

NON-DISPERSIVE INFRARED GAS ANALYZER

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1 INTRODUCTION

Because of its high selectivity and sensitivity, the non-dispersive infrared gas analyzer is generally called one of the superior gas analyzers.

Fuji Electric's non-dispersive infrared gas analyzer has a 30 year history, and has always led other manufacturers. Even at present, Fuji Electric is making every effort in developing new technologies based on this background. For example, Fuji Electric is sending out the products which lead the industrial fields with the further improved sensitivity, extended components to be measured, increased functions and extended application fields. Moreover, Fuji Electric is actively trying to export these outstanding products to the overseas during the recent years.

Selecting the typical products, this paper introduces the non-dispersive infrared gas analyzers.

2 HIGH SENSITIVITY NON-DISPERSIVE INFRARED GAS ANALYZER "FIRM SERIES" (DUAL BEAM TYPE)

Fuji "FIRM Series" uses a small micro-flow sensor having a high sensitivity, and with the countermeasure to eliminate influence of interference and improved S/N ratio, the product realized the high sensitivity and stability.

1. Features

1) Low concentration can be measured.

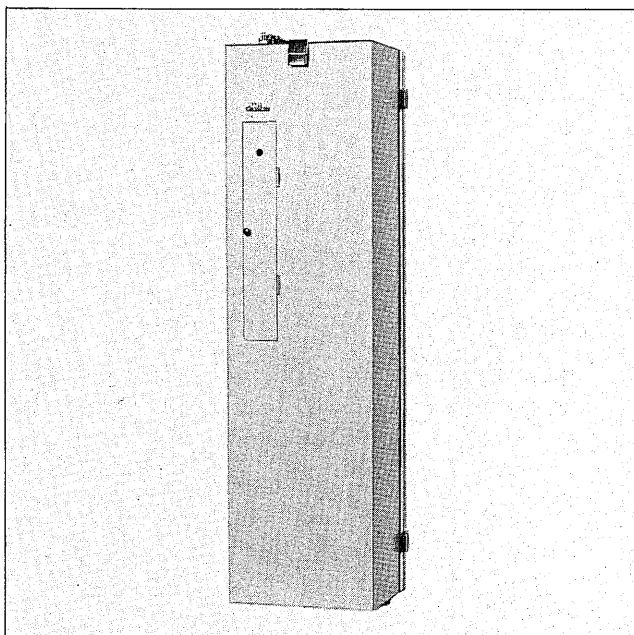
With a highly sensible micro-flow sensor, single point chopper of improved S/N ratio and other elements employed, such a low concentration as full scale 50ppm NO (which could not conventionally be measured) can now be measured. Further, the sample switching method which uses a catalytic converter and flow path switcher makes it possible to measure CO, NO, etc. of full scale 2 ppm.

2) Less influence of interference by other gas

With an interference compensation type detector used, influence of interference by other gases contained in the gas to be measured is extremely reduced.

3) High measuring accuracy and stability

Fig. 1 High sensitive NDIR gas analyzer, FIRM series



Since the analyzer uses a single light source and dual beam method, the accuracy and stability are high.

4) Maintenance is easy.

The analyzer is so constructed that the parts such as sample cell which requires maintenance service can be attached and detached simply.

5) Wide dynamic range

The range can be changed over up to 1:20.

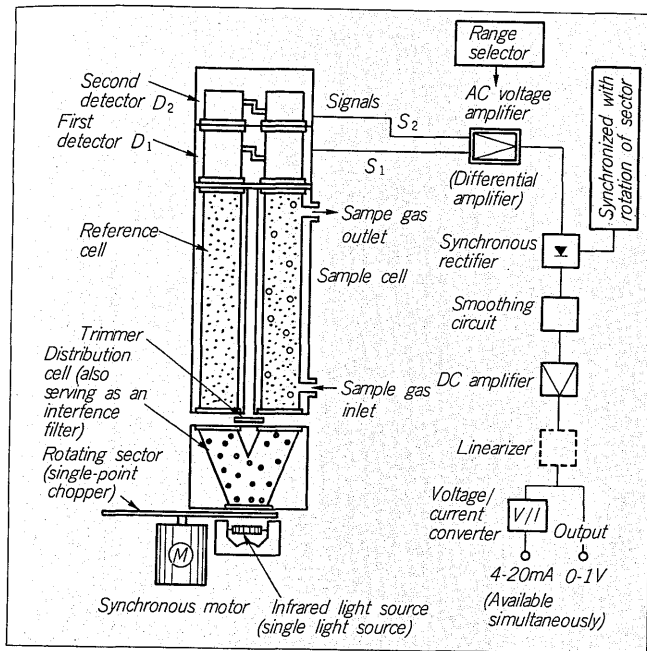
6) Two components can be measured simultaneously.

