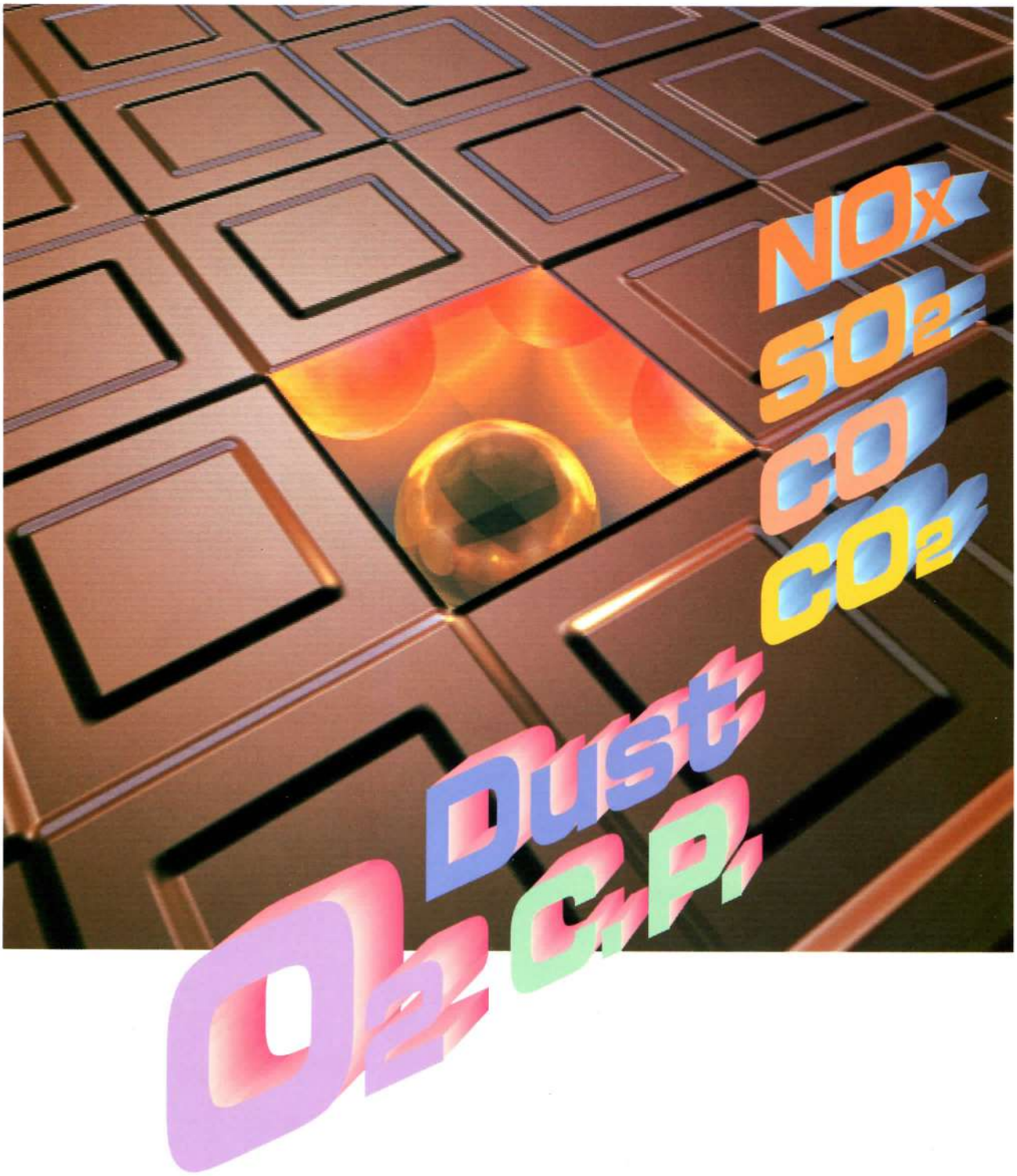
NGK

MEASURING INSTRUMENTS GUIDE



MEASURING

Measuring Instruments

Since its establishment over 84 years ago, NGK has been engaged in manufacturing ceramic insulators and is now recognized as a leading manufacturer throughout the world. Over the past 35 years, NGK developed O_2 analyzers using technology based on ZIRCONIA. Most recently, NGK has produced various instruments independently or together with other manufacturers by employing unique technology based on ZIRCONIA and INFRA-RED rays. NGK now offers a complete range of measuring instruments in addition to consultation on instrumentation and various system components.

