Technical Information

Oxygen Analyzer
Selection Guide

TI 11A03A01-01E

Model ZR22G/ZR402G/AV550G
Direct In-Situ Zirconia Oxygen Analyzer
(Separate type)
Zirconia Oxygen Averaging Converter

AV550G

ZR22G

ZR402G

Explosionproof Zirconia Oxygen Analyzer
Model ZR22S (Separate type)

Model ZR202S (Integrated type)

Model ZR202G
Direct In-Situ Zirconia Oxygen Analyzer
(Integrated type)

Model OX400
Low Concentration Zirconia Oxygen Analyzer

Model MG8G/MG8E
Paramagnetic Oxygen Analyzer

MG8G

(General purpose type)

MG8E

(Flameproof type)

Model OX100/OX102
Limiting Current Oxygen Analyzer

Model TDLS200
Tunable Diode Laser Analyzer

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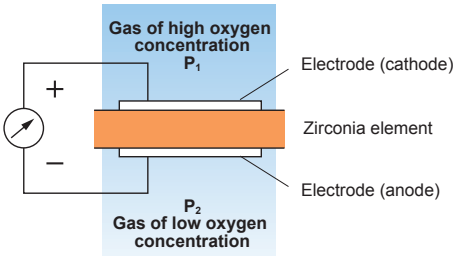
TI 11A03A01-01E
1st Edition, Jun. 2009 (YK)
2nd Edition, Nov. 2011 (YK)

■ Oxygen Analyzer Measurement Systems and Their Drawbacks and Advantages

Zirconia type measurement system

Concentration cell system

A solid electrolyte like zirconia exhibits conductivity of oxygen ions at high temperature. As shown in the figure below, when porous platinum electrodes are attached to both sides of the zirconia element to be heated up and gases of different partial oxygen concentrations are brought into contact with the respective surfaces of the zirconia, the device acts as an oxygen concentration cell. This phenomenon causes an electromotive force to be generated between both electrodes according to Nernst's equation.



Yokogawa Electric's model codes: ZR22G/ZR402G, ZR202G, ZR22S/ZR402G, ZR202S, and OX400

Advantages

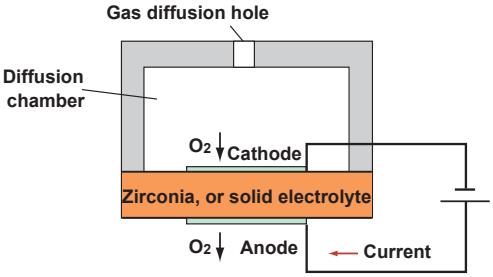
- Can be directly installed in a combustion process such as a boiler's flue and requires no sampling system. and response is faster (ZR22G, ZR202G).
- Capable of measuring trace oxygen concentration (OX400).

Drawbacks

- If the sample gas contains a flammable gas, a measurement error occurs (combustion exhaust gas causes almost no problem because it is completely burned).

Limiting Current type

As shown in the figure below, if the flow of oxygen into the cathode of a zirconia element heated to high temperature is limited, there appears a region where the current becomes constant even when the applied voltage is increased. This limited current is proportional to the oxygen concentration.



Yokogawa Electric's model codes: OX100 and OX102

Advantages

- Capable of measuring trace oxygen concentration.
- Calibration is required only on the span side (air).

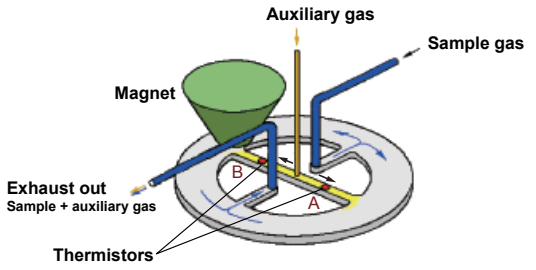
Drawbacks

- If the sample gas contains a flammable gas, a measurement error occurs.
- The presence of dust causes clogging of the gas diffusion holes on the cathode side; a filter must be installed in a preceding stage.

