

Standard range: 0.01 to 0.3 mg/L Al

Method

EZ2701



Test preparation

Before starting

Chemical exposure hazard. Obey laboratory safety procedures and wear all of the personal protective equipment appropriate to the chemicals that are handled. Refer to the current safety data sheets (MSDS/SDS) for safety protocols.

Review the Safety Data Sheets (MSDS/SDS) for the chemicals that are used. Use the recommended personal protective equipment. Dispose of chemicals and wastes in accordance with local, regional and national regulations.

Review the Safety Data Sheets (MSDS/SDS) before the bottles are filled or the reagents are prepared.

All chemicals must be of reagent grade, ACS grade or better¹. The use of pro-analysis chemicals is recommended. Use of reagents that are not of sufficient quality can have a negative effect on the analyzer performance.

All EZ analyzers are put through long tests with standard solutions, reagents and dilution water prepared with Type I water or better water as specified in ASTM D1193-91.

To get the specifications shown on the data sheet, method and reagents sheet and acceptance test reports, the same water quality (or better) must be used to prepare the standard solutions, reagents and dilution water.

In addition, prepare the standard solutions for an EZ analyzer with water that does not contain the parameter to be measured or interferences for the method.

When operating the device, always make sure to follow the reagent recommendations given in [Reagent consumption](#) on page 3.

For longer-term storage, keep the reagents in a cold and dark place. Do not keep reagents longer than recommended. If applicable, keep the reagents in a refrigerator during measurements. Refer to [Reagent consumption](#) on page 3 for the reagent temperature.

The manufacturer recommends to replace the reagents, stock and standard solution at 28-day intervals unless specified differently in the sections that follow. Do not mix used reagents with freshly prepared reagents. If reagents, standards or DI water in the containers are replaced, discard all of the container contents in accordance with local, regional and national regulations. Rinse out all of the containers and then fill each container with freshly prepared new reagent.

Specifications

Specifications are subject to change without notice.

Specification	Details
Analysis method	Pyrocatechol violet colorimetric method
Measurement wavelength	578 nm
Parameter	Long description: Aluminium, Total Short description (default): Al, Total Options: None
Unit	mg/L (default); ppm, ppb, µg/L
Precision	The precision value is found on the full-scale range for standard test solutions. Refer to Table 1 .
Cleaning	Automatic or manual; frequency is freely programmable

¹ Analytical Reagent (AR), Guaranteed Reagent (GR), UNIVAR, AnalalR, Premium Reagent (PR), ReagentCertified ACS reagent, ACS Plus reagent, puriss p.a. ACS reagent, ReagentPlus®, TraceCERT®, Suprapur®, Ultrapur®, or better are also possible.

Specification	Details
Calibration	Automatic or manual; 2-point, offset or slope; frequency is freely programmable Note: The manufacturer recommends that a calibration is done when the reagents are replaced.
Validation	Automatic or manual; frequency is freely programmable
Interferences	No significant interference from fluoride (F ⁻) and iron (Fe ³⁺) at concentrations <1 mg/L (standard range). Large quantities of color and turbidity interfere. Fats, oil, proteins, surfactants and tar interfere.

Table 1 Measuring ranges

Range code	Description	LOD (mg/L)	Range (mg/L)	Precision (%)	Cycle time (minutes)	
					Continuous	Default
C	50% of standard range	0.01	0.15	2	27	30
0	Standard range	0.01	0.3	2	27	30
V	Internal dispenser dilution (factor 5)	0.05	1.5	2	30	30
W	Internal dispenser dilution (factor 10)	0.1	3	2	30	30
X	Internal dispenser dilution (factor 25)	0.25	7.5	2	30	30

Summary of method

Summary

Aluminium in the water sample reacts with pyrocatechol violet at a pH of 6.0 (± 0.2) to form a strong orange-brown color (a blue color is only seen when the aluminium concentration is high). The absorbance is measured at a wavelength of 578 nm. The sample is first digested with heat and acid to make sure that all forms of aluminum are measured.

Analysis steps

The analyzer mixes the sample with acid in the digester vessel and heats the solution to 110 °C (230 °F) for 10 minutes (default digestion temperature and time). The undissolved and complexed forms of aluminum break apart into a reactive form. After digestion, the sample temperature is decreased until sufficiently cool.

The digested sample is then moved into the analysis vessel. The initial absorbance value is measured, which corrects for possible background color in the sample. The reagents are then added and a stir period starts.

After the stir period, the color is fully developed and the final absorbance value is measured. The analyzer uses the absorbance values and Beer's Law to calculate the concentration of aluminum in the sample.

Calibration

The calibration procedure measures the REF1 solution (Channel 9, REF1 valve) and the REF2 solution (Channel 10, REF2 valve).

Validation

The validation procedure measures the REF2 solution (Channel 10, REF2 valve).

Reagent consumption

[Table 2](#), [Table 3](#) and [Table 4](#) show the consumption rate of the reagents and calibration standards. Examine the consumption of the reagents after 28 days to adjust the quantities prepared. Refer to [Necessary reagents](#) on page 4 to collect the necessary items to prepare the reagents.

