Manual No.3010E R3

OPERATION MANUAL FOR OVEN O2 ANALYZER MODEL TYPE CP-X

READ THE OPERATION MANUAL.

ENERGY SUPPORT CORPORATION

Safety Precautions

Obsereve the following precautions without fail for safe operation of the equipment.

⚠ WARNING

1. When connecting cables to the terminals of the analyzer or when servicing inside the analyzer, take care to avoid electric shock. When servicing electrical parts, be sure to turn the power off.
2. Connect the grounding wire to prevent accidents caused by electric shock.
3. When fabricating the gas inlet/outlet pipes or disconnecting pipes for maintenance inside the analyzer, be sure to shut off the gas source valve to prevent accidents caused by gas intoxication or oxygen deficiency.
4. To prevent gas intoxication and oxygen deficiency, test gas leaks after fabricating the gas inlet/outlet pipes or performing maintenance service of piping inside the analyzer.
   Route the gas outlet at a safe place provided with the atmospheric pressure.

⚠ CAUTION

1. To prevent electric shock, before you turn on the power switch always check that the power supply wiring is correctly and securely connected, and that the supply voltage matches the power source voltage of this device.
2. To prevent gas intoxication or oxygen deficiency, before you open the gas source valve always check that the gas inlet and outlet pipes of the analyzer are correctly and securely connected, and check that there is no gas source valve.
3. To prevent burns, do not touch the transmission unit, sensor unit (detector, etc.) and their periphery during operation and shortly after operation because there portions are very hot.
4. Be sure to close the gas source valve to perform maintenance services of the piping system when the sample gas contains toxic contents to prevent gas intoxication.
5. Observe the cautions and operation methods described in this manual to operate this equipment safety. If the description is neglected during operation of the equipment, electric shock, gas intoxication, oxygen deficiency, burns, damage or deterioration of this equipment or damage to the final product (device, etc.) may be caused.

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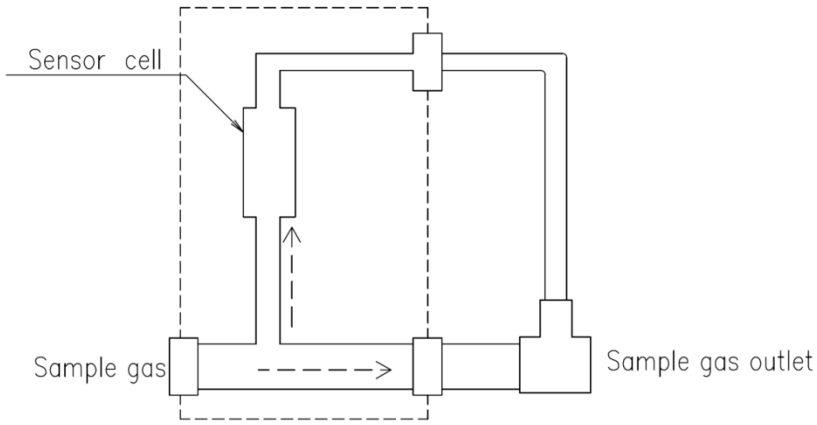
1. General

The reducing atmosphere oven O2 analyzer automatically measures the oven atmosphere inside a gives the indication and signals of the measured value.

2. Theory of measurement

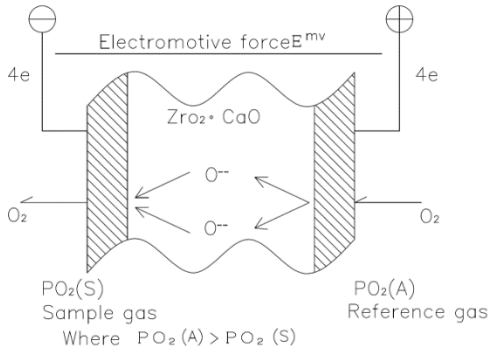
The type CP-X oxygen analyzer introduces the gas to be measured between the sample gas intake port fitted on the oven wall and the outlet. Partial pressure of oxygen in the introduced sample gas is measured with a sensor cell.

Fig. 1 Basic configuration



ig. 2 Principle of sensor cell operation

$$E = \frac{RT}{nF} \cdot \ln\left[\frac{PO_2(A)}{PO_2(S)}\right] \quad \cdots\cdots (1)$$



Where

E: Electromotive force (mV)

R: Gas constant

T: Absolute Temperature

F: Faraday constant

n: 4

$PO_2(A)$: O_2 partial pressure in reference gas (0.206 atm)

$PO_2(S)$: O_2 partial pressure in sample gas (atm)

(Normal atmospheric air is used as the reference gas)

By substituting these values into the equation (1), the following equation is obtained.

$$E = 49.6 \times T \times 10^{-3} \log_{10} \frac{0.206}{PO_2(S)} \quad \cdots\cdots (2)$$

Usually, the O_2 partial pressure in the oven atmosphere which has been denatured by the supplied gas CH_4, C_3H_6, C_4H_{10} etc. falls within 10^{-19}～10^{-21} atm.

Relationship between the oven atmosphere and carbon potential is expressed as follows.

In the oven atmosphere reaction $CO + 1/2\ O_2 \Leftrightarrow CO_2$, the following equation holds:

$$\frac{PCO \cdot PO_2^{1/2}}{PCO_2} = K_1 \quad (K1: \text{equilibrium constant})$$

$$\therefore PCO_2 = \frac{1}{K_1} \cdot PCO \cdot PO_2^{1/2}$$

In the oven atmosphere reaction $CO_2 + C \Leftrightarrow 2CO$

$$\frac{PCO_2 \cdot a_c}{PCO^2} = K_2 \quad (K_2: \text{equilibrium constant})$$

$$a_c = K_2 \cdot \frac{PCO^2}{PCO_2}$$

By substituting PCO_2 into the above equation, carbon potential a_c is obtained as follows.

$$a_c = K_2 \cdot PCO^2 \cdot \frac{1}{\frac{1}{K} \cdot PCO \cdot PO_2^{1/2}}$$

$$= K_1 \cdot K_2 \cdot PCO \cdot PO_2^{-1/2}$$

Because PCO in the oven atmosphere remains constant, carbon potential can be obtained by measuring PO_2 in the oven atmosphere.

