

Automation and Energy Optimization

Is is a modern control system, dedicated to total boiler automation and minimization of energy consumption, which is achieved through its special optimization functions

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**IGNEIS 400** 

AC \* AUTING CONTROL Automation and Energy Optimization

### Energy and Efficiency:

accummulated efficiency =

=

total produced energy total consumed energy

total steam mass x (steam enthalpy - water enthalpy)

total consumed fuel x heating value

The system computes the real boiler efficiency, caculated as the quotient of the produced energy and the consumed energy.

 $\sum m_v x (h_v - h_a)$ 

 $\sum m_c \times H_c$ 

Steam enthalpy is calculated as a function of the measured steam pressure, whereas water enthalpy is calculated from the measured water temperature. The steam mass is integrated from the measured steam mass flow.

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### System screen for flow, energy and efficiency:

TEAM 7900 mm 6800 mm 4794 2900 7,137 5408 °C 5836 bar o 8500 bar o 3000 mbar 4323 kg/m <sup>3</sup>	WATER 25.4100 mm 52.5000 mm 0.4842 0.0000 202,829 94.5250 °C 14.5793 bar e 0.8500 bar e 263.5000 mbar	GAS 24.5800 mm 82.5000 mm 0.4482 1.4000 230,553 20.4050 °C 4.7360 bor o 0.8500 bor o 191,4450 mbor	Gas Energy Steam Mass Flow Steam Entholpy Water Entholpy Steam Power Gas Flow Gas Heating Value Gas Power Steam Energy Gas Energy Recovered Energy Boilter Power	Off ENERGY OPTIONS   7,005.58 kg/h 2,776.57 kJ/kg   346.55 kJ/kg 346.55 kJ/kg   4,78 MW 485.97 m3n/h   36,149 kJ/m3 5.41 MW   673,985.0 MJ 759,509.0 MJ   18,018.0 MJ 800.00 CV
7900 mm 6800 mm 4794 2900 137 5836 bar a 5836 bar a 5836 bar a 5800 bar a 3000 mbar 4323 kg/m <sup>3</sup>	25.4100 mm 52.5000 mm 0.4642 0.0000 202,827 74.5250 °C 14.5793 bar e 0.8500 bar e 263.5000 mbar 94.1.3360 km/m <sup>2</sup>	24.5800 mm 52.5000 mm 0.4482 1.4000 230,555 20.4050 °C 4.7860 bor o 0.8500 bor o 191,4450 mbor	Steam Mass Flow Steam Entholpy Water Entholpy Steam Power Gas Flow Gas Heating Value Gas Power Steam Energy Gas Energy Recovered Energy Baller Power	7,085,38 kg/h 2,776,57 kJ/kg 346,55 kJ/kg 4,78 MW 485,97 mSn/h 36,149 kJ/m3 5,41 MW 673,985,0 MJ 759,509,0 MJ 18,018,0 MJ
4794 4794 2900 137 5836 bar a 5836 bar a 5836 bar a 5800 bar a 3000 mbar 4323 kg/m <sup>3</sup>	52.5000 mm 0.4842 0.0000 202,829 94.5250 °C 14.5793 bar e 0.8500 bar e 285.5000 mbar 941.3360 bar/m <sup>2</sup>	82.5000 mm 0.4482 1.4000 230.555 20.4050 °C 4.7860 bor e 0.6500 bor e 191.4450 mbor	Steam Entholpy Water Entholpy Steam Power Gas Flow Gas Heating Value Gas Power Steam Energy Gas Energy Recovered Energy Boller Power	2,776.57 KJ/kg 346.55 KJ/kg 4,78 MW 485.97 m3n/h 36,149 kJ/m3 5,41 MW 673,985.0 MJ 759,509.0 MJ 18,016.0 MJ 800.00 CV