Table 2 Reagent consumption

Product information			Consumption			Recommendation		
Code	Label	Product	Each analysis	Per 28 days, rate of 1 analysis/30 minutes	Use life	Containers	Operation temperature	
Red	Reagent 1	Mixed reagent	~ 0.5 mL	~ 0.7 L	28 days	Plastic; 2.5 L	10 to 30 °C (50 to 86 °F)	
Blue	Reagent 2	Color	~ 0.5 mL	~ 0.7 L	28 days	Plastic; 2.5 L	10 to 30 °C (50 to 86 °F)	
Green	Reagent 3	Buffer	~ 2.0 mL	~ 2.7 L	28 days	Plastic; 5 L	10 to 30 °C (50 to 86 °F)	
Yellow	Reagent 4	Acid	~ 1.0 mL	~ 1.4 L	28 days	Plastic; 2.5 L	10 to 30 °C (50 to 86 °F)	

Table 3 Calibration standards

Product information		Consumption		Recommendation		
Label	Product	Per calibration	Use life	Containers		
REF1	REF1 standard	~ 0.2 L	28 days	Plastic, 1 L (align with recommendation)		
REF2	REF2 standard	~ 0.2 L	28 days	Plastic, 1 L (align with recommendation)		

Table 4 Calibration recommendations

Calibration	Time (minutes)		Recommended frequency	Solutions
	No dilution	With dilution		
Offset	81	91	—	REF1
2-point (recommended)	162	182	Reagent replacement (28 days)	REF1 and REF2

DI water consumption

The volumes shown in [Table 5](#) are an estimation of the consumption for rinse and dilution water based on a standard operating procedure as given in the specifications of the EZ analyzer.

Note: Rinse water volumes can increase because of the sample matrix.

Note: The range codes C, 0 are configured as default without the use of rinse and dilution water.

Table 5 DI water consumption

Range code	Rinse water Type I (mL/analysis)	Dilution water Type I (mL/analysis)	Total (mL/analysis)	Per 28 days, rate of 1 analysis each 30 minutes
C - 0 (no dilution)	—	—	—	—
V - W - X (with dilution)	63 mL	16 mL	79 mL	107 L

Rinse water

If the analyzer does a dilution, a deionized water rinse must be used. If no dilution is done, use the sample to rinse. If there is a filter panel in front of the analyzer, make sure that the rinse water also flows through the filter.

Necessary reagents

A reagent kit with mixing instructions is available that decreases the preparation time. Refer to [Table 6](#). The full list of reagents is shown in [Table 7](#). The product name, formula, molecular weight, CAS number and the necessary quantity to prepare 1 L of the reagents are given.

Table 6 Reagent kit for EZ2701: APPC2000KTO

Code	Label	Product	Quantity	Item no.
Red	Reagent 1	Mixed reagent	2 L (1x)	APPC1001-03A
		Ascorbic acid	100 g (1x)	APPC1001-03B
Blue	Reagent 2	Color	0.50 g (2x)	APPC1001-02A
		Deionized water	1 L (2x)	27253
Green	Reagent 3	Buffer	2 L (2x)	APPC1001-01
Yellow	Reagent 4	Nitric acid	2 L (1x)	APPC2000-04
—	Stock solution	100 mg/L Al	100 mL (1x) ²	1417442
—	Stock solution	10 mg/L Al	100 mL (1x)	2305842 ³

Table 7 Reagent list

Solutions	Products	Formula	MW (g/mol)	CAS number	For each 1 L solution
Reagent 1: Mixed reagent Code: Red	Nitric acid (65%)	HNO ₃	63.01	7697-37-2	10 mL
	Magnesium sulfate heptahydrate	MgSO ₄ * 7H ₂ O	246.47	10034-99-8	250 g
	Ascorbic acid	C ₆ H ₈ O ₆	176.12	50-81-7	50 g
	1,10-Phenanthroline monohydrate	C ₁₂ H ₈ N ₂ * H ₂ O	198.22	5144-89-8	2.5 g
	Aluminum standard solution 100 mg/L ⁴	—	—	—	5 mL
Reagent 2: Color Code: Blue	Pyrocatechol violet	C ₁₉ H ₁₄ O ₇ S	386.38	115-41-3	0.50 g
Reagent 3: Buffer Code: Green	Hexamethylenetetramine	C ₆ H ₁₂ N ₄	140.19	100-97-0	210 g
Reagent 4: Acid Code: Yellow	Nitric acid (65%)	HNO ₃	63.01	7697-37-2	6 mL
Stock solution	100 mg/L Al stock solution ⁴	—	—	—	Refer to Stock solution on page 6.
REF1 calibration standard	Deionized water (Type I or better)	—	—	—	—
REF2 calibration standard	100 mg/L Al stock solution ⁴	—	—	—	Refer to REF2 calibration standard on page 6.

² More than 100 mL stock solution is necessary to prepare the REF2 calibration standard for the highest range.

