Oxidation Reduction Potential (ORP)

DOC316.53.01244

Direct Measurement Method **Method 10228**

–2000 to 2000 mV **ORP electrode**

Scope and application: For drinking water, wastewater and process water applications.

Test preparation

Instrument-specific information

This procedure is applicable to the meters and probes that are shown in Table 1. Procedures for other meters and probes can be different.

Table 1 Instrument-specific information

Meter	Probe
HQ1100 and HQ11d portable one input, pH/ORP HQ4100, HQ2100 and HQ30d portable one input, multi-parameter HQ4200, HQ2200 and HQ40d portable two input, multi-parameter HQ4300 portable three input, multi-parameter HQ411d benchtop one input, pH/mV HQ430d benchtop one input, multi-parameter HQ440d benchtop two input, multi-parameter	Intellical MTC101 ORP Intellical MTC301 refillable ORP
Sension+ pH1 portable pH Sension+ MM110 portable pH/ORP Sension+ MM150 portable pH/ORP/EC	Sension+ 5045, 5048 or 5055 multi-parameter
Sension+ pH3 lab pH Sension+ pH31 GLP lab pH Sension+ MM340 lab two input, pH/mV/ISE Sension+ MM374 lab two input, pH/mV/EC/ISE Sension+ MM378 lab two input, pH/ISE/EC/DO	Sension+ 5056 or 5057 single-parameter

Before starting

Refer to the meter documentation for meter settings and operation. Refer to probe documentation for probe preparation, maintenance and storage information.
Prepare the probe before initial use. Refer to probe documentation.
When an Intellical probe is connected to an HQ meter or an HQd meter, the meter automatically identifies the measurement parameter and is prepared for use.
Do not dilute ORP/Redox standards and samples. Use a fresh ORP/Redox standard for calibration.
ZoBell's redox potential is temperature dependent. The HQ/HQd calibration routine factors in this temperature dependency allow accurate calibrations within the temperature range of 0 to 30 °C (32 to 86 °F). Light's solution should be read at 25 °C (77 °F). Custom ORP/Redox calibration solution values and temperature are user defined.
To significantly reduce the stabilization time for reducing-type samples, put the platinum disc in Reducing Solution for ORP Electrodes for 3-10 minutes before the initial sample measurement.
Analyze the samples immediately. The samples cannot be preserved for later analysis.
Air bubbles under the sensor tip can cause slow response or measurement errors. To remove the bubbles, carefully shake the probe.
Review the Safety Data Sheets (MSDS/SDS) for the chemicals that are used. Use the recommended personal protective equipment.

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Dispose of reacted solutions according to local, state and federal regulations. Refer to the Safety Data Sheets for disposal information for unused reagents. Refer to the environmental, health and safety staff for your facility and/or local regulatory agencies for further disposal information.

This procedure is specified for the HQ meters and HQd meters. The Sension+ meters can be used, but the menus and navigation will be different.

Calculate standard hydrogen electrode (SHE)

To supply oxidation reduction (redox) potential measurements relative to the standard hydrogen electrode (SHE), do the steps that follow:

1. Select the electrode potential (C) for the temperature of the solution measured. Refer to Table 2.
2. Calculate the oxidation reduction potential of the sample relative to the SHE as follows:

   $E_{SHE} = E_0 + C$

   Where:

   E_{SHE} = oxidation reduction potential (ORP) of the sample relative to the SHE

   E_0 = measured potential across the ORP electrode (mV)

   C = potential across the reference electrode relative to the SHE

Table 2 Reference electrode potentials

Temperature	Electrode potential (C)	Temperature	Electrode potential (C)
0 °C (32 °F)	224 mV	45 °C (113 °F)	192 mV
5 °C (41 °F)	221 mV	50 °C (122 °F)	188 mV
10 °C (50 °F)	217 mV	55 °C (131 °F)	185 mV
15 °C (59 °F)	214 mV	60 °C (140 °F)	181 mV
20 °C (68 °F)	211 mV	65 °C (149 °F)	178 mV
25 °C (77 °F)	205 mV	70 °C (158 °F)	174 mV
30 °C (86 °F)	203 mV	75 °C (167 °F)	171 mV
35 °C (95 °F)	200 mV	80 °C (176 °F)	167 mV
40 °C (104 °F)	196 mV		

The electrode potentials given for 55 to 80 °C were estimated from the data of the ISO 11271:2022 standard.

Items to collect

Description	Quantity
ORP/Redox Standard Solution	25 mL
Beaker (laboratory test)	1
Wash bottle with deionized water	1
Lint-free cloth	1

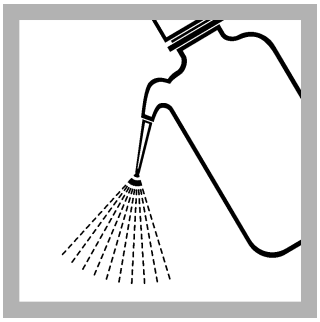
Refer to Consumables and replacement items on page 5 for order information.

