User Manual – Dual Fuel

effiMA**X**

Energy Conservation I Environment I Process Efficiency

Cloud Based effiMAX

User's Manual

This user manual corresponds to Cloud Based effiMAX product which is meant for monitoring & maintaining the peak Efficiency of the Boiler.

If you experience difficulty with the installation or operation of this system, please contact our Customer service representative.

Developed and Marketed by:

Forbes Marshall Pvt. Ltd.

V 1.0

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Safety Information

To ensure that your product is safe and without risk to health, the following points must be noted:

1. The relevant sections of these instructions must be read before proceeding.

2. The **Forbes Marshall effiMAX System** should be installed and operated only in manner specified in this User Manual.

3. Installation, Operation, Maintenance and Servicing must only be carried out by suitable trained personnel and in accordance with the information given. Any deviation from these instructions will transfer the complete liability to the user.

4. **To prevent the system from Electrical noise / transients on Earth Line, please connect separate Instrument Earth to the Earth terminal screw provided on the Panel / Enclosure.**

5. Warning labels on containers and packages must be observed.

6. Safety precautions must be taken to avoid the possibility of an accident occurring when operating in conditions of high temperature.

7. Before making any wiring changes, please make sure the Power supply to the unit is turned off.

8. The Oxygen probe is operated at the temperature level of **800°C**. Please DO NOT touch the oxygen probe surface when in operation.

9. For seamless operation of the product, It is recommended to have UPS supply to the system.

SECTION 1:
INTRODUCTION

1.1 Cloud Based effiMAX Concept

Cloud Based effiMAX, the latest offering from the effiMAX range of on-line boiler efficiency analyzers, provides the complete solution for monitoring, maintaining your boiler to the optimum efficiency and controlling FD fan and Drum level. This sophisticated yet simple to use analyzer operates on-line and continuously monitors your boiler at every instant of its operation.

effiMAX **(Dual Fuel)** calculates the efficiency of the Dual Fuel fired boiler in general accordance with the BS-845 standard based on indirect / direct efficiency computation depending on the variant and computes individually the total amount of losses in your boiler. These losses include Stack loss, Enthalpy loss, Radiation loss and Blowdown loss. The data generated by the system can then be used to fine-tune the system to generate more steam with lesser quantities of fuel.

As per the variant, the on-line parameter screen displays : Oxygen in the stack, Stack temperature, Steam flow (density compensated), fuel flow, Steam temperature, Feed-water temperature, Ambient temperature and TDS of boiler water, which forms the basis of calculating the efficiency and help you to check the operating conditions of your boiler & maintain the boiler at peak efficiency.
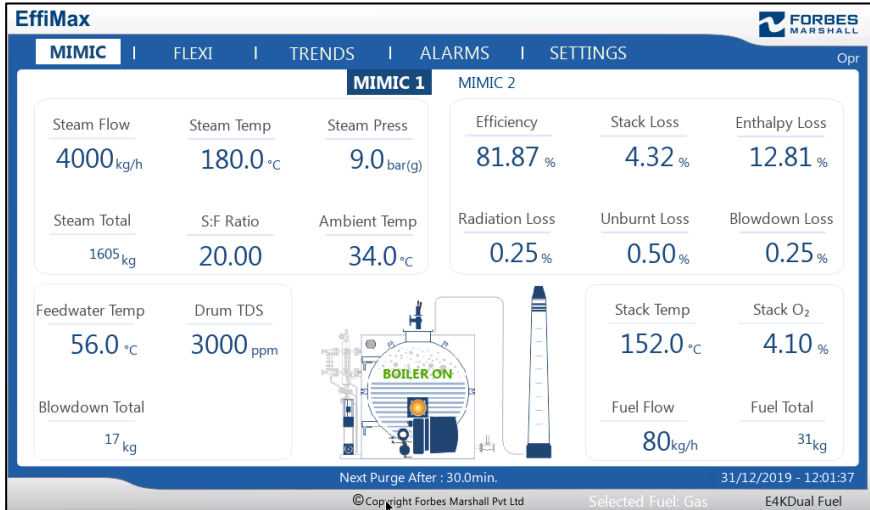
Introduction

Fig. 1- *effiMAX Monitoring System*

The effiMAX now comes with the user friendly 10" touch screen display. The first screen displays the graphical representation of the boiler and all online parameter values. The Touch screen Interface of *effiMAX* presents data like the input parameters and the losses on user friendly screens with real-time and historical trends. Boiler performance can be improved from the continuous monitoring of all the parameters.

The navigation to different screens like Trends, Alarms, Settings, etc. can be easily done by touching the specific buttons on the display.

This display also provides pop up keypad for easy data entry and settings, eliminating the use of any fixed keys.
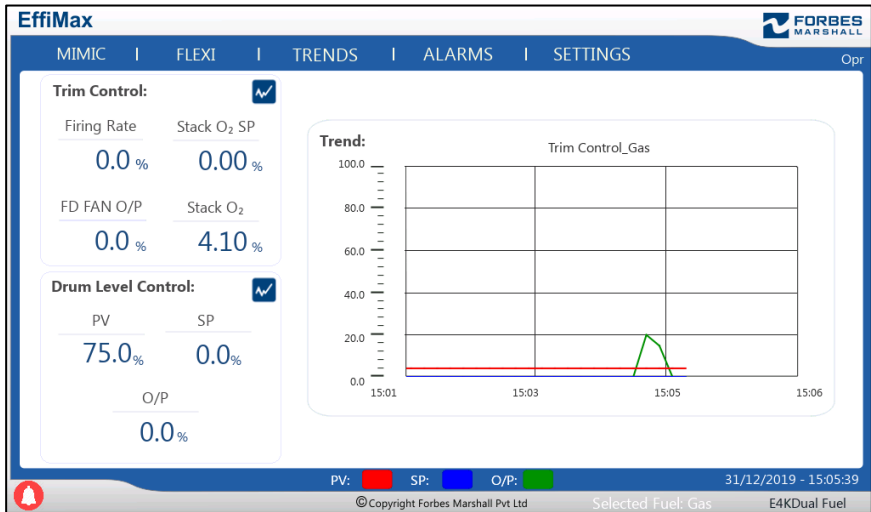
Fig. 2- *effiMAX Control System*

The Touch screen Interface of *effiMAX* presents control loop data on user friendly screens with historical trends. Boiler performance can be improved from the continuous monitoring of all the parameters. All control loops live status helps in monitoring complete boiler control performance on single page and easy to fine tune.

Historical trends for can be viewed simply by touching the Trend icon button provided on respective control tile.

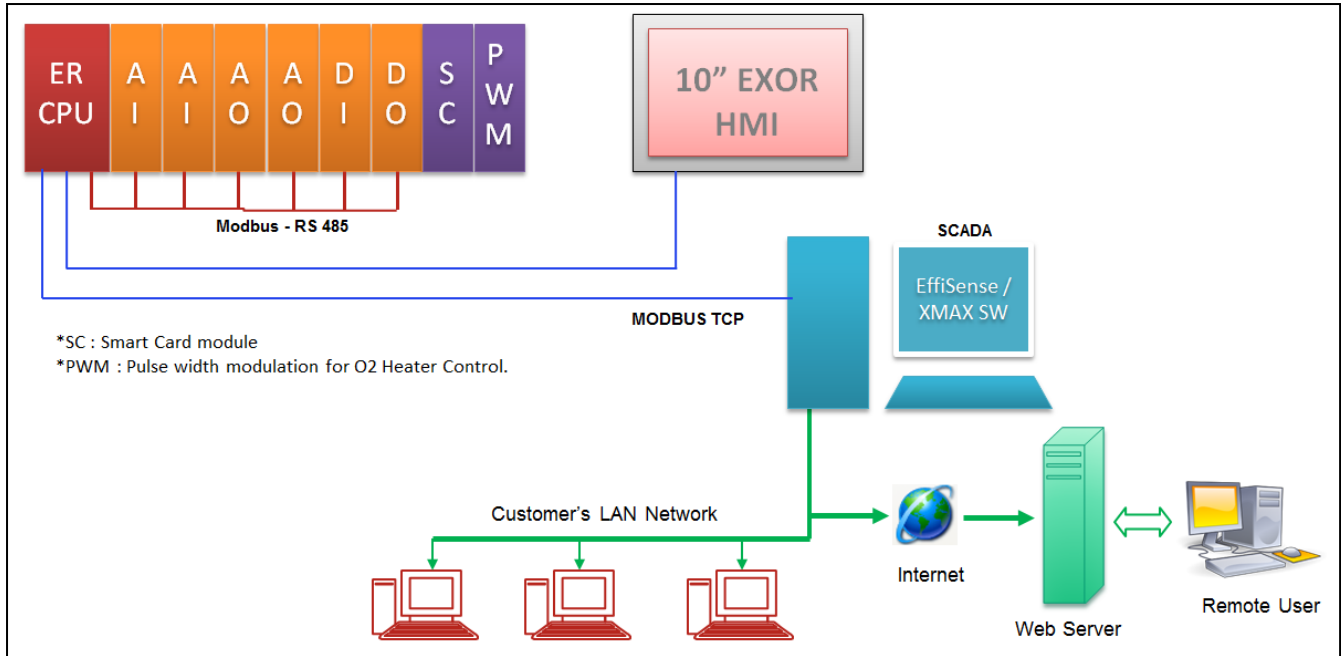*SC : Smart Card module
*PWM : Pulse width modulation for O2 Heater Control.

Fig.3 -System Architecture

EffiMAX

The *EffiMAX* system is made up of the following components:

1. Panel unit :

The Panel unit of *EffiMax* displays online data of all the input parameters and the losses on user friendly 10" touch screen with real-time and historical trends. This unit is connected to all the field mounted sensors of the system and acquires on-line data. The values transmitted by the field sensors are converted to a standard format & then and given to the HMI which displays them on its relevant screens. These values are then used to compute the efficiency of the boiler.

2. Effisense Unit :

EffiSense is a data logging & remote monitoring software system. It receives data from EffiMax Panel unit. It logs the required data and generates graphical and text reports for the boiler operator and the management, to analyze boiler performance at a glance. The data from Effisense can be viewed remotely either in the Local network or over the Internet through a Global Static IP.

3. Oxygen Measurement Probe :

The oxygen measurement probe is mounted on the stack of the boiler and it measures the % O_2 in the flue gas. This is an important parameter for efficiency calculations. The % O_2 in the flue gas indicates the operating excess air level of the boiler and hence the health of combustion.

4. Stack temperature transmitter:

The stack temperature transmitter is mounted on the stack and is used to measure the flue gas temperature. This is used for calculation of combustion losses in the boiler along with oxygen content of the flue gas, ambient temperature, calorific & stoichiometric values of the fuel used.

5. Steam flow meter:

The Vortex Steam flow meter is mounted on the main header line of steam and is used to measure the volumetric flow-rate. The volumetric flow-rate is converted into mass flow-rate in the Display unit. Steam flow of a boiler is the most important parameter to be monitored, as it indicates the total useful output from a boiler.

If instead of Vortex, Orifice flow meter is used for steam flow measurement then differential pressure, steam pressure and steam temperature will be used to calculate mass flow-rate in the Display unit.

6. Steam temperature transmitter:

The steam temperature transmitter used for measuring temperature of the steam is mounted just after the steam flow meter on the main boiler header. The steam temperature is used for on-line density compensation of the volumetric flow measured by the steam flow meter.

7. Steam Pressure transmitter:

The steam pressure transmitter used for measuring pressure of the steam is mounted on the steam line with syphon as close to the steam drum as possible. This may be used for on-line density compensation for the volumetric flow measured by the steam flow meter.

8. Blowdown TDS Sensor and Valve:

The blowdown sensor and the blowdown valve are mounted on the piping of the blowdown line. The sensor measures the Total Dissolved Solids (TDS) of the boiler drum water intermittently when the blowdown valve is opened. The EffiMAX unit then compares this value with the user fed set point and controls the TDS level.

If standalone TDS sensor is installed, then the sensor will measure the Total Dissolved solids in the Boiler water & will display it on the screen.

9. Feed-water temperature transmitter:

The feed-water temperature transmitter is mounted on the feed-water line and measures the feed-water temperature. This value is used for calculating Direct Efficiency of the Boiler.

10. Ambient Temperature Transmitter:

This transmitter is mounted near the EffiMAX unit and it measures the ambient air temperature. This value is used for the Stack and Enthalpy loss calculation.

11. Oil Flow Meter:

The Oil flow meter is a positive displacement meter which displaces a fixed amount of oil after each rotation of the internal gears. A magnetic sensor (Reed switch) is used to pick up the rotations of internal gears caused due to oil flow and these picked up pulses are fed to Frequency to current converter to generate 4-20 mA output signal from the meter.

12. Gas Flow Meter:

The gas flow meter is mounted on the boiler inlet line of gas and is used to measure the total gas consumption of boiler. Gas flow to a boiler is one of the important parameter to be monitored, as it indicates the total fuel input to a boiler.

12. R to I converter:

Resistance to Current converter is used to convert resistance output of Servomotor to current. Servomotor regulates the fuel and/or air delivery mechanism of burner. As per RPM of the motor, resistance output is generated and then converted to 4-20 mA by R to I converter. Thus, it measures the fuel firing rate in the boiler.

1.2 Features of EffiMAX

Measured Parameters:

	EffiMAX 1000	EffiMAX 2000	EffiMAX 3000	EffiMAX 4000
Steam Flow (kg/h)	√	√	√	√
Fuel Flow (kg/hr)	√	-	√	√
Stack Oxygen (%)	-	√	√	√
Steam Temperature (^{o}C)	√	√	√	√
Stack Temperature (^{o}C)	-	√	√	√
Steam Pressure (kg/cm2(g))	√	√	√	√
Feedwater Temperature (^{o}C)	√	√	√	√
Ambient Temperature (^{o}C)	-	√	√	√
Drum TDS (ppm)	Optional	√	√	√
Firing FB (%)	-	-	-	√
Drum Level (%)	-	√	√	√
FD O/P (%)	-	-	-	√
Drum Level O/P (%)	-	-	-	√

Calculated Parameters:

	EffiMAX 1000	EffiMAX 2000	EffiMAX 3000	EffiMAX 4000
Boiler Efficiency (Direct) (%)	√	-	√	√
Boiler Efficiency (Indirect) (%)	-	√	√	√
Stack Loss (%)	-	√	√	√
Enthalpy Loss (%)	-	√	√	√
Blowdown Loss (%)	-	√	√	√
Radiation Loss (%)	-	√	√	√
Unburnt Loss(%)	-	√	√	√

EffiMAX

Steam to Fuel Ratio (Direct)	√	-	√	√
Steam to Fuel Ratio (Indirect)	-	√	-	-
Steam Totalization (kg)	√	√	√	√
Fuel Totalization (kg)	√	-	√	√
Blowdown Totalization (kg)	√	√	√	√
Boiler On-Off Totalization	√	√	√	√
Boiler Blowdown control	√	√	√	√

effiMAX for Superheated boilers:

effiMAX can be used to display Superheated Steam Temperature and Pressure. Due to high temperature and pressure, instead of HTCS sensor and corresponding assembly, medium pressure BBCS is used for TDS measurement. Here, water sample is taken and cooled to ambient temperature to measure the TDS. Then corresponding 4-20mA output is given to effiMAX which displays the TDS on continuous basis. If the TDS is higher than the set point mentioned in the BBCS, blowdown control valve is opened which sends a digital signal to EffiMAX to display the total blowdown occurred.

effiMAX for Orifice meters used to measure Steam flow:

On site, if orifice meters are present to measure steam flow, it can be connected to effiMAX. Along with Steam Pressure and Temperature readings and orifice plate related parameters, effiMAX displays the steam parameters. Following parameters are to be entered on Boiler Data page of effiMAX for steam flow calculation:

GA Gain input A1, GB Gain input A2, GC Gain input A3, GO Gain Output C, BA Bias input A1, BB Bias input A2, BC Bias input A3, BO Bias Output C, Max. Delta P, Max. Steam Pressure, Max. Steam Temperature.