4794 2900 ,137 8408 °C 5836 bar a 8500 bar a 3000 mbar 4323 kg/m <sup>3</sup>	0.4842 0.0000 202,829 94.5250 °C 14.5793 bar e 0.8500 bar e 263.5000 mbar	0.4482 1.4000 230,553 20.4050 °C 4.7860 bor a 0.8500 bor a 191,4450 mbor	Sleam Power Gas How Gas Heating Value Gas Power Steam Energy Gas Inergy Recovered Energy Boller Power	4.78 MW 445.97 m3n/h 36,149 kJ/m3 5.41 MW 673,985.0 MJ 739,509.0 MJ 18,016.0 MJ
2900 2,137 8408 °C 5836 bar a 8500 bar a 5000 mbar 4323 kg/m <sup>3</sup>	0.0000 202,829 94.5250 °C 14.5793 bar o 0.8500 bar o 245.5000 mbar 941.3366 km/m <sup>2</sup>	1.4000 230,553 20.4050 °C 4.7860 ber e 0.8500 ber e 191,4450 mber	Gas Flow Gas Heating Value Gas Power Steam Energy Gas Energy Recovered Energy Boller Power	485.97 m3n/h 36,149 kJ/m3 5.41 MW 673,985.0 MJ 739,509.0 MJ 18,018.0 MJ
2,137 8408 °C 5836 bara 8500 bara 3000 mbar 4323 kg/m <sup>3</sup>	202,529 94.5250 °C 14.5793 bar e 0.8500 bar e 265.5000 mbar 941.3360 bar/m <sup>2</sup>	230,553 20,4050 °C 4,7860 bar a 0,8500 bar a 191,4450 mbar	Gas Heating Value Gas Power Steam Energy Gas Energy Recovered Energy Boller Power	36,149 kJ/m3 5.41 MW 673,985.0 MJ 739,509.0 MJ 18,018.0 MJ
8408 °C 5836 bar a 8500 bar a 3000 mbar 4323 kg/m <sup>3</sup>	94.5250 °C 14.5793 bar e 0.8500 bar e 263.5000 mbar 941.3360 ba/m <sup>2</sup>	20.4050 °C 4.7860 ber e 0.8500 ber e 191.4450 mbar	Gas Power Steam Energy Gas Energy Recovered Energy Boller Power	5.41 MW 673,985.0 MJ 739,509.0 MJ 18,018.0 MJ 800.00 CV
5836 bar a 8500 bar a 3000 mbar 4323 kg/m <sup>3</sup>	14.5793 bar a 0.8500 bar a 283.5000 mbar	4.7860 bar a 0.8500 bar a 191.4450 mbar	Steam Energy Gas Energy Recovered Energy Boller Power	673,985.0 MJ 739,509.0 MJ 18,018.0 MJ
8500 bar a 3000 mbar 4323 kg/m <sup>3</sup>	0.8500 bar o 283.5000 mbar	0.8500 ber e 191.4450 mbar	Gas Energy Recovered Energy Boiler Power	739,509.0 MJ 18,018.0 MJ
3000 mbor 4323 kg/m <sup>3</sup>	283.5000 mbar	191,4450 mbar	Recovered Energy Boiler Power	18,018.0 MJ
4323 kg/m <sup>3</sup>	941 3340 kg/m	Concession of the local division of the loca	Builder Provide	800.00 CV
The second se	Tellingene agents	3.4132 kg/m*		
6031	0.6044	0.6036	Soiler Lood	58.65 %
9936	1.0000	0.9878	Performance	48.57 44.40 mil gas, tas stears
0275	1.0287	1.0249	Ferformance	14.56 15.06 kg dwan/m3 gas
0048 m <sup>2</sup>	0.0005 m <sup>2</sup>	0.0005 m <sup>2</sup>	Boiler Efficiency	88.38 91.14 %
5786 kg/h	8,402.4326 kg/h	377.3980 kg/h	Heat Recovery	2.49 2.44 %
0	1	15:00:00 2/05/2016	16:00:00 02/05/2016	17:00:00 02/05/2016
9 0 5	936 275 068 m <sup>2</sup> 786 kg/h	936 1.0000 275 1.0267 068 m <sup>2</sup> 0.0005 m <sup>2</sup> 786 kg/h 8,402,4326 kg/h 6 0 Efficiency (%)	936 1.0000 0.9878 275 1.0257 1.0249 068 m <sup>2</sup> 0.0005 m <sup>2</sup> 0.0005 m <sup>2</sup> 786 kg/h 8.402.4326 kg/h 377.3980 kg/h 15:00:00 02405-2016 Efficiency (%)	Solid Close Close Performance   936 1.0000 0.9878 Performance   275 1.0287 1.0249 Performance   068 m² 0.0005 m² 0.0005 m² Boiler Efficiency   786 kg/h 8.402.4526 kg/h 377.3980 kg/h Heat Recovery   6 015:00:00 02/05/2016 02/05/2016   Efficiency (%) Efficiency (%) 16:00:00 02/05/2016

