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Boiler and Cooling Water Test Kit

BC-3 (2350500)

09/2017, Edition 1

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General information

In no event will the manufacturer be liable for direct, indirect, special, incidental or consequential damages resulting from any defect or omission in this manual. The manufacturer reserves the right to make changes in this manual and the products it describes at any time, without notice or obligation. Revised editions are found on the manufacturer's website.

Use of hazard information

⚠ DANGER

Indicates a potentially or imminently hazardous situation which, if not avoided, will result in death or serious injury.

⚠ WARNING

Indicates a potentially or imminently hazardous situation which, if not avoided, could result in death or serious injury.

⚠ CAUTION

Indicates a potentially hazardous situation that may result in minor or moderate injury.

NOTICE

Indicates a situation which, if not avoided, may cause damage to the instrument. Information that requires special emphasis.

Product overview

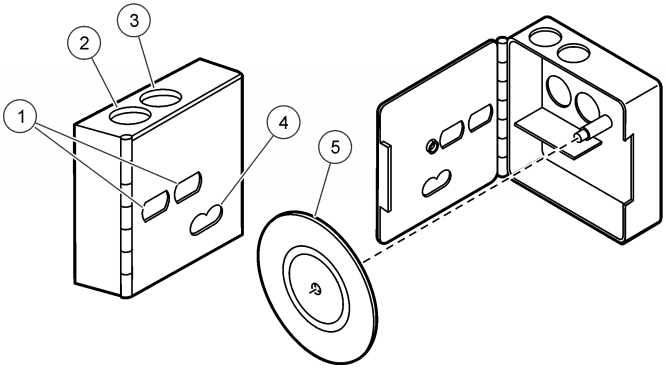
The boiler and cooling water test kit includes the necessary items to measure important parameters in boiler and cooling water. Refer to Table 1.

Some measurement methods use reagents and color discs to make a visual determination of the parameter concentration. Refer to Figure 1. Other measurement methods use reagents and titration procedures to measure the parameter concentration.

Table 1 Test kit parameters

Parameter	Range	Method
Alkalinity	0–100, 0–400 mg/L $CaCO_3$	Titration
Chloride	0–100, 0–400 mg/L Cl^-	Titration
Chlorine, total	0–3.4 mg/L Cl_2	Color disc
Hardness, total	0–20 mg/L $CaCO_3$	Titration
Iron	0–0.2, 0–2 mg/L Fe	Color disc
pH	5.6–8.4, 7.4–9.6 pH units	Color disc
Phosphate	0–40 mg/L PO_4	Color disc
Silica	0–30 mg/L SiO_2	Color disc
Sulfite	0–20, 0–200 mg/L Na_2SO_3	Titration

Figure 1 Color comparator box



1 Windows for color matching	**4** Scale window
2 Left opening for viewing tube	**5** Color disc
3 Right opening for viewing tube	

Product components

Make sure that all components have been received. Refer to the list that follows. If any items are missing or damaged, contact the manufacturer or a sales representative immediately.

- Bottle, mixing (4x)
- Carrying case
- Clamp, test tube
- Color comparator box
- Color discs (7x)
- Color viewing tubes, plastic (2x)
- Color viewing tubes, glass (2x)
- Cook kit
- Dropper (2x)
- Erlenmeyer flask, 50 mL
- Erlenmeyer flask, 125 mL
- Filter paper, 2–3 µm,12.5 cm
- Funnel, plastic
- Long-path viewing adaptor
- Stopper for color viewing tubes (2x)
- Tube, plastic 5.83 mL
- Vial, plastic measuring
- Bromcresol Green-Methyl Red Powder Pillows
- Phenolphthalein Reagent Powder Pillows
- Sulfuric Acid Reagent Solution, 0.035 N
- Chloride 2 Indicator Reagent Powder Pillows
- Silver Nitrate Titrant Solution
- DPD Total Chlorine Reagent Powder Pillows
- Hardness 1 Buffer Solution
- Hardness 2 Indicator Solution
- Hardness 3 Titrant Solution
- TPTZ Iron Reagent Powder Pillows
- Bromthymol Blue Indicator Solution
- Thymol Blue Indicator Solution
- PhosVer 3 Reagent Powder Pillows
- Sulfuric Acid Reagent Solution, 5.25 N
- Sodium Hydroxide Solution, 5.0 N
- Filtration Aid Solution
- Acid Reagent Powder Pillows
- Molybdate Reagent Powder Pillows
- Citric Acid Reagent Powder Pillows
- Silica 3 Reagent Powder Pillows
- Sulfite 1 Reagent Powder Pillows
- Sulfamic Acid Reagent Powder Pillows
- Sulfite 3 Reagent Solution

Sample collection

- Collect samples in clean glass or plastic bottles.
- Analyze the samples at room temperature as soon as possible for best results.

Alkalinity

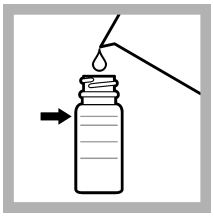
Test preparation

⚠ CAUTION

Review the Safety Data Sheets (MSDS/SDS) for the chemicals that are used. Use the recommended personal protective equipment.

- Hold the dropper vertically above the sample. Do not let the dropper touch the bottle during the titration.
- Rinse the tubes and bottles with sample before the test. Rinse the tubes and bottles with deionized water after the test.
- Alkalinity is the capacity of water to neutralize acids. Carbonates, bicarbonates and hydroxides are the primary sources of alkalinity in water. In a boiler system, alkalinity is controlled to prevent corrosion from low pH and also to prevent scaling from calcium precipitates.
- To verify the test accuracy, use a standard solution as the sample.
- To record the test result as gpg (grains per gallon), multiply the LR test result by 0.3 and the HR test result by 1.2

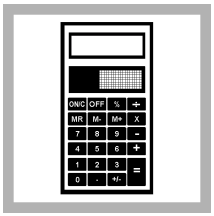
Test procedure—Alkalinity (0–100 mg/L $CaCO_3$)



1. Fill the bottle to the 23-mL mark with sample.

2. Add one Phenolphthalein Indicator Powder Pillow. Swirl to mix.
If the solution is colorless, the Phenolphthalein (P) alkalinity is zero. Go to step 5.

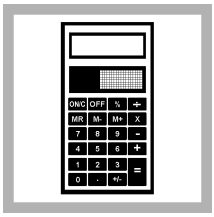
3. Add the 0.035 N Sulfuric Acid Standard Solution by drops. Mix after each drop. Count the drops until the color changes from pink to colorless.



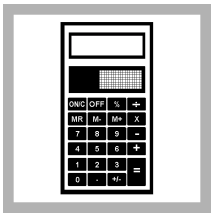
4. Multiply the number of drops by 5 to get the phenolphthalein alkalinity result as $CaCO_3$.

