of Micro oil gun



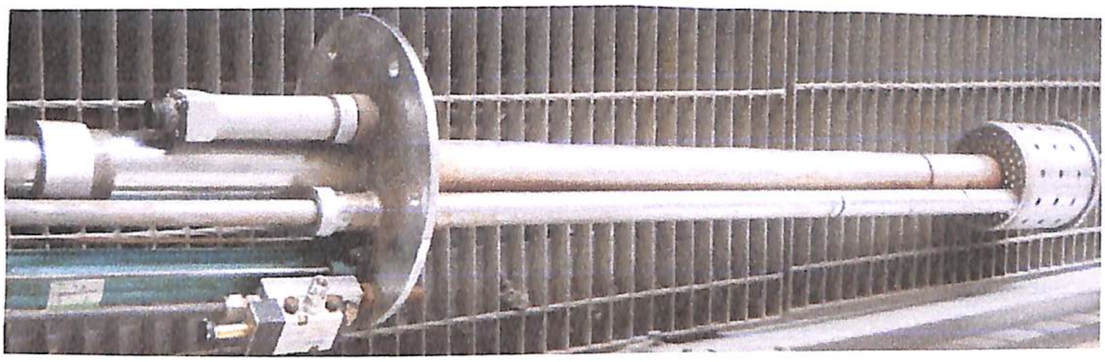
Picture showing Burner Elbow to be installed

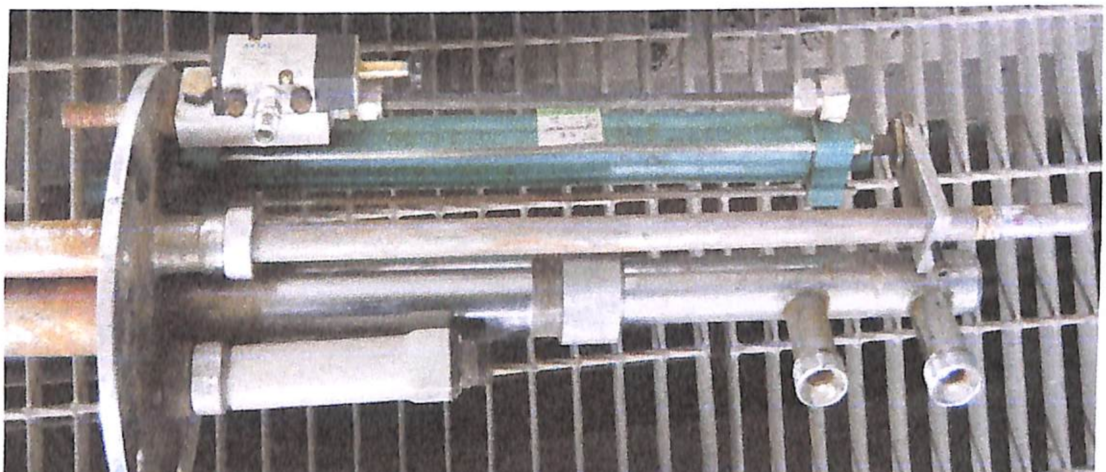
Picture showing Scanner Air Fan to be installed

MICRO OIL GUN ASSEMBLY DETAILS:

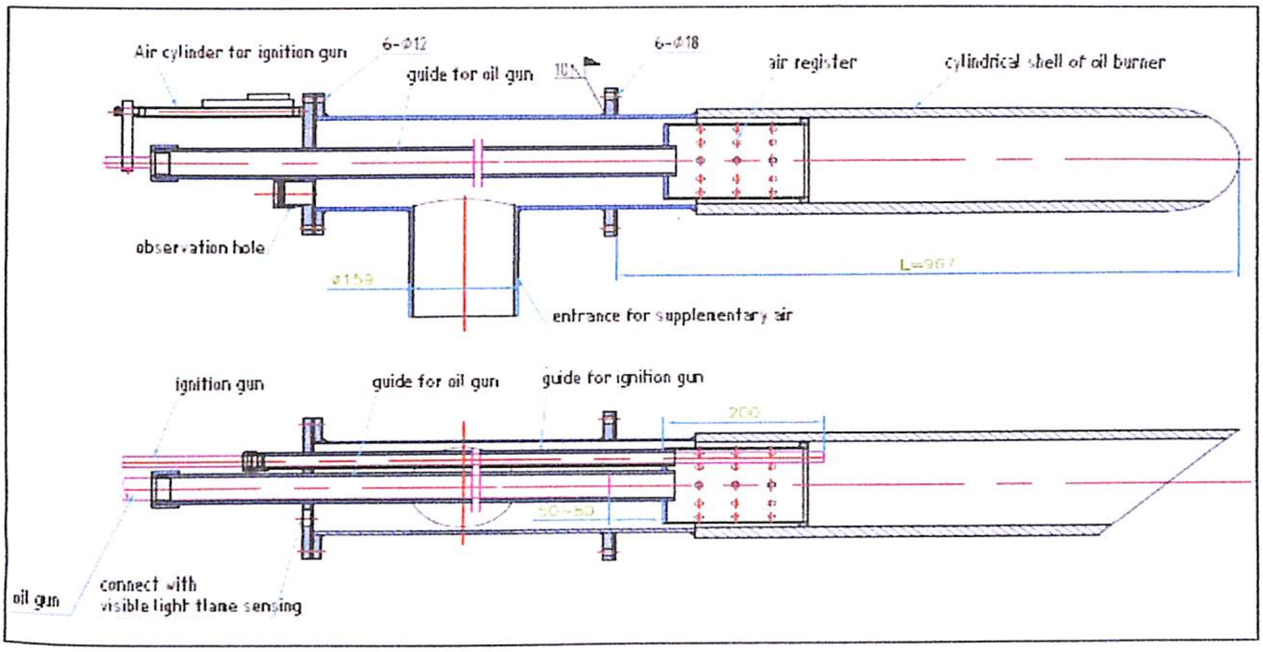
Micro Oil Gun Assembly Consists of

1) Oil Gun & atomizing nozzle (Three types)
2) Igniter & Igniter power cylinder
3) Inspection port
4) Combustion support air passage chamber
5) Air diffuser
6) Combustor chamber

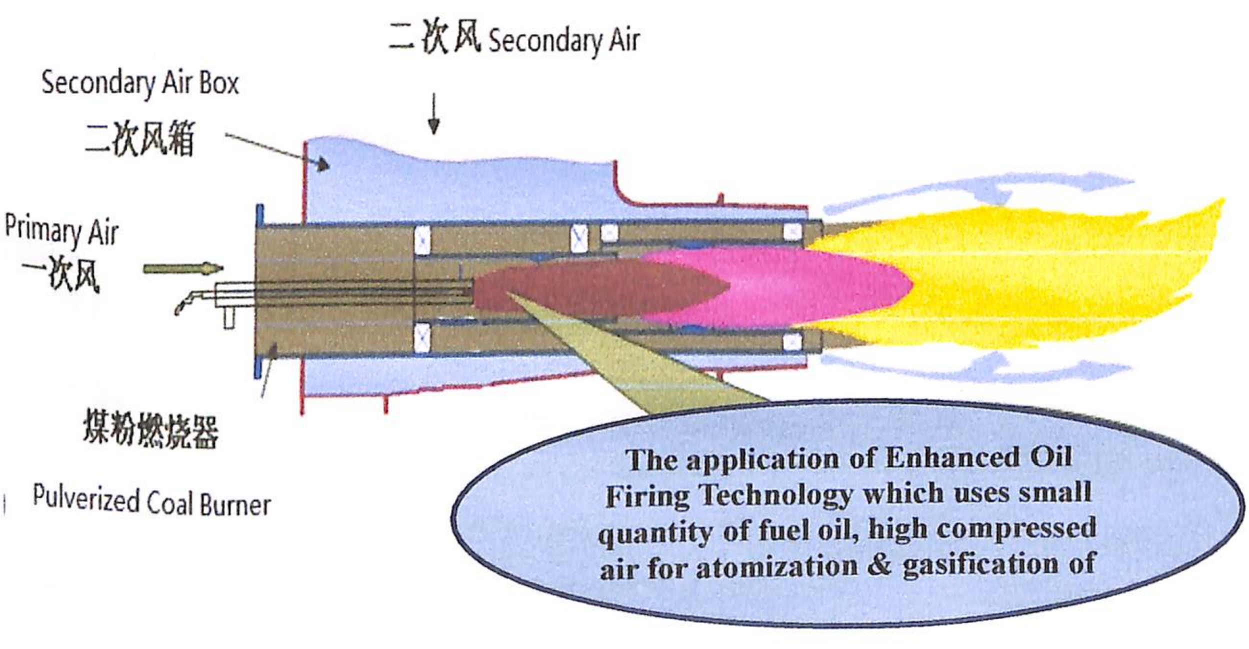




Pictures showing the Micro Oil Gun Assembly



Air cylinder for ignition gun
6-Φ12
6-Φ18
guide for oil gun
air register
cylindrical shell of oil burner
observation hole
Φ159
L=967
entrance for supplementary air
ignition gun
guide for oil gun
guide for ignition gun
200
oil gun
connect with
visible light flame sensing



二次风 Secondary Air
Secondary Air Box
二次风箱
Primary Air
一次风
煤粉燃烧器
Pulverized Coal Burner
The application of Enhanced Oil Firing Technology which uses small quantity of fuel oil, high compressed air for atomization & gasification of