Magnetic type measurement system

Paramagnetic system

This is one of the methods utilizing the paramagnetic property of oxygen. When a sample gas contains oxygen, the oxygen is drawn into the magnetic field, thereby decreasing the flow rate of auxiliary gas in stream B. The difference in flow rates of the two streams, A and B, which is caused by the effect of flow restriction in stream B, is proportional to the oxygen concentration of the sample gas. The flow rates are determined by the thermistors and converted into electrical signals, the difference of which is computed as an oxygen signal.



Yokogawa Electric's model codes: MG8G and MG8E

Advantages

- Capable of measuring flammable gas mixtures that cannot be measured by a zirconia oxygen analyzer.
- Because there is no sensor in the detecting section in contact with the sample gas, the paramagnetic system can also measure corrosive gases.
- Among the magnetic types, the paramagnetic system offers a faster response time than other systems.
- Among the magnetic types, the paramagnetic system is more resistant to vibration or shock than other systems.

Drawbacks

- Requires a sampling unit corresponding to the sample gas properties or applications.

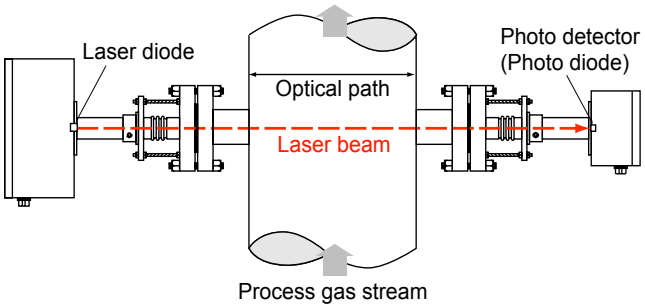
Tunable Diodel Laser measurement system

Tunable Diode Laser (or TDL) measurements are based on absorption spectroscopy. The TruePeak Analyzer is a TDL system and operates by measuring the amount of laser light that is absorbed (lost) as it travels through the gas being measured. In the simplest form a TDL analyzer consists of a laser that produces infrared light, optical lenses to focus the laser light through the gas to be measured and then on to a detector, the detector, and electronics that control the laser and translate the detector signal into a signal representing the gas concentration.
Gas molecules absorb light at specific colors, called absorption lines. This absorption follows Beers law.
TDL Analyzers are effectively infrared analyzers which obey the Beer-Lambert Law.

$I = I_0 \cdot e^{-E.G.L}$

where I is the radiation intensity after absorption
I_0 is the initial radiation intensity
E is the extinction coefficient
G is the gas concentration
and L is the path length of the measurement area

Yokogawa Electric's model code: TDLS200



Advantages

- Capable of measuring a number of nearinfrared absorbing gases in difficult process applications.
- Capability of measuring at very high temperature, high pressures and under difficult conditions (corrosive, aggressive, high particulate service).
- Most applications are measured in-situ, reducing installation and maintenance costs.
- Most measurements are rapid (5 seconds) and interference free.

Drawbacks

- Initial installation for the mounting flange is required.