5. Add one Bromcresol Green-Methyl Red Powder Pillow. Swirl to mix.

6. Add the 0.035 N Sulfuric Acid Standard Solution by drops. Mix after each drop. Count the drops until the color changes from green to pink.

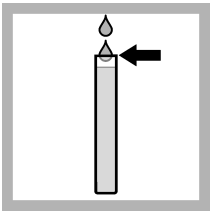


7. Add the number of drops from step 3 and step 6.



8. Multiply the total number of drops by 5 to get the total (methyl orange) alkalinity result as $CaCO_3$.

Test procedure—Alkalinity (0–400 mg/L $CaCO_3$)

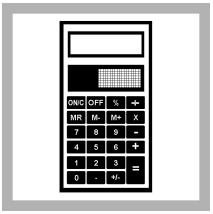


1. Fill the measuring tube with sample.

2. Pour the sample into the mixing bottle.

3. Add one Phenolphthalein Indicator Powder Pillow. Swirl to mix.
If the solution is colorless, the Phenolphthalein (P) alkalinity is zero. Go to step 6.

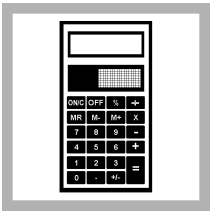
4. Add the 0.035 N Sulfuric Acid Standard Solution by drops. Mix after each drop. Count the drops until the color changes from pink to colorless.



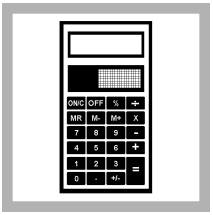
5. Multiply the number of drops by 20 to get the phenolphthalein alkalinity result as $CaCO_3$.

6. Add one Bromcresol Green-Methyl Red Powder Pillow. Swirl to mix.

7. Add the 0.035 N Sulfuric Acid Standard Solution by drops. Mix after each drop. Count the drops until the color changes from green to pink.



8. Add the number of drops from step 4 and step 7.



9. Multiply the total number of drops by 20 to get the total (methyl orange) alkalinity result as $CaCO_3$.

Determine the alkalinity relationships

The primary forms of alkalinity in water are hydroxide, carbonate and bicarbonate ions. The concentration of these ions in a sample can be determined from the phenolphthalein alkalinity and total alkalinity values. Refer to Table 2 and the steps that follow to determine the hydroxide, carbonate and bicarbonate alkalinities.

1. If the phenolphthalein (P) alkalinity is 0 mg/L, use Row 1.
2. If the phenolphthalein (P) alkalinity is equal to the total alkalinity, use Row 2.
3. Divide the total alkalinity by 2 to calculate one-half of the total alkalinity.
   a. Compare the phenolphthalein (P) alkalinity to one-half of the total alkalinity. Then, use Row 3, 4 or 5.
   b. Do the calculations in the row (if applicable).
4. Make sure that the sum of the three alkalinity types is equal to the total alkalinity.
   Example:

   A sample has 170 mg/L as $CaCO_3$ phenolphthalein alkalinity and 250 mg/L as $CaCO_3$ total alkalinity.

   The phenolphthalein alkalinity of 170 mg/L is more than one-half of the total alkalinity, so use Row 5.

   - Hydroxide alkalinity: 2 x 170 = 340; 340 – 250 = 90 mg/L hydroxide alkalinity
   - Carbonate alkalinity: 250 – 170 = 80; 80 x 2 = 160 mg/L carbonate alkalinity
   - Bicarbonate alkalinity: 0 mg/L

   Sum of the alkalinity types: 90 mg/L hydroxide alkalinity + 160 mg/L carbonate alkalinity + 0 mg/L bicarbonate alkalinity = 250 mg/L total alkalinity.

Table 2 Alkalinity relationships

Row	Titration result	Hydroxide alkalinity	Carbonate alkalinity	Bicarbonate alkalinity
1	P alkalinity = 0	0	0	= Total alkalinity
2	P alkalinity = Total alkalinity	= Total alkalinity	0	0
3	P alkalinity is less than ½ of Total alkalinity	0	= P alkalinity × 2	= Total alkalinity – (P alkalinity × 2)
4	P alkalinity = ½ Total alkalinity	0	= Total alkalinity	0
5	P alkalinity is more than ½ Total alkalinity	= (P alkalinity × 2) – Total alkalinity	= (Total alkalinity – P alkalinity) × 2	0

Replacement items

Note: *Product and Article numbers may vary for some selling regions. Contact the appropriate distributor or refer to the company website for contact information.*

Description	Unit	Item no.
Bromcresol Green-Methyl Red Indicator Powder Pillows	100/pkg	94399
Phenolphthalein Indicator Powder Pillows	100/pkg	94299
Sulfuric acid standard solution, 0.035 N	100 mL MDB	2349732
Bottle, square, 29 mL, with 10, 15, 20 and 23-mL marks	6/pkg	232706
Measuring tube, plastic, 5.83 mL	each	43800

Optional items

Description	Unit	Item no.
Alkalinity standard solution, 500 mg/L as $CaCO_3$	1 L	2826253
Water, deionized	500 mL	27249

Chloride

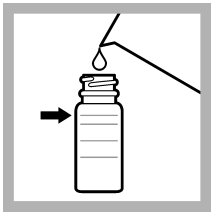
Test preparation

⚠ CAUTION

Review the Safety Data Sheets (MSDS/SDS) for the chemicals that are used. Use the recommended personal protective equipment.

- Hold the dropper vertically above the sample. Do not let the dropper touch the bottle during the titration.
- Rinse the tubes and bottles with sample before the test. Rinse the tubes and bottles with deionized water after the test.
- Keep the silver nitrate titrant solution in the closed test kit case when not in use. The titrant solution slowly decomposes in light.
- To verify the test accuracy, use a standard solution as the sample.
- To record the test result as mg/L sodium chloride (NaCl), multiply the chloride result by 1.65.
- In boiler water, the chloride concentration is used to determine when the dissolved solids have increased to a level that requires removal by blowdown.

Test procedure—Chloride (0–100 mg/L Cl^-)

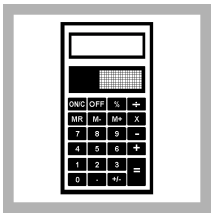


1. Fill the bottle to the 23-mL mark with sample.

2. Add one Chloride 2 Indicator Powder Pillow.

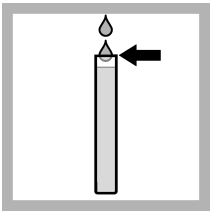
3. Turn the bottle left and right to mix.

4. Add the Silver Nitrate Titrant Solution by drops. Mix after each drop. Count the drops until the color changes to red-brown.



5. Multiply the total number of drops by 5 to get the result in mg/L.

Test procedure—Chloride (0–400 mg/L Cl^-)



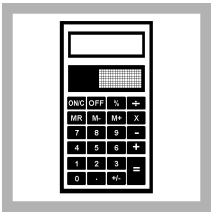
1. Fill the measuring tube with sample.