ZIRCONIA CERAMIC SENSOR

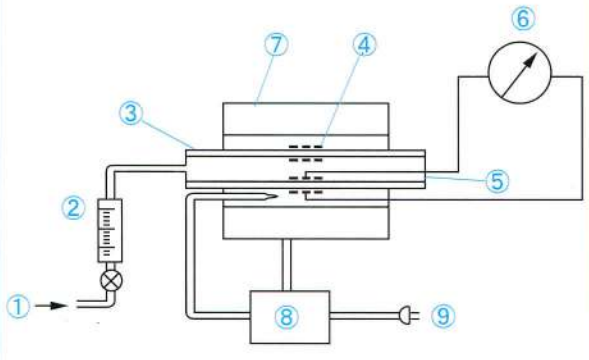
■ Principle of ZIRCONIA SENSOR

Zirconia ceramics with the conductive characteristics at high temperature due to oxygen ions can be an oxygen concentration cell by making the ceramic pipe at high temperature with electrodes on the inner and outer side of the pipe. Presence of gas with different oxygen concentrations on each side of electrodes will cause electromotive force to be generated by the movement of oxygen ions. In this instance, the electromotive force is calculated by the following Nernst equation:

$$E = \frac{RT}{nF} \log_e \frac{P_C}{P_A} = 49.6 \times 10^{-3} \cdot T \log_{10} \frac{P_C}{P_A}$$

Where: n: 4
R: Gas constant
F: Farady constant
T: Absolute temperature

NGK's ceramics engineering ensures a stable output.



① Sample gas inlet
② Flow meter
③ Detection cell
④ Electrode
⑤ Sample gas outlet
⑥ Oxygen concentration indicator
⑦ Electric heater
⑧ Temperature controller
⑨ Power source

INFRA-RED SENSOR

■ Principle of INFRA=RED SENSOR

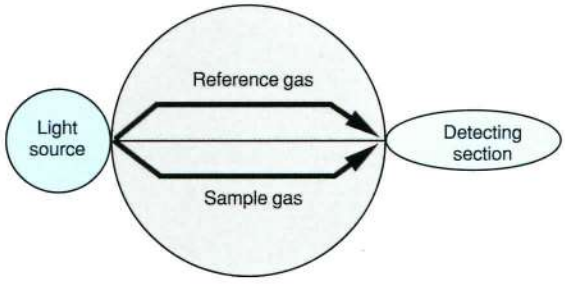
Infra-red is located in the light wave at the place shown in the diagram below.

Wavelength →	0.3 μ	1 μ	6 μ	1000 μ
X ray and Ultraviolet	Visible Light	Infra-red	Far infra-red	Radio waves

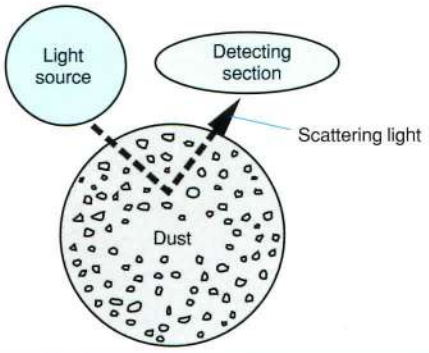
(units: μ 1/1000 mm)

In particular, infra-red with the wavelength of 1-6? is absorbed by moisture having different atomic elements such as moisture (H_2O) and CO. Measuring the degree of the absorption can find the concentration. Also measuring the strength of scattered light reflected by suspended dust can find dust concentration. However, as measurements are generally affected by temperature, moisture, etc., NGK fs unique sophisticated technology plays an important role in isolation of these elements.