Introduction

Flexi Parameters:

In addition to the standard effiMAX parameters, if more parameters are to be displayed like Water flow total, Furnace Pressure etc., the facility is available in effiMAX. Standard Analog input (4-20mA) signal is required for the same. Maximum 12 nos of flexi inputs can be configured but according to the variant's number of AI cards need to be installed in panel.

Configuration of these parameters is done from Product Page in the Settings tab. The parameter name and unit are to be assigned. Depending on the averaging or totalization requirement, select 'Avg.' or 'Total' option.

EffiMAX

Range of the parameters is to be entered from Range Page -> Flexi (Under drop down).

Thus, these flexi parameters are displayed on Flexi page.

1.3 Specifications

ANALYZER UNIT SPECIFICATIONS	

EffiMAX Panel unit :

Mechanical enclosure:	Wall-mount / Floor Mount unit
Electrical supply:	230V AC, 3A, 50Hz, **UPS Supply**
Power Consumption:	
Operating Temp:	$0 - 50\,^{\circ}C$

Parameter Ranges :

Efficiency Indication:	0 - 100 %
Stack Loss:	0 - 100 %
Radiation Loss:	0 - 100 %
Enthalpy loss:	0 - 100 %
Blowdown loss:	0 - 100 %
Blowdown Totalization:	0 - 1000000000 kg
Ambient air temperature Indication:	$0 - 100\,^{\circ}C$
Feed-water temperature Indication:	$0 - 200\,^{\circ}C$
Steam temperature Indication:	$0 - 300\,^{\circ}C$
Stack temperature Indication:	$0 - 400\,^{\circ}C$
Oxygen Indication:	0.0 - 20.9%
ID Output	0 – 100%
FD Output	0 – 100%
Feeder Output	0 – 100%
Drum Level Control Output (Optional)	0 – 100%
Steam flow indication:	As per the programmed range (kg/h)
Steam flow Totalization:	0 - 1000000000 kg
Fuel flow Totalization:	0 - 1000000000 kg
S:F ratio:	0 - 20
TDS Set Point range:	0 - 6000 ppm.

EffiMAX

TDS Measurement

Sensor:	HTCS Sensor
Sensor chamber:	ASTM A-182 F304 body
Max boiler pressure:	31 bar g

BBCS (Boiler Blowdown Control System)

Air pressure required:	3 to 6 bar g
Blowdown valve:	SS ball valve with pneumatic actuator and solenoid in the air line
Solenoid voltage:	230 V AC, 50 Hz

Steam Flow Meter

Measuring error:	±1.0% of measured value (Re ≥ 20000) ±2.0% of measured value (10000 < Re < 20000) **Pressure and temperature compensation:** ±1.5% of measured value (Re ≥ 20000); ±2.5% of measured value (10000 < Re < 20000)
Repeatability:	+/- 0.1% of measured value

Stack Temperature Transmitter

Temperature Sensor:	2-wire loop powered, integral head mounted transmitters
Range:	0 to 400 ^{o}C
Accuracy:	1 % of measured value
Process connection:	½" BSP (male), Length – 18" below the head

Steam Temperature Transmitter

Temperature Sensor:	2-wire loop powered, integral head mounted transmitters
Range:	0 to 300 ^{o}C

Introduction

Accuracy:	1% of measured value
Process connection:	½" BSP (male), Length – 12" below the head

Feed-Water Temperature Transmitter

Temperature Sensor:	2-wire loop powered, integral head mounted transmitters
Range:	0 to 200 $^{\circ}$C
Accuracy:	1% of measured value
Process connection:	½" BSP (male), Length – 6" below the head

Ambient Air Temperature Transmitter

Temperature Sensor:	2-wire loop powered, integral head mounted transmitters
Range:	0 to 100 $^{\circ}$C
Accuracy:	1% of measured value
Process connection:	½" BSP (male), Length – 6" below the head

Oil Flow Meter :

Port size:	½" BSP (Female)
Range:	7-800 l/h
Operating Temperature:	0-120 $^{\circ}$C
Accuracy:	+/-0.5 %
Operating Pressure Max:	1.18 MPa
LCD Display:	7 Segment 8 digit

EffiMAX

Gas Flow Meter

Measuring error:	±1.0% of measured value (Re ≥ 20000)
	±2.0% of measured value (10000 < Re < 20000)
	Pressure and temperature compensation:
	±1.5% of measured value (Re ≥ 20000);
	±2.5% of measured value (10000 < Re < 20000)
Repeatability:	+/- 0.1% of measured value

R to I converter for measurement of firing rate:

Power Supply:	230V AC, 50 Hz Supply
Type of converter (Based on I/P signal from Drive) :	0 to 150 Ω
Output signal:	4-20 mA

1.4   Product Dimension Details

800 x 550 x 250 mm

1800 X 600 X 250 mm

Fig.4 - Product Dimension Details

SECTION 2: INSTALLATION

2.1 Unpacking and Inspection

❖ Inspect the shipping carton for any damages. If there are no visual damages open the carton.

❖ Check all the items as per packing list. If any of the items are missing, please inform the same to **Forbes Marshall** local representative.

❖ If it is damaged then, inform the damage to the transporter for further action. It is recommended to take photograph in case of any insurance claims.

2.2 Packing List

	Qty.	EffiMAX 1000	EffiMAX 2000	EffiMAX 3000	EffiMAX 4000
1. Panel Unit	1 No.	√	√	√	√
2. EffiSense Monitoring Unit	1 No.	√	√	√	√
3. Temperature Transmitter (0-100 ^{o}C)	1 No.	-	√	√	√
4. Temperature Transmitter (0-200 ^{o}C)	1 No.	√	√	√	√
5. Temperature Transmitter (0-300 ^{o}C)	1 No.	√	√	√	√

6. Temperature Transmitter (0-400 ^{o}C)	1 No.	-	√	√	√
7. O2 Sensor Probe	1 No.	-	√	√	√
8. Oil Flow Meter	1 No.	√	-	√	√
9. Gas Flow Meter	1 No.	√	-	√	√
10. Steam Flow Meter	1 No.	√	√	√	√
11. BBCS Sensor (TDS)	1 No.	√	√	√	√

2.3 Tools required for installation

1. 1/4-inch flathead screwdriver (for the Analyzer unit).

2. 1/8-inch flathead screwdriver (for the Analyzer unit).

3. ½-inch BSW box spanner with torque wrench (for installation).

4. Size 8 and 10 adjustable spanner wrench (for steam flow meter, temperature transmitters and the Blowdown system).

2.4 Location and Mounting

❖For best results install the unit in area where temperature is ambient & vibrations are less.
❖Install the panel, such that on left or right side there is place for cable entry.
❖Fix the panel to the floor by using fasteners through the holes provided at the bottom of the panel.
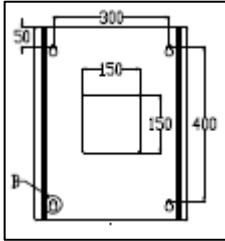
Mounting Plate for Enclosure:
Ensure that mounting bracket is held properly on the wall.

2.5   Installing the Sub-System

To prevent the system from Electrical noise / transients on Earth Line, please connect separate Instrument Earth to the Earth terminal screw provided on the Signal Conditioning Enclosure.

Please don't short the transmitter wires. It may cause analog input failure!

2.5.1   Installing Steam Flow Meter:

- The Steam flow meter should be installed with straight pipe of (20 x size of meter) at upstream & (5 x size of meter) at downstream of the meter.
- Please refer 'Steam flow Meter Installation diagram' in Section 11 & 'installation video' for Installation details.

2.5.2   Installing Stack Temperature Transmitter:

- Screw the adapter of Stack temperature transmitter into the ½" BSP socket - welded for the same on the stack. Ensure a leak tight connection. Use Teflon tape if required.
- Pass temperature transmitter through the adapter and tighten it.
- Please refer 'Stack Temperature Transmitter Installation diagram' in Section 11 & 'installation video' for Installation details

2.5.3   Installing Ambient Air Temperature Transmitter:

- Screw the adapter of ambient temperature transmitter into the ½" BSP socket welded for the same on the combustion air duct or in the Ambient mounting bracket, depending on where the sensor needs to be installed. Ensure a leak tight connection when mounted on duct. Use Teflon tape if required.
- Pass temperature transmitter through the adapter and tighten it.
- Make sure the transmitter is protected from direct sunlight and water.

2.5.4   Installing Steam temperature transmitter:

- Install this transmitter only at the downstream of the Steam Flow meter and not before it.
- Screw the thermowell into the ½" socket welded for the same on the steam line.
- Ensure that the connection is leak tight. Use Teflon tape for sealing if required.
- Pour a small quantity of transformer oil, sufficient enough to fill the gap between the inner wall of the thermowell and the outer wall of the temperature transmitter, into the thermowell.
- Screw the temperature transmitter into thermowell.
- Please refer 'Steam Temperature Transmitter Installation diagram' in Section 11 & 'installation video' for Installation details.

2.5.5   Installing Steam pressure transmitter:

- Tapping should be provided on the steam line for connecting steam pressure transmitter.
- Connect the syphon to protect the transmitter from extreme temperatures. Water barrier formed in the syphon protects the transmitter from impurities. Size and material of the syphon should be suitable as per the pressure rating.

- Use least no. of fittings to avoid leakage problems and install as close to the steam drum as possible.
- Install the transmitter on the provided mounting bracket.
- Protect pressure transmitter from direct contact of water and other liquids.

2.5.6   Installing Feed-water temperature transmitter:

- Screw the thermowell into the ½" socket welded for the same on the feed-water line.
- Ensure that the connection is leak tight. Use Teflon tape for sealing if required.
- Pour a small quantity of transformer oil, sufficient enough to fill the gap between the inner wall of the thermowell and the outer wall of the temperature transmitter, into the thermowell.
- Screw the temperature transmitter into thermowell.
- Please refer 'Feed water Temperature Transmitter Installation diagram' in Section 11 & 'installation video' for Installation details.

2.5.7   Installing Stack Oxygen Probe:

- The dimensions for the hole in the flue gas duct and the mounting of the adapter plate (mating flange) are shown in the dimensional drawing below. The mating flange is to be fitted by the customer and when mounting please ensure an air tight seal.
- The part of the protection tube projecting from the duct wall must be insulated or heated, if necessary, to prevent its temperature from dropping below the dew point.
- Electrical heaters are available from FORBES MARSHALL as accessories. The bolts of the probe flange must remain accessible.
- The special cables for electronic systems must be left long enough (coiled up) so that the probe can be drawn out of the protection tube without disconnecting it.

2.5.8   Installing a Blowdown System:

Blowdown system can be installed either for monitoring & controlling the Boiler water TDS (BBCS) or for only monitoring the TDS value (standalone TDS Sensor).

BBCS Installation:

The main Blowdown valve is fitted at the bottom of the boiler for draining and removing any sludge accumulation from the bottom of the boiler. It should be fitted into the space left in the Boiler Blowdown Control System (in which a spool piece is supplied) and should be manually opened for a few seconds on a daily basis. The Boiler Blowdown Control System limits the concentration of dissolved and suspended solids in the boiler water. Therefore, the take-off point need not be from the bottom of the boiler. Indeed, using a side connection (if one exists) instead reduces the chance of scale entering the Blowdown valve. In case the system has been supplied as separate components, follow the instructions in Section 4 of this User Manual for assembling the system.

The EffiMAX Analyzer unit gives a 230/115Vac Signal for the solenoid valve to operate. This connection should be made when the unit is switched off.

Standalone TDS sensor installation:

The TDS sensor measures the concentration of dissolved and suspended solids in the boiler water. This sensor is installed in a sensor housing chamber which is then fitted on the Blowdown line. Please refer section 4 for detailed installation instructions.

The plug tail supplied is 1.25 m long. For longer distances use a junction box and screened cable. The screen should not be connected to earth anywhere along its length.