3. Features of CP-X type O_2 analyzer

(1)Maintenance-free

CP-X type O_2 analyzer is subject to minimum drift and requires minimum maintenance in sampling.

(2)High sensitivity

High sensitivity enables detecting slight change in the oven atmosphere.

(3)Quick response

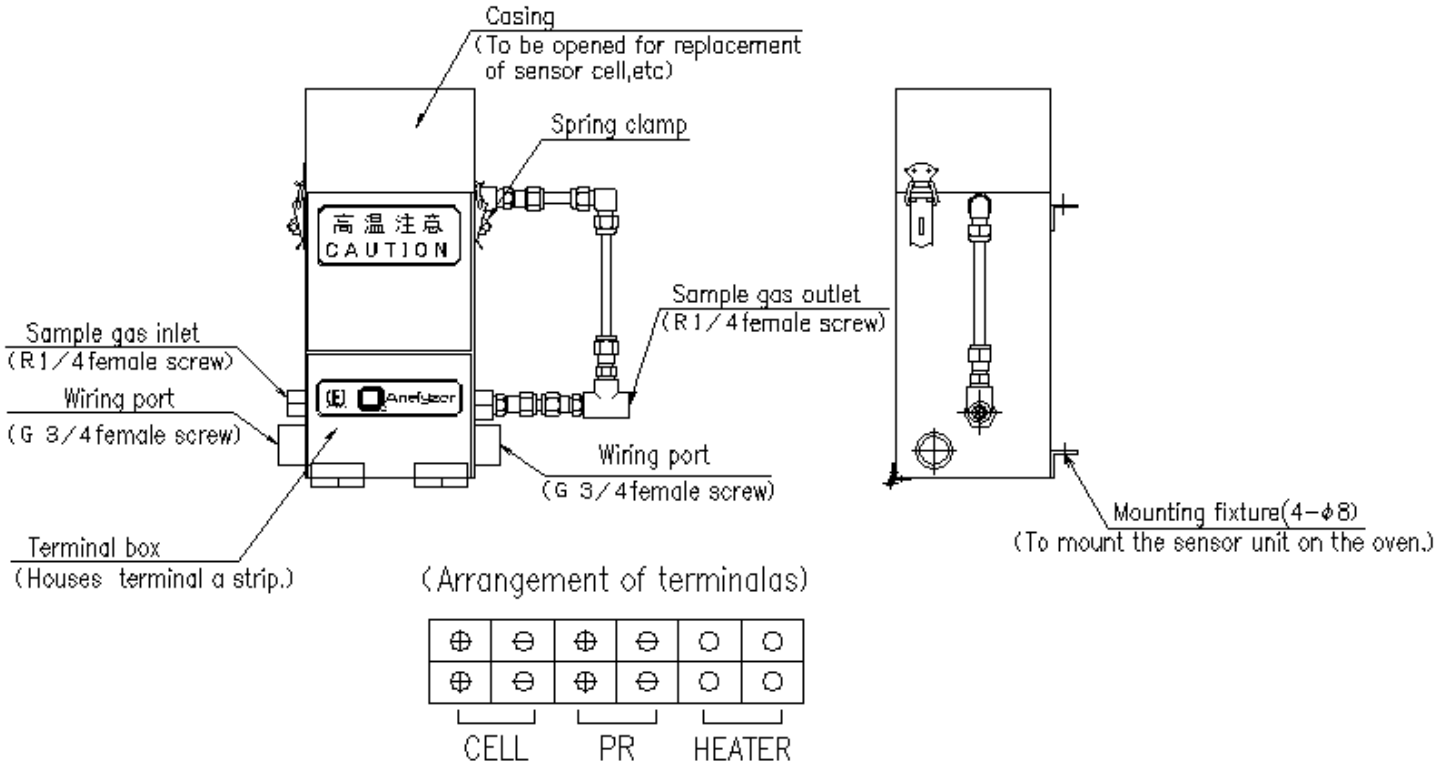
(4)Measurement by means of the sample gas in the flue allows a shorter sample line, making it free from clogging.

4. Specifications

Model:	CP-X type KS-16410□-□
Response time:	Within 10 seconds (90% response)
Operating temperature range:	Sensor unit -10～150℃
Power requirement:	AC100±10V 260VA
Warm-up time:	About 20 minutes
Insulation resistance:	Sensor unit 100KΩ or over
Dimensions:	See the drawing.

5. Names and functions of parts

5-1 Sensor unit



6. Installation work

6-1 Selection of gas sampling point

Select the sample gas intake point or the sensor unit mounting position, observing the following conditions.

(1) Where the sampled gas shows the representative values.

(2) Where the gas is less likely to undergo quick change.