Two components such as CO/CO₂ and SO/NO_x can be measured simultaneously.

2. Measuring Principle and Construction

Generally, polyatomic molecules such as CO, CO₂ and SO₂ have a specific absorption spectrum in the infrared region, and there is a certain relationship between the infrared ray absorbing strength and concentration. The infrared gas analyzer uses this relationship, and measures gas concentration from the light absorbing degree of infrared ray. Fig. 2 shows a principle diagram of dual beam method gas analyzer.

Fig. 2 Principle diagram of dual beam method NDIR gas analyzer



The infrared ray emitted from the light source is divided into two beams by the distribution cell. One beam goes through the reference cell which does not absorb infrared ray, the other goes through the sample cell in which absorption occurs depending on the gas to be measured, and these two beams reach the detectors. Each detector has two chambers in which, normally, the same kind of gas as the measured gas is sealed, and there is a micro-flow sensor in the intermediate position on the path which connects both chambers. With a difference between infrared absorptions

by both chambers, a differential pressure rise occurs, and as the result, a very minor flow occurs. This very minor flow is detected by the micro-flow sensor and is converted to electrical signals.

The micro-flow sensor is a kind of highly sensible hot wire anemometer, in which metal grid of micron order produced by applying the integrated circuit manufacturing technique is arranged. The micro-flow sensor detects very small gas flow in the form of resistance change.

The sample switching method used to measure low concentration is so constructed that the gas can be flowed through both the reference cell and sample cell. With this construction, reference gas and sample are flowed to both the reference and sample cells alternately.

With this method, the signals having mutually inverse polarities, which proportion to the concentration of measured component can be obtained alternately. S/N ratio can be doubled in comparison with an ordinary method by holding these signals and by outputting them after treating them with arithmetic operations. Further, low concentration can be measured very accurately because zero drift primarily becomes drift free.

3. Specifications

Table 1 shows the general specifications. The Model ZRC shown in Fig. 3 is a compact type. The minimum measurable range is 0 to 20 ppm CO, and this model can be installed on a desk top or 19" rack, or can be panel mounted.

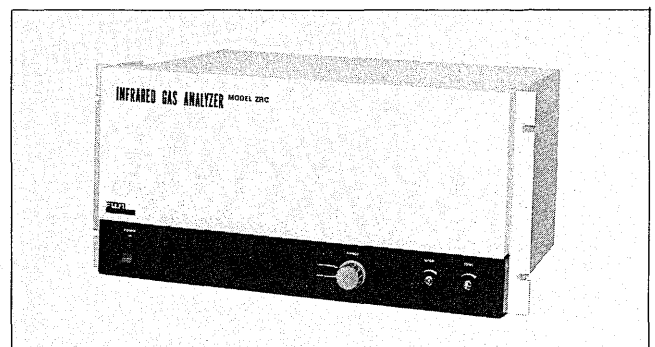
4. Applicable Fields

Because of the higher selectivity (in comparison with other measuring principles), high response, high stability and other features such as that continuous measurement can be made and maintenance and handling are easy, non-dispersive infrared gas analyzers are used for industrial purposes and may other fields. The included are burnt exhaust gas analyzation, steel plant exhaust gas analyzation, heat treatment, ceramic industries, cement industries, gas concentration measurements at various plants, monitoring for environment protections, breathing analysis for medical purposes, various laboratory applications, etc.

Table 1 Specifications of high sensitive NDIR gas analyzer, FIRM series

Measuring principle	NDIR dual beam method	
		Min. measurable range
	CO ₂	0 to 20 ppm
	CO	0 to 2 ppm
	SO ₂	0 to 2 ppm
	NO	0 to 2 ppm
	NH ₃	0 to 2 ppm
	CH ₄	0 to 200 ppm
	N ₂ O	0 to 50 ppm
	CF ₃ CHBrCl	0 to 10 ppm
Output signal	DC0 to 1V and DC4 to 20mA	
Repeatability	±0.5% of full scale	
Power supply	AC100V, 50 or 60Hz (AC115V or AC220V is available)	
Weight	Approx. 22 kg	
External dimensions	883 × 239 × 217 mm (H × W × D)	

Fig. 3 Compact type NDIR gas analyzer, model ZRC



FIRM Series can be used for the most of the above indicated fields because many different kinds of gas can be measured and measuring range can be selected from the wide range from low to high concentrations. Especially, for measurement of a low concentration, this series is most suited.