2. Pour the sample into the mixing bottle.

3. Add one Chloride 2 Indicator Powder Pillow.

4. Turn the bottle left and right to mix.

5. Add the Silver Nitrate Titrant Solution by drops. Mix after each drop. Count the drops until the color changes to red-brown.



6. Multiply the total number of drops by 20 to get the result in mg/L.

Interferences—chloride test

Interfering substance	Interference level
Bromide	Interferes directly and is included in the test result.
Cyanide	Interferes directly and is included in the test result.
Iodide	Interferes directly and is included in the test result.
Iron	Concentrations that are more than 20 mg/L prevent the color change at the endpoint.
Orthophosphate	Concentrations that are more than 25 mg/L cause a precipitate to form.
Highly buffered samples or extreme sample pH	Can prevent the correct pH adjustment (of the sample) by the reagents. Sample pretreatment may be necessary.
Sulfide	Remove sulfide interference as follows: **1.** Add the contents of one Sulfide Inhibitor Reagent Powder Pillow to approximately 125 mL of sample. **2.** Mix for 1 minute. **3.** Pour the solution through folded filter paper in a funnel. **4.** Use the filtered sample in the chloride test procedure.
Sulfite	Concentrations that are more than 10 mg/L interfere with this method. To remove sulfite interference, add 3 drops of 30% Hydrogen Peroxide to the sample, then start the test.

Replacement items

Note: *Product and Article numbers may vary for some selling regions. Contact the appropriate distributor or refer to the company website for contact information.*

Description	Unit	Item no.
Chloride 2 Indicator Powder Pillows	100/pkg	104399
Chloride Titrant, Silver Nitrate, 0.0493 N	100 mL MDB	2349832
Bottle, square, 29 mL, with 10, 15, 20 and 23-mL marks	6/pkg	232706
Measuring tube, plastic, 5.83 mL	each	43800

Optional items

Description	Unit	Item no.
Chloride standard solution, 100 mg/L Cl^-	1000 mL	2370853
Dropper, glass, 0.5- and 1.0-mL marks	5/pkg	1419705
Filter paper, 2–3 micron, pleated, 12.5 cm	100/pkg	189457
Flask, Erlenmeyer, 125 mL	each	50543
Funnel, poly, 65 mm	each	108367
Hydrogen Peroxide Solution, 30%, ACS	473 mL	14411
Sulfide Inhibitor Reagent Powder Pillows	100/pkg	241899
Water, deionized	500 mL	27249

Total Chlorine

Test preparation

⚠ CAUTION

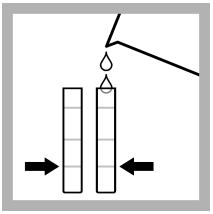
Review the Safety Data Sheets (MSDS/SDS) for the chemicals that are used. Use the recommended personal protective equipment.

NOTICE

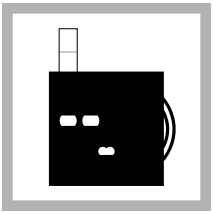
This product has not been evaluated to test for chlorine and chloramines in medical applications in the United States.

- Analyze samples immediately after collection.
- Put the color disc on the center pin in the color comparator box (numbers to the front).
- Use sunlight or a lamp as a light source to find the color match with the color comparator box.
- Rinse the tubes with sample before the test. Rinse the tubes with deionized water after the test.
- If the color match is between two segments, use the value that is in the middle of the two segments.
- If the color disc becomes wet internally, pull apart the flat plastic sides to open the color disc. Remove the thin inner disc. Dry all parts with a soft cloth. Assemble when fully dry.
- Undissolved reagent does not have an effect on test accuracy.

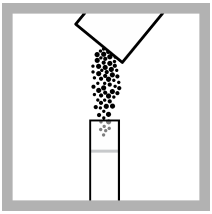
Test procedure—Total chlorine (0–3.4 mg/L Cl_2)



1. Fill two tubes to the first line (5 mL) with sample.

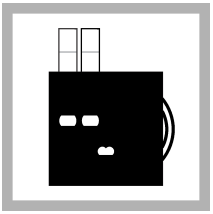


2. Put one tube into the left opening of the color comparator box.

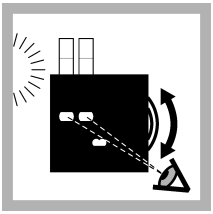


3. Add one DPD Total Chlorine Powder Pillow to the second tube.

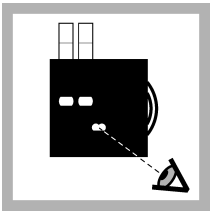
4. Wait 3 minutes. Read the result within 6 minutes.



5. Put the second tube into the color comparator box.



6. Hold the color comparator box in front of a light source. Turn the color disc to find the color match.



7. Read the result in mg/L in the scale window.

Interferences

Interfering substance	Interference level
Acidity	More than 150 mg/L $CaCO_3$. The full color may not develop or the color may fade instantly. Adjust to pH 6–7 with 1 N Sodium Hydroxide. Measure the amount to be added on a separate sample aliquot, then add the same amount to the sample that is tested. Correct the test result for the dilution from the volume addition.
Alkalinity	More than 250 mg/L $CaCO_3$. The full color may not develop or the color may fade instantly. Adjust to pH 6–7 with 1 N Sulfuric Acid. Measure the amount to add on a separate sample aliquot, then add the same amount to the sample that is tested. Correct the test result for the dilution from the volume addition.
Bromine, Br_2	Interferes at all levels
Chlorine Dioxide, ClO_2	Interferes at all levels
Chloramines, organic	May interfere
Hardness	No effect at less than 1000 mg/L as $CaCO_3$
Iodine, I_2	Interferes at all levels
Ozone	Interferes at all levels
Peroxides	May interfere
Highly buffered samples or extreme sample pH	Can prevent the correct pH adjustment (of the sample) by the reagents. Sample pretreatment may be necessary.

Replacement items

Note: *Product and Article numbers may vary for some selling regions. Contact the appropriate distributor or refer to the company website for contact information.*

Description	Unit	Item no.
DPD Total Chlorine Reagent Powder Pillows, 5 mL	100/pkg	1407699
Color disc, DPD chlorine, 0–3.4 mg/L	each	990200
Color comparator box	each	173200
Glass viewing tubes, 18 mm	6/pkg	173006
Stoppers for 18-mm glass tubes and AccuVac Ampuls	6/pkg	173106

Optional items

Description	Unit	Item no.
Water, deionized	500 mL	27249

Hardness, Total

Test preparation

⚠ CAUTION

Review the Safety Data Sheets (MSDS/SDS) for the chemicals that are used. Use the recommended personal protective equipment.