■ Selection Guide for Oxygen Analyzers

Measuring System	Zirconia				Limiting Current	
Model	ZR22G,ZR402G/ ZR22S,ZR402G(*2)	ZR202G/ ZR202S (*2)	ZR22G,ZR22S AV550G	OX400	OX100/OX102	
Specifications						
Min. measuring range	0 – 5 vol% O_2	0 – 5 vol% O_2	0 – 5 vol% O_2	0 – 10 ppm O_2	0 – 1000 ppm O_2/ 0 – 100 ppm O_2	
Max. measuring range	0 – 100 vol% O_2	0 – 100 vol% O_2	0 – 100 vol% O_2	0 – 100 vol% O_2	0 – 25 vol% O_2	
Measuring range setting	Settable arbitrarily within the range (in vol% O_2 units)			Auto/Man.	Fixed to 2 ranges/ 0 – 100 ppm O_2	
Partial range	Available	Available	Available	Available	Not available	
Output signal	4 – 20 mA DC HART	4 – 20 mA DC HART	4 – 20 mA DC 8 points Fieldbus	4 – 20 mA DC and 0-1, 5, 10 V DC (selectable)	4 – 20 mA DC or 1 – 5 V DC/ 4 – 20 mA DC	
Sample gas temperature	0 – 1400°C (*1)	0 – 700°C	0 – 1400°C (*1)	0 – 50°C	0 – 70°C	
Sample gas pressure	-5 – 250 kPa (*3)	-5 – 250 kPa	-5 – 250 kPa (*3)	0 – 300 Pa	1013±40 hPa Abs	
Response time (90%) (When gas is introduced from the detector inlet)	5 sec or less	5 sec or less	5 sec or less	10 sec or less (1% O_2 or more) 30 sec or less (less than 1% O_2)		
Warm-up time	20 min	20 min	20 min	20 min or less		
Explosionproof construction	Non-explosion-proof protected (*2)	Non-explosion-proof protected(*2)	Non-explosion-proof protected	Non-explosion-proof protected	Non-explosion-proof protected	
Application form	Stationary	Stationary	Stationary	Stationary/ Transportable	Stationary	
Separately installed sampling system	Not required	Not required	Not required	May be required depending on applications.		
Application						
Package boiler combustion control, gas fired	A	A	B	X	X	
Combustion control of power generation boilers, gas fired	A	B	A	X	X	
Combustion control of pulverized coal boilers	A	A	A	X	X	
Combustion control of hot stoves for steelmaking	A	A	A	X	X	
Heating and combustion exhaust gas control of coke ovens for steelmaking	A	A	A	X	X	
Low-oxygen concentration control of reheating and soaking furnaces for steelmaking	A	A	A	X	X	
Air leakage detection of sintering furnaces for steelmaking	A	A	A	X	X	
Low-oxygen concentration control of CDQ plants for steelmaking	X	X	X	X	X	
Lime kiln combustion control	A	B	B	X	X	
Cement kiln combustion control	A	B	B	X	X	
Combustion control of heating furnaces for oil refinery & petrochemical industry	B	X	X	X	X	
Naphtha cracking furnaces	X	X	X	X	X	
Oxygen concentration control of gas containing a flammable gas	X	X	X	X	X	
Safety control (explosion prevention) at various plants	X	X	X	X	X	
Measurement of trace oxygen concentration in various manufacturing processes	X	X	X	X	X	
City gas quality control	B	X	X	X	X	
Incinerator combustion control	A	B	A	X	X	
Oxygen concentration measurement in oxygen enrichment facilities	A	A	A	X	X	
Oxygen concentration measurement of exhaust gas from activated sludge process equipment	A	A	A	X	X	
Oxygen concentration control of N_2 reflow furnaces	X	X	X	A	B/A	
Atmospheric control of semiconductor manufacturing equipment	X	X	X	A	B/A	
N_2 and air purity control for air separators	X	X	X	A	B/A	
Oxygen deficiency prevention	X	X	X	X	A	
Oxygen concentration control of glove boxes for research and development and parts machining	X	X	X	A	B/A	
Oxygen concentration control of experimental clean rooms for environment, fermentation, biochemistry, etc.	X	X	X	B	A	
Continuous measurement of flow gases during food packaging	X	X	X	B	A	