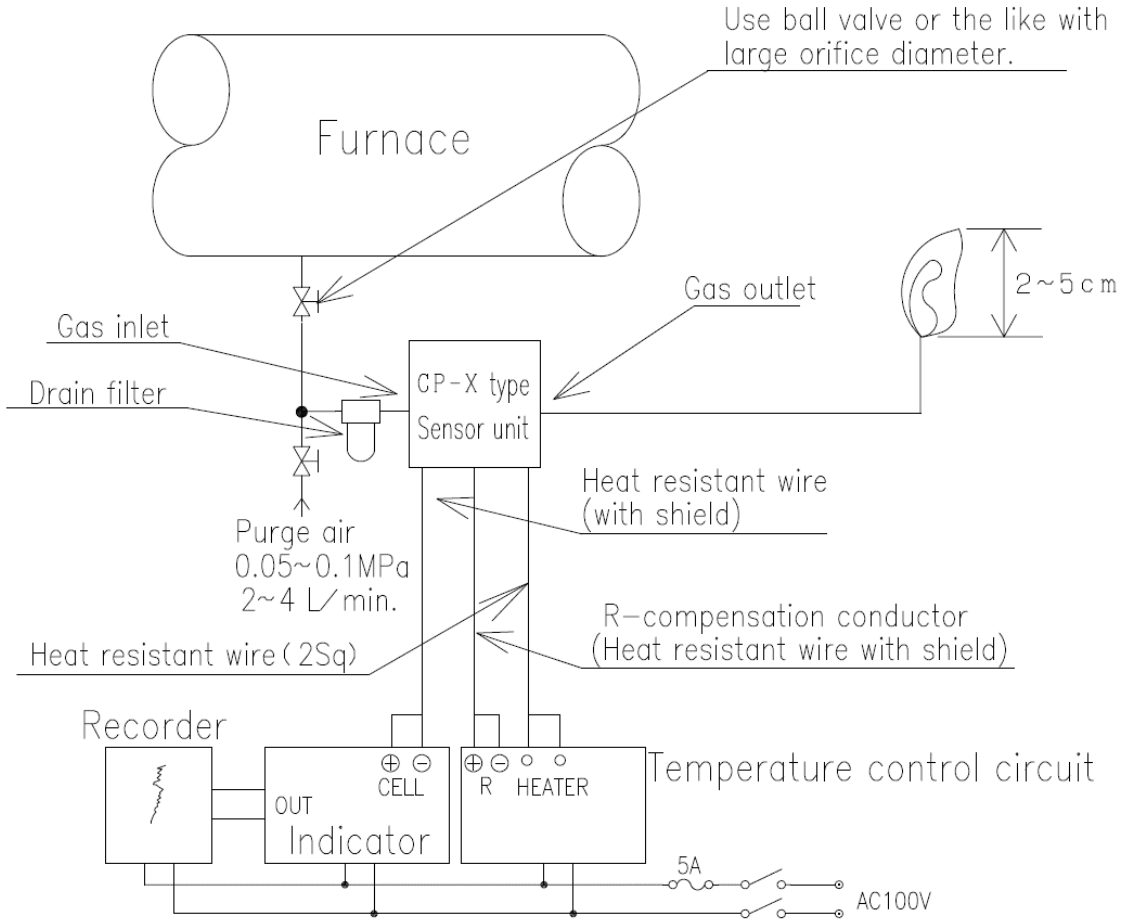
(3) Where a laminar flow of sample gas exists.

(4) Where the sensor unit is not subject to vibration or impact.

(5) Where maintenance service can be performed easily.

(6) Where ambient temperature is not higher than 150℃.

6-2 Wiring and piping (Reference)



Note: Piping and wiring shall be given due consideration to the following.

(1) Place signal wires (CELL R BR) and power wires (CMV, Heater, etc.) in a separate conduit.

(2) Do not use the cable exceeding 100m between the transmitter and receiver.

(3) As the terminal temperature in the transmitter goes up 70-80℃ above ambient, use R-compensated wire connecting to the transmitter for thermocouple (R).

(4) Use shielded wires for signal lines.

(5) Make sure to ground the shield of the signal lines

(6) Type CP-X transmitter

① Use control copper tube (CUT ϕ 10/ ϕ 8-6/ ϕ 4)and make the tube as short as possible and without sharp bend, and connectors if possible.

② Pipe so that diversion type sample gas is discharged through flair bend. Adjust so that flame length is 2-5 cm at the flair bend for the gas flow volume of 2-4L/min. This flair length specification is based on the RX sample gas, which discharged to atmosphere through control copper tube. For other specification, install flow meter upstream of the transmitter.

③ Make sure to install a drain filter in the sample gas piping.

④ Connect instrument air for purging to the transmitter using control copper tube (CUT ϕ 10/ ϕ 8-6/ ϕ 4)

⑤ Burn out the transmitter internal for 3-5 minutes with the compressed air of 2-4L/min once per week. (Depending on the soot condition in the transmitter, maintain furnace temperature rise due to soot burning at 850+30℃)

⑥ As soot at the low temperature part in the transmitter cannot be burnt out, remove it from the cleaning hatch.

7. Operation

7-1 Inspection before operation

Check the following for the installations made in accordance to the instruction in 6. Installation work.

(1) Check the piping and wiring to see they are completed correctly in compliance to the drawings.

(2) Check with a DC500V megger to make sure of no earth leakage and insulation defect. Be sure to not connect the control unit in this check.

*Across PR (R), CELL and case (ground): 100 KΩ or over

*Across OUT and case (ground): 10 MΩ or over

(3) Check to make sure that power voltage is 100 ±10V.

8. Inspection and maintenance

(1)Inspection of indicated value, recorder chart: once/3 days.

(2)Air purging from sensor unit and pipe line: once /week.