Sample collection

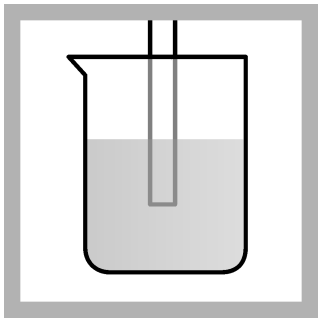
- Analyze the samples immediately. The samples cannot be preserved for later analysis.
- Collect samples in clean glass or plastic bottles.

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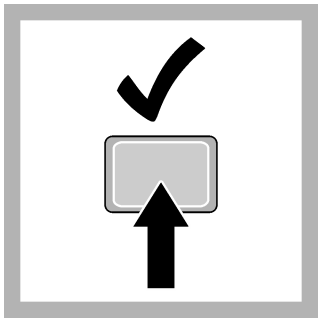
Test procedure



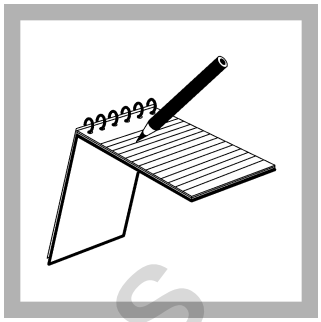
1. Rinse the probe with deionized water. Dry the probe with a lint-free cloth.



2. Laboratory test: Put the probe in a beaker that contains the solution. Do not let the probe touch the stir bar, bottom or sides of the container. Remove the air bubbles from under the probe tip. Stir the sample at a slow to moderate rate.
Field test: Put the probe in the sample. Move the probe up and down to remove bubbles from the probe tip.



3. Push **Read**. A progress bar is shown. When the measurement is stable, the lock icon is shown.



4. When the value is stable, store or record the mV value and the temperature value.

Interferences

Many factors limit the interpretation of ORP measurements in water. These factors include irreversible reactions, electrode poisoning, multiple redox couples in the sample, very small exchange currents and inert redox couples. ORP measurements in the field can correlate poorly with ORP values calculated from the redox couples in the sample. Because of these factors, the interpretation of ORP measurements will be specific to the particular application.

Accuracy check

Standard solution method—Procedure A

Use one of the two standard solution methods to validate the test procedure and the instrument.

Items to collect:

- Light's Solution ampule or 25 mL of ORP standard solution
- Beaker, 50-mL

1. Pour the content of the ampule in the beaker.
2. Immediately put the probe in the beaker.
3. Use the test procedure to measure the ORP of the solution.
4. Compare the expected result to the actual result. The potential should be 475 ± 10 mV or the specified ORP value.
   Note: *This potential is the standard reduction potential for Fe_2^+/Fe_3^+ with the reference electrode potential subtracted. The solution is 0.01 M in both Fe_2^+ and Fe_3^+.*

Standard solution method—Procedure B

⚠ DANGER

Chemical exposure hazard. Potassium Ferrocyanide and Potassium Ferricyanide are toxic. Keep cyanide solutions at more than pH 11 to prevent exposure to hydrogen cyanide gas. Dispose of reacted solutions according to local, state and federal regulations.

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Use either standard solution method to validate the test procedure and the instrument.

Items to collect:

- Potassium Ferrocyanide, 4.64 g
- Potassium Ferricyanide, 3.3 g
- Potassium Fluoride, 3.39 g
- 100-mL volumetric flask, Class A (2x)
- 150-mL beaker (2x)
- Deionized water, 200 mL

1. Prepare Solution A (0.1 M Potassium Ferrocyanide and 0.05 M Potassium Ferricyanide) as follows:
   a. Put the items that follow in a 100-mL volumetric flask.
      - 4.22 g reagent-grade $K_4Fe(CN)_6 \cdot 3H_2O$
      - 1.65 g reagent-grade $K_3Fe(CN)_6$
   b. Add 50 mL of deionized water to dissolve the solids. Mix well.
   c. Dilute to the mark with deionized water. Mix well.
2. Prepare a Solution B (0.01 M Potassium Ferrocyanide, 0.05 M Potassium Ferricyanide and 0.36 M Potassium Fluoride) as follows:
   a. Put the items that follow in a 100-mL volumetric flask:
      - 0.42 g reagent-grade $K_4Fe(CN)_6 \cdot 3H_2O$
      - 1.65 g reagent-grade $K_3Fe(CN)_6$
      - 3.39 g of reagent-grade $KF \cdot 2H_2O$
   b. Add 50-mL of deionized water to dissolve the solids. Mix well.
   c. Dilute to the mark with deionized water. Mix well.
3. Put Solution A in a 150-mL beaker.
4. Use the test procedure to measure the solution. The reading should be approximately 234 mV.
5. Put Solution B in a 150-mL beaker.
6. Rinse the probe with deionized water. Dry the probe with a lint-free cloth.
7. Use the test procedure to measure the solution. The reading should be approximately 66 mV higher than Solution A.
8. Rinse the probe with deionized water. Dry the probe with a lint-free cloth.