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# Fuel oil mass flow measurement



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# Steam mass flow measurement





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### Volume flow meter arrangement for fuel gas



### **Combustion Optimization**



- An air-to-fuel characteristic is defined with up to 30 points, from low to high fire, for every kind of fuel (light oil, heavy oil, natural gas, LP, biofuels, etc.).
- Every point of the air-to-fuel characteristic is so determined as to find the value where the maximum efficiency is attained for that firing rate, as shown on the screen.
- The system memorizes the percentage of oxygen at stack, at wich the maximum efficiency was attained for every firing rate.
- Full characterizacion consists therefore of a set of 3 values for every firing rate: fuel valve position, air damper position, oxygen at stack.
- Henceforth, the system will adjust the air-to-fuel ratio automatically to maintain maximum efficiency at any firing rate, in spite of varying air and fuel conditions.
- Adjustment of the air-to-fuel ratio is possible by means of the air damper or of a variable speed drive at the fan.
  - Increases in boiler efficiency have been registered in the order of 4...12%.
  - Air-to-fuel characteristics are stored twofold in the system: in the controller's flash memory and on the operator terminal's hard disk; they can be recalled and reloaded at any moment



# Boiler characterization screen

Boiler 1 Gas/Air Characteristic									
Indica	X GAS1(%)	Y AIRE (%)	· Index	XFIRE (%)	X CONVERNISP (No.)	X 0AS- YAR	AUTOMATIC CHARACTERIZATION		
0	15.008	7,000		0.000	1,200	50	CONTRACTOR DO NOT		
1	21.008	3,860	1	4.082	3,800		A DAMAGE CONTRACTOR		
2	23.000	10,680	2	8,163	3,000				
3	25.000	12,000	1	12.245	3,500	40	and the second se		
4	26.000	13,490	4	\$4,286	3,500		29.25 %		
5	28.009	15,000	1	18.367	3,400		AIR DAMPER		
6	30.009	18,000	6	22,449	3,400				
7	31.000	19,000	7	24.490	3,400		- C . C . C . C . C . C . C . C . C . C		
8	33.000	21,000	1	28.571	3,300	20	CARAVALIS		
9	35.000	23,000	1	32,653	3,300		GRS VALVE		
- 16	37.000	25,000	10	36,735	3,200		3.15.02		
.11	39.000	27,000	- 11	48.816	3,200	.10	OXYGEN		
12	41.000	29,000	12	44.898	3,200				
13	45.000	31,000	12	53,861	3,200		9.73 Bar		
14	48.000	33,000	14	39,104	3,200	0 20 40 60 60 10k	STEAM PRESSURE		
15	50.000	35,000	15	63.265	3,999				
16	55.000	37,000	16	73.469	3.100		465.67 m3.h		
17	58.000	38,000	17	79.592	3.100		GAS FLOW		
18	68.000	40,000	18	100.000	3.000	\$105 1010	CAST LOW		
19	68.000	40,000	19	100.000	3.000	OAVE LOAD			
28	68.000	40,000	20	100.000	3.000				

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# Air damper and fuel valve actuators on a dual fuel burner

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# Variable speed drives for fan and water pump



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Oxygen measurement at stack

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### **Boiler Control Unit**



## Level Control: can be switched between 1 element and 3 elements.

One Element Level Control: An archimedic level transmitter is used for level measurement; a PID controller modulates the water feed valve to keep level constant. This transmitter is unaffected by bubbles or corrosion.

**Level Control Valve** 

Three Element Level Control: Besides the level transmitter, steam flow and water flow are taken into consideration. The system keeps both flows in balance; an increase in steam flow causes an increase in water flow; likewise, a decrease in steam flow causes a decrease in water flow. Level is thus maintened constant even at sudden demand spikes.

Archimedic level transmitter



### Surface Blowdown (Salts)

Salt concentration is determined through continuous measurement of water conductivity. A PID controller commands the surface blowdown valve by means of width modulated pulses; longer pulses are sent to the valve at deviation from setpoint; short pulses are applied when near to the setpoint. Salts concentration is thus kept at constant value.

Surface blowdown valve

Conductivity setpoint is determined through water analysis at the laboratory and set by the user.

Conductivity sensor and transmitter



#### Sludge Blowdown

Several blowdown valves can be operated sequentially in the case of large boilers.

The blowdown valve is a globe type one, for high differential pressure and tight closing. A limit switch confirms the opening of the valve; failure to open at the programmed intervals causes an alarm.The valve can also be operated manually. Sludge blowdown is accomplished by the system at programmable intervals. Length of the intervals and duration of the blowdown are adjusted by the user, in accordance with water analysis.



#### **Chemicals Feed**



Low level at the dosing tank causes an alarm.

The correct dose for each chemical is determined by laboratory analysis and set by the user. A separate dosing pump is used for each chemical and controlled with an analog signal. Chemicals for inhibition of corrosion and binding of oxygen are fed into the boiler and to the deaereator in proportion to the measured water flow. In this way, a higher water feed flow causes a larger dosage of chemicals, a smaller water flow reduces the dosage. This results in dosing only the needed amount, saving chemicals.



### Water Pump Control

In case of boiler systems with several pumps, these are staged automatically, following header pressure.

Failure of one pump causes the next pump to start automatically. Pump sequence is rotated periodically by the system; periods are determined by the user. Controlling the water feed pressure to the boiler assures a very even level control. A pressure transmitter is installed in the water feed header and the pump speed is modulated by means of a variable epeed drive, thus keeping pressure constant with a PID algorithm.



### **Operator Terminal**



A wide screen monitor is built in the control cabinet , allowing the user to operate the boiler locally. Many operator screens are available, enabling monitoring and operating functions, i.e.:

- General boiler overview screen
- Controls tuning screens (for pressure, combustion, level, blowdown, etc.)
- Energy and efficiency monitoring screen
- Trends screen ( pressure, level, steam flow, water flow, stack oxygen, fuel flow, efficiency, etc.)
- Data logs (all measured and calculated values)
- Alarms screen and log (of all possible alarms)
- Para meter and configuration screen



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