GAS COMPOSITION



DUST



NGK's Instruments Are Employed in Various Areas of Many Industrial Uses

Selection Table by Industries

Industry	Facility and Application	Models by Measuring Principle		
		Zirconia	Infra-red	Others
Marine Products and Foodstuffs	Measuring water content of raw materials, intermediate and final products			
	Monitoring atmosphere in foodstuff storage	SH-IID		
Paper and Pulp	Measuring water content of chips and paper			
	Measuring O_2 content in soda recovery boiler	TF-III · TF-10		
Textiles	Measuring water content of raw materials, and intermediate products			
	Monitoring atmosphere for humidity control	RE-210-M		
Petroleum and Petrochemicals	Measuring O_2 content of refinery furnaces	TF-II		
	Measuring O_2 content in industrial boilers	TF-10 · PA-210-A		
Chemical and Gases	Measuring water content of raw materials, and intermediate products			
	Measuring O_2 content of combustible gases			SAG
Glass	Measuring O_2 content in exhaust gas from glass melting furnaces	TF-IIIG		
Ceramics and Fine Ceramics	Atmosphere measuring of kilns	SH-IID · PA-210-B		
Mining	Measuring water content of raw materials and products			
Iron and Steel	Measuring water content of raw materials for sintering and coal for coke charging			
	Measuring dust in sintering, blast, and revolving furnaces		ISS-101	
	Measuring gas components in continuous annealing plants	TF-III	IAG-500	DP · H_2 · SAG
	Measuring N_2, O_2, Ar, etc. in oxygen plants and others	SH-IID		SAG
	Measuring O_2 in exhaust gases of hot blast stoves, heating and soaking furnaces	TF-III · PA-210		
	Measuring O_2 in exhaust gases of industrial boilers	TF-III · TF-10		
Metallic Products and Machine Parts	Atmospheric control of oil carbonizing and thermal refining ovens	CP		
Primer Movers and Shipbuilding	Industrial boiler, inert gas system	TF-III · TF-10		
Industrial Machinery	Industrial boilers	TF-III · TF-10		
Semi Conductors and Electronic Parts	Atmospheric measurements	SH-IID · IIID		
Automotive	Atmospheric control oil carbonizing and thermal refining ovens	CP		
Power Station	Measuring O_2 at outlet of boiler economizer	MLP-10		
	Measuring O_2 in boiler window box	TF		
	Measuring dust at outlet of electric precipitator boiler (EP)		ISS-101	
	Flame detector for boiler torches			FD
	Charge detectors for substation interrupters			AL
Incinerators	Measuring O_2 in oxidizing domain	TF-10 · TF-IV		
	Measuring O_2 and CO in reduction domain			SAG
	Measuring NOx and SO_2 at inlet of smokestack		IAG-500	
	Measuring dust at inlet of smokestack		ISS-101	

ZIRCONIA 2 CELL TYPE O_2 ANALYZER (TF Series)

ZIRCONIA TYPE EXPLOSION-PROOF O_2 ANALYZER

Model TF-II CAT.No MIT316

Application: Combustion control and atmospheric gas of furnaces in petroleum refineries, petrochemical plants, city gas generating facilities and industrial furnaces

Model TF-II
Sensor probe

Model TF-IIM
Receiver

- Model TF-II is a unique explosion-proof O_2 analyzer based on the latest ceramic technologies. Explosion proof structure of the unit was made by reduced size integrating the zirconia sensor and ceramic heater and minimizing power consumption.

Features

1. Zirconia dual cell pump type O_2 analyzer is approved under the following numbers:
   - Sensor probe: No.44241
   - Receiver: No.45930
2. Low sensor power consumption (Approx. 13W)
3. Calibration feasible by air only
4. Short equipment warm up time (Approx. 3 minutes)
5. Maintenance-free sampling part
6. Compact

ZIRCONIA TYPE O_2 ANALYZER FOR STEEL AND BOILERS

Model TF-III CAT.No MIT506, 507

Applications: Monitoring of combustion at heating and soaking ovens, blast furnaces, and monitoring and control of boilers

Sensor probe

Receiver

- Model TF-III is a unique O_2 analyzer based on the latest ceramic technologies. It can be used for measuring high temperature gases from heating and soaking furnaces in steel mills and for combustion exhaust gas containing corrosive exhaust gas.