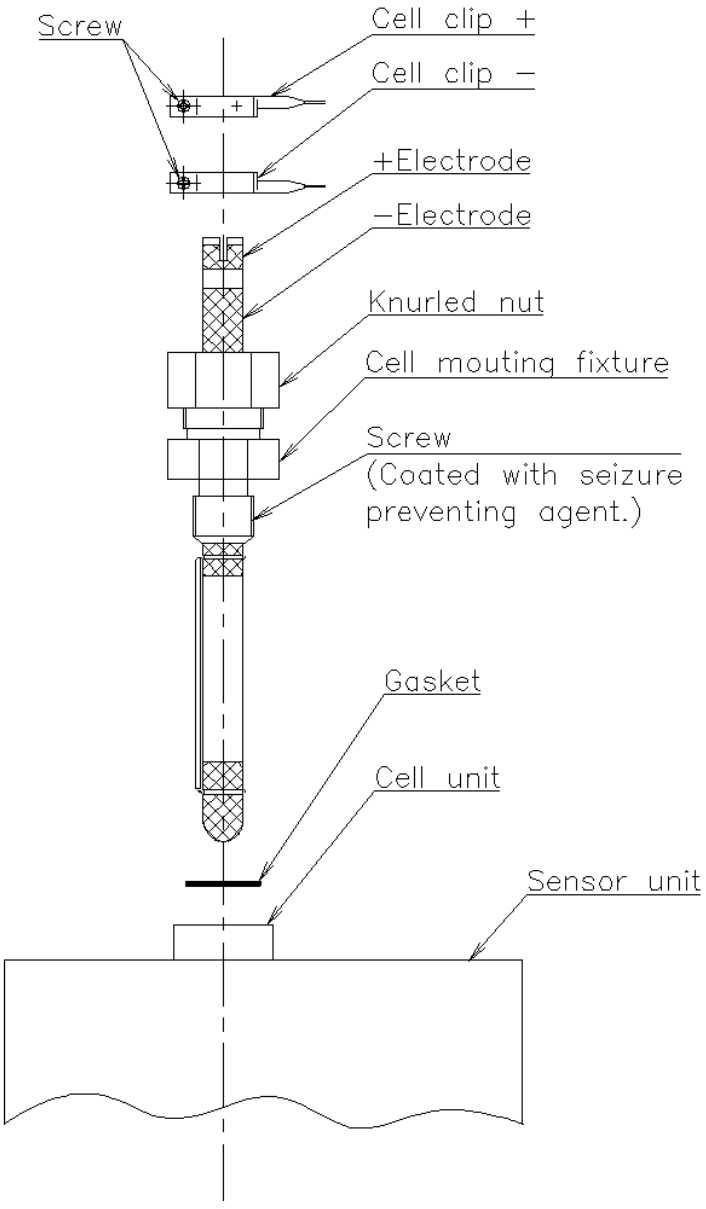
(3)Inspection for sticking material and clogging in sensor unit with the sensor unit disconnected:
Occasionally (guide line: once / 3 months).

(4)Take out the sensor unit and check the appearance with eyes.
Once/year.

Note : 1)In the event of a failure which may affect the measurement, replace the unit.
2)When removing the clogging in the sensor unit, pay great care to not damage the sensor cell.

(Replacement of sensor cell)

The sensor cell should be replaced in the following procedure after turning off the power to the electric oven and the electric oven has cooled down enough.



a) Loosen the cell clip screw and remove the cell clip.

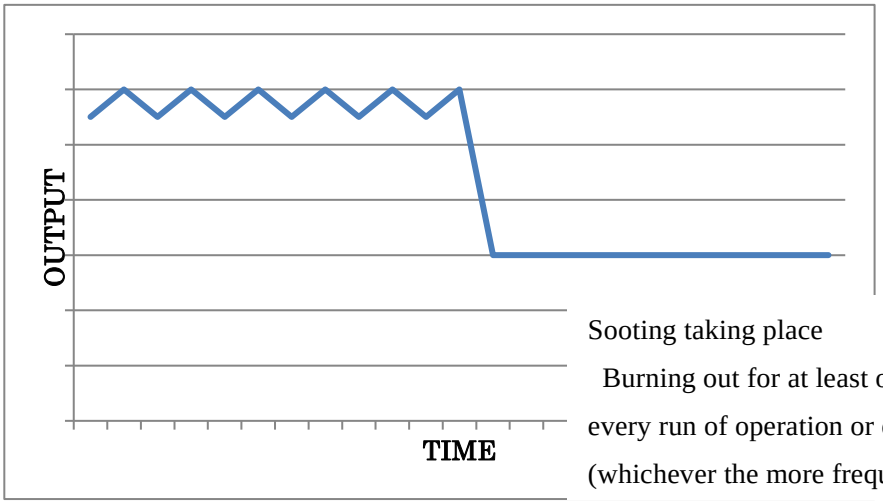
b) Apply spanners to the cell mounting fixture and the spanners flat and loosen the cell mounting fixture (counter-clockwise).When loosened, the fixture is to be removed by turning it manually.

c) Mount a spare sensor cell in the reverse order of the disassembly.

Note: Handled the sensor cell with great care as it may break when impact is applied.

8-1 Effects of sooting

Sooting causes the indication to lower below the normal measurement level, with the variation in the indication diminishing.

