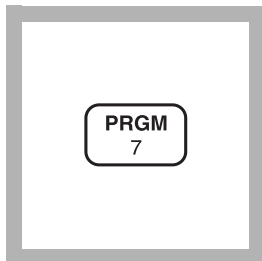


**ALUMINUM (0 to 0.80 mg/L)****For water and wastewater****Aluminon Method\***

**1.** Enter the stored program number for aluminum (Al).

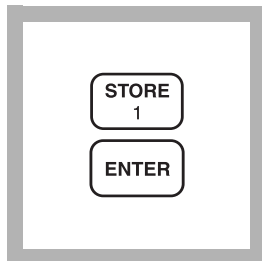
Press: **PRGM**

The display will show:

**PRGM ?**

*Note:* Adjust the pH of stored samples before analysis.

*Note:* For most accurate results, perform a Reagent Blank Correction using deionized water (see Section 1).

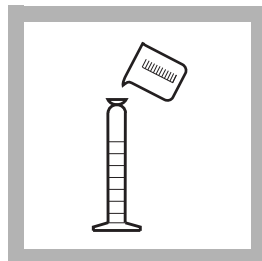


**2.** Press: **1 ENTER**

The display will show **mg/L, Al** and the **ZERO** icon.

*Note:* Total aluminum determination requires a digestion prior to analysis (see Section 2).

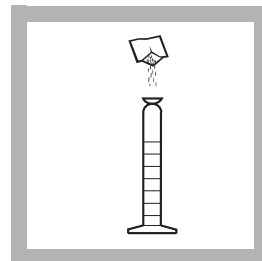
*Note:* For alternate form ( $Al_2O_3$ ), press **CONC**.



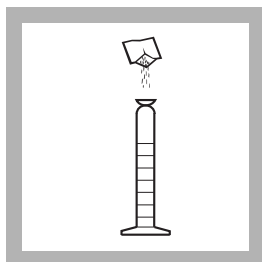
**3.** Fill a 50-mL graduated mixing cylinder to the 50-mL mark with sample.

*Note:* Rinse cylinder with 1:1 Hydrochloric Acid and deionized water before use to avoid errors due to contaminants absorbed on the glass.

*Note:* Sample temperature must be 20-25 °C (68-77 °F) for accurate results.



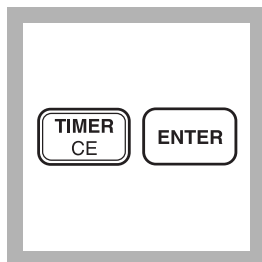
**4.** Add the contents of one Ascorbic Acid Powder Pillow. Stopper. Invert several times to dissolve powder.



**5.** Add the contents of one AluVer® 3 Aluminum Reagent Powder Pillow. Stopper.

*Note:* A red-orange color develops if aluminum is present.

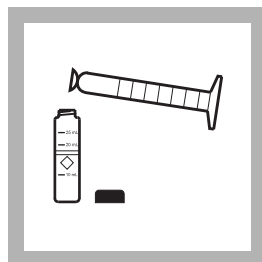
*Note:* Inconsistent results will occur if any powder is undissolved.



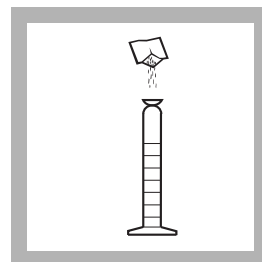
**6.** Press:

**TIMER ENTER**

A three-minute reaction period will begin. Invert the cylinder repeatedly for the three minutes.



**7.** Pour 25 mL of mixture into a 25-mL sample cell (the prepared sample).



**8.** Add the contents of one Bleaching 3 Reagent Powder Pillow to the remaining 25 mL in the mixing graduated cylinder (the blank). Stopper the cylinder.

\* Adapted from *Standard Methods for the Examination of Water and Wastewater*

## ALUMINUM, continued

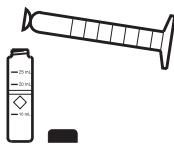


9. The display will show: **00:30 Timer 2**

Press: **ENTER**

A thirty-second reaction period will begin. Vigorously shake the cylinder for the 30-second period.

*Note: This solution should turn a light to medium orange upon bleaching. It will not become colorless.*



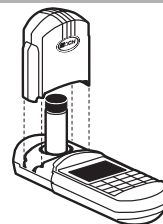
10. Pour the 25 mL of mixture in the cylinder into a second 25-mL sample cell (the blank).



11. The display will show: **15:00 TIMER 3**

Press: **ENTER**

A 15-minute reaction period will begin.



12. Within three minutes after the timer beeps, place the blank into the cell holder. Tightly cover the sample cell with the instrument cap.

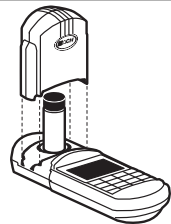


13. Press: **ZERO**

The cursor will move to the right, then the display will show:

**0.000 mg/L Al**

*Note: If Reagent Blank Correction is on, the display may flash "limit". See Section 1.*



14. Immediately place the prepared sample into the cell holder. Tightly cover the sample cell with the instrument cap.



15. Press: **READ**

The cursor will move to the right, then the result in mg/L aluminum will be displayed.