2.5.9   Skid Assembly for Oil Flow Meter (Refer if fuel used is OIL)

CONFIGURATION 1

FOR APPLICATIONS WHERE THE OIL TANK IS INSTALLED AT A HIGHER LEVEL

APPLICABLE FOR

METER SIZE (INCH)	OIL TEMP. (DEG C)	MAX. FLOW (L / H)	END TO END DIST. (mm)	END CONNECTION FLANGE SIZE
1/2	40	1100	1500	1/2" ANSI # 150
1	40	1000	1600	1" ANSI # 150
1 1/2	40	1000	1600	1 1/2" ANSI # 150
2	40	1000	1700	2" ANSI # 150
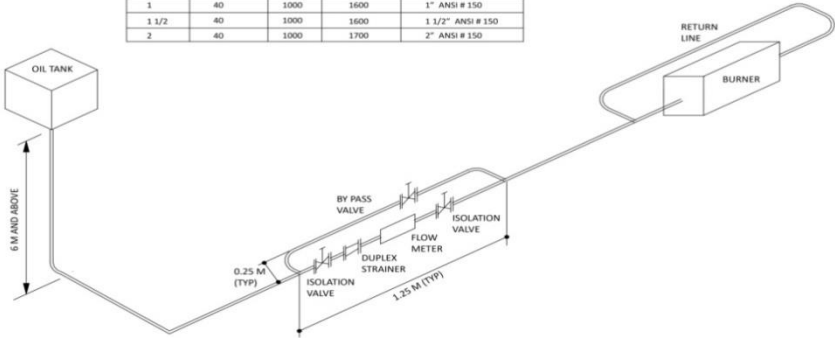
IF GRAVITY HEAD IS LESS THAN 6 M, THEN EXTERNAL PUMPING OF OIL IS REQUIRED

CONFIGURATION 2

FOR APPLICATIONS WHERE THE OIL TANK IS INSTALLED AT LOW LEVELS

FOR ANY SIZE OIL FLOW METERS WITH OIL AT 40°C AND ABOVE

PRV SETTING OF MINIMUM 2.5 BAR
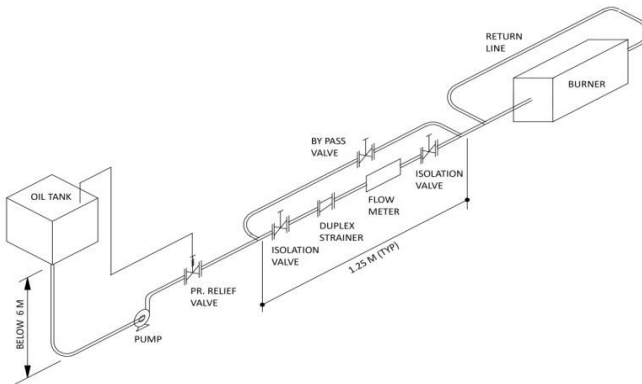
IF GRAVITY HEAD IS LESS THAN 6 M, THEN EXTERNAL PUMPING OF OIL IS REQUIRED

CONFIGURATION 3

FOR APPLICATIONS WHERE THE OIL TANK IS RETURNED
TO THE TANK

MAXIMUM FLOW RATE OF 1000 L/H FOR
ANY SIZE OF OIL FLOW METER AT 40° C

MAXIMUM FLOW RATE OF 3000 L/H FOR
ANY SIZE OF OIL FLOW METER AT 110° C
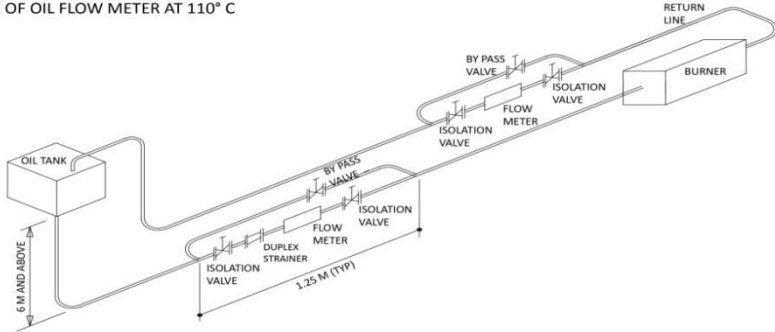
FOR CALCULATING THE DIFFERENCE IN THE MAIN OIL LINE
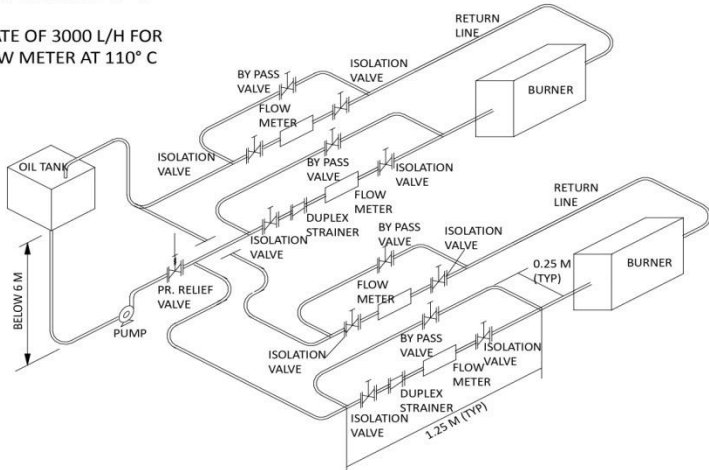AND THE RETURN LINE , A SUBSTRACTOR UNIT WILL BE SUPPLIED

CONFIGURATION 4

FOR APPLICATIONS WHERE THE OIL TANK IS RETURNED
TO THE TANK AND THE TANK IS AT LOW LEVEL

MAXIMUM FLOW RATE OF 1000 L/H FOR
ANY SIZE OF OIL FLOW METER AT 40°C

MAXIMUM FLOW RATE OF 3000 L/H FOR
ANY SIZE OF OIL FLOW METER AT 100° C
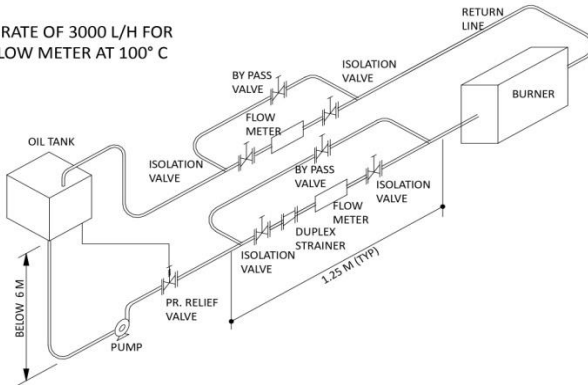
FOR CALCULATING THE DIFFERENCE IN THE MAIN OIL LINE
AND THE RETURN LINE, A SUBSTRACTOR UNIT WILL BE SUPPLIED

CONFIGURATION 5

FOR APPLICATIONS WHERE THE OIL TANK IS INSTALLED
AT A HIGHER LEVEL (MULTIPLE BOILER INSTALLATION)
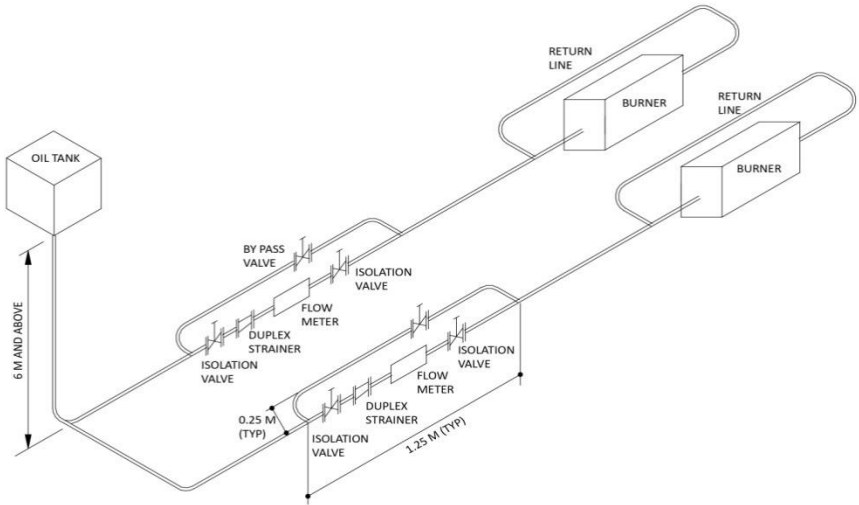
IF GRAVITY HEAD IS LESS THAN 6 M, THEN
EXTERNAL PUMPING OF OIL IS REQUIRED

CONFIGURATION 6

FOR APPLICATIONS WHERE THE OIL TANK IS RETURNED
TO THE TANK (MULTIPLE BOILER INSTALLATION)

MAXIMUM FLOW RATE OF 1000 L/H FOR
ANY SIZE OF OIL FLOW METER AT 40° C

MAXIMUM FLOW RATE OF 3000 L/H FOR
ANY SIZE OF OIL FLOW METER AT 110° C
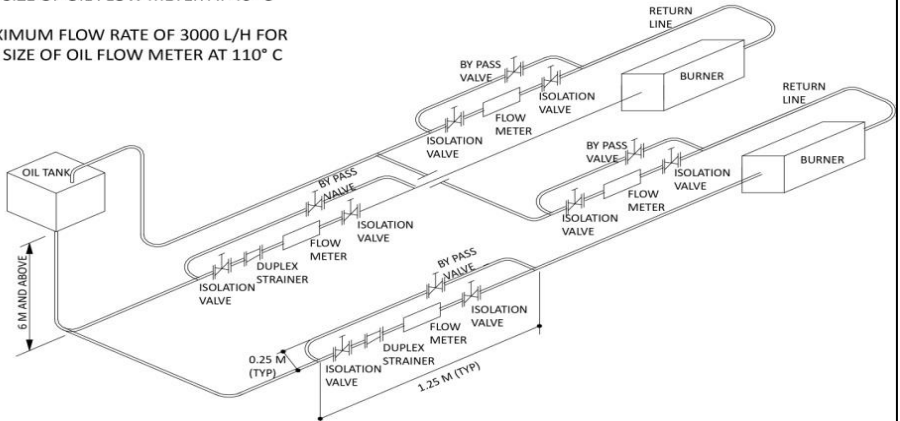
FOR CALCULATING THE DIFFERENCE IN THE MAIN OIL LINE
AND THE RETURN LINE, A SUBSTRACTOR UNIT WILL BE SUPPLIED

CONFIGURATION 7

FOR APPLICATIONS WHERE THE OIL TANK IS RETURNED
TO THE TANK AND THE TANK IS AT LOW LEVEL (MULTIPLE BOILER INSTALLATION)

MAXIMUM FLOW RATE OF 1000 L/H FOR
ANY SIZE OF OIL FLOW METER AT 40° C

MAXIMUM FLOW RATE OF 3000 L/H FOR
ANY SIZE OF OIL FLOW METER AT 110° C

FOR CALCULATING THE DIFFERENCE IN THE MAIN OIL LINE
AND THE RETURN LINE, A SUBSTRACTOR UNIT WILL BE SUPPLIED

Fig.4 – Configuration of Oil skid Assemblies
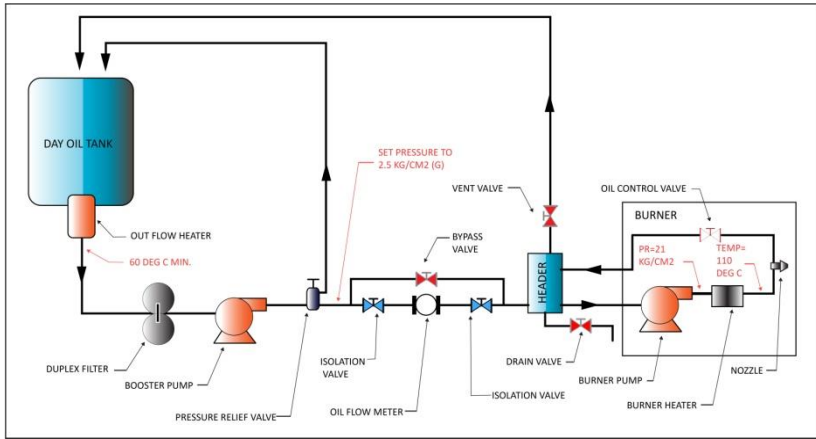
Fig.5 – Oil Flow Meter Loop diagram

Explanation of Oil Flow Meter Loop:-

The oil from the day oil tank is heated in a range of 50 to 55 ^{o}C. This oil is then passed through the duplex filter. The mesh size of this filter is 100 micron. This filter protects the pump and the meter from damage due to solid particulate matter. The oil is then pumped by the booster pump to the pressure relief valve. The booster pump is required to overcome the pressure drop because of filter and meter. The pressure relief valve is protected as the booster pump is a gear pump and hence gives a fixed throughput. The oil in excess of what is required by the burner is returned from this valve back to the day oil tank. The oil pressure at the exit of the pressure relief valve should be set to 2.5 kg/cm^2. A pressure of 2.5 kg/cm^2 ensures the water in the oil will not vaporize to steam and cause vapor locking problem. The oil is then sent to the meter and then to the header. This header acts like a surge tank. Typical size of this header should be about 36" in length and diameter of

about 24". The pressure in the header is now 2.5 kg/cm^2 because of the booster pump. The burner pump takes the oil from this header and pressurizes it to about 21 kg/cm^2. This pump is a gear pump and hence delivers a fixed throughput. The oil is then passed through a heater where the temperature is increased to 110 ^{o}C. Some oil is consumed by the nozzle of the burner. The quantity of oil consumed by the nozzle depends on the oil control valve installed on the return line. The pressure of the oil drops across this valve and becomes equal to the pressure applied on the downstream of this valve. Hence, the oil pressure here will be 2.5 kg/cm^2. The quantity of oil returned gets added to the header because of booster pump, through the meter.

For correct measurement of oil consumption, the bypass valve of the meter, vent valve and drain valve on the header should always be kept fully closed. The two isolation valves of the oil flow meter (OFM) should be kept fully open.

In systems where OFM and booster pump is not installed, the return oil from the burner is taken back to the day oil tank. As the oil is heated to 110 ^{o}C in the burner and the pressure of oil drops to atmospheric after oil control valve, the water in the oil evaporates to steam. This steam is escaped to the atmosphere hence there was no vapor locking problems. In the schematic shown above, the return oil is returned to the header instead of the day oil tank. Here the water in oil will evaporate to steam if the pressure in the header drops below 1.5 kg/cm^2. To avoid this, the booster pump and hence the header pressure is maintained at 2.5 kg/cm^2.

Also, the return pressure monitored on the burner is measured before the oil control valve. After the control, valve, the oil pressure drops down to 2.5 kg/cm^2 and is not equal to the pressure indicated on the burner return oil gauge. It can be easily realized that in case the return

oil line was kept open to atmosphere, instead of returning it to the header, the oil pressure at the valve outlet would have been atmospheric and not the valve upstream pressure. Hence, the oil being returned to the header is at 2.5 kg/cm^2 and not at the valve inlet pressure (which may vary between 5 to 15 kg/cm^2 during operation with changing fuel flow rate).

As a pressure of 2.5 kg/cm^2 is being applied to the downstream of the valve, instead of atmospheric, had the return line been taken back to the day oil tank, the oil throughput from the nozzle would increase for the same cam settings and damper settings. Once the booster pump is installed, the oil cam on the burner should be adjusted (oil throughput reduced) to ensure proper combustion. This can be easily done by adjusting the cam such that the return oil pressure is maintained as it was before installing the booster pump.

2.5.10 Installing F to I converter:

- Make sure the Input Frequency range of the converter provided is according to the oil flow meter sizing. (Default range is 0 to 37.5 Hz)
- Please confirm external supply voltage. It can be either 0-230 volt AC or 0-110 volt AC.
- F to I converter should be installed near the Oil flow meter or inside the panel on 35 millimeter DIN rail.
- Protect F to I converter from direct contact of water and other liquids.
- Please refer the 'Oil Flow Meter Installation' Video for connection details.

2.5.11 Installing R to I converter:

- Make sure the Input resistance range of the converter provided is according to the servomotor output.
- The variation in resistance is either from 0 to 150 ohm or 0 to 1 kilo ohm.

Installation

- Please confirm external supply voltage. It can be either 0-230 volt AC or 0-110 volt AC.
- R to I converter should be installed near the Servomotor or inside the panel on 35 millimeter DIN rail.
- Protect R to I converter from direct contact of water and other liquids.
- Please refer the 'Firing Feedback Signal Installation' Video for connection details.

2.6 Cable and Wiring of sub-system and analyzer

Lay down the cables from the sub-systems to the Signal Conditioning unit. Use the below given check list to make sure that all the cables are laid as per the specifications given in the above section.

➢ Power supply cable for Panel unit :
3 core, 14/36 gauge, 5A Mains Power Cord with Molded 3 pin male socket connection & other end open.

➢ Special Cable from the oxygen sensor to the Signal Conditioning unit.