START UP PROCEDURE WITH MOIS

1. After Boiler Purge activity is completed
2. Start APH & PA Fan-A (Slowly increase the PA header Pr- 7.5 Kpa)
3. Start Mill Seal Air Fan
4. Start MOIS Scanner Air Fan
5. Start MOIS Ignitor Cooling Fan
6. Take SCAPH into service
7. Prerequisites before starting the Micro Oil Guns
    a. Ensure the PA velocity in Mill-B four coal pipes is > 20 m/s
8. (Purge the Mill-A coal pulveriser for 300 sec)
    a. The primary inlet air pressure is @4.0 to 5.0 Kpa
    b. The Scanner air fan is running (Cooling for Flame Camera)
    c. The LDO header pressure is 0.8 to 1.5 MPa (1.0 MPa)
    d. The Atomizing header air pressure is 0.4 to 0.8 MPa (0.65 MPa)
9. Start APH soot blowing.
10. Using SCAPH adjust the mill O/L temp, achieve steady condition of mill outlet temp @65 to 75 °C.
11. Ignite the Micro Oil Guns one by one, check flame intensity is normal.
12. Switch to "Mini Oil Mode" in Mill-B.
13. Open the SADC of the Mill-B coal burner @50% to ensure coal burner cooling & Maintain the burner wall temperature < 500°C
14. Mill-A outlet temperature @ 65 to 70 °C, Start Mill-A , Start coal feeder –A & observe the coal flame appearance from the flame camera. (Coal flame is established within 180 sec).
15. Control the PA inlet temperature to Mill-B with coal air damper & number of guns in service.
16. Initial coal feed rate (20 tph to 25 tph) depending upon the coal GCV. (Equivalent to 4 LDO guns)
17. $\frac{2500 \times 10500 \times 4}{4500 \times 1000} = 21$ tph.
18. Mill-B feed rate to be controlled as per the initial temp rise of 1 °C / min during cold startup.

MOIS OPERATION PARAMETERS:

Major parameters of enhanced Micro oil firing burner:

1) Micro oil burner

Oil pressure: 0.8 ~ 1.5 MPa

Compressed air pressure: 0.4 ~ 0.7 MPa

Output of Mini-oil burner: 100 / 120 / 160 kg/h (Nozzle size)