*Note: Clean the graduated cylinder and sample cells with soap and brush immediately following the test.*

*Note: Standard Adjust may be performed using a prepared standard (see Section 1).*

# ALUMINUM, continued

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## Sampling and Storage

Collect samples in a clean glass or plastic container. Preserve the sample by adjusting the pH to 2 or less with nitric acid (about 1.5 mL per liter). Preserved samples can be stored up to six months at room temperature. Before analysis, adjust the pH to 3.5–4.5 with 5.0 N Sodium Hydroxide. Correct the test result for volume additions; see *Correcting for Volume Additions* in *Section 1* for more information.

## Accuracy Check

### Standard Additions Method

- a) Snap the neck off an Aluminum Voluette Ampule Standard Solution, 50 mg/L as Al.
- b) Use the TenSette Pipet to add 0.1 mL, 0.2 mL, and 0.3 mL of standard, respectively, to three 50-mL samples. Swirl gently to mix. Also prepare a sample without any standard added (the unspiked sample).
- c) Analyze each sample as described above. The aluminum concentration should increase 0.1 mg/L for each 0.1 mL of standard added.
- d) If these increases do not occur, see *Standard Additions (Section 1)* for more information.

### Standard Solution Method

Prepare a 0.40-mg/L aluminum standard solution by pipetting 1.00 mL of Aluminum Standard Solution, 100 mg/L as  $\text{Al}^{3+}$ , into a 250-mL volumetric flask. Dilute to the mark with deionized water. Prepare this solution immediately before use. Perform the aluminum procedure as described above. The mg/L Al reading should be 0.40 mg/L Al.

Or, using the TenSette Pipet, add 0.8 mL of solution from an Aluminum Voluette Ampule Standard Solution (50 mg/L as Al) into a 100-mL volumetric flask. Dilute to volume with deionized water. Prepare this standard immediately before testing and use as the sample.

## Method Performance

### Precision

In a single laboratory, using a standard solution of 0.40 mg/L Al and two representative lots of reagent with the instrument, a single operator obtained a standard deviation of  $\pm 0.013$  mg/L Al.

## ALUMINUM, continued

### Estimated Detection Limit

The estimated detection limit for program #1 is 0.013 mg/L Al. For more information on the estimated detection limit, see *Section 1*.

### Interferences

Interfering Substance	Interference Levels and Treatments
Acidity	Acidity interferes at greater than 300 mg/L as CaCO <sub>3</sub> . Treat samples with greater than 300 mg/L acidity as CaCO <sub>3</sub> as follows: <ol style="list-style-type: none"><li>1. Add one drop of m-Nitrophenol Indicator Solution to the sample taken in Step 3.</li><li>2. Add one drop of 5.0 N Sodium Hydroxide Standard Solution. Stopper the cylinder. Invert to mix. Repeat as often as necessary until the color changes from colorless to yellow.</li><li>3. Add one drop of 5.25 N Sulfuric Acid Standard Solution to change the solution from yellow back to colorless. Continue with the test.</li></ol>
Alkalinity	1000 mg/L as CaCO <sub>3</sub> . Eliminate interferences from higher alkalinity concentrations using the following pretreatment: <ol style="list-style-type: none"><li>1. Add one drop of m-Nitrophenol Indicator Solution to the sample taken in Step 3. A yellow color indicates excessive alkalinity.</li><li>2. Add one drop of 5.25 N Sulfuric Acid Standard Solution. Stopper the cylinder. Invert to mix. If the yellow color persists, repeat until the sample becomes colorless. Continue with the test.</li></ol>
Calcium	Does not interfere.
Fluoride	Interferes at all levels. See graph below.
Iron	Greater than 20 mg/L.
Phosphate	Greater than 50 mg/L.
Polyphosphate	Polyphosphate interferes at all levels by causing negative errors and must not be present. Before running the test, polyphosphate must be converted to orthophosphate by acid hydrolysis as described under the phosphorus procedures.