Features

1. Can be directly connected without sampling pipe for high temperature and corrosive exhaust gas.
2. Rapid response, and most suitable for combustion control
3. Easy maintenance simple structure
4. Calibration feasible by air only (no need for a reference gas)
5. Heater integrated compact sensor requiring short warm up time

ZIRCONIA TYPE O_2 ANALYZER FOR GLASS MELTING FURNACES

Model TF-IIIG CAT.No MIT505

Applications:
Monitoring and control of combustion at glass melting furnaces

Sensor probe

Receiver

- Model TF-IIIG is a unique O_2 analyzer based on the latest ceramic technologies. It is most suitable O_2 analyzer for measuring high temperature exhaust gas from glass melting furnaces

Features

1. Can be directly connected without sampling pipe for high temperature exhaust gas.
2. Rapid response, and most suitable for combustion control
3. Easy maintenance simple structure
4. Calibration feasible by air only (no need for a reference gas)
5. Heater integrated compact sensor requiring short warm up time

ZIRCONIA TYPE O_2 ANALYZER FOR DUST AND SLUDGE INCINERATORS

Model TF-IV CAT.No MIT504

Applications: Monitoring and control of combustion at the outlet of refuse and sludge incinerators and at the outlet of melting furnaces

Sensor probe

Receiver

- Model TF-IV is a unique O_2 analyzer based on the latest ceramic technologies. It is most suitable for measuring high temperature dust laden exhaust gas from dust and sludge incinerators.

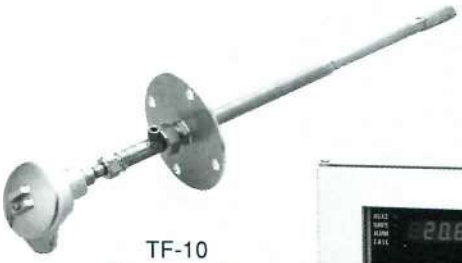
Features

1. Can be directly connected without sampling pipe for high temperature exhaust gas.
2. Rapid response, and most suitable for combustion control
3. Easy maintenance simple structure
4. Calibration feasible by air only (no need for a reference gas)
5. Heater integrated compact sensor requiring short warm up time

ZIRCONIA TYPE O_2 ANALYZER FOR COMBUSTION EXHAUST GAS

Model TF-10 Oxygen Analyzer CAT.No MIT901

Applications: Monitoring and control of boilers and industrial furnaces



TF-10
Sensor probe

DTF-101
Receiver

■ Features

1. No need for reference gas cylinder
2. No need for standard air
3. No need for routine maintenance with integrated self calibration function
4. Low installation cost
5. Low power consumption
6. Small diameter, compact and light weight

ZIRCONIA TYPE PORTABLE O_2 ANALYZER

Models PA-210, SH-IID

Applications: Measuring of boilers and industrial furnace exhaust gas, and gas purity control

PA-210
(CAT. No. MIT503)

Model SH-IID
(CAT. No. MIT002)

- Model SH-II D O_2 analyzer is multi-function digital version of conventional design without restriction to gas concentrations, and can be used in combination with a portable sampling unit.
- Model PME O_2 analyzer is extremely compact and light weight and can be used in laboratory.

■ Standard measuring ranges

Model	Measuring Range	Output
PA-210-A	0~5/10/25%	4 to 20mA 0 to 1V. etc
PA-210-B	-15~0~25%/-6~0~10%/-3~0~5%	
SHIID	0~10,20,50,100,200,500ppm 0~1000,2000,5000ppm 0~1,2,5,10,25,50,100%	4 to 20mA 0 to 10mV, or 0-1V

ZIRCONIA TYPE REDUCTION ATMOSPHERE FURNACE CONTROL SYSTEM

Applications: Gas generating furnaces, continuous and batch carbureting, quenching, annealing furnaces