Rating: A=Recommended, B=Applicable, X=Not applicable

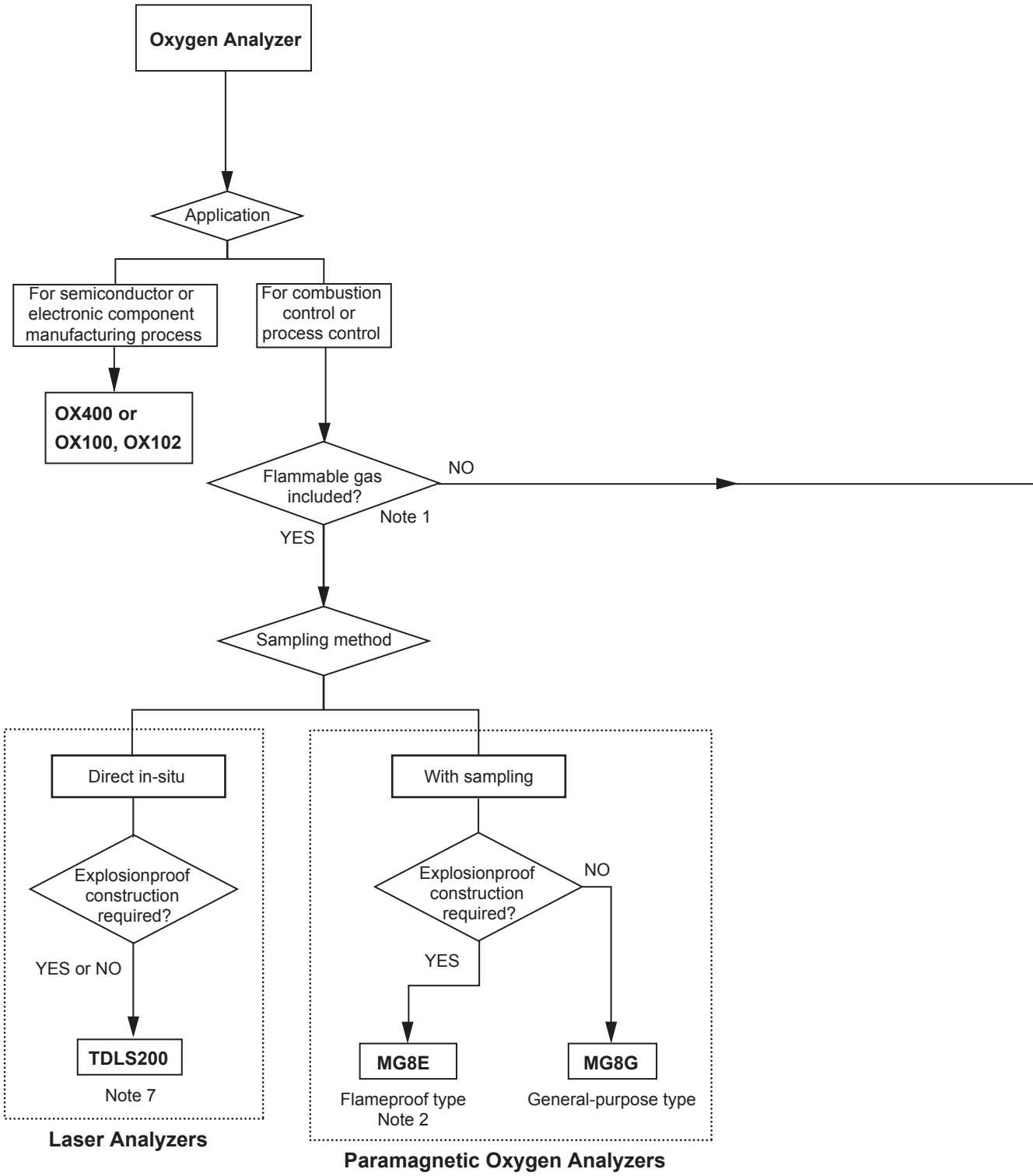
*1: If the sample gas temperature exceeds 700°C, the ZO21P high-temperature probe adapter is required.
*2: If explosion-proof is required, use the ZR22S/ZR402G or ZR202S, consult your sales representative or our sales office.
*3: If the ZO21P high-temperature probe adapter is used, the sample gas pressure is -0.5 to 5 kPa.
Note 1: This Selection Guide should be used as a guide only. If you are not sure of which model to choose, consult your sales representative or our sales office.
Note 2: For the detailed specifications of an instrument or the details of combinations of instruments, see note on page 7 General Specification or catalogs to be referred.