2) High-energy spark ignition device

   Ignition energy: 20 J

   Working voltage: 220 V AC

3) Visible flame scanner

   Output signal: ON/OFF

   Flame Camera: Video Display

MOIS INTERLOCK & PROTECTION

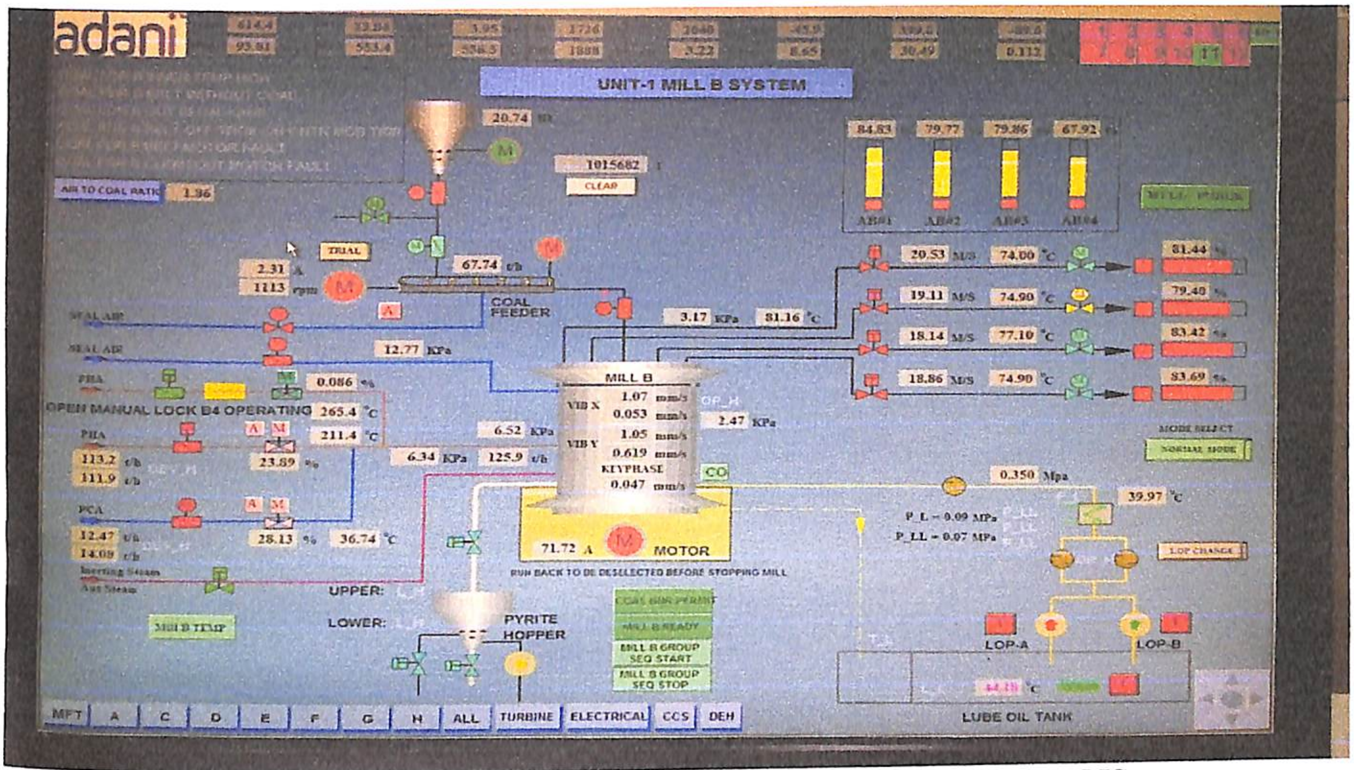
Two Modes of Operation are defined

- Mini oil Mode
- Normal Mode

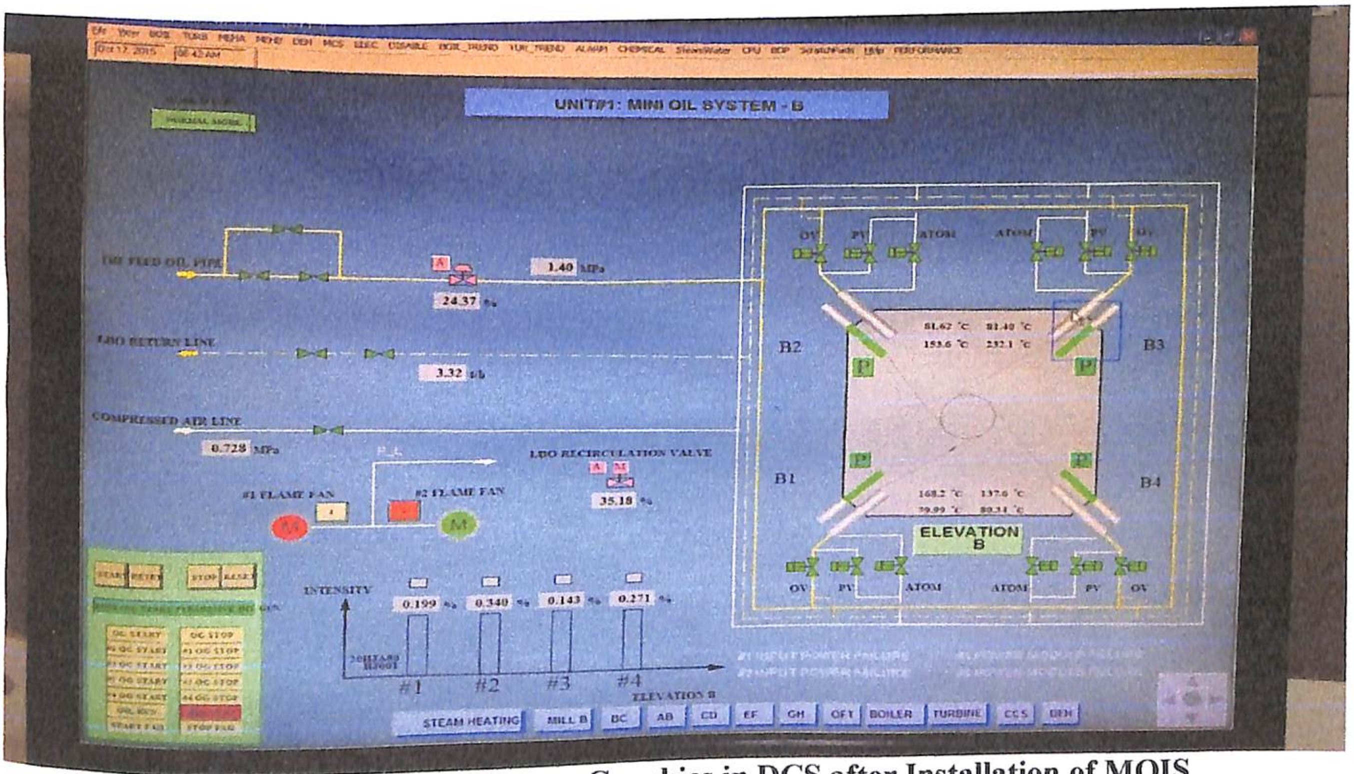
Prerequisites before starting the Micro Oil Guns

a. Ensure the PA velocity in Mill-B four coal pipes is > 20 m/s (Purge the Mill-A coal pulveriser for 300 sec)

b. The MOIS Scanner air fan is running (Cooling for Flame Camera)
c. The LDO header pressure is 0.8 to 1.5 MPa (1.0 MPa)
d. The Atomizing header air pressure is 0.4 to 0.8 MPa (0.65 MPa)
e. The Coal Burner Sprout & Center location thermocouple temperature should be < 500 °C (Alarm at 500 °C & at 600 °C Corresponding MDV closed).
f. In the "Mini Oil Mode" operation Mill-B in service & if one micro oil guns fails then close the corresponding MDV.
g. In the "Mini Oil Mode" operation Mill-B in service & after feeder start, no coal flame appear in 2/4 within 180 sec then MFT will occur.
h. In the "Micro Oil Mode" operation & if any Micro oil gun in service & PA fan trips then MFT will occur.
i. Initial feed rate at Feeder start is 15 tph, should be increased @ 21 to 24 tph.