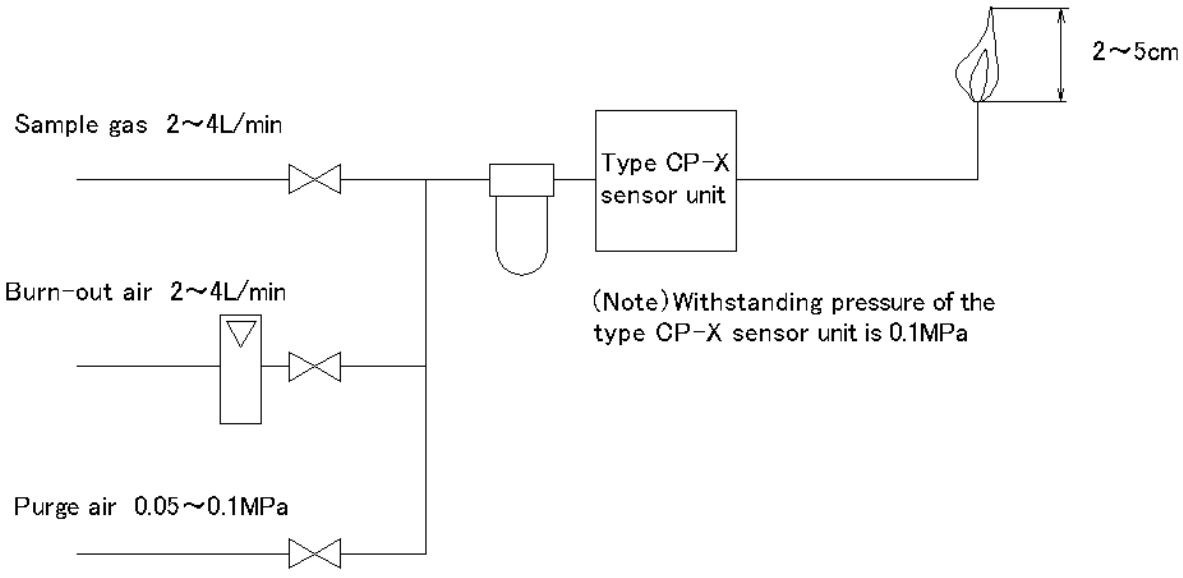


Sooting taking place

Burning out for at least one hour should be carried out at every run of operation or once every three days (whichever the more frequent).

When such a phenomenon as above is observed, carry out a burning out by means of air. (Carry out burning out for a period at an interval which depends on the sooting condition.)

8-2 Burn-out procedure



(1) Keep the temperature of the type CP-X sensor unit controlled at 850℃

(2) Shut off the sample gas.

(3) Supply 2～4L/min of burn-out air.

(4) Keep the supply of burn-out air until the cell output (voltage across CELL⊕and⊖) of the type CP-X sensor unit becomes +10mV or below.

(5) Stop the burn-out air and supply 2～4L/min of sample gas to make measurement.

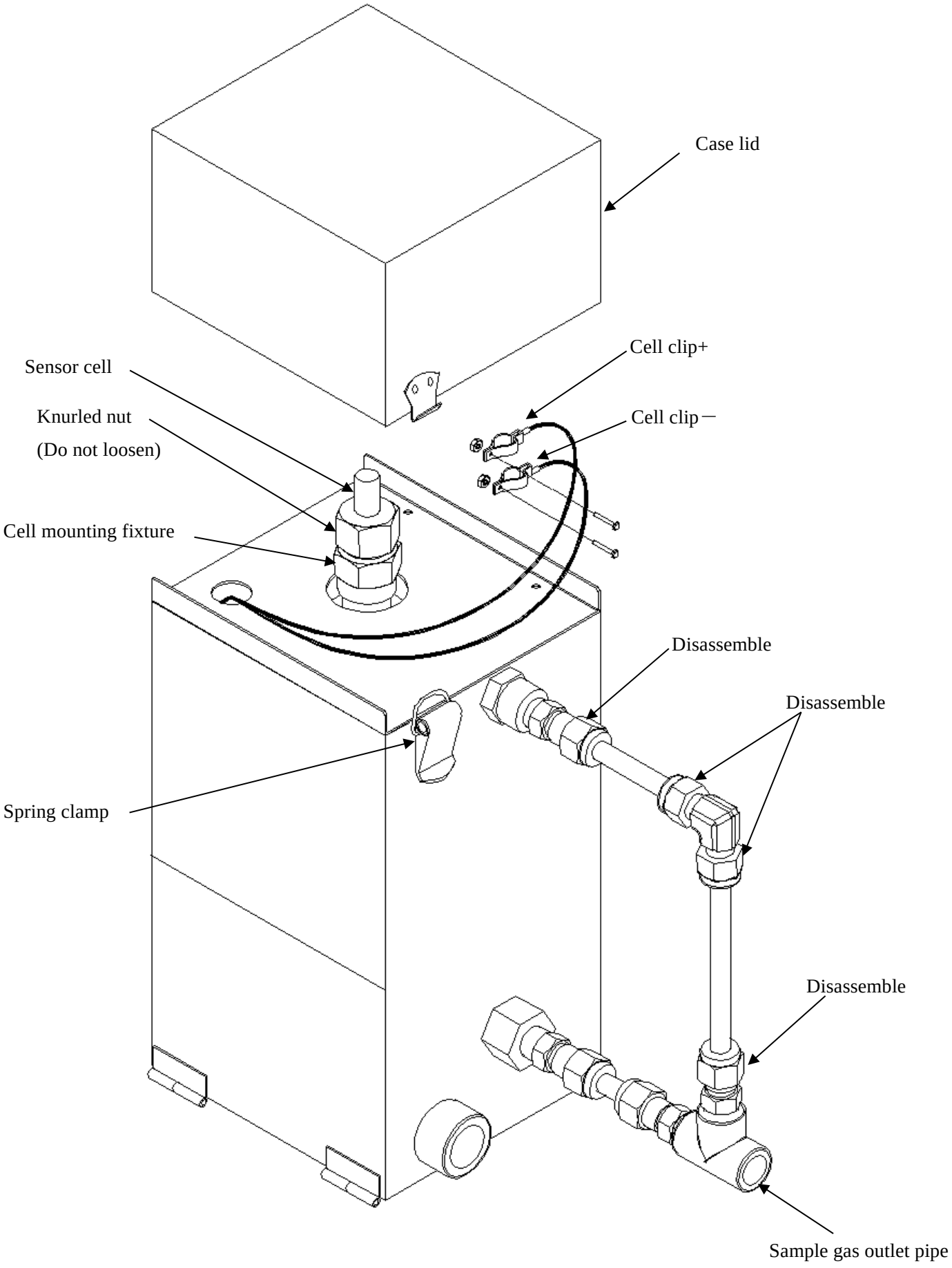
Note : Frequency of burning out

Frequency of burning out depends on the carbon potential of the sample gas and other factors, but once per week is recommended as the guide line.