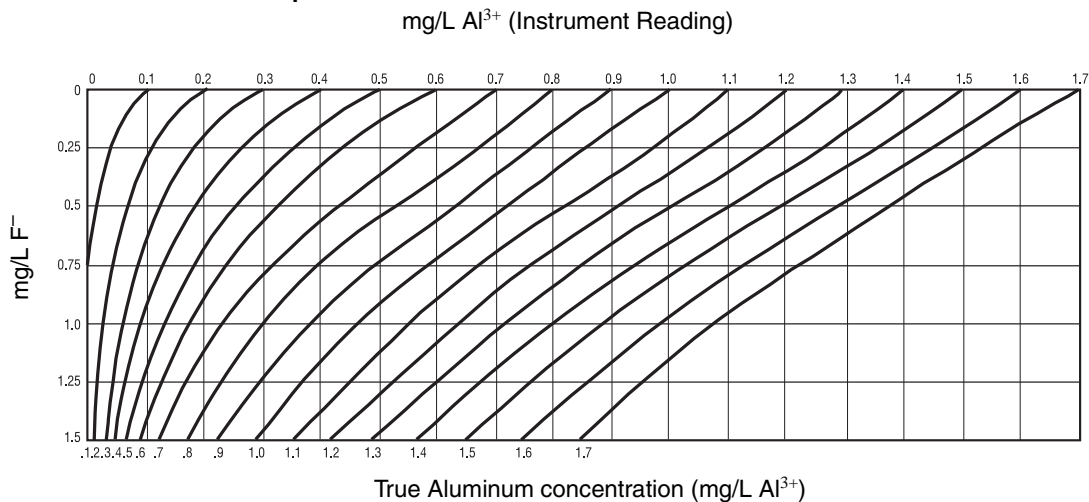
Fluoride interferes at all levels by complexing with aluminum. The actual aluminum concentration can be determined using the Fluoride Interference Graph when the fluoride concentration is known. To use the fluoride interference graph:

## ALUMINUM, continued

1. Select the vertical grid line along the top of the graph that represents the aluminum reading obtained in Step 15.
2. Locate the point of the vertical line (instrument reading) where it intersects with the horizontal grid line that indicates how much fluoride is present in the sample.
3. Extrapolate the true aluminum concentration by following the curved lines on either side of the intersect point down to the true aluminum concentration.

For example, if the aluminum test result was 0.7 mg/L  $\text{Al}^{3+}$  and the fluoride present in the sample was 1.0 mg/L  $\text{F}^-$ , the point where the 0.7 grid line intersects with the 1.0 mg/L  $\text{F}^-$  grid line falls between the 1.2 and 1.3 mg/L Al curves. In this case, the true aluminum content would be 1.27 mg/L.

### Fluoride Interference Graph



### Summary of Method

Aluminon indicator combines with aluminum in the sample to form a red-orange color. The intensity of color is proportional to the aluminum concentration. Ascorbic acid is added to remove iron interference. The AluVer 3 Aluminum Reagent, packaged in powder form shows exceptional stability and is applicable for fresh water samples.

# ALUMINUM, continued

## REQUIRED REAGENTS

Aluminum Reagent Set (100 Tests).....			<b>Cat. No.</b>
			22420-00
Includes: (1) 14290-99, (1) 14577-99, (1) 14294-49			

Description	Quantity Required		Cat. No.
	Per Test	Unit	
AluVer 3 Aluminum Reagent Powder Pillow.....	1 pillow	100/pkg	14290-99
Ascorbic Acid Powder Pillow.....	1 pillow	100/pkg	14577-99
Bleaching 3 Reagent Powder Pillow .....	1 pillow	100/pkg	14294-49

## REQUIRED APPARATUS

Cylinders, graduated mixing, 50 mL .....	1	each	1896-41
Sample Cell, 10-20-25 mL, w/ cap.....	2	6/pkg	24019-06

## OPTIONAL REAGENTS

Aluminum Standard Solution, 100 mg/L.....	100 mL	14174-42
Aluminum Standard Solution, Voluette ampule, 50 mg/L as Al, 10 mL.....	16/pkg	14792-10
Hydrochloric Acid Solution, 6N (1:1) .....	500 mL	884-49
m-Nitrophenol Indicator Solution, 10 g/L .....	100 mL	2476-32
Nitric Acid, ACS.....	500 mL	152-49
Nitric Acid Solution, 1:1.....	500 mL	2540-49
Sodium Hydroxide Standard Solution, 5.0 N .....	100 mL MDB	2450-32
Sodium Hydroxide Standard Solution, 5.0 N .....	50 mL SCDB	2450-26
Sulfuric Acid Standard Solution, 5.25 N .....	100 mL MDB	2449-32
Water, deionized.....	4 L	272-56

## OPTIONAL APPARATUS

Ampule Breaker Kit.....	each	21968-00
Brush.....	each	690-00
Flask, volumetric, Class A, 100 mL .....	each	14574-42
Flask, volumetric, Class A, 250 mL .....	each	14574-46
Fluoride Combination Electrode.....	each	51928-00
Fluoride ISA Powder Pillows .....	25/pkg	2589-99
pH Indicator Paper, 1 to 11 pH .....	5 rolls/pkg	391-33
pH/ISE Meter, <i>sensio</i> <sup>TM</sup> 2, portable.....	each	51725-00
Pipet, TenSette, 0.1 to 1.0 mL.....	each	19700-01
Pipet Tips, for 19700-01 TenSette Pipet .....	50/pkg	21856-96
Pipet Tips, for 19700-01 TenSette Pipet .....	1000/pkg	21856-28
Pipet, Volumetric, Class A, 1.00 mL .....	each	14515-35
Thermometer, -20 to 110 °C, non-mercury .....	each	26357-02

### ***For Technical Assistance, Price and Ordering***

In the U.S.A.—Call 800-227-4224

Outside the U.S.A.—Contact the Hach office or distributor serving you.