CAT.No MIT003

Model CP-D (DR) type sensor probe

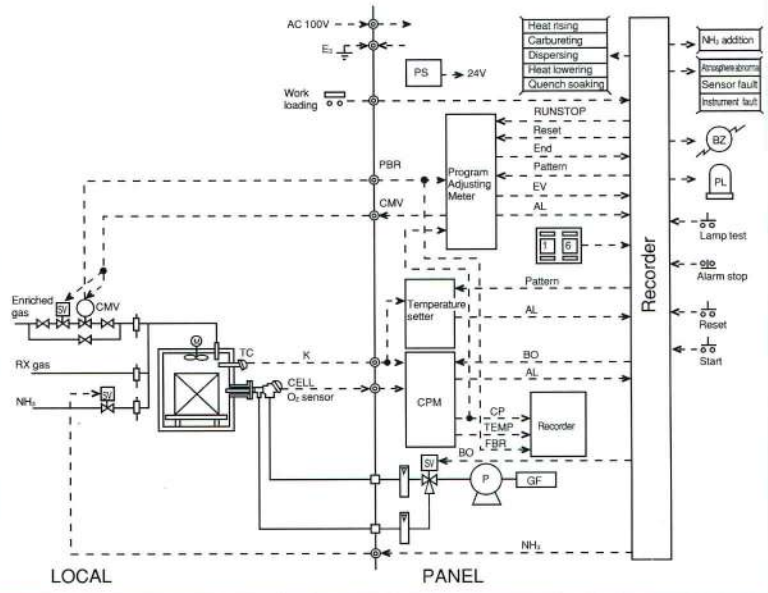
Model CPM
computing unit

Model CP-X
type sensor unit

■ Features

Conventional measuring of furnaces using a dew point meter, and CO_2 meter are not satisfactory in way of maintenance and responses. A new system that enables to automatic control of furnaces by computing and displaying the measured carbon potential value obtained through the Zirconia O_2 partial pressure instrument from the furnace has been developed. This new system should be a powerful tool in quality control, reduction in resources and energy saving.

■ Flow Example of Batch Furnace System



ZIRCONIA MICRO OXYGEN ANALYZER

Model TF-21D201, TF-30D301, SH-301

Applications: TF-21D201: Semiconductor manufacturing facilities, diffusion furnaces, RTP, various N2 furnace environments measuring, air separators.
TF-30D201:Reflow, ferrite sintering ovens, various environment control, and combustion control

CAT. No. MIT0203

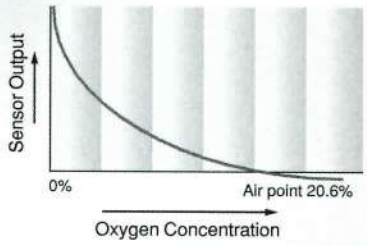
■ Features

1. Extremely small sensor enabling measuring in % and 0-10ppm range.
2. Foot space reduced by separating probe and receiver
3. Swedgelock fitting enables easy and positive sensor connection
4. Thick film sensor conforming to the specifications for vacuuming such as load locking
5. Four measuring ranges in % and 0-10ppm selectable
6. Range switching with local/remote/auto range selections
7. Free NC/NO upper and lower alarm setting
8. Extremely resistant to organic silicone with special treatment

■ Principle

TF-21D201 using NGK thick film sensor technology is the sensor that uses the maximum capacity of zirconia concentration cell.

Output Characteristics of Concentration Cell



NON DISPERSIVE INFRA-RED ABSORPTION (NDIR) OTHER ANALYZERS

Applications: Measuring of incinerator exhaust gases, petroleum related reaction gases, gases in powder transport, blast, converters, and coking furnaces, and O_2, SO_2, NOx in various combustible gases

SAG
(CAT. No. MIT006)

Model 316RA

■ Example of Sampling Equipment Incorporation

Model	Measuring Principle	Measuring Range	Features
SAG	Magnetic	0~100% 99~100%	Settable to 1, 2, 4 and 10% spans
315 · 316RA	Galvanic	0~10/100/1000/10000ppm	Gas containing CO_2
IAG-500	Infrared	0~10/100/1000/10000ppm	Gas containing SO_2, NOx

INFRA-RED RADIATION SCATTERED DUST CONCENTRATION ANALYZER

Model ISS-101 CAT.No MIT902

Applications: Monitoring of exhaust stack inlet of boiler, refuse incinerator, and sludge incinerators, sintering furnace, and dust concentration at the exit of various incinerators