Picture showing the Mill-B Graphics in DCS after Installation of MOIS



Picture showing the Mini Oil System Graphics in DCS after Installation of MOIS

CALCULATION OF PAY BACK PERIOD

MOIS

According to the manufacturer if project savings is calculated:

Total cost of oil used for extreme cold start up =68,46,000 Rs(From previous calculations)

Savings in Extreme/normal Cold Startup = 0.7*68,46,000 = 47,92,900 Rs

Total cost of oil used for extreme cold start up =39,40,000 Rs(From previous calculations)

Savings in Warm/Hot Startup = 0.8*39,40,000= 31,52,000 Rs

PAY BACK PERIOD CALCULATIONS FOR UNIT#1 MOIS:

Average Warm/Hot start up's in Year = 4

Savings in Warm/Hot start up's in Year = 4* 47,92,000 = 1,91,68,000 Rs

Average Cold Star up's in Year = 2

Savings in Warm/Hot start up's in Year = 2* 31,52,000 = 63,04,000 Rs

TOTAL SAVINGS IN ALL START UP'S IN A YEAR = 2,54,72,000 RS

Installation Cost of MOIS = 4.0 CRORE

PAY BACK PERIOD = INSTALLATION COST/ TOTAL SAVINGS = 1.57 Years.

So, MOIS installation is a best option to reduce the fuel costs in thirora units as payback period is only 1.57 Years. Of course the payback period is little greater than the manufacturer guaranteed payback period of 1.5 Years.

SYSTEM-2

OPERATION OF UNIT AT 10 DEGREE CENTIGRADE DECREASED TEMPERATURE FROM RATED TEMPERATURE:

The Operation process to keep the metal temperature in limits is as follows:

1. Keeping the OHDR in lesser values(aaprox. 28 Deg Celcius)
2. Keeping less Feeding on Top Mills
3. Using Secondary Air Damper Control
4. Using Flue Gas Temperature Control Dampers
5. Using optimized Spray in both FSH And FRH

SOLUTION OF OPERATION OF UNIT AT 10 DEGREE CENTIGRADE DECREASED TEMPERATURE FROM RATED BY SANGHAI BOILER MANUFACTURER:

Thirora Boiler is designed to operate at 600 Degree Centigrade of both Final Super Heater and Final Re-Heater Metal temperature, a decreased temperature of 10 Degree Centigrade in both implies 590 Degree Centigrade of both Final Super Heater and Final Re-Heater Metal temperature should be maintained.

By maintaining these parameters, number of shut downs are decreased by 3

The cost involved in decreasing the temperature by 10 Degree Centigrade is as follows:

For Thirora Boiler 1Degree decrease in Final Super Heater temperature from rated causes 0.606 Kcal/ KWh

So, 10 Degree decrease in temperature causes loss of 0.606*10= 6.06Kcal/KWh

For Thirora Boiler 1Degree decrease in Final Re-Heater temperature from rated causes 0.424 Kcal/ KWh

So, 10 Degree decrease in temperature causes loss of 0.424*10= 4.24Kcal/KWh

TOTAL LOSS CAUSED IN HEAT RATE IS 6.06+4.24 = 10.3 KCAL/KWH

CALCULATION OF PAY BACK PERIOD

Average single unit generation in a Year(approx.320 days of operation) after removing auxiliary consumption is 600,0000*24*320 = 4.608 billion units

1 KWh generation need 2200 Kcal energy in Thirora Boiler.

Average loss in each unit generated by 10.3 Kcal= (10.3*1KWh)/2200 =0.004682 KWh

AVERAGE LOSS IN A YEAR IN GENERATION = 0.004682*4.608 = 0.021574 BILLION UNITS

cost of each unit generated = 1.50 Rs.

AVERAGE AMOUNT LOSS IN A YEAR = 1.50* 0.021574 = 0.032361 BILLION RUPEES=3.2361 Crore Rs

*If the shut downs decreased to 2 by Exfoliation (as suggested by SANGHAI Boilers.)

The loss due to shut downs will be 2*2 = 4 Crore Rs

total saving involved is = 12Cr – 4Cr -3.2361 Cr = 4.7639 Crore Rs

PAY BACK PERIOD = 4.7639/3.2361 = 1.472 Years ,

Hence it is profitable to operate plant in decreased parameters (up to 10 Deg Celsius)

3.APPLICATION, BENEFIT & LIMITATION

APPLICATION-1

MOIS APPLICATIONS:

MOIS is applicable to any plant which uses coal as main fuel.

BENEFIT:

1. Specific oil consumption per each unit per year is decreased.
2. Plant economy is improved.

LIMITATION OF MOIS INSTALLATION:

a. MILL-1B should be in service for using MOIS
b. Auxiliary steam is needed for SCAPH of MOIS
c. MOIS installation need some initial cost.

APPLICATION-2

OPERATION OF UNIT WITH DECREASED TEMPERATURE

Operation at lower temperature is inevitable to save the boiler from exfoliation and increase the life time of boiler.

BENEFIT:

Tripping's and life of unit is improved.

LIMITATION OF CHANGES IN OPERATION:

1. This operation hampers the life of turbine as the Main Steam & Re-heater temperature is maintained below the design.
2. This causes overall efficiency reduction.
3. This causes more fuel requirement to generate same power
4. This reduces the Heat Rate of unit.