If the measuring instrument mentioned in (4) is not used, carry out burning out for about 30 minutes.

Burning out should be done to keep the sensor unit temperature within a range of 850 ±30℃.

8-3 Soot removal after disassembly



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(1) Shut off the sample gas.
(2) Supply 2～4L/min of burn-out air.
(3) Shut off the power to the type CP-X sensor unit and turn off the sensor unit heater power.
(4) Leave the sensor unit to stand for about 60 minutes.
(5) Undo the spring clamp of the type CP-X sensor unit and remove the case lid.
(6) Remove the cell clip from the sensor cell by using a + screw driver and a pair of long-nosed pliers.
(The upper one is the + cell clip.)
(7) Loosen the cell mounting fixture with a spanner or a monkey wrench.
(Do not loosen the knurled nut which is for sealing of the sensor cell.)
(8) Remove the sensor cell.
(9) Dismantle the sample gas outlet pipe and three blind plugs using a spanner or a monkey wrench.
(10)Remove soot from the inside of the sensor unit through the cell mounting seat, blind plug hole and the sampled gas outlet pipe, by using a pipe of 5mm in O.D. or the like.

Note: Supplying purge air (0.05～0.1MPa) during the soot removal in (10) will be effective.

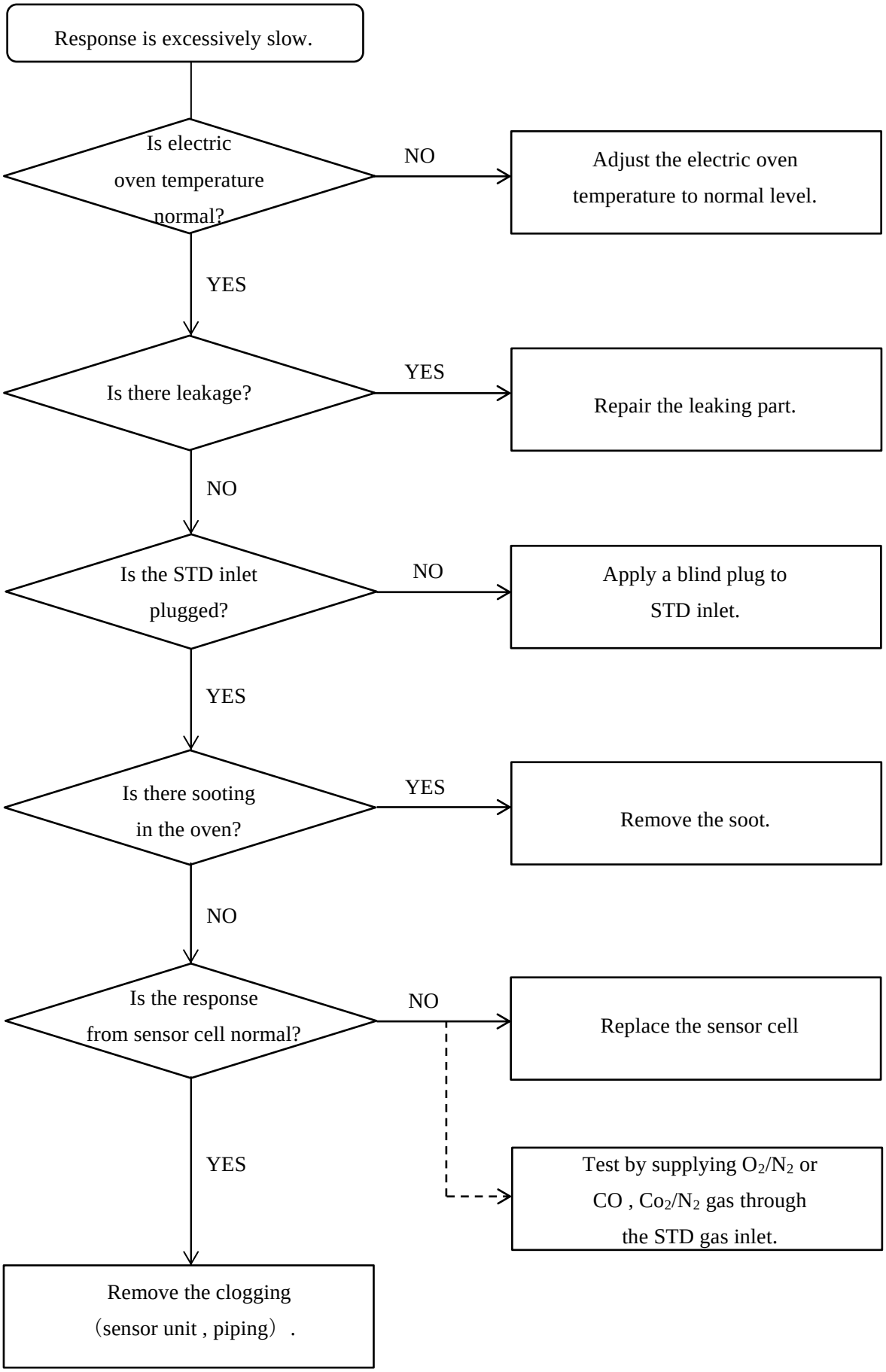
Measurement condition can be obtained by reversing the procedure above.