	Tunable Diode Laser	Paramagnetic	Measuring System
	TDLS200	MG8G/MG8E	Model
	Specifications		
	0 – 1 vol% O_2	0 – 5 vol% O_2/ 0 – 1 vol% O_2	Min. measuring range
	0 – 25 vol% O_2	0 – 25 vol% O_2	Max. measuring range
		Settable arbitrarily up to 3 ranges in the measuring range	Measuring range setting
		Not available	Partial range
	4 – 20 mA DC Ethernet (IEEE 802.3)	4 – 20 mA DC	Output signal
	0 – 1500°C (*6)	0 – 50°C	Sample gas temperature
	1 MPa or less (*6)	Atmospheric pressure or more /0 – 7 kPa or more	Sample gas pressure
	6 sec or less (100% Response time)	3 sec or less	Response time (90%) (When gas is introduced from the detector inlet)
	60 min or less	Approx. 3 hr./ 2.5 hr.	Warm-up time
	Non-explosion or explosion proof protected	Non-explosion-proof protected/ Flameproof	Explosionproof construction
	Stationary	Stationary	Application form
	Not required	Required	Separately installed sampling system
	Application		
	B	X	Package boiler combustion control, gas fired
	A	X	Combustion control of power generation boilers, gas fired
	B	X	Combustion control of pulverized coal boilers
	A	X	Combustion control of hot stoves for steelmaking
	A	X	Heating and combustion exhaust gas control of coke ovens for steelmaking
		X	Low-oxygen concentration control of reheating and soaking furnaces for steelmaking
	B	X	Air leakage detection of sintering furnaces for steelmaking
		A	Low-oxygen concentration control of CDQ plants for steelmaking
	B	X	Lime kiln combustion control
	B	X	Cement kiln combustion control
	A	X	Combustion control of heating furnaces for oil refinery & petrochemical industry
	A	X	Naphtha cracking furnaces
	A	A (*5)/A	Oxygen concentration control of gas containing a flammable gas
	A	A (*5)/A	Safety control (explosion prevention) at various plants
	A	A (*5)/A	Measurement of trace oxygen concentration in various manufacturing processes
	A	A (*5)/A	City gas quality control
	A	B	Incinerator combustion control
	B	B	Oxygen concentration measurement in oxygen enrichment facilities
	B	B	Oxygen concentration measurement of exhaust gas from activated sludge process equipment
	X	B	Oxygen concentration control of N_2 reflow furnaces
	X	X	Atmospheric control of semiconductor manufacturing equipment
	X	X	N_2 and air purity control for air separators
	X	X	Oxygen deficiency prevention
	X	X	Oxygen concentration control of glove boxes for research and development and parts machining
	X	X	Oxygen concentration control of experimental clean rooms for environment, fermentation, biochemistry, etc.
	X	X	Continuous measurement of flow gases during food packaging