4.FEASIBILITY STUDY

MOIS Project is feasible as it saves oil & profit is made with a pay back period of only 1.57 Years as shown by calculations previously.

Operational Changes are inevitable to save the boiler which is also profitable with a pay back period of only 1.472 Years as shown by calculations previously.

ECONOMIC FEASIBILITY:

Both the projects are Economically Feasible as:
Pay Back Period of MOIS is 1.57 Years
While Pay Back Period for Operational changes is 1.472 Years

TECHNICAL FEASIBILITY:

MOIS is already installed in ADANI- MUNDRA which is proved to be technically feasible. While decreasing the operation parameters of boiler has technical problems as the life period of Turbine decreases but inconsiderable compared to the benefits.

TIME FEASIBILITY:

Both projects are time feasible as installation of MOIS take only 1.5 months according to manufacturer and can be done during Over Hauling Period while Operational changes can be started instantly.

5.EXPECTED OUTCOME

EXPECTED OUT COME BY MOIS INSTALLATION

These are the conclusions made from above calculations:

	WITHOUT MOIS	WITH MOIS
LDO Consumption(cold start up)	7.5 KL	39.15 KL(Manufacturer Guarantee)
HFO Consumption(cold start up)	123KL	0 KL
LDO Consumption(Warm start up)	5 KL	15 KL(Manufacturer Guarantee)
HFO Consumption(Warm start up)	70KL	0 KL
Total cost Of oil (Cold)	68,46,000 Rs	20,53,800 Rs
Total cost Of oil (Warm)	39,40,000 Rs	7,88,000 Rs
PAY BACK PERIOD	-----------	1.57 Years
Saving in a Year per 1 Unit	-----------	2,54,72,000 Rs

EXPECTED OUT COME BY OPERATION OF UNIT AT 10 DEGREE CENTIGRADE DECREASED TEMPERATURE FROM RATED TEMPERATURES

These are the conclusions made from above calculations:

	Before Operational Changes	After Decreasing Metal Temperature Operation by 10 Deg Celsius
Number Of Shutdowns Due to Exfoliation	6	2(As Per SANGHAI-Boiler Manufacturer)
Total Loss due to Shut Downs	12 Crore Rs	4 Crore Rs
Total Loss due to operational changes	----------------	3.2361 Crore Rs
Pay Back Period	----------------	1.472 Years
Total saving by Operational changes	----------------	4.7639 Crore Rs

6.CONCLUSIONS AND SCOPE FOR FUTURE WORK

MOIS System

As per the expected out comes, MOIS system installation is profitable since pay back period is much less than 2 years and it will have a high scope for saving oil costs which are growing day to day. Based on the results observed in the first unit after installation it can be extended to other units.

Operating below the rated temperature

Although there is a loss due to reduced temperature but benefit of availability is high as it is observed the pay back period in this process is less than 2 years , it can also be observed that high availability of plant makes it reliable which is important in the present competitive market. If this way of operation is observed beneficial it can be continued until exfoliation problem persists in boiler.

BIBLIOGRAPHY

Books

Operation & Technical Service Department of Adani power Maharashtra Ltd., Thirora Technical Diary, Thirora, Pages referred: 6,39,47,76

Disha Members, Specific Heat Rate Hand Book, Pages referred: 1,3,8

Thermal Power Plant Operations, National Power Training Institute Pages Referred – 27 To 96

Thermal Power Plant Efficiency, National Power Training Institute Pages Referred – 45 To 64

The MOIS Engineering, Design, Manufacturer & Supplier hand book, M/s Yantai Longyuan Power Technology Ltd, China, book referred.