8-4 About sensor unit

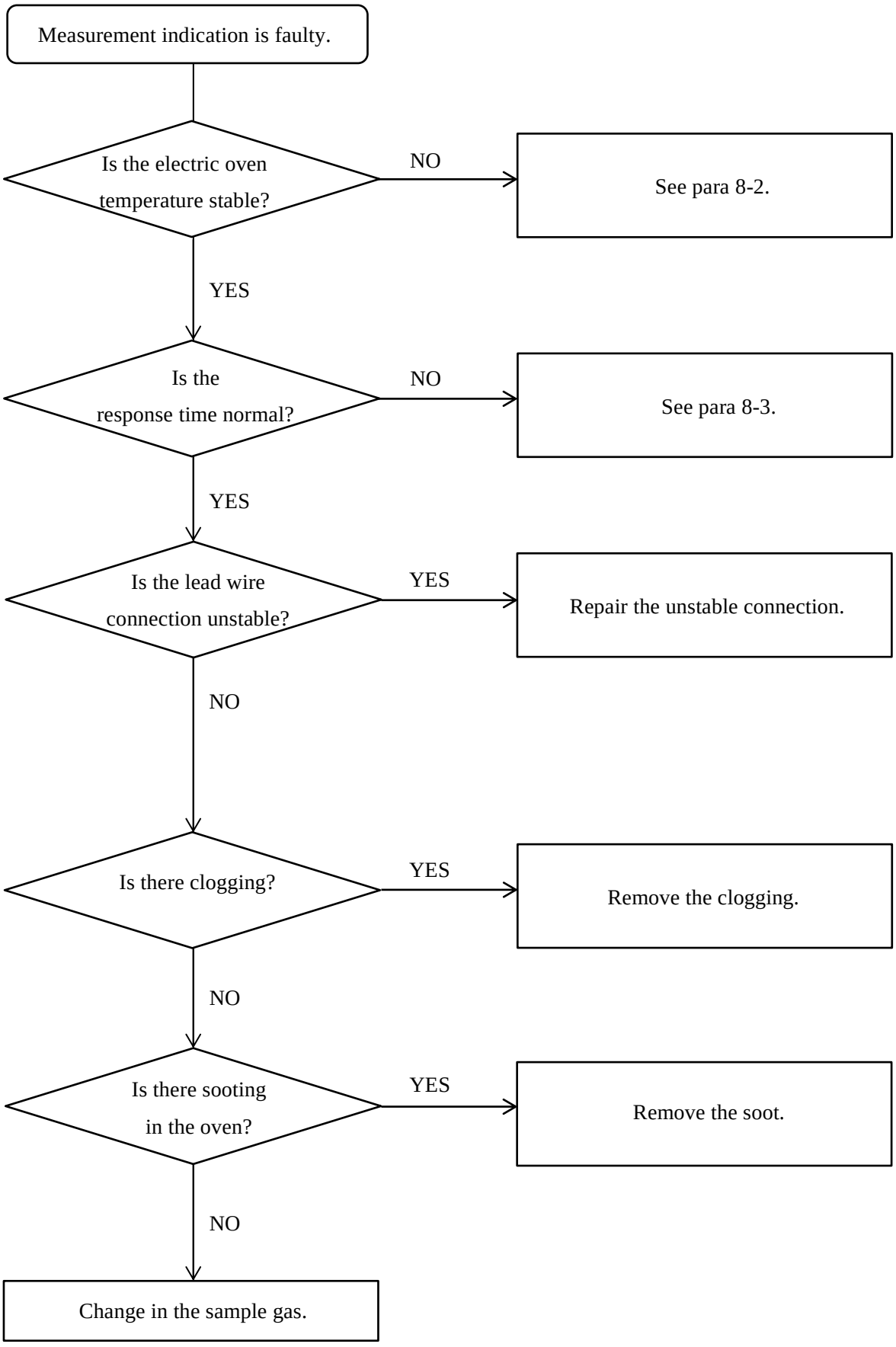
・Please download the Safety Data Sheet (SDS) for IsoWool Bulk (artificial mineral fiber) used in the transmitter of this product from our homepage.