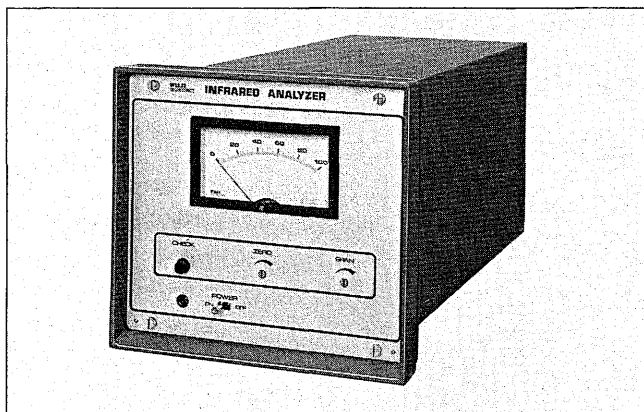
When the applicable measuring range is in a medium or high concentration range, the single beam type infrared gas analyzer, Model ZAU introduced later may be used because of its lower price than the FIRM Series.

3 SINGLE BEAM TYPE NON-DISPERSIVE INFRARED GAS ANALYZER

The single beam type analyzer does not use reference cell but a sample cell only, and for this reason, it was conventionally assumed to be difficult to make a practical one.

As the results of improvement derived by the studies on optical systems, Fuji Electric has developed products of simple construction provided with the features that the conventional dual beam type does not have.

Fig. 4 Single beam method NDIR gas analyzer, model ZAU



1. Features

1) High stability

The improved optical system provides the high stability. Especially, the drift caused by contamination in the sample cell is less than that of the conventional dual beam type, and the long term stability is excellent.

2) Less influence of interference by other gas

Influence of interference by other gas is minimized by the permeation series double layer type detector construction.

3) Simple handling and maintenance

Since this gas analyzer does not use reference cell but a sample cell only, it is not necessary to take optical balance (while the dual beam method must take optical balance). For this reason, no delicate adjustment is required, and handling and maintenance are easy.

4) Less influence of tilting

When a dual beam type analyzer is tilted, optical im-

balance is likely to occur between the sample cell and the reference cell causing an indication error. This imbalance does not occur on the single beam method, minimizing an indication error due to tilting.

5) Less influences by vibration and shock

Influences by vibration and shock are reduced to the minimum by using the micro-flow sensor having a high vibration resistance and detector construction which is hardly to be affected by vibration.

6) Simple construction and high reliability

The construction is simple, number of parts is small (less than a half in comparison with the conventional Fuji Electric's products), and reliability is high.

7) Two components can be measured simultaneously

The two component measurable type is capable of measuring two different kinds of gas simultaneously. Therefore, economical and installation space can be reduced.

8) Power saving type

The power consumption is only 30VA; An energy saving product

2. Measuring Principle and Construction

Fig. 5 shows a principle diagram of the single beam method analyzer. The infrared ray emitted from the light source goes to the sample cell, where a part of the infrared ray is absorbed by the gas in the sample cell, and then, the infrared ray reaches the detector. The detector consists of a front chamber and rear chamber which are normally filled with the same gas as the gas to be measured.

Both chambers are joined through a thin path, and a micro-flow sensor is installed in the path. When the infrared ray reaches the detector, first, a part of it is absorbed by the front chamber, and the remaining is absorbed by the rear chamber. With these absorptions, pressure rises occur in both chambers. However, as it is so designed that the pressure rise in the front chamber differs from that in the rear chamber, a very minor flow occurs in the path connecting both chambers due to the pressure difference. This very minor flow is detected by the micro-flow sensor, and is converted to electrical signals.

When the measured gas contains interfering gas which absorption band is partially overlapped with that of the gas

Fig. 5 Principle diagram of single beam method NDIR gas analyzer

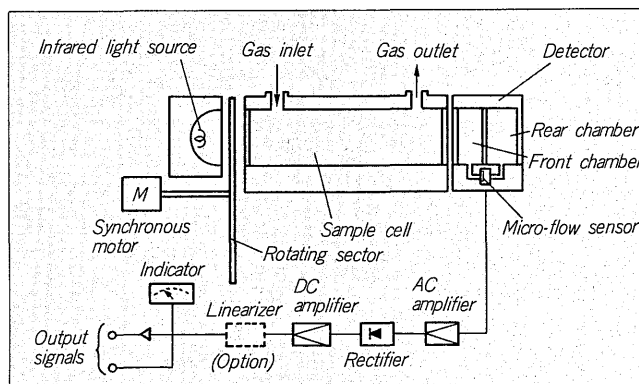


Table 2 Specifications of single beam method NDIR gas analyzer, model ZAU

Measuring principle	NDIR single beam method
Measuring components and measuring range	CO 0 to 500ppm ... 0 to 100% CO ₂ 0 to 500ppm ... 0 to 100%
Output signal	DC0 to 1V, DC0 to 100mV, DC0 to 10mV, or DC4 to 20mA (Option)
Repeatability	±0.5% of full scale
Stability	±2% of full scale/week
Power supply	AC 100V or 115V, 50 or 60Hz, 30VA (AC 220V is available)
Weight	Approx. 11 Kg
External dimensions	226 × 250 × 541 mm (H × W × D)