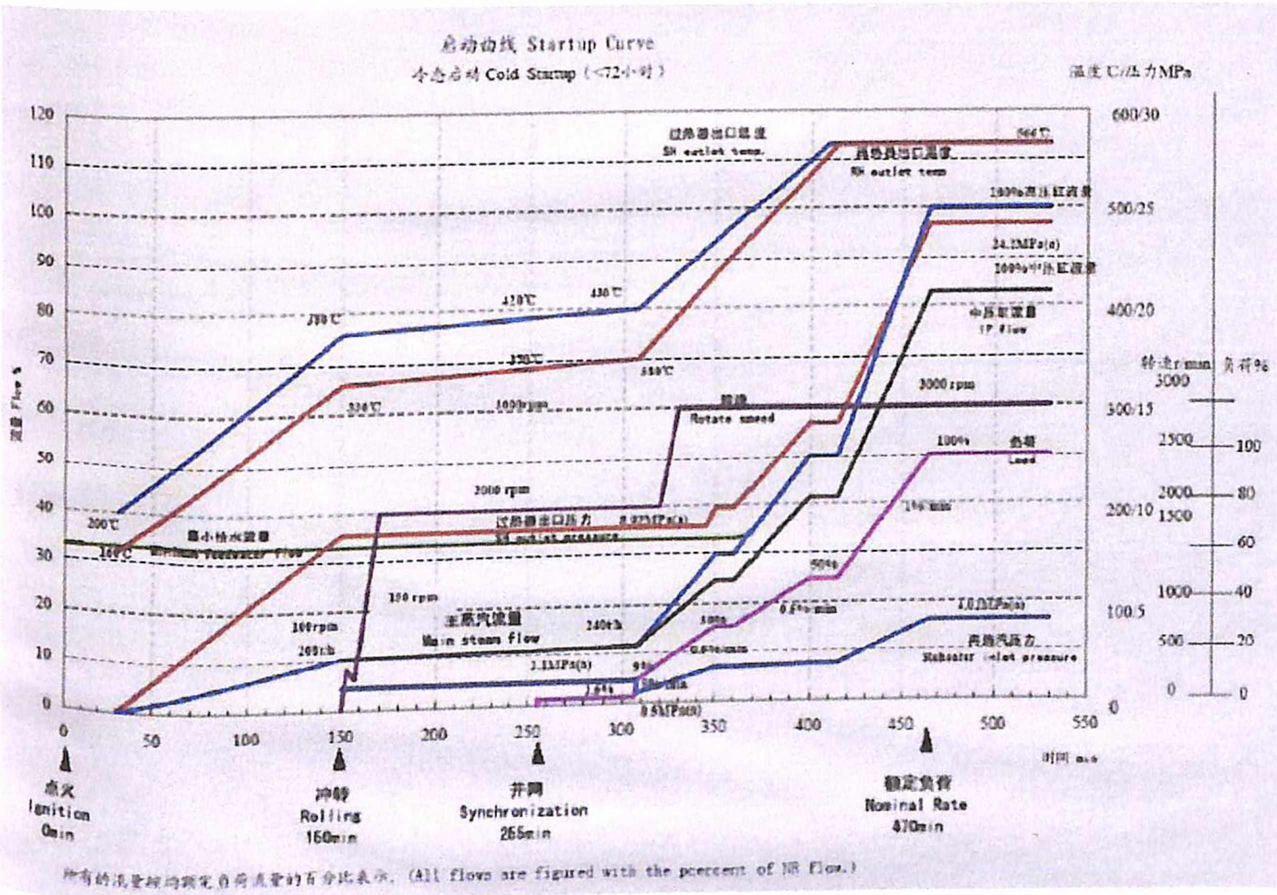
Presentations

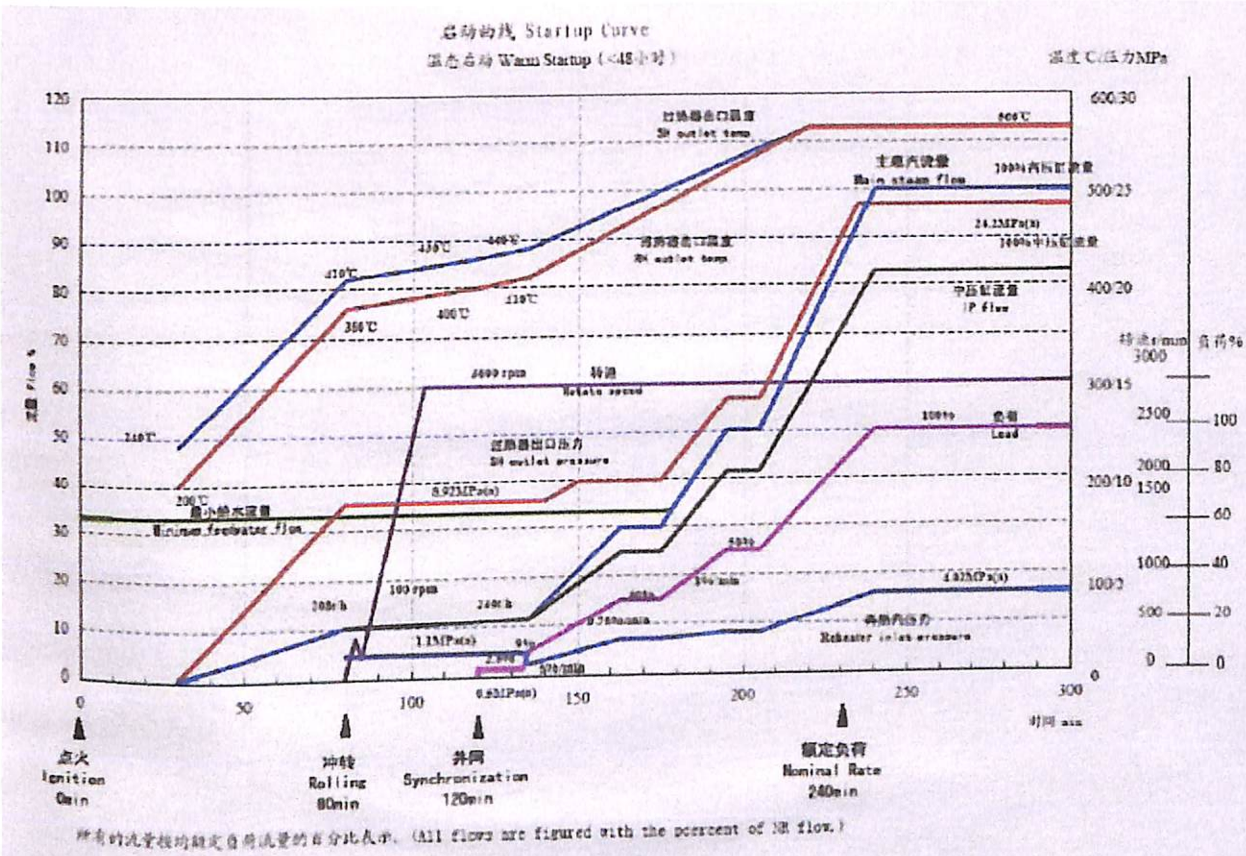
J P Bayad, Operation & Technical Services micro oil gun system presentation, Adani power Maharashtra Ltd., Thirora