➢ Shielded 2 core cable from :

Cable Connection	EffiMAX 1000	EffiMAX 2000	EffiMAX 3000	EffiMAX 4000
1. Stack temperature transmitter to Panel.	-	√	√	√
2. Feed water temp. Transmitter to Panel.	√	√	√	√
3. Ambient temperature Transmitter to Panel.	-	√	√	√
4. Steam temperature transmitter to Panel.	√	√	√	√
5. Steam flow meter to Panel.	√	√	√	√
6. Oil flow meter to Panel.	√	-	√	√

7. Gas flow meter to Panel.	√	-	√	√
8. Firing F/B to Panel.	-	-	-	√
9. Blowdown valve to Panel.	√	√	√	√
10. BBCS Sensor cable to Panel	√	√	√	√
11. FD Output to Variable Frequency Drive.	-	√	-	√
12. Drum level control Output to control valve.	-	√	-	√
13. Oil Selection F/B to Panel	√	-	√	√
14. Gas Selection F/B to Panel	√	-	√	√
15. Burner ON/OFF contactor to the Panel.	√	√	√	√

➤ LAN cable from the Effisense from panel to Effisense CPU.

➤ TDS Special cable from :
1. TDS sensor to the panel.

✓ Please refer to each mechanical and electrical installation sub-section for specific wiring diagrams and directions.

EffiMAX

✓ Use Proper size of lug suitable for 0.5 to 1 sq.
mm wire with length of 6-8 mm for termination on both analyzer and sub-system side.

✓ Use Proper size of ferrule suitable for 1 to 1.5 sq. mm wire for terminal number identification.

✓ Use weatherproof cable glands to keep the water, oil, and moisture entering inside the analyzer unit.

✓ Connect all the wires coming from the field mounted sensors to the effiMAX panel terminals.

2.7   Connection Details

2.7.1 Terminal Connection Details (Connect as per the panel drawings).

Note:

PE= POWER EARTH

IE= INSTRUMENT EARTH

The Toroidal Transformer gets the supply from the Signal Conditioning Motherboard. Please do not turn the unit ON unless proper connection is done.

The O2 Heater signal is mains 115V/230V hence do not touch the connectors wherever caution is indicated**.**

    To prevent the system from Electrical noise / transients on Earth Line, please connect separate Instrument Earth to the Earth terminal screw provided on the Signal Conditioning Enclosure.

2.7.2 Terminal Connection Diagram:

Group Marker	Terminal No	Connection Details
Panel Input 230VAC 50Hz	1	Live
	2	Neutral
	3	Earth
	4	Instrument Earth
24VDC BB1		For internal 24vdc
AITB1	1	Ambient TT
	2	
	3	Steam TT
	4	
	5	Stack TT
	6	
	7	FW TT
	8	
	9	Steam Flow
	10	
	11	Oil Flow
	12	
	13	Input from BBCS Sensor: TDS Input (Yellow)
	14	TDS Input (Red)
	15	Input from BBCS Sensor: Blowdown Temp Input (White)
	16	Blowdown Temp Input (White)

AITB2	1	O2 Probe (Brown)
	2	O2 Probe (Brown-White)
	3	O2 Probe (Green)
	4	O2 Probe (Green-White)
	5	Drum level
	6	
	7	Firing FB
	8	
	9	Sup Steam Pr/NC
	10	
	11	Gas Flow
	12	
	13	NC
	14	
	15	NC
	16	
	17	NC
	18	
AITB3	1	NC
	2	
	3	NC
	4	
	5	Flexi 1
	6	
	7	Flexi 2
	8	
	9	Flexi 3
	10	

	11	Flexi 4
	12	
	13	Flexi 5
	14	
	15	Flexi 6
	16	
AITB4	1	Flexi 7
	2	
	3	Flexi 8
	4	
	5	Flexi 9
	6	
	7	Flexi 10
	8	
	9	Flexi 11
	10	
	11	Flexi 12
	12	
	13	NC
	14	
	15	NC
	16	

	1	O2_RxTx
AOTB1	2	
	3	TDS_RxTx
	4	

	5	O2_PID_OP
	6	
	7	FD1_OP
	8	

	1	DL_OP
	2	
	3	NC
AOTB2	4	
	5	NC
	6	
	7	NC
	8	

	1	NC
	2	
	3	NC
AOTB3	4	
	5	NC
	6	
	7	NC
	8	

AOTB4	1	NC
	2	
	3	NC
	4	
	5	NC
	6	
	7	NC
	8	

DITB1	1	Boiler On/Off
	2	
	3	Oil Flow Selection
	4	
	5	Gas Flow Selection
	6	
	7	Blowdown Valve I/P
	8	
	9	Oil Pulse I/P
	10	
	11	NC
	12	
	13	NC
	14	
	15	NC
	16	

DOTB1	1	Blowdown Valve 230VAC L (Through 1 A fuse)
	2	NC
	3	NC
	4	
	5	NC
	6	
	7	NC
	8	

O2 Heater	1	O2 Probe Blue (Through 4 A fuse)
	2	O2 Probe Black

2.8 Commissioning the Product

• Each sub-system must be properly installed, commissioned and maintained to ensure correct efficiency readings. Please refer to each sub-system's section to properly commission your EffiMAX.

• After completion of all the installation and wiring, SWITCH ON the unit.

• Click on Restore to Default on Product page and check the range sheet as shown below to confirm that the values of all the parameters (like the maximum and the minimum values of the Steam Flow Rate) are as per your application.

Default Ranges:

Parameter	Minimum Range	Maximum Range
Stack Temperature	0 ^{o}C	400 ^{o}C
Ambient Air Temperature	0 ^{o}C	100 ^{o}C
Steam Temperature	0 ^{o}C	300 ^{o}C
Feed water Temperature	0 ^{o}C	200 ^{o}C
Stack Oxygen	0 %	20.9 %
Steam Flow	0.0 kg/h	5000 kg/h
Oil Flow	0.0 lit/hr	800 lit/hr
Oil Flow	0.0 lit/hr	800 lit/hr
Steam Pressure	0.0 kg/cm^{2}	16.0 kg/cm^{2}
ID Pressure	-25 mmWC	25 mmWC

Installation

- In case you need to change any of these, please refer to the individual sub system details given in section 4 of this manual.

- In applications where Oxypro has been supplied, please ensure that the dedicated electronics of the Oxypro (SME5) is powered on. It takes about 30 minutes for the sensor to heat up to the operating temperature. Correct oxygen readings will be shown only after this time.

- The default timer settings for the BBCS are
    - 30 minutes between purges
    - 30 seconds for the purge cycle
    - 20 seconds for each blow-down
    - 20 seconds between each blow-down

- Please refer to BBCS details in section 5 of this manual to study the automatic blow-down controller operation and for making changes to the timer values if required.

- Although boiler efficiency is continuously displayed on the unit, it is updated only when the Burner On/Off signal is present. The updating starts about 20 seconds after the signal goes high and is then updated continuously till the signal is present. The Efficiency and losses values are held made 0 when the signal goes low. The parameters being monitored and measured directly are still updated continuously.

- Monitor the system before taking control actions from the effiMAX panel, once the system is stable start taking control loops one by one in auto mode.

- Start with Feeder control which is based on steam pressure, then take FD fan in control based on O2 levels & finally ID in auto mode which is based on furnace pressure.

- Ensure that proper negative draft is maintained in furnace.

- For detailed sensor installations refer Commissioning software & videos prepared for those sensors.

- **This completes the commissioning of EffiMAX.**

SECTION 3:
Eversense INSTALLATION

- **To view Data on the computers in LAN through EffiSense Software, refer installation guidelines of Eversense.**

- **Ethernet settings for eversense machine:**

  IP Address: 192.168.1.200
  Subnet Mask: 255.255.255.0

- **System Settings:**
  1. Product: effiSENSE
  2. Logo: effiSENSE
  3. No of rows in Device Settings: 200.

Internet Settings

- **Device Settings:**

1. **Channel Configuration:**
   - Add Device: Select respective variant name from drop down list.
   - IP address: IP address of the ER CPU port in use.
   - Port – 502
   - Channel Type- Ethernet.
   - Click on Save to reflect the changes in settings.

SECTION 4:
OPERATING EFFIMAX

4.1 Operating the System from Plant Level

4.1.1   EffiMAX Display:

• After powering up, the first screen (Mimic Screen) displayed on HMI displays all the measured parameter values from the field and the calculated efficiency value with the losses.

• The figure given below gives the details of the Display unit. This screen is called the **Mimic** Screen. There are four main screens as below. You can change over from one screen to another by touching / clicking these buttons.

• The Mimic screen contains the link to the following screens:
  1. Flexi
  2. Trends
  3. Alarms
  4. Settings

Operating EffiMAX

Mimic Screen:

The HMI has 2 mimic screens :

1. Mimic 1 : All Monitoring parameters
2. Mimic 2 : All control related parameters

The parameters displayed on these screens will be updated after every second.

Mimic 1 :
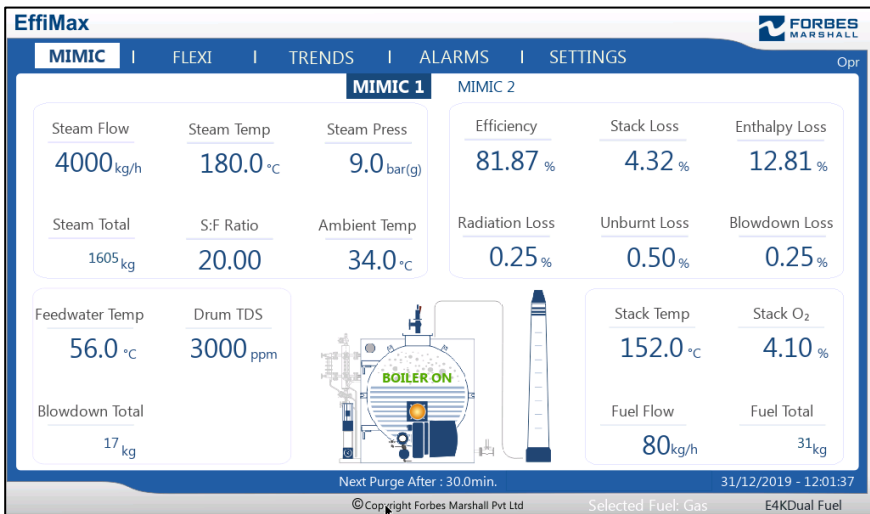
Mimic 2 :

    The Trends button on each control displays the Trends of that control loop in the Trends section of this page.

Operating EffiMAX

Black Mimic :
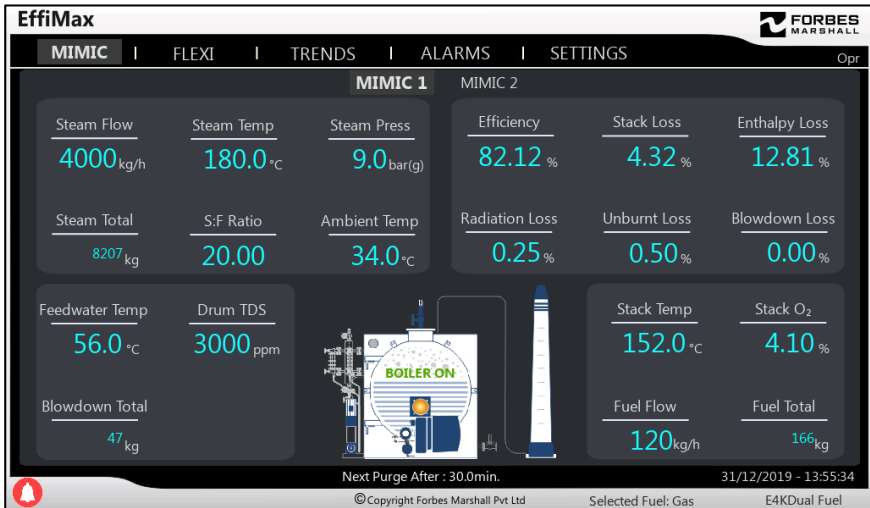
One more feature of dark theme is provided, it enhances visual ergonomics by reducing eye strain and providing comfort of use at night or in dark environments.

Flexi Screen:

The Flexi screen shows real time values of the additional parameters configured in effiMAX. Maximum 12 parameters can be configured in one system.

This screen shows parameter's live value, unit & its totalized value (if selected from settings). The totalizer can be reset from this screen by turning ON the checkbox.

Trends Screen:

The Trends screen shows real time Trends in groups. The groups are created as per the type of parameters.
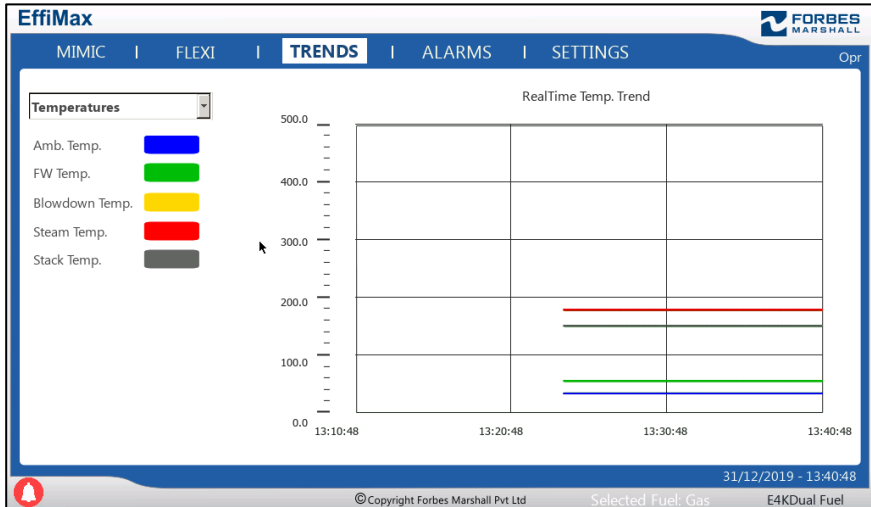
Option No.	Groups		Option No.	Groups
1	Temperatures		5	Others
2	Flow		6	Flexi Inputs 1
3	Losses		7	Flexi Inputs 2
4	Percentage			

Alarm Screen:

The alarm screen displays the alarm values of different parameters which are deviated either from the high limit values or the lower limit values.

The active alarms are displayed on Active Alarms screen with red background with State being displayed as "Triggered not Acked". The alarm can be acknowledged by ACK button on this screen. The alarms which were active but its condition has now become healthy are shown in the Alarms History page which can be opened by clicking on the alarm History button on this screen. An array of last 15 alarms will be shown on screen.

<u>Settings Screen:</u>

The settings screen contains the following options:

1. O2 Calibration: To calibrate the Oxygen analyzer with standard gases.

2. PID Controller: To adjust the PID parameters of O2 Probe temperature, FD and Drum Level control.

3. Boiler Data: Boiler specific data is entered on this screen.

4. Fuel type: These settings are used select the type of fuel likewise FO, HUSK or Coal.

5. Blow Down: To calibrate the TDS sensor as well adjustment for purge time.

6. Limits: To specify Min & Max limits for the calculated variables.

7. Range: This screen is for entering the transmitter ranges.

9. System: System Screen is used to check and set date, time, brightness of HMI, IP address of HMI, AI/AO/DI/DO connection details navigations, etc.