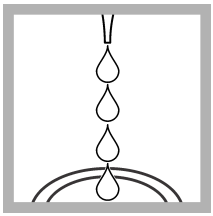
- Hold the dropper vertically above the sample. Do not let the dropper touch the bottle during the titration.
- To verify the test accuracy, use a standard solution as the sample.
- Rinse the flask with sample before the test. Rinse the flask with deionized water after the test.
- If the sample color is blue after the indicator is added, the water is soft.
- Hardness in boiler or cooling water can cause scale in the system and decrease the efficiency of the boiler or cooling tower.

Test procedure—Hardness (0–20 mg/L $CaCO_3$)

1. Fill the flask to the 100-mL mark with sample.

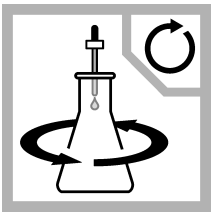
2. Add two full droppers of the Hardness 1 Buffer Solution.

3. Swirl to mix.

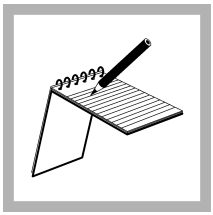


4. Add four drops of the Hardness 2 Indicator Solution. A pink color develops.

5. Swirl to mix.



6. Add the Hardness 3 Titrant Solution by drops. Swirl to mix after each drop. Count the drops until the color changes from pink to blue.



7. Record the number of drops. The number of drops of the titrant solution is the result in mg/L.

Replacement items

Note: *Product and Article numbers may vary for some selling regions. Contact the appropriate distributor or refer to the company website for contact information.*

Description	Unit	Item no.
Hardness 1 Buffer Solution	100 mL MDB	42432
Hardness 2 Indicator Solution	100 mL MDB	42532

Replacement items (continued)

Description	Unit	Item no.
Hardness 3 Titrant Solution	100 mL MDB	42632
Bottle, square, glass, 29 mL	6/pkg	43906
Flask, Erlenmeyer, 125 mL	each	50543

Optional items

Description	Unit	Item no.
Hardness standard solution, 5 mg/L as $CaCO_3$	1 L	2696353
Water, deionized	500 mL	27249

Iron

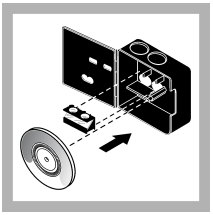
Test preparation

⚠ CAUTION

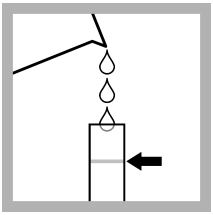
Review the Safety Data Sheets (MSDS/SDS) for the chemicals that are used. Use the recommended personal protective equipment.

- Put the color disc on the center pin in the color comparator box (numbers to the front).
- Use the color disc that is applicable to the test procedure range.
- Rinse the tubes with sample before the test. Rinse the tubes with deionized water after the test.
- This test is very sensitive to contamination. For best results, clean all glassware with 6.0 N (1:1) hydrochloric acid solution, then rinse fully with deionized water.
- If the sample is clear with no color or turbidity, prepare a reagent blank for best results. To prepare a reagent blank, fill the measuring vial to the 25-mL mark with deionized water. Add one TPTZ Iron Reagent Powder Pillow. Swirl immediately to mix. Pour the solution into a clean viewing tube to the line that is shown in step 2 of the test procedure. Continue the test procedure with step 3.
- If the pH is less than 3 or more than 4 after the reagent is added to the sample, the color may not fully develop, may fade quickly or turbidity may develop. Adjust the sample pH to 3–8 before the addition of reagent with iron-free acid or base such as 1.0 N Sulfuric Acid Standard Solution or 1.0 N Sodium Hydroxide Standard Solution.
- The long-path adapter for the low range test shows the color in the tubes from top to bottom. Make sure the light source is above the tubes during the color match.
- If the color match is between two segments, use the value that is in the middle of the two segments.
- If the color disc becomes wet internally, pull apart the flat plastic sides to open the color disc. Remove the thin inner disc. Dry all parts with a soft cloth. Assemble when fully dry.
- To verify the test accuracy, use a standard solution as the sample.
- The reagent contains a reducing agent that changes precipitated or suspended iron, such as rust, to ferrous iron (Fe^{2+}). The indicator in the reagent forms a blue color with ferrous iron.
- Copper, cobalt, chromium or mercury in the sample cause an interference that gives high results, but the effect is small.

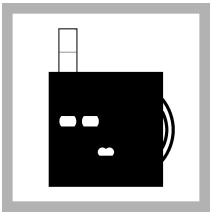
Test procedure—Iron (0–0.2 mg/L Fe)



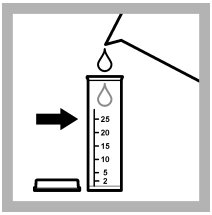
1. Install the long-path adapter in the color comparator box.



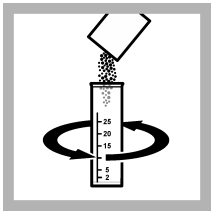
2. Fill a tube to the top line with sample.



3. Put the tube into the left opening of the color comparator box.

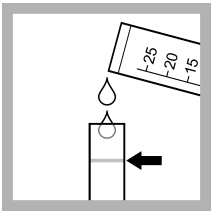


4. Fill the vial to the 25-mL mark with sample.

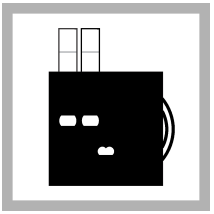


5. Add one TPTZ Iron Reagent Powder Pillow. Immediately swirl to mix.

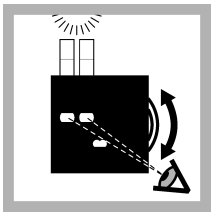
6. Wait 3 minutes. A blue color develops.



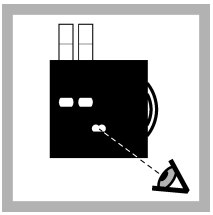
7. Fill a second tube to the top line with the prepared sample.



8. Put the second tube into the color comparator box.

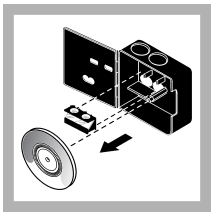


9. Hold the color comparator box below a light source. Turn the color disc to find the color match.

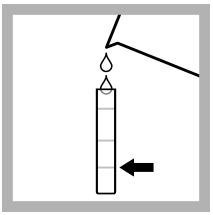


10. Read the result in mg/L in the scale window.

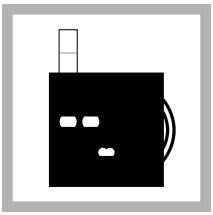
Test procedure—Iron (0–2 mg/L Fe)



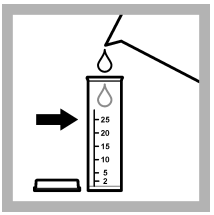
1. If installed, remove the long-path adapter.