9. Troubleshooting

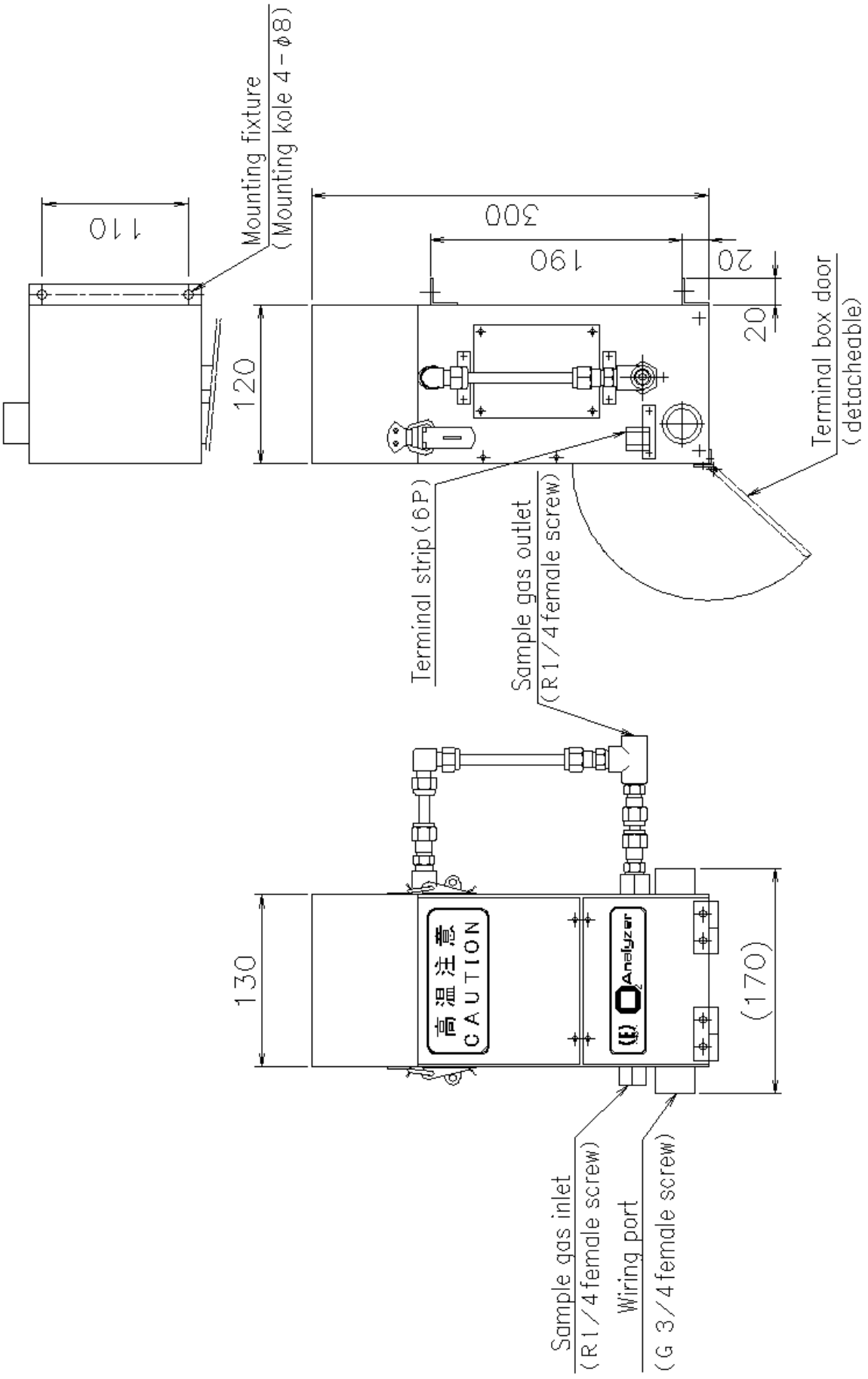
(1) Response is excessively slow.



(2) Measurement indication is faulty.



10.Attashed drawings (Sensor unit)



$$CP-X \quad EMF-O_2\left[EMF=-49.6\times10^{-3}\times(273+850)\times\log_{10}\frac{O_2}{20.6\%O_2}\right]$$

EMF(mv)	O2(%)	EMF(mv)	O2(%)	EMF(mv)	O2(%)	EMF(mv)	O2(%)	EMF(mv)	O2(%)	EMF(mv)	O2(%)	EMF(mv)	O2(%)
0	20.6	200	0.005287	400	1.36E-06	600	3.48E-10	800	8.94E-14	1000	2.29E-17	1200	5.89E-21
10	13.62492	210	0.003497	410	8.97E-07	610	2.30E-10	810	5.91E-14	1010	1.52E-17	1210	3.89E-21
20	9.011577	220	0.002313	420	5.94E-07	620	1.52E-10	820	3.91E-14	1020	1.00E-17	1220	2.58E-21
30	5.960293	230	0.00153	430	3.93E-07	630	1.01E-10	830	2.59E-14	1030	6.64E-18	1230	1.70E-21
40	3.942161	240	0.001012	440	2.60E-07	640	6.66E-11	840	1.71E-14	1040	4.39E-18	1240	1.13E-21
50	2.607361	250	0.000669	450	1.72E-07	650	4.41E-11	850	1.13E-14	1050	2.90E-18	1250	7.45E-22
60	1.724519	260	0.000443	460	1.14E-07	660	2.92E-11	860	7.48E-15	1060	1.92E-18	1260	4.93E-22
70	1.140604	270	0.000293	470	7.51E-08	670	1.93E-11	870	4.95E-15	1070	1.27E-18	1270	3.26E-22
80	0.7544	280	0.000194	480	4.97E-08	680	1.28E-11	880	3.27E-15	1080	8.40E-19	1280	2.16E-22
90	0.498963	290	0.000128	490	3.29E-08	690	8.43E-12	890	2.16E-15	1090	5.56E-19	1290	1.43E-22
100	0.330016	300	8.47E-05	500	2.17E-08	700	5.58E-12	900	1.43E-15	1100	3.67E-19	1300	9.43E-23
110	0.218274	310	5.60E-05	510	1.44E-08	710	3.69E-12	910	9.47E-16	1110	2.43E-19	1310	6.24E-23
120	0.144367	320	3.71E-05	520	9.51E-09	720	2.44E-12	920	6.26E-16	1120	1.61E-19	1320	4.13E-23
130	0.095485	330	2.45E-05	530	6.29E-09	730	1.61E-12	930	4.14E-16	1130	1.06E-19	1330	2.73E-23
140	0.063154	340	1.62E-05	540	4.16E-09	740	1.07E-12	940	2.74E-16	1140	7.03E-20	1340	1.80E-23
150	0.04177	350	1.07E-05	550	2.75E-09	750	7.06E-13	950	1.81E-16	1150	4.65E-20	1350	1.19E-23
160	0.027627	360	7.09E-06	560	1.82E-09	760	4.67E-13	960	1.20E-16	1160	3.08E-20	1360	7.89E-24
170	0.018273	370	4.69E-06	570	1.20E-09	770	3.09E-13	970	7.93E-17	1170	2.03E-20	1370	5.22E-24
180	0.012086	380	3.10E-06	580	7.96E-10	780	2.04E-13	980	5.24E-17	1180	1.35E-20	1380	3.45E-24
190	0.007993	390	2.05E-06	590	5.27E-10	790	1.35E-13	990	3.47E-17	1190	8.90E-21	1390	2.28E-24

$$E - n = 10^{-n}$$

The contents of this manual are subject to change without notice for improvement.

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Inquiry form URL：https://www.energys.co.jp/english/inq/all.php
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