10. Pulse (Oil Flow Input): For Pulse related settings of oil flow meter.

11. Product: To select the EffiMAX variants, type of fuel flow meter, type of Density calculation and type of Oxygen signal as well.

12. Alarm Limits: This screen is used to set the high & low Alarm Limits of the parameters.

For detailed explanation on the Settings screen please refer Assembly & Testing section.

4.2 Operational Guidelines
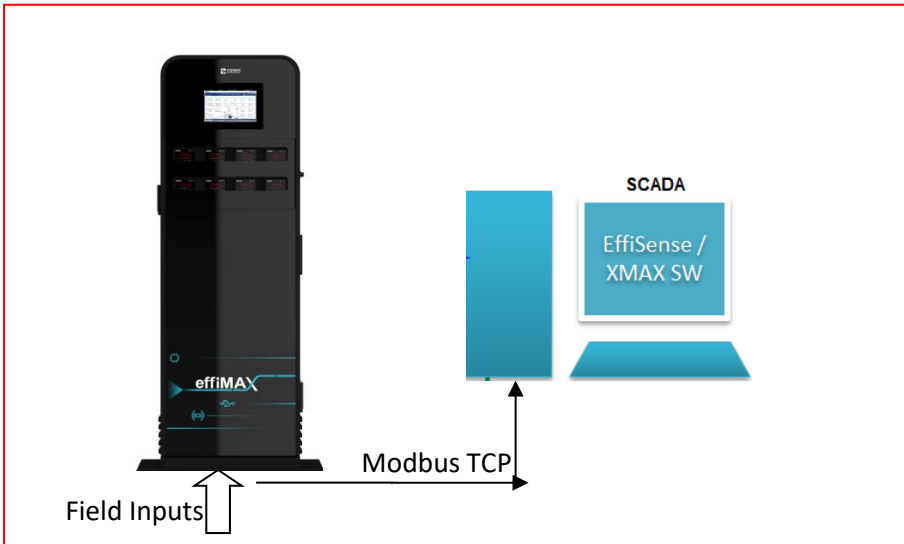
Fig. 6 Hardware Architecture

As shown in the diagram, the effiMAX consists of Panel unit and data logging unit. The panel unit is with a touch screen HMI which will display the online boiler data. The product performs following tasks simultaneously:

- Accepts inputs from all the field-mounted sensors.
- Displays the readings of all the parameters with their units.
- Computes individual losses of the boiler and the over-all efficiency.
- Directly or indirectly calculates the steam to fuel ratio from the consumption & generation of the boiler (depending on the variant selection).
- Measures and controls the TDS of the boiler drum water.
- Maintains the O2 cell operating temperature.
- Maintains Oxygen levels through FD fan control logic.

Operating EffiMAX

- Provides an interface to the user for programming the required parameters.
- Provides remote data interface through LAN or any client server based network.
- Provides remote health checkup of the boiler house by viewing data remotely from any geographical place through internet.

Below mentioned settings needs to be done specific to the customer's site.

Screens to be set as per the variant selection:

Sr. No.	Screens Visible	EffiMAX 1000	EffiMAX 2000	EffiMAX 3000	EffiMAX 4000
1	O2 Calibration	√	√	√	√
2	PID Controller	√	√	√	√
	FD Fan Control Oil	-	-	-	√
	FD Fan Control Gas	-	-	-	√
	Drum Level Control (Optional)	-	-	-	√
3	Boiler Data	√	√	√	√
4	Fuel Type	√	√	√	√
5	Blowdown	(Optional)	√	√	√
6	Limits	√	√	√	√
7	Range	√	√	√	√
8	OFM	√	-	√	√
9	Product	√	√	√	√
10	Alarms	√	√	√	√

4.2.1   The O2 calibration screen:

- To calibrate the Oxygen analyzer with standard gases.

Please perform the single point calibration for the O2 probe:

1. Ensure that boiler is in off condition and probe temperature is maintained at 800 deg C.
2. Open the sensor calibration port of O2 sensor.
3. Press **Calibrate Span** button.
4. Connect the test gas to the calibration port.
5. Enter the calibration gas O2 percentage value.
6. Press **Calibrate Slope** button.

EffiMax								FORBES MARSHALL
MIMIC	I FLEXI	I TRENDS	I ALARMS	I **SETTINGS**				Opr
O₂ Cal	PID	Boiler Data	Fuel Type	Blowdown	Limits		Range	
System		Product	Alarm Limits					

O₂ Calibration   **BOILER OFF**

		Calibration Type	Parameter	Current	New	
Furnace Temp. (°C)	798.0					
Stack O₂ (%)	20.90	**Manual**	Cell Constant	0.00	-5.00	
Actual Count	0		Slope	45.0	45.0	Save
Cell Constant	-10.00					
		Span	Cell Constant	0.00	-10.00	Calibrate / Save
		Slope	Test Gas O₂ (%)		2.0	Calibrate
			Slope	45.0	-9.8	Save

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4.2.2   PID Controller screen:

- To adjust the PID parameters of Oxygen Probe Temperature control.

Below mentioned are the default values for the PID control:

1. **Set Point** – 800 °C
2. **Proportional Gain** – 1
3. **Integral Time** – 10 sec
4. **Startup Time** – 5 min
5. **SP Offset** – 30 °C
7. **Minimum Delta Temperature** – 0.1 ^{o}C
8. **Minimum Delta Time** – 2 min
9. **O/P Max** – 75%
10. **O/P Min** – 0%

Bump less transfer: To avoid Sudden changes while switching from Manual to Auto mode and vice versa.

4.2.3   Boiler Data:

- Boiler specific data is entered on this screen.

a) **Boiler Capacity:**
   The Steam generation capacity of Boiler in kg/h is entered here.

b) **Boiler Startup Time:**
   This indicates the time duration for the combustion to stabilize. The efficiency calculation starts after this initial time has elapsed.

c) **Oxygen Cut Off Value:**
   This value is used to display the boiler status in case Boiler on/off signal is not connected. If the value set is 15.0, then software presumes that if Oxygen value is greater than 15.0 % the boiler is off.

d) **Boiler Un-burnt Loss:**
   This loss is manually entered to take care of the un-burnt losses which are not measured.

e) **Fuel density:**
   This entry indicates the density of the fuel being fed in. For Solid
   fuels this value will be 1.

f) **S:F Ratio Averaging Time:**
   This period is the time during which the averaging of S:F ratio is
   done. By default it is 30 mins. This value is important to get the
   accurate S:F ratio.

g) **Fuel Cutoff Value:**
   System has a provision to detect Boiler On/OFF on fuel flow value
   if digital contact is unavailable. Fuel flow cut off value indicates
   the threshold value below which boiler will be considered as OFF.

h) **Steam Density:**
   This is calculated parameter based on the Steam Temp and Steam
   Pr., this will be used when Steam flow input is Volumetric.

i) **Steam Enthalpy:**
   This is calculated parameter based on the Steam Temp and Steam
   Pr., this will be used for direct efficiency calculations.

j) **Constants (GA, GB, BA, BB...):**
   This is calculated parameter based on orifice plate parameters; this
   will be used for delta P based steam flow calculations.
   Contact Forbes Marshall representative for this data.

k) **Boiler On-Off Count:**
   This will indicate the total number of times boiler shutdown, value
   will be reset after 65535.

l) **Oil On-Off Count:**
   This will indicate the total number of times boiler changeover to
   Oil, value will be reset after 65535.

m) Gas On-Off Count:

This will indicate the total number of times boiler changeover to Gas, value will be reset after 65535.

n) Reset Totalizers:

These 4 totalizer buttons to be used to reset that specific totalizer value to zero.

4.2.4   Fuel Type:

- These settings are used select the type of fuel likewise HUSK Coal, etc.
- Choose the type of fuel being used in the boiler.
- By changing the fuel type the constants related to each fuel will change accordingly. And these values are taken for further calculations.
- effiMAX is a versatile unit designed to run on various types of fuels.
- The fuel type selection is important because the efficiency calculations use different types of constants (like – calorific value of fuel, etc.) which are specific to each type of fuel.
- The fuel type of your boiler is factory set.

Note: For first time user need to define fuel type for oil and gas, after that for every switchover previously selected fuel type will come in to effect.

4.2.5   The Blowdown Screen:

- To calibrate the TDS sensor as well adjustment for purge time.

Calibration of TDS Sensor:
1. Select Manual Mode.

2. Press **Purge** & collect the sample of blowdown water.

3. Ensure that there is no flashing.

4. Do not purge again after taking sample till calibration data is entered.

5. Take a sample of the blowdown water in a beaker.

6. Measure its TDS with a calibrated and certified meter or the Lab test value of blowdown water.

7. Enter the TDS value in TDS calibration value.

8. Now Press **Purge** button & while the purge is ON, press **Calibrate** button.

9. The system is now calibrated to the actual TDS Value.

10. Now select Auto mode which will blowdown after select interval.

EffiMax						FORBES MARSHALL
MIMIC	I FLEXI	I TRENDS	I ALARMS	I **SETTINGS**		Opr
O₂ Cal	PID	Boiler Data	Fuel Type	**Blowdown**	Limits	Range
System		Product	Alarm Limits			

Blowdown Control Mode: Auto   Purge Mode On   **BOILER ON**

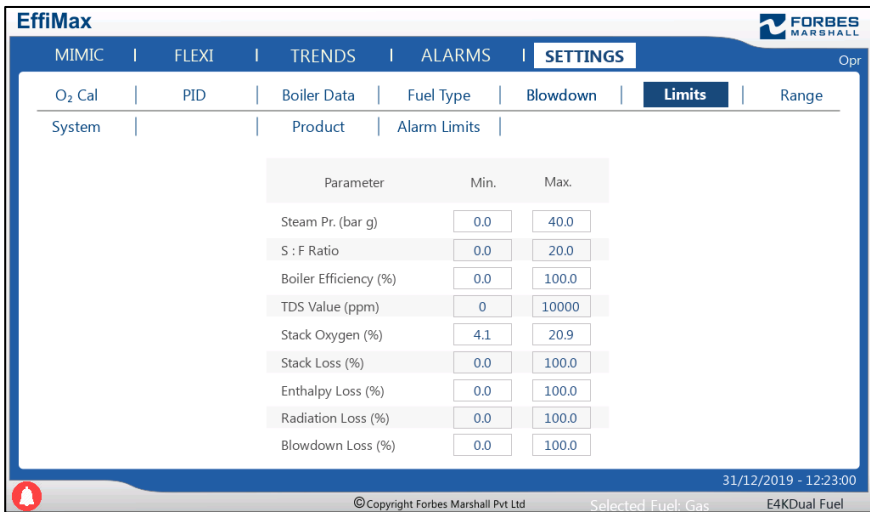|			
Current TDS (ppm)	3000	Time between Purge Cycles (mins)	30
TDS Constant K	7.03 Invalid K	Purge Time (sec)	30
TDS Resistance (ohm)	400	Blowdown Time (sec)	20
TDS Setpoint (ppm)	3500	TDS Calibrated Value (ppm)	3000
Blowdown Temp. (°C)	180.6	TDS Deadband (ppm)	50

Manual

Next Purge After : 30.0min.

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Note: Blowdown is inactive once the Boiler is OFF, so boiler won't drain during long OFF cycles.

4.2.6   Limits Screen:

- To set Min & Max limits for the calculated parameters

With this page, we can configure the minimum & maximum display value limits for all the calculated parameters.

Parameter	Min.	Max.
Steam Pr. (bar g)	0.0	40.0
S : F Ratio	0.0	20.0
Boiler Efficiency (%)	0.0	100.0
TDS Value (ppm)	0	10000
Stack Oxygen (%)	4.1	20.9
Stack Loss (%)	0.0	100.0
Enthalpy Loss (%)	0.0	100.0
Radiation Loss (%)	0.0	100.0
Blowdown Loss (%)	0.0	100.0

EffiMax — MIMIC | FLEXI | TRENDS | ALARMS | **SETTINGS** — Opr

O₂ Cal | PID | Boiler Data | Fuel Type | Blowdown | **Limits** | Range
System | | Product | Alarm Limits

31/12/2019 - 12:23:00
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4.2.7   Range Screen:

- For setting minimum and the maximum ranges of the standard field mounted sensors.

Parameter	Min. Count	Max. Count	Min. Range	Max. Range	Actual Count	Actual Value
Ambient Temp	10486	52428	0	0	0	0.0 °C
Feed Water Temp	10486	52428	0	0	0	0 °C
Stack Temp	10486	52428	0	0	0	0 °C
Mass Steam Flow	10486	52428	0	0	0	0 kg / h
Oil Flow	10486	52428	0	0	10473	0 Lit/h
Steam Temp	10486	52428	0.00	0.00	0	0.00 °C
Firing F/B	10486	52428	0.00	0.00	0	0.00 %
Drum Level	10486	52428	0	0	0	0 %
Gas Flow	10486	52428	0	0	0	0 Nm3/h
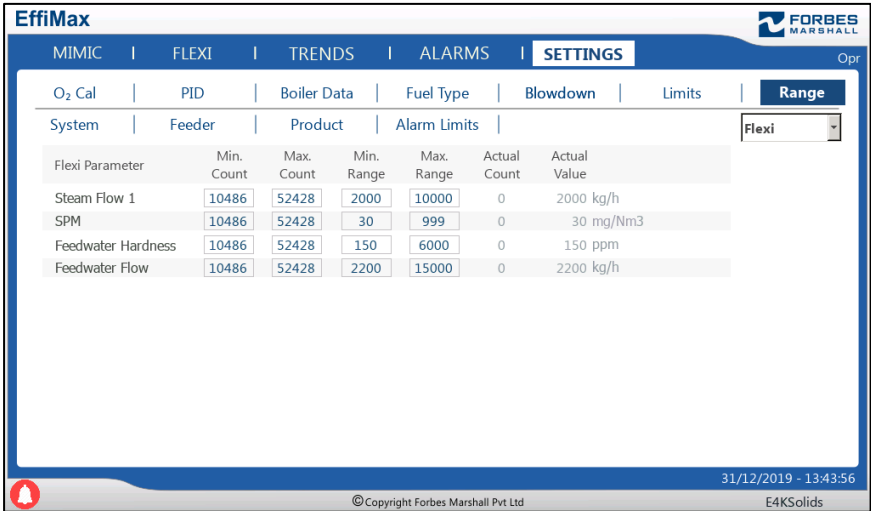
Parameter	Min. Count	Max. Count	Min. Range	Max. Range	Actual Count	Actual Value
Stack Oxygen	10486	52428	0.00	0.00	0	4.10 %
TDS	10486	52428	0	0	0	0 ppm
Blowdown Temp	10486	52428	0.0	0.0	0	0.0 °C

Range Settings for Flexi parameters:

EffiMax						FORBES MARSHALL
MIMIC	FLEXI	TRENDS	ALARMS	SETTINGS		Opr

O₂ Cal	PID	Boiler Data	Fuel Type	Blowdown	Limits	**Range**
System	Feeder	Product	Alarm Limits			Flexi

Flexi Parameter	Min. Count	Max. Count	Min. Range	Max. Range	Actual Count	Actual Value
Steam Flow 1	10486	52428	2000	10000	0	2000 kg/h
SPM	10486	52428	30	999	0	30 mg/Nm3
Feedwater Hardness	10486	52428	150	6000	0	150 ppm
Feedwater Flow	10486	52428	2200	15000	0	2200 kg/h

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Above fig indicates default ranges configured for the Field sensors.