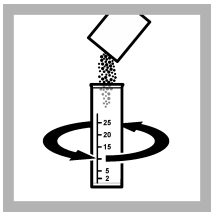
2. Fill a tube to the first line (5 mL) with sample.



3. Put the tube into the left opening of the color comparator box.

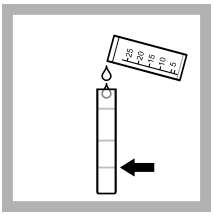


4. Fill the vial to the 25-mL mark with sample.

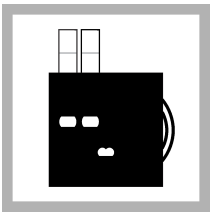


5. Add one TPTZ Iron Reagent Powder Pillow. Immediately swirl to mix.

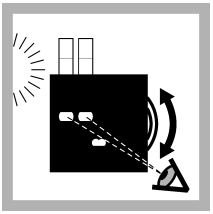
6. Wait 3 minutes. A blue color develops.



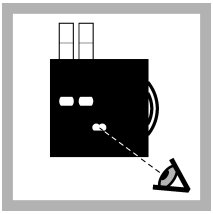
7. Fill a second tube to the first line (5 mL) with the prepared sample.



8. Put the second tube into the color comparator box.



9. Hold the color comparator box in front of a light source. Turn the color disc to find the color match.



10. Read the result in mg/L in the scale window.

Replacement items

Note: *Product and Article numbers may vary for some selling regions. Contact the appropriate distributor or refer to the company website for contact information.*

Description	Unit	Item no.
TPTZ Iron Reagent Powder Pillows, 25 mL	100/pkg	2275699
Color disc, iron, TPTZ, 0–0.2 mg/L	each	9265400
Color disc, iron, TPTZ, 0–2.0 mg/L	each	9264300
Color comparator box	each	173200
Long-path adapter	each	2412200
Glass viewing tubes, 18 mm	6/pkg	173006
Stoppers for 18-mm glass tubes and AccuVac Ampuls	6/pkg	173106
Vial, graduated to 2, 5, 10, 15, 20 and 25 mL	each	219300

Optional items

Description	Unit	Item no.
Hydrochloric acid standard solution, 6.0 N (1:1)	500 mL	88449
Iron standard solution, 1 mg/L Fe	500 mL	13949
Sodium hydroxide standard solution, 1.0 N	100 mL MDB	104532
Sulfuric acid standard solution, 1.0 N	100 mL MDB	127032
Water, deionized	500 mL	27249

pH

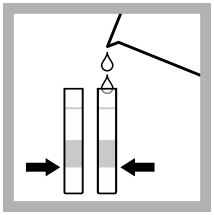
Test preparation

⚠ CAUTION

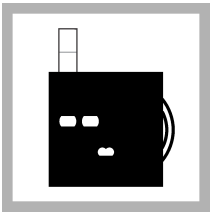
Review the Safety Data Sheets (MSDS/SDS) for the chemicals that are used. Use the recommended personal protective equipment.

- Put the color disc on the center pin in the color comparator box (numbers to the front).
- Use sunlight or a lamp as a light source to find the color match with the color comparator box.
- Rinse the tubes with sample before the test. Rinse the tubes with deionized water after the test.
- If the color match is between two segments, use the value that is in the middle of the two segments.
- If the color disc becomes wet internally, pull apart the flat plastic sides to open the color disc. Remove the thin inner disc. Dry all parts with a soft cloth. Assemble when fully dry.
- To verify the test accuracy, use a buffer solution as the sample.
- More than 1 mg/L chlorine interferes with the test. To remove chlorine from the sample, add 1 drop of 0.1 N sodium thiosulfate solution to 25 mL of sample and mix. Use this dechlorinated sample in the test procedure. The sodium thiosulfate removes a maximum of 10 mg/L chlorine from the sample.
- The bromthymol blue test procedure, with a range of 5.6 to 8.4 pH units, gives the most accurate results in the 6.0–8.0 pH units range. For accurate results above this range, use the thymol blue test procedure, which has a range of 7.4 to 9.6 pH units.

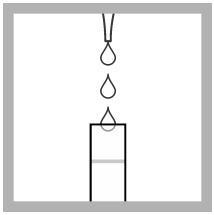
Test procedure—pH (5.6–8.4 pH units)



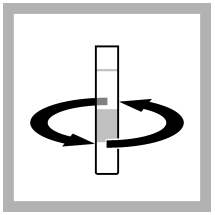
1. Fill two tubes to the first line (5 mL) with sample.



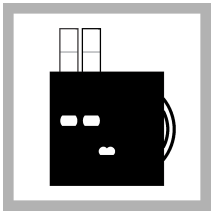
2. Put one tube into the left opening of the color comparator box.



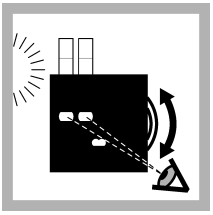
3. Add 8 drops of bromthymol blue pH indicator solution to the second tube.



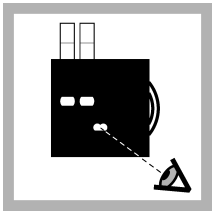
4. Swirl to mix.



5. Put the second tube into the color comparator box.

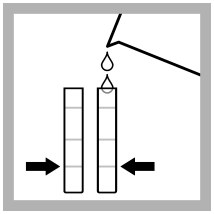


6. Hold the color comparator box in front of a light source. Turn the color disc to find the color match.

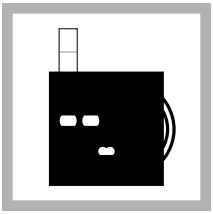


7. Read the result in pH units in the scale window.

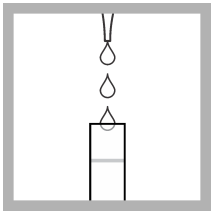
Test procedure—pH (7.4–9.6 pH units)



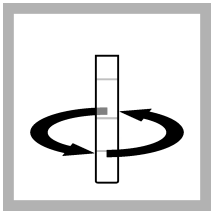
1. Fill two tubes to the first line (5 mL) with sample.



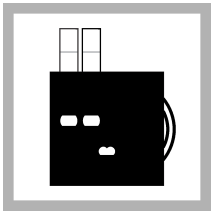
2. Put one tube into the left opening of the color comparator box.



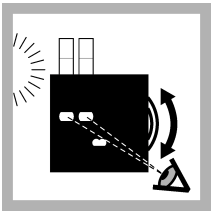
3. Add 6 drops of thymol blue pH indicator solution to the second tube.



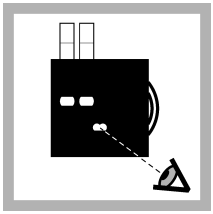
4. Swirl to mix.