Transmitter appearance

Front of transmitter

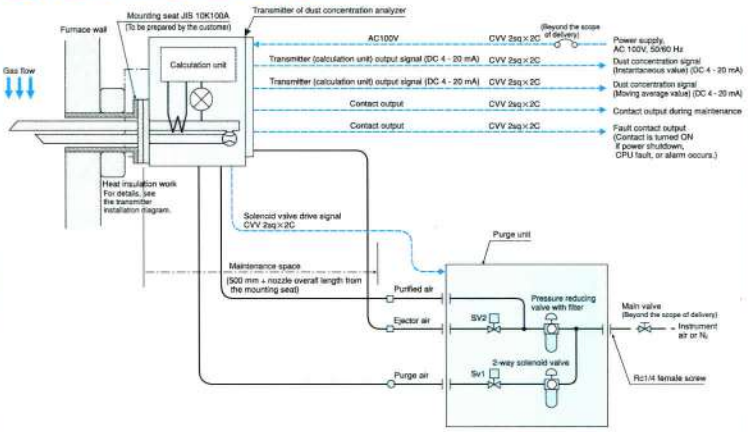
Principle

Radiating light to dust particles will cause the light to scatter. The dust concentration meter uses the fact that the intensity of the scattered light has relationship with the dust concentration. The intensity of the scattered light proportionate with dust weight if the shape distribution, composition and color are same. Using these characteristics, pulse light from the transmitter on the left is radiated to the dust in measuring gas to receive the scattered light to detect and compute dust concentration continuously.

Features

1. Standard high sensitivity range of 0-10mg/m^{3}N
2. Stable zero point with automatic zero point calibration function
3. Zero and span calibration can be done while plants in operation.
4. Less affected by gas velocity with little measuring error as compared to sample gas suction method, as it uses near equal velocity suction method
5. Improved calibration accuracy due to data automatic reading for zero and span calibration
6. Enhanced computation and self diagnosis function

System Configuration Diagram



[Computation Function]
- Moving average computation function
- O_2 concentration compensation function
- Automatic zero point calibration function
- Automatic purge (blow back) function
- Delayed primary computation function
- Hold function

[Self Diagnosis Function]
- Transmitter fault
- Receiver fault
- Zero calibration error
- Span calibration error

ZIRCONIA NOx - O_2 ANALYZER

Model DTN-101 Model NOx - O_2 Analyzer

Applications: Exhaust gas analysis for cogeneration system, NOx control of de-nitration system Boiler combustion adjustments, analysis of exhaust gas from various combustion equipment

Model DTN-101
NOx - O_2 analysis receiver

NOx sensor

Principle

- Basic Chemical reaction $NO \rightleftarrows \frac{1}{2} N_2 + \frac{1}{2} O_2$
- Controlling O_2 to low concentration to decompose NO to N_2 and O_2.
- Measuring the decomposed O_2 to convert NO concentration

Features

1. Compact and light weight
2. Rapid response
3. NOx sensor can be directly inserted
4. Short warm up time to measure

Applications

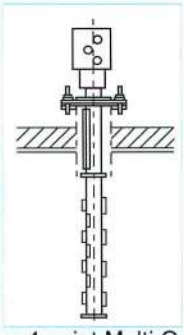
1. Exhaust gas analysis for cogeneration system
2. Research of NOx control in de-nitration system
3. Foodstuff: Sugar, wheat powder, salt, oil strained lees, and other powder materials
4. Combustion adjustments of boilers
5. Exhaust gas analysis of various combustion equipment

ZIRCONIA MULTI-TYPE EXHAUST GAS ANALYZER

MLP Model CAT.No MIT209

Applications: Large boilers control

4 point Multi O_2 analyzer for Electric Boiler



4 point Multi O_2 probe transmitter

Features

1. Multiple points measurable by the 1-4 points sensor/O_2 probe laid out in duct in a mesh configuration
2. O_2 traverse measure enables flexible response to change in O_2 concentration with the duct.
3. Compact sensing part limits replacement work to the sensor part to ease field maintenance

4 point Multi receiver

CONTROL UNIT FOR REDUCTION ATMOSPHERE FURNACE

CP Panel

ZIRCONIA MULTI TYPE EXHAUST GAS ANALYAZER

MLP Model Multi Type Exhaust Gas Analyzer

OTHER INSTRUMENTS

- **Power station plants**
  O_2 analyzer for economizer output (LP-10)
  O_2 analyzer for Window box (TF)
  Torch flame detector (FD)
- **Power substations**
  Electric charge detector for line interrupters (AL)
- **Steel Mills**
  O_2 analyzer for radiant tubes (RT)
  Gas analyzer for furnace atmosphere (CGL)
- **Control system for furnace atmosphere of ceramic plants**
- **Instrumentation and installation for individual and peripheral devices**
- **General engineering services for instruments and instrumentation**

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The products fall under the category of 1-16 in the attached table of the Export Trading Law Table.