- In addition to the sensor ranges, actual count received from the I/O Module as well as its actual value is displayed.
- This screen would be very useful while commissioning the unit as it shows the Raw as well as scaled values of the sensors.
- The list of parameters changes with the type of product selected.
- The range of Stack Oxygen is normally -10.0mV to 125.00mV in case direct oxygen is measured.
- In case if Stack Oxygen is measured using dedicated electronics or any other analyzer, the range should be 0.0 to 20.9%.

4.2.8   System Screen:

- To set additional features like Date, Time, IP Address, Brightness level.
- In addition user can view Connection Details and its status

EffiMax

FORBES MARSHALL

| MIMIC | I | FLEXI | I | TRENDS | I | ALARMS | I | **SETTINGS** | Opr |

| O₂ Cal | PID | Boiler Data | Fuel Type | Blowdown | Limits | Range |

| System | Product | Alarm Limits |

AITB 3

No.	Parameters	Counts
AIN1	Feeder5	0
AIN2	Feeder6	0
AIN3	Flexi Input 1	0
AIN4	Flexi Input 2	0
AIN5	Flexi Input 3	0
AIN6	Flexi Input 4	0
AIN7	Flexi Input 5	0
AIN8	Flexi Input 6	0

AITB 4

No.	Parameters	Counts
AIN1	Flexi Input 7	0
AIN2	Flexi Input 8	0
AIN3	Flexi Input 9	0
AIN4	Flexi Input 10	0
AIN5	Flexi Input 11	0
AIN6	Flexi Input 12	0
AIN7	NC	0
AIN8	NC	0

Previous

AO

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EffiMax

FORBES MARSHALL

| MIMIC | I | FLEXI | I | TRENDS | I | ALARMS | I | **SETTINGS** | Opr |

| O₂ Cal | PID | Boiler Data | Fuel Type | Blowdown | Limits | Range |

| System | Product | Alarm Limits |

AOTB 1

No.	Parameters	Counts
AOUT1	O2_RxTx	18714
AOUT2	TDS_RxTx	23069
AOUT3	O2PID_OP	10486
AOUT4	FD1 _OP	10486

AOTB 2

No.	Parameters	Counts
AOUT1	DL_OP	10486
AOUT2	NC	10486
AOUT3	NC	10486
AOUT4	NC	10486

AI

DI

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| MIMIC | I | FLEXI | I | TRENDS | I | ALARMS | I | SETTINGS | Opr |

| O₂ Cal | PID | Boiler Data | Fuel Type | Blowdown | Limits | Range |

| System | | Product | Alarm Limits | |

DITB 1   **DITB 1**

No.	Parameters	Status
DIP1	Boiler ON/OFF	🟥
DIP2	Oil Flow Selection	🟥
DIP3	Gas Flow Selection	🟥
DIP4	Superheated Bldn Valve I/P	🟥
DIP5	Oil Pulse I/P	🟥
DIP6	NC	🟥
DIP7	NC	🟥
DIP8	NC	🟥

No.	Parameters	Status
DIP9	NC	🟥
DIP10	NC	🟥
DIP11	NC	🟥
DIP12	NC	🟥
DIP13	NC	🟥
DIP14	NC	🟥
DIP15	NC	🟥
DIP16	NC	🟥

AO   DO

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| MIMIC | I | FLEXI | I | TRENDS | I | ALARMS | I | SETTINGS | Opr |

| O₂ Cal | PID | Boiler Data | Fuel Type | Blowdown | Limits | Range |

| System | | Product | Alarm Limits | |

DOTB 1   **DOTB 1**

No.	Parameters	Status
DO1	Blowdown valve	🟥
DO2	NC	🟥
DO3	NC	🟥
DO4	NC	🟥
DO5	NC	🟥
DO6	NC	🟥
DO7	NC	🟥
DO8	NC	🟥

No.	Parameters	Status
DO9	NC	🟥
DO10	NC	🟥
DO11	NC	🟥
DO12	NC	🟥
DO13	NC	🟥
DO14	NC	🟥
DO15	NC	🟥
DO16	NC	🟥

DI

31/12/2019 - 15:37:46

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4.2.9   Trim Screen Oil / Gas:

Trim screen is used to configure the parameters for O2 trim control. The firing table needs to be filled in to define the desired oxygen levels at different load conditions. This table can be opened by clicking on the Show button in front of firing table. Range of firing rate should be entered on this page. The trim control logic will consider these values as a window under which O2 will be controlled.

Stack O_2: This is the process variable which needs to be controlled at all firing loads.

O2 SP: This is the Set point for controlling O_2 at different firing rates. This set point is derived from the firing table.

Firing Rate: This is the actual firing feedback received from the burner. This indicates the present firing load of the burner based on which oxygen set-point is varied and PID minimum values are determined to ensure safe minimum outputs are given at all loads.

The burner can give firing feedback in either 4-20 mA standard or a potentiometer with gear mechanism needs to be mounted on burner to get the actual firing load from burner.

Firing Table: This table is used to feed the Set points & FAN OP as per the load, so as the load changes set points & OP's are derived from these tables.

Manual Output: This is the entered manual output. Based on the selection of Manual mode, this fixed output will be given.

Ramped FD Output: This is the final output that will be given to FD fan VFD whether in auto or manual mode with ramp rate as entered in FD Ramp Time (%/sec).

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| MIMIC | I | FLEXI | I | TRENDS | I | ALARMS | I | **SETTINGS** | Opr |

| O₂ Cal | **PID** | Boiler Data | Fuel Type | Blowdown | Limits | Range |

| System | | Product | Alarm Limits | | O2 Trim Oil ▼ |

FD Fan Control_Oil   **Boiler OFF**

Stack O₂ (%) :	20.90	P - Gain :	1.0
O₂ SP (%) :	0.00	I - Time :	10.0
Firing Rate(%) :	20.0	FD Ramp Time (%/sec) :	2
Firing Table :	Show	FD Startup Time (sec) :	10
		FD Start Air (%) :	20
Ramped FD Output :	0.0 (0.0)	FD FAN LoLimit (%) :	0.0
		FD FAN HiLimit (%) :	80.0

Mode (A /M):   Manual

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EffiMax   ⚡ **FORBES MARSHALL**

| MIMIC | I | FLEXI | I | TRENDS | I | ALARMS | I | **SETTINGS** | Opr |

| O₂ Cal | **PID** | Boiler Data | Fuel Type | Blowdown | Limits | Range |

| System | | Product | Alarm Limits | | O2 Trim Gas ▼ |

FD Fan Control_Gas   **Boiler OFF**

Stack O₂ (%) :	20.90	P - Gain :	1.0
O₂ SP (%) :	0.00	I - Time :	10.0
Firing Rate(%) :	20.0	FD Ramp Time (%/sec) :	2
Firing Table :	Show	FD Startup Time (sec) :	10
		FD Start Air (%) :	20
Ramped FD Output :	0.0 (0.0)	FD FAN LoLimit (%) :	0.0
		FD FAN HiLimit (%) :	80.0

Mode (A /M):   Manual

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Proportional Gain (P): Proportional value in the PID controller used to calculate the Output. This gain (P) should be tuned based on the response of the O_2 probe & the boiler combustion.

Repeats / Min (I): Integral Value in the PID controller used to calculate the Output. This indicates the rate of output value updating in a minute. For ex. If I is set as 10, then 60sec / 10 = 6. This means after every 6 sec output is re-calculated to control the damper / motor.

Boiler Start Air (%) and Boiler Startup Time (Sec): These two parameters are interlinked. Whenever burner on feedback is received every time burner ignition happens, an entered 'Boiler Start Air (%) 'Output will be given for 'entered 'Boiler Startup Time (Sec)'.

This is to ensure pre-purging is completed before actual trimming begins.

FD Ramp Time (%/sec): The actual output will vary according to these entered values. For e.g. if value entered as 2 the actual output will vary at the rate of 2% per sec. This is to ensure that there is bump less transfer of output when shifted from auto to manual or manual to auto mode.

FD Fan LoLimit (%): This value is derived from firing table, this set the low limit to FD fan.

This means if the setpoint is lower than actual O2%, controller will try to reduce the O2 level by reducing the FD fan speed till FD Fan LoLimit, even though O2 level is higher than setpoint it won't go below this settings for safety concern.

FD Fan HiLimit (%): This value is settable from this screen only; this value limits the maximum speed of the FD fan.

This means if the setpoint is higher than actual O2%, controller will try to increase the O2 level by increasing the FD fan speed till FD Fan

HiLimit, even though O2 level is lower than setpoint it won't go beyond this settings for safety concern.

Firing Table:

This table is used to feed the Set points & FAN OP as per the load, so as the load changes set points & OP's are derived from these tables.

4.2.10   Drum Level:

Drum Water Level: The Drum Water Level can be set 0-100%.

Setpoint: Selection of Set point is based on the SP mode selection. This is the value of O_2 set by user or derived from firing table for a particular firing rate.

Proportional Gain (P): Proportional value in the PID controller used to calculate the Output. This gain (P) should be tuned based on the response of the O_2 probe & the boiler combustion.

Repeats / Min (I): Integral Value in the PID controller used to calculate the Output. This indicates the rate of output value updation in a minute. For ex. If I is set as 10, then 60sec / 10 = 6. This means after every 6 sec output is re-calculated to control the damper / motor.

Derivative Gain (D): Derivative value in the PID controller used to calculate the Output.

PID OP Min: This value is used to limit the PID output in Auto mode, so that output should not go below the minimum operating value.

PID OP Max: This value is used to limit the PID output in Auto mode, so that output should not go above the maximum operating value.

Manual Output: In manual mode user can set the FD Fan output as required by user.

Action: Forward or Reverse action can set.

Mode: This helps to switch from auto to manual mode and vice versa. Manual Mode is used to bypass the control action and user can enter the Output as required from 0 – 100%.

4.2.11   Product Screen:

This screen sets the type of effiMAX variant, Input steam flow type, & many other crucial Product configurations as shown below:

• Flexi Parameters Settings:

This screen is to configure input name, type and unit of the additional parameters.

Parameter Name: To configure the name of parameter, just enter blank field under Flexi parameter, keypad will pop-up to enter the name of parameter.

Parameter Type: Depending on the averaging or totalization requirement, select 'Avg.' or 'Total' option.

Units: Respective parameters unit need to be entered through pop-up keyboard.

Enable: Once check box is selected, respective parameter and its total value will be displayed on Flexi parameters page.

4.2.12 Alarms Screen:

This page is used to set the alarm levels for the parameters configured in the effiMAX. Parameter Name is mentioned and user is supposed to enter Low alarm value below which alarm will be generated of that parameter. Also, enter High alarm value above which alarm will be generated.

SECTION 5:
BLOWDOWN SYSTEM

5.1 Introduction

STANDALONE TDS MEASUREMENT SYSTEM:

- The **standalone TDS measurement system** measures the total dissolved solids of the boiler water & helps the user to keep the records of the same. This sensor is installed on the blowdown line.

- For installation of TDS sensor please refer 'Installation diagram of TDS sensor' in Section 11.

BBCS:

The **Boiler Blowdown Control System (BBCS)** system is designed to maintain boiler water total dissolved solids (TDS) within a band as indicated by the boiler manufacturer, water treatment specialists or in standards for TDS control.

- It maintains the TDS of drum water specified by the boiler attendant.

5.2 Operating Principle

The BBCS system periodically opens the Blowdown valve automatically and purges the water.

The BBCS sensor, mounted in the sensor chamber, measures the TDS of the Blowdown water.

This measured value is compared with the user-fed set point on the display in a following manner:

1.   If the measured value is lower than the set point, the Blowdown valve closes at the end of the purge time and remains closed until the next purge.

2.   If the measured value is higher than the set point, the controller continues the Blowdown cycle until the measured value drops below the set point.

Typical Operations:
❖   **Measured TDS lower than the set point**
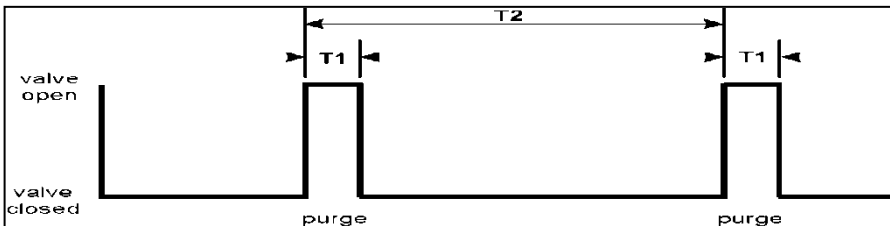
Fig. 7 Typical Operation 1

T1: Initial purge time: Standard setting is 10 seconds. It can be varied between 1 to 60 seconds in the computation unit.

T2: Time between purges: Default setting is 30 minutes & can be programmed on the analyzer as per required in the application.

T3: Time between blowdown: Standard setting is 20 seconds. This is useful in cases where the expected blowdown is less than 800 kg/h. It will make the blowdown cycles intermittent.

T4: Blowdown time: Default setting is 10 seconds. It can be varied from 1 second to up to 60 seconds on the computation unit.

Blowdown System
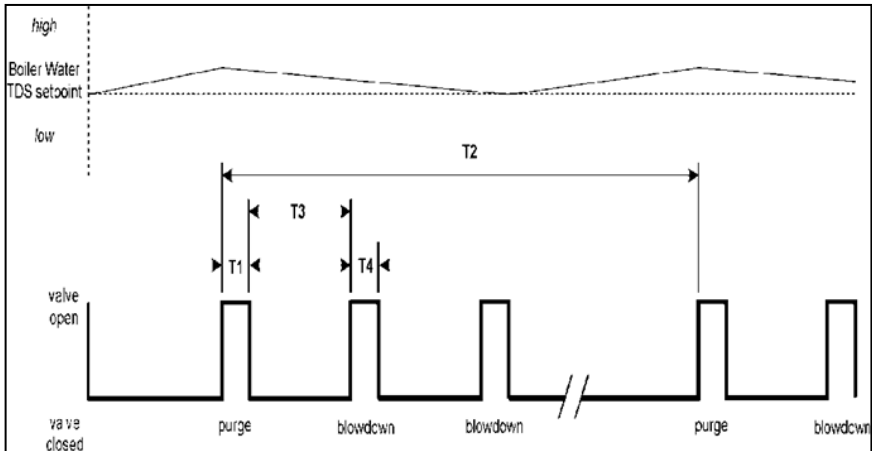
Fig. 8 Typical Operation 2

❖ **TDS being controlled near set point:**

A conductivity sensor measures the boiler water TDS during the purge cycle. The resistance of this sensor changes with the change in conductivity. This is sensed by the EffiMAX Signal conditioning unit and the actual TDS value is the computed and displayed by the Display unit. This is then compared with the set-point in the blowdown controller and action is taken accordingly.