5. Put the second tube into the color comparator box.



6. Hold the color comparator box in front of a light source. Turn the color disc to find the color match.



7. Read the result in pH units in the scale window.

Replacement items

Note: *Product and Article numbers may vary for some selling regions. Contact the appropriate distributor or refer to the company website for contact information.*

Description	Unit	Item no.
Bromthymol blue pH indicator solution	100 mL MDB	25532
Thymol blue pH indicator solution	100 mL MDB	25732
Color disc, pH, bromthymol blue, 5.6–8.4 pH units	each	9261200
Color disc, pH, thymol blue, 7.4–9.6 pH units	each	9263500
Color comparator box	each	173200
Plastic viewing tubes, 18 mm, with caps	4/pkg	4660004

Optional items

Description	Unit	Item no.
pH 7.0 buffer solution, colorless	500 mL	1222249
Buffer Powder Pillows, pH 9.00 (NIST), colorless	50/pkg	1410766
Caps for plastic viewing tubes (4660004)	4/pkg	4660014

Optional items (continued)

Description	Unit	Item no.
Sodium thiosulfate, 0.1 N	100 mL MDB	32332
Water, deionized	500 mL	27249

Phosphate

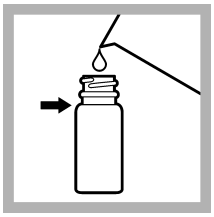
Test preparation

⚠ CAUTION

Review the Safety Data Sheets (MSDS/SDS) for the chemicals that are used. Use the recommended personal protective equipment.

- Put the color disc on the center pin in the color comparator box (numbers to the front).
- Use sunlight or a lamp as a light source to find the color match with the color comparator box.
- Rinse the tubes with sample before the test. Rinse the tubes with deionized water after the test.
- For best results, clean the tubes and bottles with 6.0 N (1:1) hydrochloric acid solution, then rinse with deionized water.
- If the color match is between two segments, use the value that is in the middle of the two segments.
- If the color disc becomes wet internally, pull apart the flat plastic sides to open the color disc. Remove the thin inner disc. Dry all parts with a soft cloth. Assemble when fully dry.
- Undissolved reagent does not have an effect on test accuracy.
- To verify the test accuracy, use a standard solution as the sample.
- Use the filtration procedure for samples that contain turbidity.
- To determine metaphosphate, use the digestion procedure to determine the total inorganic phosphate. Subtract the result of an orthophosphate test (without digestion) from the total inorganic phosphate result.
- To record the test result as mg/L P, divide the mg/L PO_4 test result by 3.

Filtration procedure for turbid samples

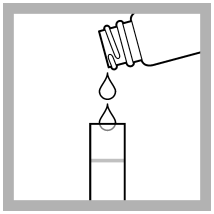


1. Fill a bottle to the shoulder with sample.

2. Add one drop of Filtration Aid Solution. Swirl to mix.

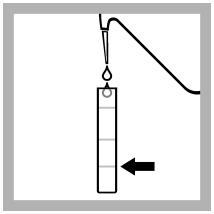
3. Put the filter paper in the funnel. Put the funnel on a second bottle.

4. Pour the sample from the first bottle into the funnel.

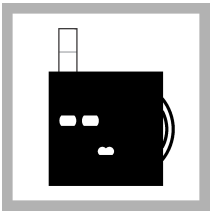


5. Use the filtered sample in the test procedure. Record the results as soluble phosphate.

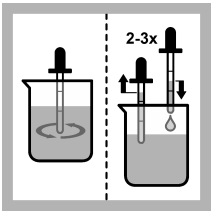
Test procedure—Orthophosphate (0–40 mg/L PO_4)



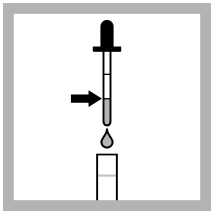
1. Fill a tube to the first line (5 mL) with deionized water.



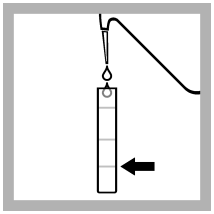
2. Put the tube into the left opening of the color comparator box.



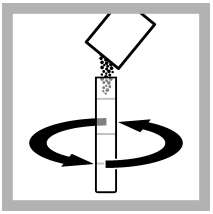
3. Fully rinse the dropper with the sample.



4. Use the dropper to add 0.5-mL of sample to a second tube.

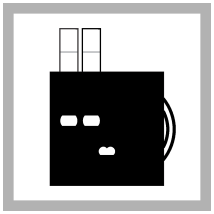


5. Add deionized water to the first line (5 mL) on the second tube.

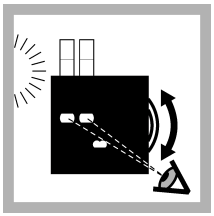


6. Add one PhosVer 3 Phosphate Reagent Powder Pillow to the second tube. Swirl to mix.

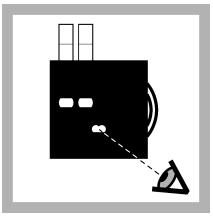
7. Wait 1 minute. Read the result within 5 minutes. A blue color develops.



8. Put the second tube into the color comparator box.

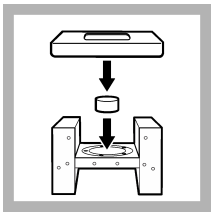


9. Hold the color comparator box in front of a light source. Turn the color disc to find the color match.

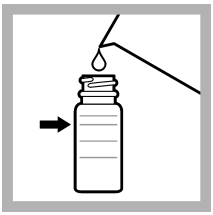


10. Read the result in mg/L in the scale window.

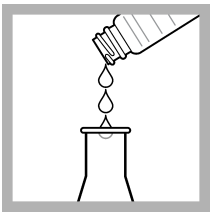
Digestion procedure for total inorganic phosphate



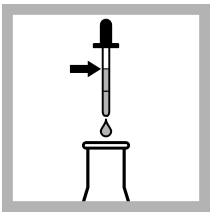
1. Assemble the heating apparatus.



2. Fill the bottle to the 20-mL mark with sample.

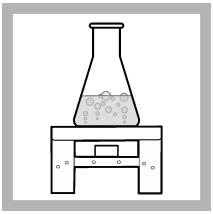


3. Pour the sample into a clean 50-mL Erlenmeyer flask.



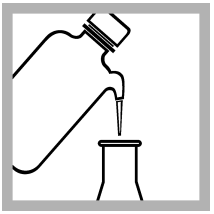
4. Use the dropper to add 2.0 mL of 5.25 N sulfuric acid.