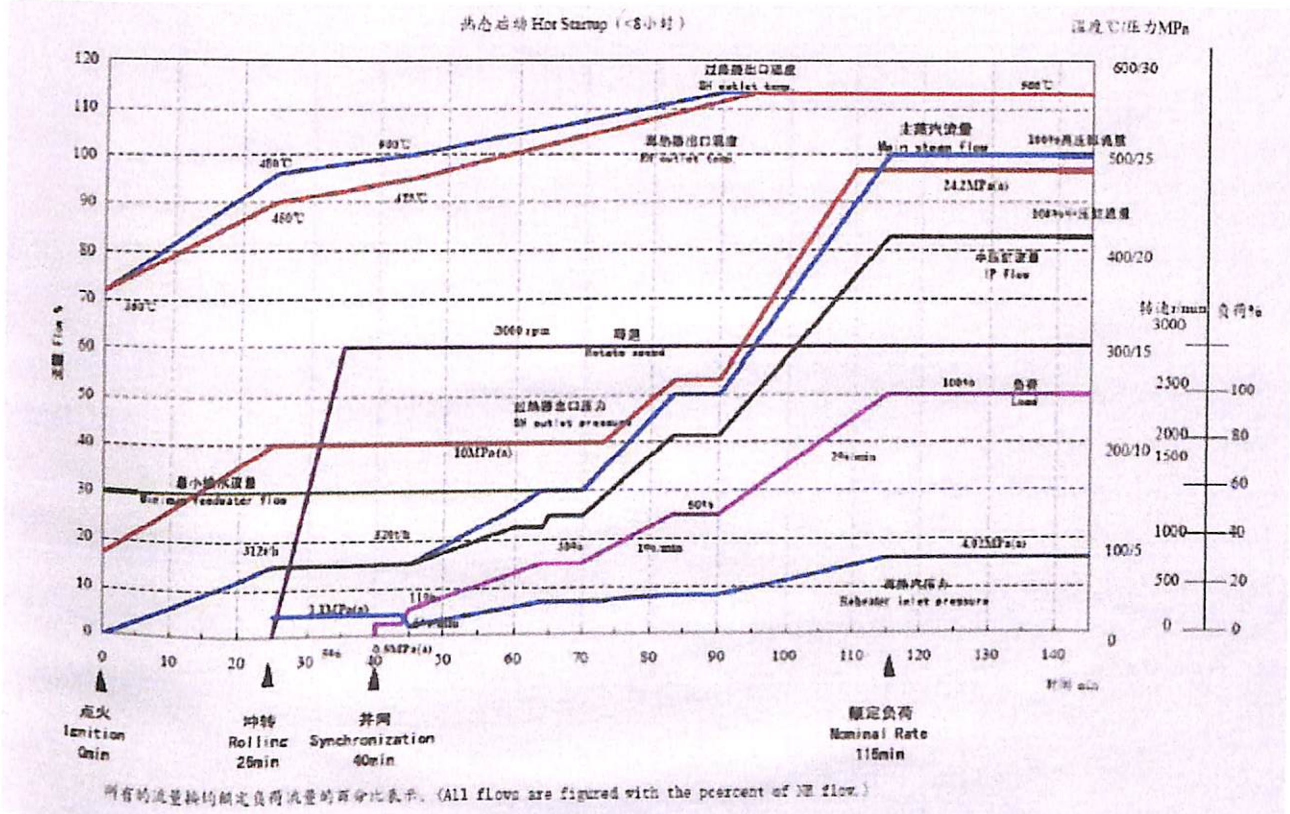
Delegates by Sanghai boiler works co. Ltd., Special Report on Oxide Layer of Adani Project

APPENDIX

START UP CURVES




Startup Curve
Warm Startup
SH outlet temp
Main steam flow
RH outlet temp
IP flow
Rotate speed
SH outlet pressure
Load
Minimum feedwater flow
Reheater inlet pressure
Ignition
0min
Rolling
80min
Synchronization
120min
Nominal Rate
240min
(All flows are figured with the percent of MR flow.)


Hot Startup
SH outlet temp.
Main steam flow
24.2MPa(a)
IP flow
3000 rpm
Rotate speed
SH outlet pressure
10MPa(a)
Minimum feedwater flow
312t/h
320t/h
Load
Reheater inlet pressure
Ignition
0min
Rolling
25min
Synchronization
40min
Nominal Rate
115min
(All flows are figured with the pcercent of