❖ **Features and Benefits:**

· Reduced operating costs (less feed water consumption; chemical treatment and higher heating efficiency)

· Reduced maintenance and repair costs (minimized carryover and deposits)

· Cleaner and more efficient steam

· Minimize energy loss from boiler blowdown

· Compact and complete boiler blowdown control solution

· High quality components requiring low maintenance

5.3 Assembly of the system

A typical installation is shown in the Boiler Blowdown Control System assembly drawing below. Assemble the system using the gaskets supplied between flanges. Note the following points.

BBCS Assembly diagram:
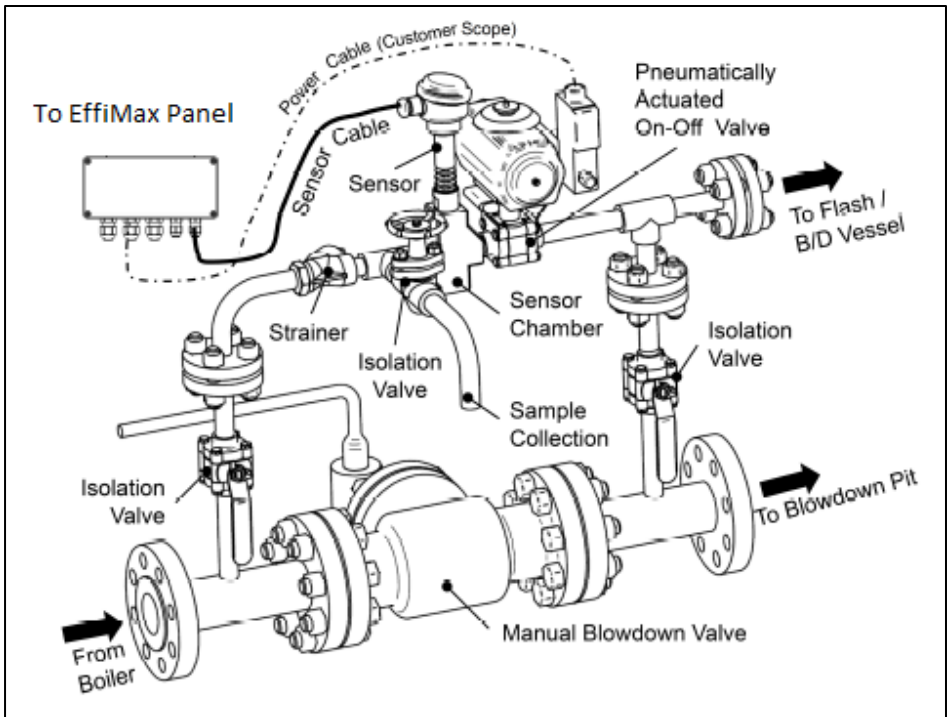
Fig. 9 BBCS Assembly details

Blowdown System

❖ **Core components of BBCS**

- High Temperature Conductivity Sensor (HTCS) with built-in

Temperature Sensor.(Cell Constant K=1)

- Sensor Chamber

- 4-Core Shielded Cable for BBCS Sensor

- Boiler Blowdown Control Piping

System comprises of following –

1. Isolation Valves,

2. 'Y' Strainer,

3. Sample Collection Point,

4. Sensor Chamber,

5. Pneumatically Operated On-off Blowdown Valve

6. Manual Blowdown Valve

❖ **Pressure and Temperature Limits:**

1. Mechanical:

• Maximum Operating Pressure: 31 Kg/cm2(g)

• Maximum Operating Temperature: 238 °C

• Cold Hydraulic Test Pressure: 47 kg/cm2(g)

• Minimum Operating Temperature: 0 °C

• Instrument Air Supply: 4 to 6 Kg/cm2(g)

2. Measurement:

• TDS Range: 500 to 10000 ppm, Resolution: 10 ppm

• Temperature Range: 0 to 250 °C, Resolution: 0.1 °C

❖ **Boiler Bottom Blowdown Line Connections**

All connecting pipe work should always be free from external stresses & adequately supported.

Forbes Marshall BBCS unit must not be operated above the maximum pressure & temperature of boiler blowdown water indicated on system general arrangement drawing / product nameplate.

Connect the Inlet & Outlet boiler blowdown line as indicated in respective general arrangement drawing for to BBCS unit.

❖ **BBCS Sensor Installation**

Fit the sensor chamber in a horizontal pipeline with suitable isolation valves to facilitate inspection/cleaning of the sensors. Process flow must be in the direction of arrow marked on sensor chamber. **The sensor must be fitted in vertical direction with sensor head upwards**. The sensor is supplied with a gasket for sealing between sensor & sensor chamber.

Do not install the sensor outdoors without additional weather protection

Do not install the sensor in inverted/horizontal position

Fit the sensor to the sensor chamber by gripping it across flat provided on sensor for spanner only. Do not apply torque to sensor aluminium head or extension piece with cooling fins to fit sensor to sensor chamber.

Ensure that sensor cable is not exposed to a temperature greater than 120°C

❖ **Air Supply**

Connect instrument air supply at 4 to 6 kg/cm2(g) to Air Filter Regulator mounted on On-off blowdown valve.

Blowdown System

❖ **Signal Cable Connections:**

   It is mandatory to use Forbes Marshall BBCS Sensor Cable only, supplied along with BBCS unit to connect the BBCS Sensor to EffiMax.

   Length of BBCS Sensor cable is limited to 5 meters. In special case it can be 30 meters max. Maintain distance between the BBCS sensor & EffiMax accordingly.
   Forbes Marshall BBCS sensor cable available in Length 5 meter as Standard & 30 meter as optional. Sensor cable length must be specified in Purchase order.
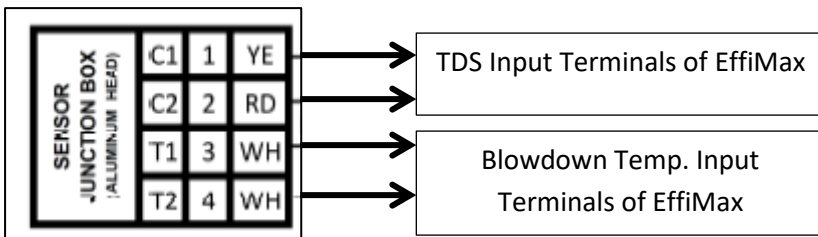
   YE: Yellow

   RD: Red

   WH: White

   C1, C2: Conductivity Input

   T1, T2: Blowdown Temperature Input.

5.4 Commissioning the System

Ensure that the downstream of blowdown valve is fully open.

After mechanical and electrical installation, the system must be commissioned as follows:

1) Testing for leaks:
Open the two ball valves and with the boiler under pressure open the blowdown valve for the purge time T1 by briefly pressing the "purge" button on the controller.

Blowdown should be discharged to the blowdown vessel for approximately 30 seconds (the standard setting). Check that the pipe-work becomes hot (indicating flow) and that there are no leaks.

2) Setting the purge time T1:
For most small boilers the standard purge time of 30 seconds is sufficient to ensure that hot blowdown at boiler temperature reaches the sensor so that the controller can measure its true TDS.

Where there is rather long or large bore pipe-work upstream of the sensor, a longer purge time may be required.

The necessary purge time may be programmed through software (as shown below).

Starting with the blowdown pipe-work reasonably cold (e.g. after standing for at least 15 minutes) press and hold the "purge" button until the display reaches its highest steady reading. The time taken to reach the highest reading is the minimum required purge time.

If the required purge time is longer than 30 seconds, set the required purge time as was shown below. After adjustment the purge time can be checked by briefly pressing the "purge" button, when the blowdown valve will open for the set purge time. Make adjustments as necessary.

3) Setting the blowdown time T3:

For most process boilers, the standard time between blow-downs (T3) of 40 seconds is satisfactory. For very high blowdown rates, T3 may be set to zero so that blowdown is continuous. It is important that the required blowdown rate is not more than the maximum rate possible through the valve; otherwise the valve will remain open and still not be able to regulate TDS. The maximum blowdown rates at various boiler pressures are as follows:

Boiler Pressures	Blowdown rates (kg/h)	
	T3 = 20 seconds	T3 = 0 seconds
5.5	333	1000
10.5	900	2700
17.5	1233	3700
21.5	1500	4500
31.5	1900	5500

4) Setting the time between purges (T2):

Time T2 should be set as specified by the boiler manufacturer or as found out by experience of the boiler operator. EffiMAX uses a default setting of 30 minutes.

5) Setting the blowdown time (T4):

This should be set on the basis of the operating pressure of the boiler and on the distance of the sensor from the boiler. The default value of 20 seconds is generally sufficient and need not be disturbed. It is important to remember that a larger T4 will mean more water flowing out of the boiler. This can result in triggering the low water alarm of the boiler.

5.5 Trouble Shooting

In case of problems, refer to the following points:

1)   The boiler water TDS continue to rise above the set point although the 'Purge' message is flashing on the controller and blowdown is being discharged through the blowdown valve:
     The controller is operating correctly, but the blowdown valve is passing insufficient flow.
     The valve or pipe work may be partially blocked, or it may be necessary to set the time between blowdown (T3) to zero).
     Where a heat recovery system is installed, ensure that the blowdown is being properly discharged, and is not contaminating the feed-water system. Increasing boiler water TDS may also be caused by condensate or feed-water contamination from any source.

2)   The boiler water TDS continues to fall although the 'Blowdown Cycle' message never flashes on the controller:
     Check that the blowdown valve shuts off tight and ensure that the purge time (T1) is set as low as possible. If the boiler water TDS continues to fall ensure that other blow down are not excessive. Examples could be a leaking bottom blow down valve or leaking level control chamber drain valves.

3)   The blowdown valve does not operate even though the 'Blowdown Cycle' message flashes on the controller display:
     This may be caused by a blocked pneumatic line to the pneumatic Blowdown Valve. Often, the air-lines get clogged by dirt or fluid.
     A globe valve, strainer and pressure regulator in the air line are recommended.

SECTION 6:
TEMPERATURE TRANSMITTER

6.1 Introduction

The **Stack, Steam, Feed-Water and Ambient Air Temperature Transmitters** are two wire loop powered temperature transmitters. The primary sensing element is an RTD, PT-100. These sensors have built-in transmitters located on the head of the instruments. This are powered from the EffiMAX Signal Conditioning unit (24 V DC) and provides an output of 4-20 mA.

After installing the temperature transmitters, check the reading on the display unit. This should be between +/- 2° C of temperature measured at that location with any other calibrated and certified temperature-measuring instruments such as a thermometer.

These transmitters have different output ranges. These ranges are programmed into the Electronics unit from the factory. In case where the temperature transmitters are procured locally make sure the ranges are same as mentioned in the specifications.

SECTION 7:
MAINTENANCE SCHEDULE

Given below is a matrix of the maintenance that needs to be carried out on each sub-system. Please ensure that maintenance is carried out regularly and as per the instructions given below it.

	Weekly	Monthly	Annual
TDS System	Yes		Yes
Oxypro		Yes	
Temperature transmitters		Yes	

7.1 TDS System

- **Weekly**

Ensure following things are inline during maintenance schedule:

i. Pneumatic (air) line is pressurized.

ii. On purging, pneumatic valve is powered with 230VAC.

iii. Blowdown water is actually discharged when the purge button is pressed (e.g. by temperature or sound)

iv. Strainer is cleaned & strainer mesh is in good condition.

v. Upstream & downstream of blowdown skid isolation valves are fully open.

vi. There is no scaling on the sensor tip to have accurate sensing.

vii. Connection between field cables & sensor cables are intact.

Measure the boiler water TDS and perform the calibration.

Maintenance Schedule

- **Annually**

Isolate the system by turning off Isolation valves (or when the boiler is empty) & remove the sensor from the sensor chamber. Clean the sensor tip and the insulator with a bristle brush or cloth. If damaged, replace the sensor (with the joint gasket). Internally clean and check sensor chamber, blowdown valve and check valve. If damaged, replace these items.

7.2 Oxypro

- Switch off the unit.
- Remove the unit from the stack.
- Clean the filter on its tip gently.
- Perform 20.9 % calibration on monthly basis.

7.3 Temperature Transmitter

- Remove the Temperature Transmitter from the field & have visual inspection of RTD stem & thermowell.
- Ensure that field cable running should not be in contact with hot surfaces like steam line or flue gas ducts.
- Compare the current displayed temperature value with corresponding resistance value of RTD using a standard RTD Resistance chart.

Procedure for on-site cross checking of RTD Temperature Sensor:

i. Remove the TT from the process.
ii. Ensure that there is no any physical damage to the TT.
iii. Remove the Red 1, Red 2 & white cable of RTD from Transmitter head.

iv.   Allow the temperature of TT settle down to Ambient
         temperature.
v.   Measure the resistance between any of Red & white cable.
vi.   At ambient temp. consider of 25 deg C,

$$R = (Temp * 0.39) + 100$$

$$= (25*0.39) + 100$$

$$= 9.75 + 100$$

$$= 109.75 \text{ ohms}$$

For resistance values refer the standard RTD chart.

So at ambient conditions cross check the resistance. If resistance is in
Mega Ohms then it indicates the sensor is open OR if it is around 0 ohm
then it indicates the sensor is short internally.

If there is any deviation, please perform the calibration as per the
standard procedure or contact to concern person.

SECTION 8:
SPARES LIST

The following is a list of recommended spares available from Forbes Marshall:

Item
ER CPU
ER AI Card
ER AO Card
ER DI Card
ER DO Card
Smart Card
PWM-RTD Card
EXOR 10 inch HMI
24Vdc Power Supply
AM Station
Isolators
Oil Flow Meter
Gas Flow Meter
Signal Splitter
Thermowell
Stack Temp transmitter
Steam Temp transmitter
Feed water Temp transmitter
Ambient Temp transmitter
O2 Probe
Steam Flow Meter

SECTION 9:
DO's & DON'Ts

1. Do make sure that all the wiring is protected from physical damage.

2. Do ensure that the blow down valve downstream is fully open.

3. Don't clean the TDS sensor with a wire brush or other abrasive methods.

4. Don't disconnect wiring without switching OFF the power supply.

5. Don't attempt to repair the PCB assembly.

6. Don't fit a needle valve in the air line.

7. Don't turn the calibration potentiometer unless informed to FM.

8. Don't make any transmitter connection without switching OFF unit.

9. Don't short the transmitter inputs. It may cause analog input failure.

10. Do not touch transformer with Greasy/Oily/Dirty hands. Keep Touch screen in clean environment and wipe with clean cloth every day.