5. Swirl to mix.

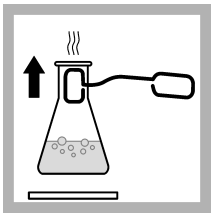


6. Put the flask on the heating apparatus.

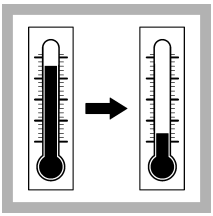
7. Boil the solution for 10 minutes.



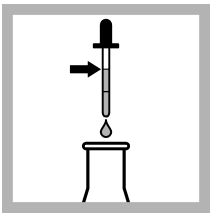
8. Add some deionized water during the boil time, if necessary, to keep some solution in the flask.



9. Use the clamp to remove the flask.

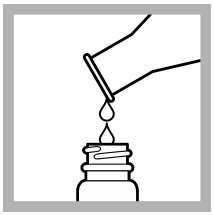


10. Wait until the solution is cool.

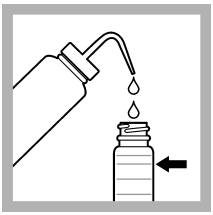


11. Use the dropper to add 2.0 mL of 5 N sodium hydroxide.

12. Swirl to mix.

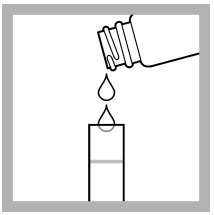


13. Pour the solution into the bottle.



14. Add deionized water to the 20-mL mark.

15. Swirl to mix.



16. Use the digested sample in the test procedure. The result is total inorganic phosphate.

Replacement items

Note: *Product and Article numbers may vary for some selling regions. Contact the appropriate distributor or refer to the company website for contact information.*

Description	Unit	Item no.
PhosVer® 3 Phosphate Reagent Powder Pillows, 5 mL	100/pkg	220999
Bottle, square, 29 mL, with 10, 15, 20 and 23-mL marks	6/pkg	232706
Clamp, test tube holder	each	63400
Color comparator box	each	173200
Color disc, phosphate, 0–40 mg/L	each	9262100
Cookit stove with Heatab fuel tablets	each	220600
Cookit support cover	each	217900
Dropper, glass, 0.5- and 1.0-mL marks	5/pkg	1419705
Dropper assembly, 0.5 & 1.0 mL	6/pkg	2318506
Flask, Erlenmeyer, 50 mL	each	50541
Glass viewing tubes, 18 mm	6/pkg	173006
Heatab dry fuel tablets for Cookit stove	21/pkg	220700
Sodium hydroxide standard solution, 5.0 N	100 mL MDB	245032
Stoppers for 18-mm glass tubes and AccuVac Ampuls	6/pkg	173106
Sulfuric acid standard solution, 5.25 N	100 mL MDB	244932

Optional items

Description	Unit	Item no.
Boiling chips, carbon	227 g	1483531
Caps for plastic viewing tubes (4660004)	4/pkg	4660014
Filter paper, 2–3 micron, pleated, 12.5 cm	100/pkg	189457
Filtration aid solution, 29-mL dropper bottle	29 mL	104633
Funnel, poly, 65 mm	each	108367
Hydrochloric acid standard solution, 6.0 N (1:1)	500 mL	88449
Phosphate standard solution, 30 mg/L as PO_4 (NIST)	946 mL	1436716
Water, deionized	500 mL	27249

Silica

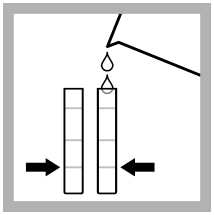
Test preparation

⚠ CAUTION

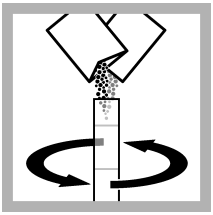
Review the Safety Data Sheets (MSDS/SDS) for the chemicals that are used. Use the recommended personal protective equipment.

- Put the color disc on the center pin in the color comparator box (numbers to the front).
- Use sunlight or a lamp as a light source to find the color match with the color comparator box.
- Rinse the tubes with sample before the test. Rinse the tubes with deionized water after the test.
- If the color match is between two segments, use the value that is in the middle of the two segments.
- If the color disc becomes wet internally, pull apart the flat plastic sides to open the color disc. Remove the thin inner disc. Dry all parts with a soft cloth. Assemble when fully dry.
- Undissolved reagent does not have an effect on test accuracy.
- To verify the test accuracy, use a standard solution as the sample.
- The sample temperature must be 15–25 °C (59–77 °F) for accurate results.
- Phosphate levels of more than 50 mg/L PO_4^{3-} interfere with the 0–30 mg/L test procedure. If 60 mg/L PO_4^{3-} is in the sample, the error is –2% silica . If 75 mg/L PO_4^{3-} is in the sample, the error is –11% silica . Use the high range test procedure if high levels of phosphate are in the sample.

Test procedure—Silica (0–30 mg/L SiO_2)

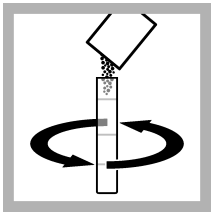


1. Fill two tubes to the first line (5 mL) with sample.



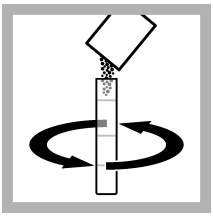
2. Add one Acid Reagent Powder Pillow and one Molybdate Reagent Powder Pillow to one tube. Swirl to mix.

3. Wait 10 minutes. A yellow color develops if silica or phosphate is in the sample.



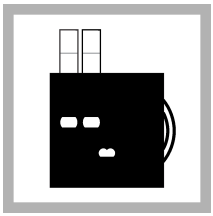
4. Add one Citric Acid Powder Pillow to the same tube. Swirl to mix.

5. Wait 2 minutes. Interference from phosphate is removed.

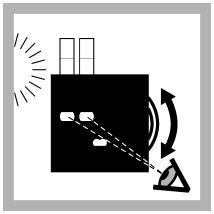


6. Add one Silica 3 Reagent Powder Pillow to the same tube. Swirl to mix.

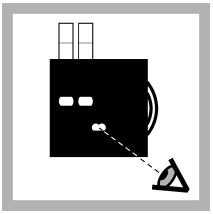
7. Wait 5 minutes. A blue color develops if silica is in the sample.



8. Put the blank tube into the left opening of the color comparator box. Put the prepared sample tube into the color comparator box.



9. Hold the color comparator box in front of a light source. Turn the color disc to find the color match.

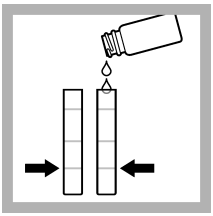


10. Read the result in mg/L in the scale window.

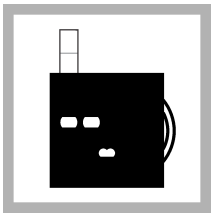
Test procedure—Silica (0–300 mg/L SiO_2)

1. Use the dropper to add 1 mL of sample to the bottle.

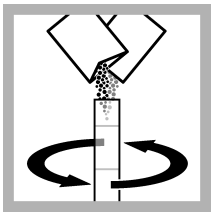
2. Fill the bottle to the 10-mL mark with deionized water. Swirl to mix.