Clean the probe

Clean the probe when:

- Drifting/inaccurate readings occur as a result of contamination on the sensing element or incorrect storage conditions.
- Slow response time occurs as a result of contamination on the sensing element.
- The slope is out of range as a result of contamination on the sensing element.

For general contamination, complete the steps that follow.

1. Rinse the probe with deionized water. Blot dry with a lint-free cloth.
2. If harsh contaminants are attached to the probe, polish the probe tip with a soft cloth or cotton swab to remove the contaminants.
3. Soak the probe in deionized water for 1 minute.

Summary of method

The ORP probe is a two-electrode probe that makes a potentiometric measurement. The ORP electrode is an electron donor or electron acceptor, based on the test solution. A reference electrode supplies a constant stable output for comparison. Platinum is used as

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an indicating sensor and the potential is measured against the reference electrode, usually Ag/AgCl.

Consumables and replacement items

HQ meters, HQd meters and probes

Description	Unit	Item no.
HQ1110 portable one input, pH/ORP meter	each	LEV015.53.1110A
HQ2100 portable one input, multi-parameter meter	each	LEV015.53.2100A
HQ2200 portable two input, multi-parameter meter	each	LEV015.53.2200A
HQ4100 portable one input, multi-parameter meter	each	LEV015.53.4100A
HQ4200 portable two input, multi-parameter meter	each	LEV015.53.4200A
HQ4300 portable three input, multi-parameter meter	each	LEV015.53.4300A
HQ411d benchtop one input, pH/mV meter	each	HQ411D
HQ430d benchtop one input, multi-parameter meter	each	HQ430D
HQ440d benchtop two input, multi-parameter meter	each	HQ440D
Intellical ORP gel probe, standard with 1 m cable	each	MTC10101
Intellical ORP gel probe, standard with 3 m cable	each	MTC10103
Intellical ORP gel probe, rugged with 5 m cable	each	MTC10105
Intellical ORP gel probe, rugged with 10 m cable	each	MTC10110
Intellical ORP gel probe, rugged with 15 m cable	each	MTC10115
Intellical ORP gel probe, rugged with 30 m cable	each	MTC10130
Intellical ORP refillable probe, standard with 1 m cable	each	MTC30101
Intellical ORP refillable probe, standard with 3 m cable	each	MTC30103

Sension+ meters and probes

Description	Unit	Item no.
Sension+ pH3 lab pH meter	each	LPV2010T.97.002
Sension+ pH31 GLP lab pH meter	each	LPV2110T.97.002
Sension+ MM340 lab two input, pH/mV/ISE meter	each	LPV2200.97.0002
Sension+ MM374 lab two input, pH/mV/EC/ISE meter	each	LPV4110.97.0002
Sension+ MM378 lab two input, pH/ISE/EC/DO meter	each	LPV4130.97.0002
Sension+ 5045 multi-parameter probe	each	LZW5045.97.0002
Sension+ 5048 multi-parameter probe	each	LZW5048.97.0002
Sension+ 5056 single-parameter probe	each	LZW5056.97.0002
Sension+ 5057 single-parameter probe	each	LZW5057.97.0002

Optional reagents and apparatus

Description	Unit	Item no.
Beaker, polypropylene, 50 mL, low form	each	108041
Beaker, 100 mL, polypropylene	each	108042
Beaker, 150 mL, polypropylene	each	108044
Beaker, 250 mL, polypropylene	each	108046

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Optional reagents and apparatus (continued)

Description	Unit	Item no.
Beaker, 400 mL, polypropylene	each	108048
Beaker, 600 mL, polypropylene	each	108052
Flask, volumetric, Class A, 100 mL	each	1457442
Light's Solution, ampules, 20 mL	20/pkg	2612520
ORP Standard Solution, 200 mV	500 mL	25M2A1001-115
ORP Standard Solution, 600 mV	500 mL	25M2A1002-115
Probe clips, color-coded, for IntelliCAL probes	50/pkg	5818400
Probe, depth markers, rugged LDO probe only	10/pkg	5828610
Probe holder, 3 probes, for sensION+ benchtop meters	each	LZW9321.99
Probe stand, universal	each	8508850

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HACH COMPANY
WORLD HEADQUARTERS
Telephone: (970) 669-3050
FAX: (970) 669-2932

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