³ The 10 mg/L Al stock solution is not used with the EZ2701 Aluminum, Total Analyzer.

⁴ Hach 1417442

Table 7 Reagent list (continued)

Solutions	Products	Formula	MW (g/mol)	CAS number	For each 1 L solution
Validation standard (optional)	REF2 calibration standard	—	—	—	Refer to Validation standard on page 6.
Cleaning solution (optional)	Hydrochloric acid (36%)	HCl	36.46	7647-01-0	41.5 mL

Reagent preparation

As an alternative to the reagent kit, the user can prepare the reagents as follows. Refer to [Table 7](#) on page 4 to collect the applicable items. To calculate the correct reagent quantity, refer to [Reagent consumption](#) on page 3.

Make sure to discard the remaining solution from the analyzer bottles before new reagents are added.

Reagent 1: Mixed reagent

1. Add 700 mL of deionized water to a plastic beaker.
2. Slowly mix in 10 mL of concentrated nitric acid (HNO₃ 65%).
3. Add the items that follow and mix well after each addition:
 - 250 g magnesium sulfate heptahydrate (MgSO₄ * 7H₂O)
 - 50 g ascorbic acid (C₆H₈O₆)
 - 2.5 g 1,10-Phenanthroline monohydrate (C₁₂H₈N₂ * H₂O)
 - 5 mL 100-mg/L aluminum standard solution
4. Pour the solution into a 1000-mL volumetric flask.
5. Add deionized water to the mark.
6. Fully mix the solution.
7. Keep the solution in a plastic container.

Reagent 2: Color

1. Add 500 mL of deionized water to a plastic beaker.
2. Add 0.50 g of pyrocatechol violet (C₁₉H₁₄O₇S).
3. Mix until fully dissolved.
4. Pour the solution into a 1000-mL volumetric flask.
5. Add deionized water to the mark.
6. Fully mix the solution.
7. Keep the solution in a plastic container.

Reagent 3: Buffer

1. Add 800 mL of deionized water to a plastic beaker.
2. Add 210 g of hexamethylenetetramine (C₆H₁₂N₄).
3. Mix until fully dissolved.
4. Pour the solution into a 1000-mL volumetric flask.
5. Add deionized water to the mark.
6. Fully mix the solution.
- Note: The pH value of the buffer solution should be approximately 9.*
7. Keep the solution in a plastic container.

Reagent 4: Acid

1. Add 500 mL of deionized water to a beaker.
2. Slowly mix in 6 mL of nitric acid (HNO₃, 65%).
3. Pour the solution into a 1000-mL volumetric flask.
4. Add deionized water to the mark.
5. Fully mix the solution.

Calibration standards

Calibrations are completed with two standards: a REF1 calibration standard and a REF2 calibration standard. The REF2 calibration standard is a dilution of a stock solution.

Stock solution

Use a 100 mg/L as Al (NIST) standard solution for the stock solution. Refer to [Table 8](#).

Table 8 Prepared stock solution

Product	Brand	Product No.
Aluminium standard solution, 100 mg/L as Al (NIST), 100 mL	Hach	1417442

REF1 calibration standard

Use deionized water for the REF1 calibration standard.

REF2 calibration standard

Dilute the stock solution to prepare the REF2 calibration standard.

1. Use a pipet to add the applicable quantity (mL) of the stock solution into a 1000-mL volumetric flask. Refer to [Table 9](#).
2. Add deionized water to the mark.
3. Fully mix the solution.

Table 9 Calibration standard preparation

Range code	REF2 concentration (mg/L Al)	Quantity (mL) of stock solution
C	0.15	1.5
0	0.3	3
V	1.5	15
W	3.0	30
X	7.5	75

Validation standard

By default, the automatic validation procedure is not enabled. When enabled, the default validation standard is the REF2 calibration standard. For best results, use a different standard solution from a different source for the validation standard. The concentration of the validation standard must be within the measuring range of the analyzer.

Before validation, connect the REF2 sample line to the validation standard. After validation, connect the REF2 sample line to the REF2 calibration standard again. For multi-channel setups, a different channel can be used.

Cleaning solution

By default, the automatic cleaning procedure is not enabled. When enabled, the default volume of cleaning solution that is used during each cleaning cycle is 30 mL.

The cleaning procedure must prevent the collection of chemicals in the analyzer. For an accurate cleaning procedure, examine the cleaning solution and the cleaning interval for each application. Make sure that the cleaning procedure is sufficient. Change the cleaning procedure if necessary.

The manufacturer recommends to use a 0.5 M hydrochloric acid (HCl) solution. Refer to [Reagent consumption](#) on page 3. Prepare the solution as given in the steps that follow or use a commercially available solution.

1. Add 500 mL of deionized water to a beaker.
2. Slowly mix in 41.5 mL of concentrated hydrochloric acid (HCl, 37%).
3. Pour the solution into a 1000-mL volumetric flask.
4. Add deionized water to the mark.
5. Fully mix the solution.



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