3. Fill two tubes to the first line (5 mL) with the diluted sample.

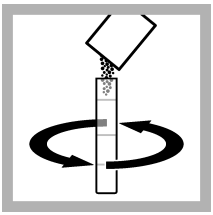


4. Put one tube into the left opening of the color comparator box.



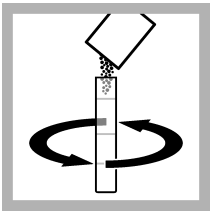
5. Add one Acid Reagent Powder Pillow and one Molybdate Reagent Powder Pillow to the second tube. Swirl to mix.

6. Wait 10 minutes. A yellow color develops if silica or phosphate is in the sample.



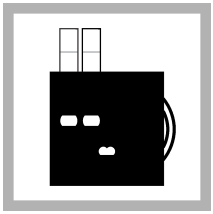
7. Add one Citric Acid Powder Pillow to the same tube. Swirl to mix.

8. Wait 2 minutes. Interference from phosphate is removed.

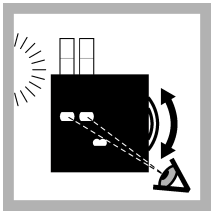


9. Add one Silica 3 Reagent Powder Pillow to the same tube. Swirl to mix.

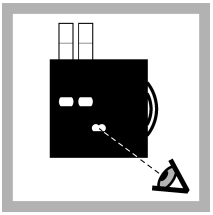
10. Wait 5 minutes. A blue color develops.



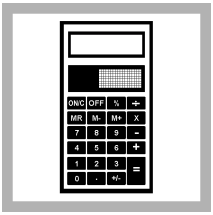
11. Put the second tube into the color comparator box.



12. Hold the color comparator box in front of a light source. Turn the color disc to find the color match.



13. Read the value in the scale window.



14. Multiply the value by 10 to get the result in mg/L.

Replacement items

Note: *Product and Article numbers may vary for some selling regions. Contact the appropriate distributor or refer to the company website for contact information.*

Description	Unit	Item no.
Acid Reagent Powder Pillows, 5 mL	100/pkg	1454599
Citric Acid Powder Pillows, 5 mL	100/pkg	1454999
Molybdate Reagent Powder Pillows, 5 mL	100/pkg	1454699
Silica 3 Reagent Powder Pillows	100/pkg	27169
Bottle, square, 29 mL, with 10, 15, 20 and 23-mL marks	6/pkg	232706
Color disc, silica, 0–30 mg/L	each	9262000
Color comparator box	each	173200
Dropper, glass, 0.5- and 1.0-mL marks	5/pkg	1419705
Glass viewing tubes, 18 mm	6/pkg	173006
Stoppers for 18-mm glass tubes and AccuVac Ampuls	6/pkg	173106

Optional items

Description	Unit	Item no.
Silica standard solution, 10 mg/L as SiO_2 (NIST)	500 mL	140349
Water, deionized	500 mL	27249

Sulfite

Test preparation

⚠ CAUTION

Review the Safety Data Sheets (MSDS/SDS) for the chemicals that are used. Use the recommended personal protective equipment.

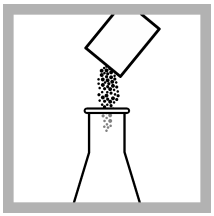
- Hold the dropper vertically above the sample. Do not let the dropper touch the bottle during the titration.
- Rinse the measuring tube, bottle or flask with sample before each test. Rinse with deionized water after each test.
- To verify the test accuracy, use a standard solution as the sample.
- To record the test result as mg/L SO_3, multiply the mg/L Na_2SO_3 test result by 0.64.

Test procedure—Sulfite (0–20 mg/L Na_2SO_3)

1. Fill the flask to the 100-mL mark with sample.

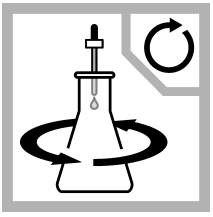
2. Add one Sulfite 1 Reagent Powder Pillow.

3. Swirl to mix.

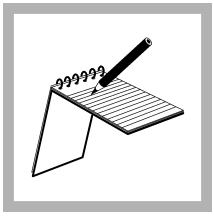


4. Add one Sulfamic Acid Reagent Powder Pillow.

5. Swirl to mix.



6. Add the Sulfite 3 Reagent by drops. Mix after each drop. Count the drops until the color changes to grey-blue.



7. Record the number of drops. The number of drops of the titrant solution is equal to the result in mg/L.

Test procedure—Sulfite (0–200 mg/L Na_2SO_3)

1. Fill the bottle to the 10-mL mark with sample.

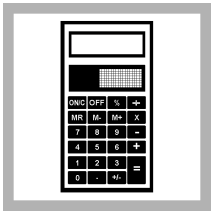
2. Add one Sulfite 1 Reagent Powder Pillow.

3. Turn the bottle left and right to mix.

4. Add one Sulfamic Acid Reagent Powder Pillow.

5. Turn the bottle left and right to mix.

6. Add the Sulfite 3 Reagent by drops. Mix after each drop. Count the drops until the color changes to grey-blue.



7. Multiply the total number of drops by 10 to get the result in mg/L.

Interferences—Sulfite test

Table 3 shows the substances that can interfere with this test.

Table 3 Interferences

Interfering substance	Interference level
Metals	Some metals, especially copper, catalyze the oxidation of sulfite to sulfate. Immediately add one Sulfamic Acid Powder Pillow or one Dissolved Oxygen 3 Powder Pillow for each liter of sample during sample collection to prevent the interference.
Nitrite	Reacts with sulfite and causes low results.
Organic compounds	Oxidizable organic compounds can cause high results.
Oxidizable compounds	Cause high results.
Sulfide	Causes high results.

Replacement items

Note: *Product and Article numbers may vary for some selling regions. Contact the appropriate distributor or refer to the company website for contact information.*

Description	Unit	Item no.
Sulfite 1 Reagent Powder Pillows	100/pkg	220399
Sulfamic Acid Powder Pillows	100/pkg	105599
Sulfite 3 Reagent	100 mL MDB	70532

Replacement items (continued)

Description	Unit	Item no.
Bottle, square, 29 mL, with 10, 15, 20 and 23-mL marks	6/pkg	232706
Flask, Erlenmeyer, 125 mL	each	50543

Optional items

Description	Unit	Item no.
Demineralizer bottle, 473-mL capacity	each	2184600
Sulfite standard solution (equivalent), 15 mg/L as SO_3 (23.4 mg/L as Na_2SO_3)	500 mL	2408449
Water, deionized	500 mL	27249

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