Rating: A=Recommended, B=Applicable, X=Not applicable

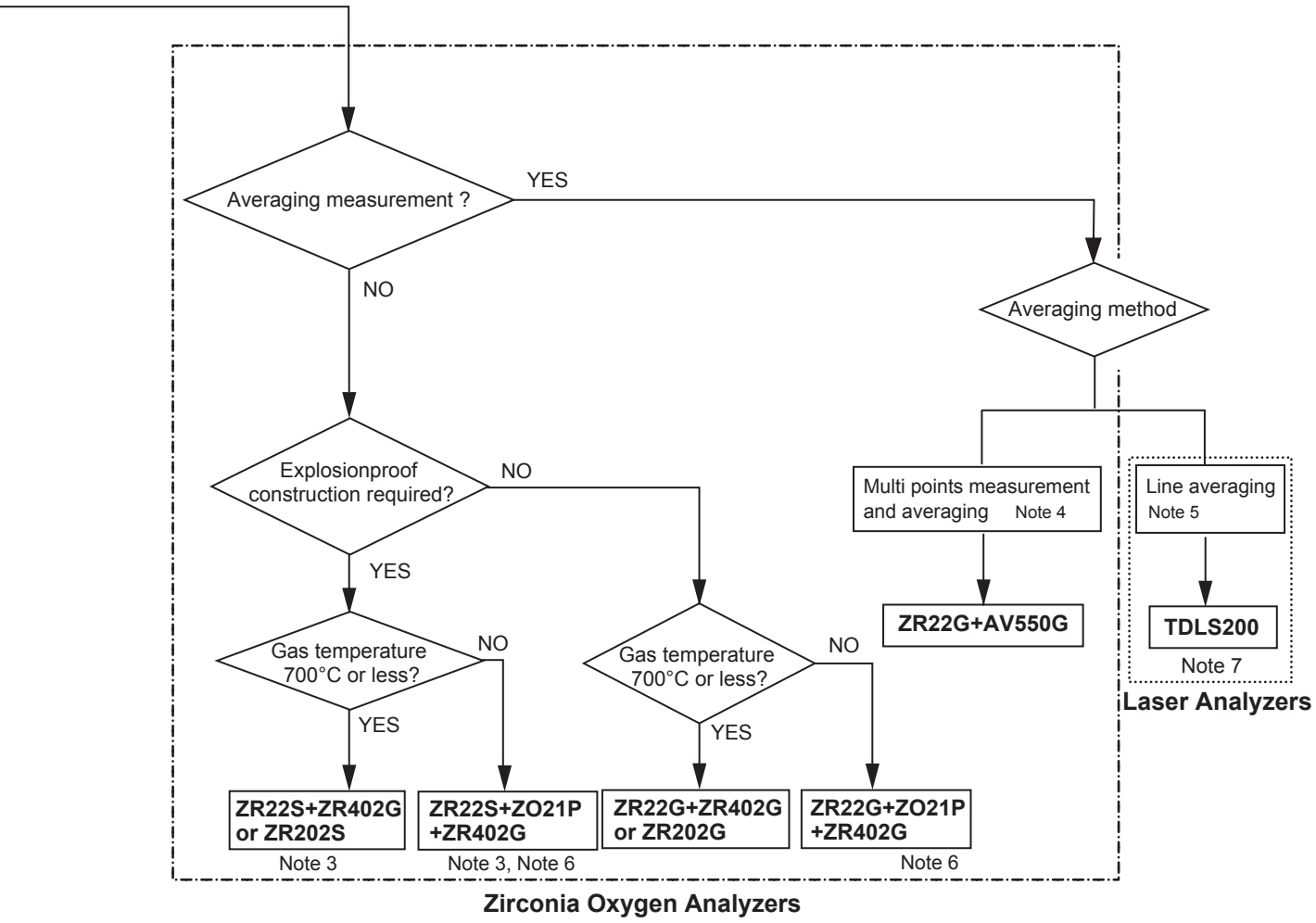
*5: Inapplicable if explosion-proof is required.
*6: Dending on application.
Note 1: This Selection Guide should be used as a guide only. If you are not sure of which model to choose, consult your sales representative or our sales office.
Note 2: For the detailed specifications of an instrument or the details of combinations of instruments, see note on page 7 General Specification or catalogs to be referred.

■ Oxygen Analyzer Selection Flow Chart



Note: General Specification or catalogs to be referred.
- ZR22G, ZR402G: GS 11M12A01-01E, TI 11M12A01-01E
- ZR202G : GS 11M12A01-01E
- ZR22S, ZR202S : GS 11M13A01-01E
- OX400 : GS 11M10B01-01E, Bulletin 11M10B01-01E
- OX100, OX102 : Bulletin 11M10A01-03E
- MG8G : GS 11P03A03-01E
- MG8E : GS 11P03A05-01E
- TDLS200 : GS 11Y01B01-01E-A
- AV550G : GS 11M12D01-01E

Note 1: If the content of a flammable gas is 0.5 % of measuring range or less, select “NO” of flowchart.
Note 2: Instruments are all handled as custom orders.
Note 3: ZR402G converter must not be located in hazardous area.
Note 4: Max. 8 points measurement and averaging.
Note 5: Optical path averaging
Note 6: ZO21P; High temperature probe adapter
Note 7: ATEX Group II for zone 1 (Cat 2G) or zone 2 (Cat 3G) with purge systems



Revision Information

- Title : Oxygen Analyzer Selection Guide
- Manual No. : TI 11A03A01-01E

Nov. 2011/2nd Edition
Model OX51, OX61 deleted

Jun. 2008/1st Edition
Newly published