SECTION 10:
LOG REPORT

10.1 Data Logging Sheet

The report format given on the next page can be used for manually logging the readings of effiMAX, in case the data is not being logged on a PC.

EffiMAX Report:

Boiler ID: **Date:**

Time	Steam Total (kg)	Fuel Total (kg)	Steam Flow (kg/h)	Efficiency (%)	Stack Temp (^{o} C)	Stack Oxygen (%)	Steam Temp (^{o} C)	FW Temp (^{o} C)	Drum TDS (ppm)

SECTION 11:
INSTALLATION DRAWINGS

Below are the details of the Installation of the individual sensors.

These diagrams indicate typical installation of the sensors. Actual installation can vary as per the customer's specific requirements.

To get the feel of installation please check the installation videos, these videos will help for proper installation of filed instruments.
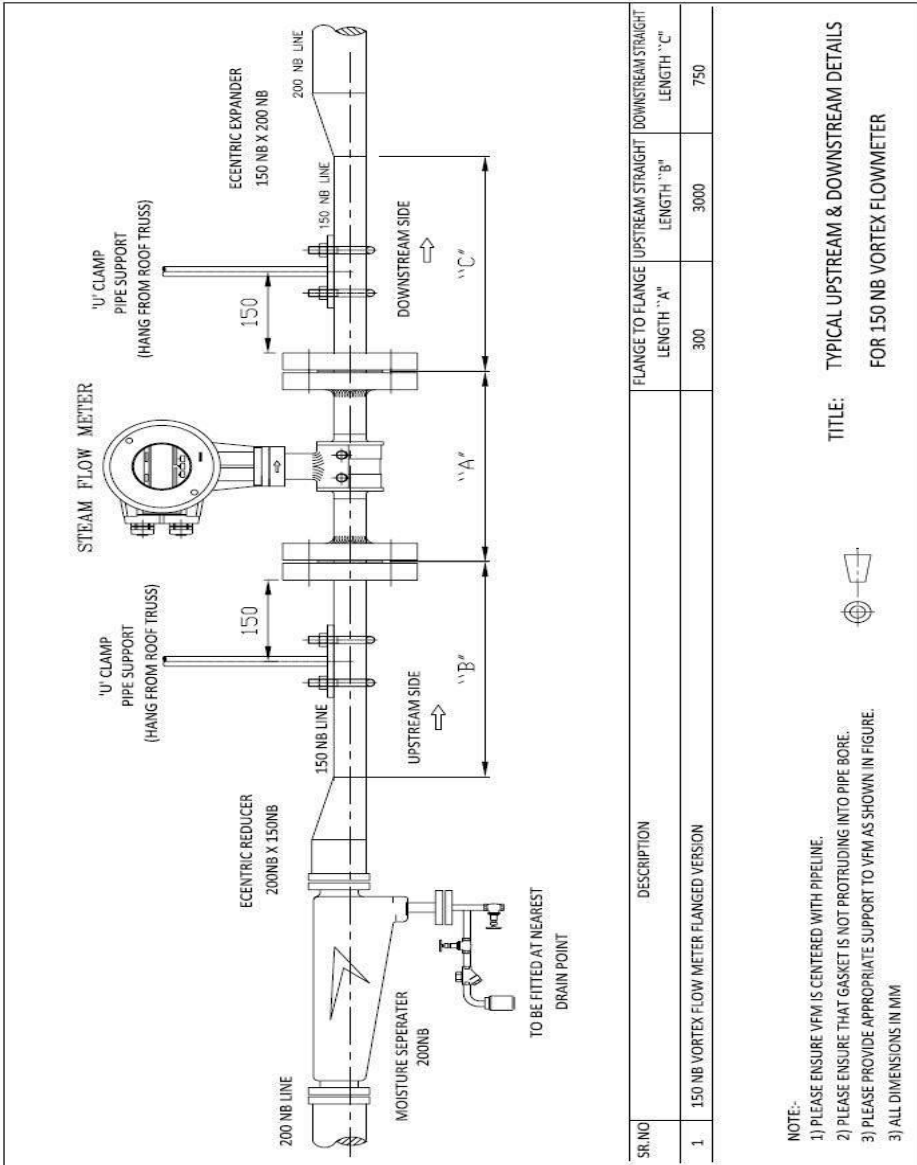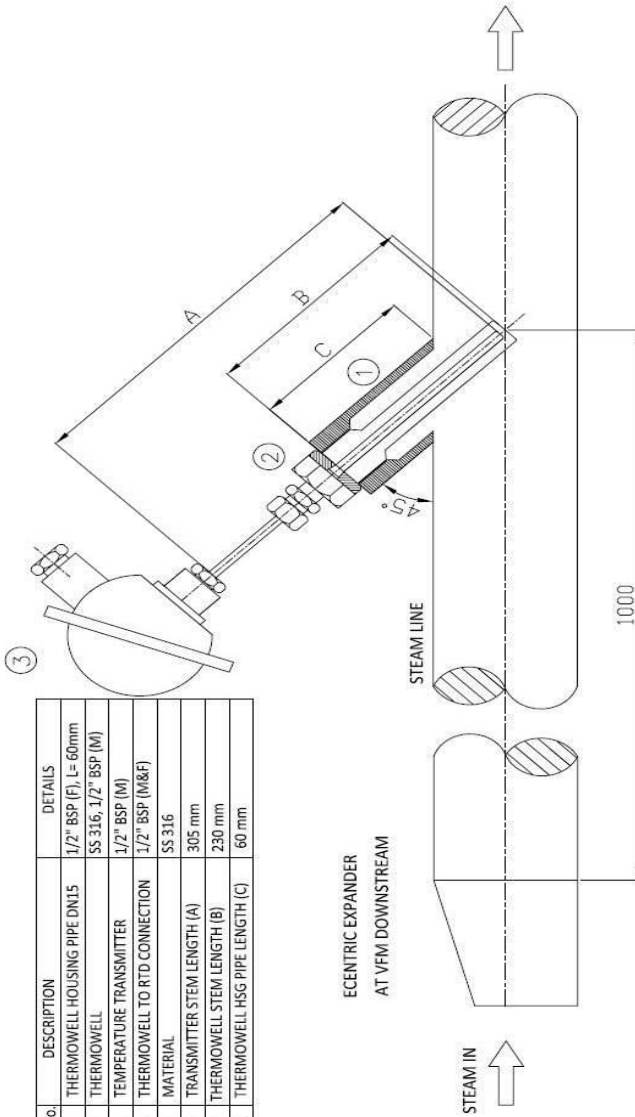
Fig. 10 Steam Flow Meter Installation diagram

SIZE	φ	Δφ	SIZE	φ	Δφ
DN (mm)	mm (inch)	mm (inch)	DN (inch)	mm (inch)	mm (inch)
10S	8.9 (0.35)	0.4 (0.016)	3/8"S	8.9 (0.35)	0.4 (0.016)
10	12.6 (0.50)	0.4 (0.016)	3/8"	12.6 (0.50)	0.4 (0.016)
15	14.9 (0.59)	0.4 (0.016)	1/2"	14.9 (0.59)	0.4 (0.016)
20	20.9 (0.82)	0.4 (0.016)	3/4"	20.9 (0.82)	0.4 (0.016)
25	28.5 (1.12)	0.4 (0.016)	1"	26.7 (1.05)	0.4 (0.016)
40	43.1 (1.70)	0.4 (0.016)	1/5"	40.9 (1.61)	0.4 (0.016)
50	54.5 (2.15)	0.6 (0.024)	2"	52.6 (2.07)	0.6 (0.024)
80	82.5 (3.25)	0.6 (0.024)	3"	78 (3.07)	0.6 (0.024)
100	107.1 (4.22)	0.6 (0.024)	4"	102.4 (4.03)	0.6 (0.024)
150	159.3 (6.27)	0.8 (0.031)	6"	154.2 (6.07)	0.8 (0.031)
200	206.5 (8.13)	1 (0.039)	8"	202.7 (7.98)	1 (0.039)

Steam Flow Meter Sizing Details

Fig.11 Steam Temp. Transmitter Installation diagram

S.No.	DESCRIPTION	DETAILS
1	THERMOWELL HOUSING PIPE DN15	1/2" BSP (F), L=100mm
2	THERMOWELL	SS 316, 1/2" BSP (M)
3	TEMPERATURE TRANSMITTER	1/2" BSP (M)
4	THERMOWELL TO RTD CONNECTION	1/2" BSP (M&F)
5	MATERIAL	SS 316
6	TRANSMITTER STEM LENGTH (A)	152 mm
7	THERMOWELL STEM LENGTH (B)	152 mm
8	THERMOWELL HSG PIPE LENGTH (C)	100 mm

FEEDWATER LINE

FEED WATER IN

TITLE: TYPICAL INSTALLATION DETAILS

FOR FEEDWATER TEMPERATURE TRANSMITTER

NOTE:- ALL DIMENSIONS IN MM
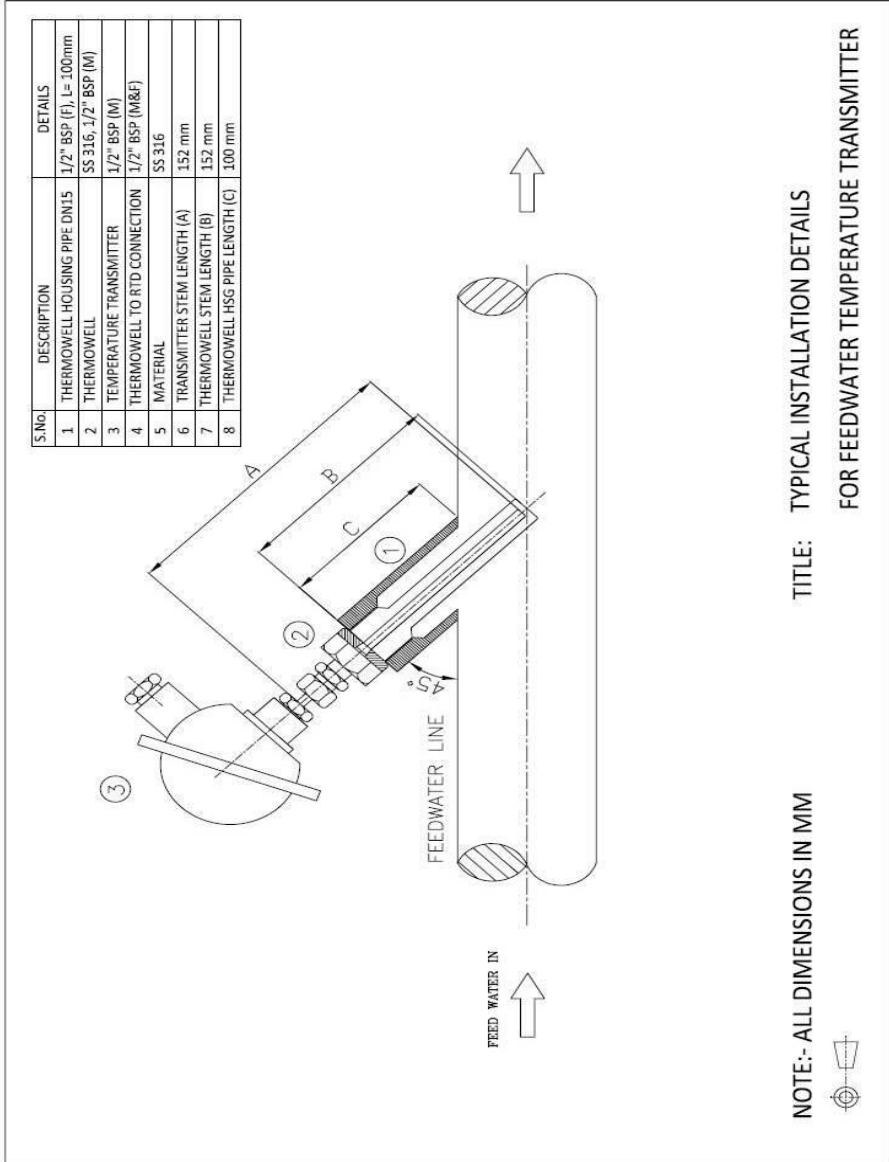
Fig.12 Feed water Temp. Transmitter Installation diagram

S.No.	DESCRIPTION	DETAILS
1	TRANSMITTER HOUSING PIPE DN15	1/2" BSP (F), L= 30mm
2	TEMPERATURE TRANSMITTER	1/2" BSP (M)
3	TRANSMITTER STEM LENGTH (A)	457 mm
4	TRANSMITTER HSG PIPE LENGTH (C)	30 mm
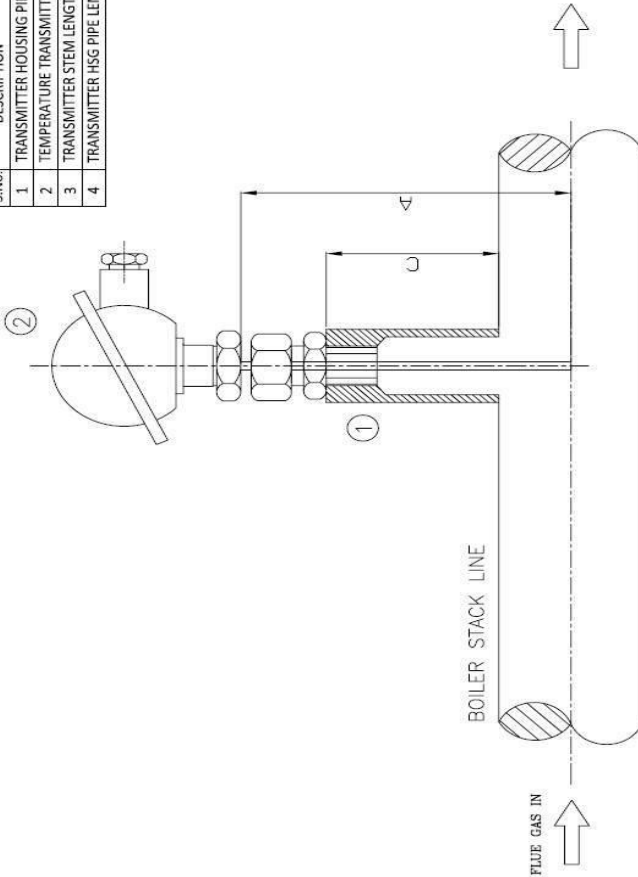
TITLE: TYPICAL INSTALLATION DETAILS
FOR STACK TEMPERATURE TRANSMITTER

BOILER STACK LINE

FLUE GAS IN

NOTE:- ALL DIMENSIONS IN MM

Fig.13 Stack Temp. Transmitter Installation diagram

Installation Drawings

Fig.14 Stack Oxygen Sensor Installation diagram

Fig.15 TDS Sensor Installation diagram

Installation Drawings

Fig.16 Steam Pressure Transmitter Installation diagram

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Notes:

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