to be measured, pressure rises occur equally in both front and rear chambers. In this case, however, as the analyzer is so designed that the pressure rises are almost equalized, they cancel each other, minimizing the influence.

3. Specifications

Table 2 shows the general specifications.

4. Applicable Fields

The applicable fields are approximately same as those of the above introduced dual beam type gas analyzer.

4 LOW COST TYPE NON-DISPERSIVE INFRARED GAS ANALYZER "ZFP SERIES"

Since infrared gas analyzers have many features, it is assumed that the application range can be further expanded if the cost could be reduced. ZFP Series is a single beam method product for special applications developed by aiming at the use in new fields of infrared gas analyzers. In comparison with the conventional analyzers, the price is lower, smaller in dimensions, lighter in weight, power consumption is less, handling is easy, and has many other features.

The typical product examples are introduced below.

1. CO₂ Control for agricultural applications (ZFP1)

To promote light synthesis and to improve quality and productivity of vegetables, CO₂ concentration within green houses is maintained in the optimum level by detecting CO₂ concentration, generating control signals and by controlling CO₂ generators. At present, many products of this type are exported mainly to Holland for agricultural applications and favourably accepted.

2. Ventilation Control for energy saving in building air conditioning (ZFP6)

In the present building air conditioning system, a certain volume of fresh air is taken into the system to prevent room air contamination. In this system, the energy

Fig. 6 Infrared CO₂ controller for agricultural glass house, model ZFP1

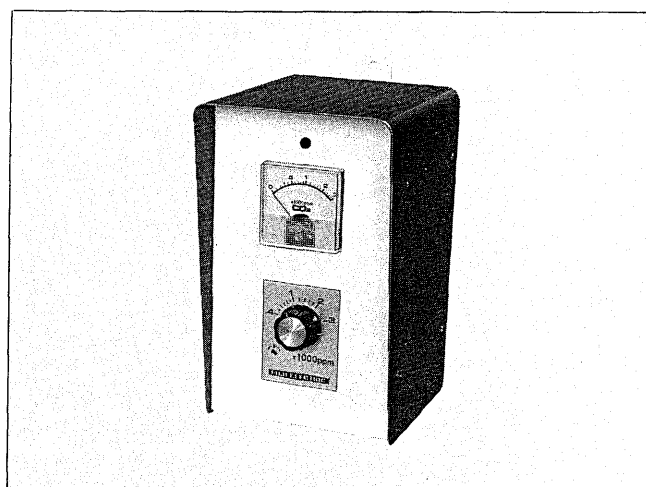


Fig. 7 Infrared CO₂ controller for air conditioning, model ZFP6

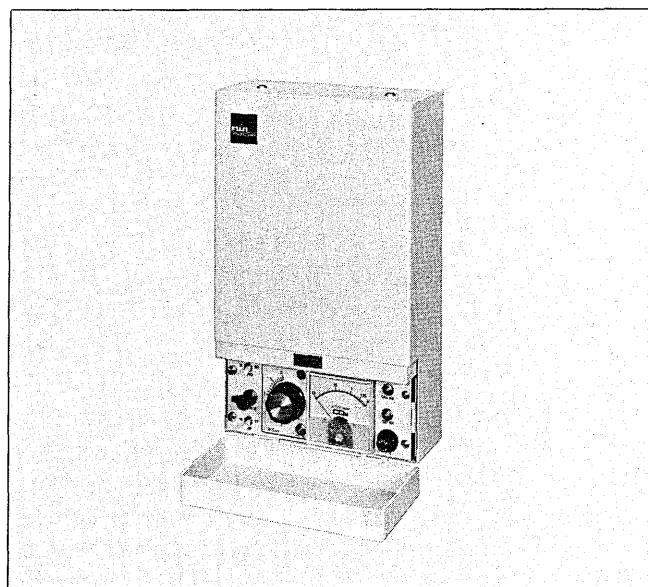


Table 3 Specifications of infrared CO₂ controller, model ZFP1 and ZF6

	ZFP1	ZFP6
Measurable gas	CO ₂	CO ₂
Measuring range	0 to 3000 ppm	0 to 2000 ppm
Settable range	300 to 3000 ppm	300 to 2000 ppm
Control output	Contact 1a	Contact 1c
Analytical output	DC0 to 100mV	DC0 to 100mV or DC4 to 20mA
Power supply	AC100V/200V, 50/60Hz	
Weight	Approx. 3.5 kg	Approx. 4.5 kg
External dimensions	148 × 290 × 170mm	300 × 180 × 90mm
Others	—	Gas aspirating pump and membrane filter built in

