APPLICATION NOTE

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Controlling the Air-Fuel Ratio in Combustion Furnaces

Industry: Machinery (Heat Treatment)
Product: Control and Measurement Station (CX1000/CX2000)

Overview

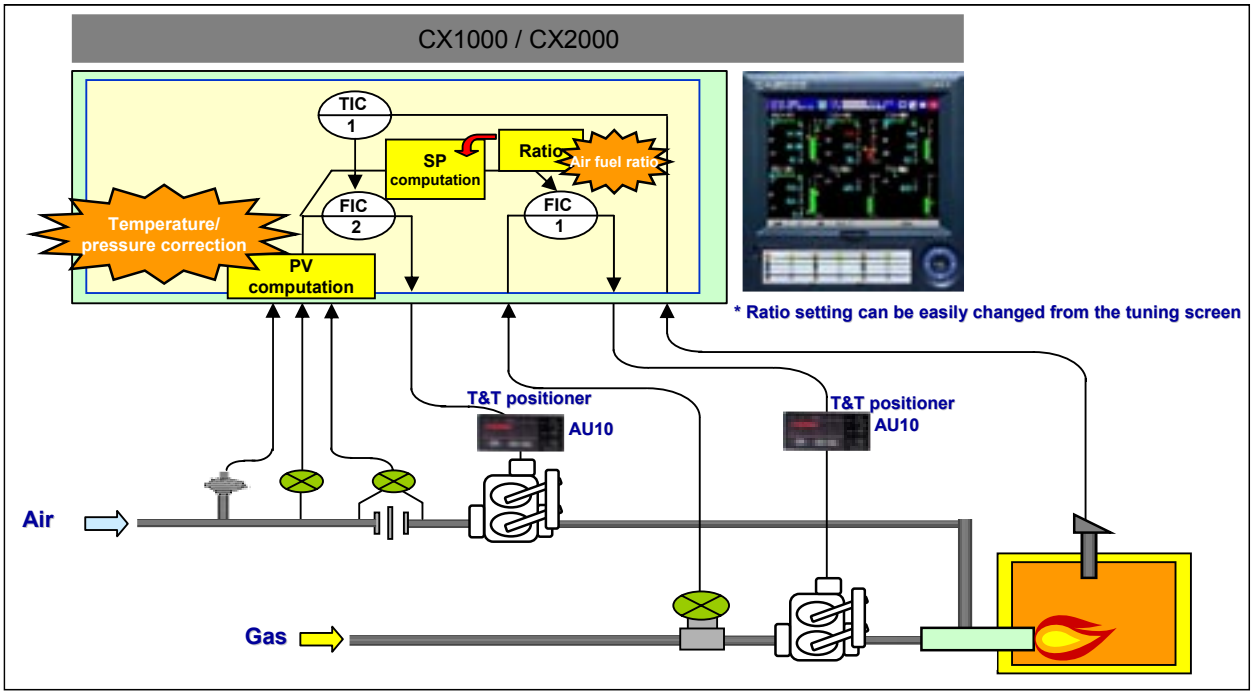
The CX1000/CX2000 Measurement and Control Station has a simple structure and is equipped with temperature and pressure correction functions that help you increase operating efficiencies in combustion furnaces. These functions accurately ascertain quantities used extensively in combustion furnace control such as the air fuel ratio and amount of air supplied to the combustion furnace.

Customer Needs

- A highly reliable local controller that controls and monitors the air fuel ratio in industrial combustion furnaces.
- To raise fuel efficiency by accurately determining gas flow using temperature and pressure correction and precisely controlling the air fuel ratio.
- To avoid using external instruments or complicated programming.
- To achieve low cost operation into the future by digitally recording control processes and saving the results as quality data, and by reducing maintenance man-hours for the spare parts.
- To achieve such CP control and electronic recording in a simple and high cost-performing solution.

Process Outline

The amount of air mass flow and supply of combustion gas inside combustion furnaces must be controlled. Control of the air mass flow first requires accurate measurement of the air's mass. In general, air mass is measured with a differential pressure flow type meter, but if the actual operating temperature and pressure in the furnace differ from the theoretical values on which its design was based, corrections will have to be made to the measured pressure and temperature (temperature/pressure correction).
The CX comes with PV calculation functions that can perform temperature and pressure corrections without the need for difficult programming by enabling the user to combine calculation functions, enter the needed parameters, and accurately capture the air mass flow. The flow of gas is controlled so that a certain ratio is always maintained relative to the fluctuating air mass flow. The CX1000/CX2000 calculates the air fuel ratio with an SP computation function that maintains a uniform amount of air and gas supplied. The CX improves fuel efficiency by controlling the combustion such that it uses an air fuel ratio based on the precise air mass flow, and contributes to stability in quality and reduction of operating costs.



YOKOGAWA

Temperature/Pressure Correction Formula

Expression for correcting the temperature and pressure in the gas flow measured by the differential pressure flow type meter

$$Qf = \sqrt{\Delta P} * \sqrt{\frac{Pf}{Pb}\frac{Tb}{Tf} * \frac{1}{K}}$$

Qf:	Positive displacement flow (after correction)
ΔP:	Differential pressure input
(0-1)Pb:	Standard pressure
Pf:	Fluid pressure
Tb:	Standard temperature
Tf:	Fluid temperature:
K:	Gaseous standard deviation coefficient (usually 1)

Setting Example on the CX2000

Using control input CI01-CI03 on the CX2000

(LOOP1 PV is the amount of flow after correction of temperature and pressure). The following expression is set for the PV computation.

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CI01*(SQR(((CI02+W3)/(W1+W3))*((W2+W4)/(CI03+W4))))
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Differential pressure input: CI01ch

(Range setting, mode: Square root extracted using Sqrt and set as the amount of flow prior to correction)

Pressure input: CI02ch kpa

Temperature input: CI03ch °C

W1: Standard pressure kpa

W2: Standard temperature °C

W3: 101.32 kpa

W4: 273.15 °C

Yokogawa's Solution

Flow, pressure, and temperature measurement, temperature and pressure correction computation, air fuel ratio control, display, and recording, can all be handled with a single unit.

CX1000/CX2000

CX1000

- Two-loop controller built in to the 144 mm x 144 mm size case
- Max. eight-point paperless recorder built-in (two points of control + 6 points for measurement)

CX2000

- Max. six-loop controller built in (288 mm x 288 mm)
- Max. twenty-six-point paperless recorder (six points of control + 20 points for measurement)

CX1000/CX2000 Common Functions for Combustion Furnaces

- With the PV computation function, you can perform temperature and pressure correction of air mass flow with no programming (by combining computation functions).
- Recording of furnace temperature, gas flow, and air mass flow can also be carried out simultaneously.
- The air fuel ratio setting can be changed from the tuning screen.
- Universal input means no need for converters for flow, temperature, and other kinds of input.
- Calculation of amount of flow is also possible with the /M1 option.

Conclusion

CX series instruments provide temperature and pressure computation functions and control of fuel air ratio in a single unit, and achieve improved quality and combustion furnace efficiency in a simple and high cost-performance solution.
Also, by digitally recording the control process, you can reduce spare parts maintenance cost and operation, allowing for low cost operation into the future.