consumed by the air conditioner to regulate temperature and humidity of the fresh air is considerably high. As the matter of fact, energy saving effect can be enhanced by reducing volume of intake air within such a proper range as that the room environment is not worsened. Model ZFP6 collects air in a room, measures CO₂ concentration to decide air contamination, and sends control signals. With this controller, volume of intake air can be adequately controlled.

In addition to those introduced above, more analyzers are available in series for special applications, and expansions of the demand are expected.

Table 3 shows general specifications of Models ZFP1 and ZFP6.

5 POST SCRIPT

As introduced in this report, Fuji Electric Co., Ltd. is manufacturing non-dispersive infrared gas analyzers having various features.

Sending out the highly reliable analyzers which completely meet with the needs of the society, we will further concentrate our efforts in the research and development and will respond the needs.

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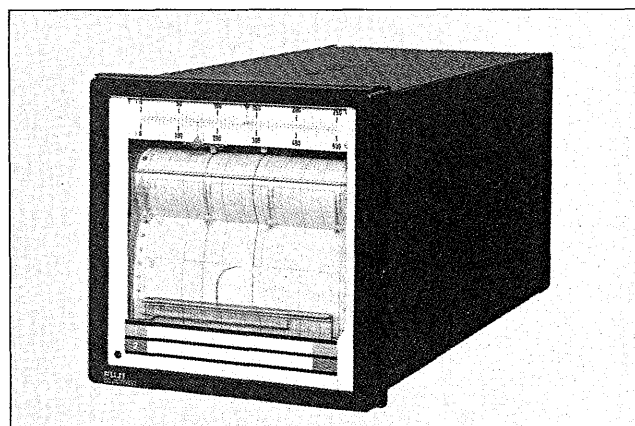
TOPICS

COMPACT SELF-BALANCING RECORDER

Thousands of Fuji's industrial recorders have been used widely from a large scale plant instrumentation to a small scale general purpose instrumentation, accumulating a rich experience and many accomplishments. During recent years, micro-computers have been used popularly, and even today, analogue recorders hold their applications to various purposes as a man-machine interface, and the application range is being expanded from the productive fields such as process instrumentation and test to the non-productive fields such as environment protection, maintenance, weather forecast and medical applications. In a scene like this, Fuji Electric has developed small, light and low price compact self-balancing recorders (Type: PGK) of high reliability, durability and maintenanceability, and has started selling not only to the domestic market but also to the markets in the overseas.

PGK features its performance and quality equivalent to large recorders. The dimensions are 144 mm wide, 144 mm high and 285 mm deep, and recording width of this analogue recorder is 100 mm. A resistance bulb, thermocouple and other various electrical values can be directly input, allowing 1-pen, 2-pen, 3-point and 6-point recordings. Each unit of the inside system is independent, which provides the quality improvement and maintenance ease. The typical features are introduced below.

- 1) The chart is of a Z-fold type which is convenient for arranging and filing data. Since it is 15.5 meter long, continuous recording can be made for one month (with 20 mm/H chart speed), and further, the recorder is equipped with a remained chart indicating scale.
- 2) The range card which decides measuring input is of a plug-in type. Therefore, kind and span of inputs can be changed easily, and maintenance and inspection can be



made simply.

- 3) Multi-point type of double range specifications is available, allowing two different inputs to be measured, which is convenient for data collection and arrangement.
- 4) In case of non-linear inputs such as a resistance bulb and thermocouple, a linearizing circuit can be attached, and recorded data can be read out and compared easily.
- 5) The electronic alarm unit features its high vibration resistance and reproducing performance, and in response to an application, up to 6 points relay contacts can be output.
- 6) As for chart speed, a multi-speed type is also available. This type is capable of changing over the chart speed in 17 steps from 10 to 12,000 mm/H so that records can be obtained in fitting to input fluctuations.
- 7) A conveniently carried portable type is also available, facilitating the use for experiments and data collection at various places.