EZ1036 Sulfate Analyzer

DOC313.53.94186

Standard range: 5 to 40 mg/L SO_4

Method EZ1036

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 better[1]. 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	Barium chloride precipitation colorimetric method
Measurement wavelength	450 nm
Parameter	Long description: Sulfate Short description (default): SO_4 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, AnalaR, 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	Other metals that form complexes with EDTA interfere. Silica (SiO_2) > 500 mg/L, organic matter in water. Suspended or colloidal organic matter also can interfere with the endpoint. 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
0	**Standard range**	**5**	**40**	**2**	**10**	**10**
V	internal dispenser dilution (factor 5)	25	200	2	13	15
W	internal dispenser dilution (factor 10)	50	400	2	13	15
X	internal dispenser dilution (factor 25)	125	1000	2	13	15
Y	internal dispenser dilution (factor 50)	250	2000	2	13	15
Z	internal dispenser dilution (factor 75)	375	3000	2	13	15
5	internal dispenser dilution (factor 100)	500	4000	2	13	15

Summary of method

Summary

Sulfate in the water sample precipitates with barium chloride in an acidic medium to form barium sulfate crystals of uniform size. The absorbance of the $BaSO_4$ suspension is measured at a wavelength of 450 nm.

Analysis steps

The analysis vessel is rinsed and filled with new sample. The buffer solution is added to acidify the sample to pH 1.5. After a stabilization period, the initial absorbance value is measured. The barium chloride solution is added and a stir period starts.

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

When the analysis is complete, the analysis vessel is drained and rinsed with deionized water, then an EDTA solution is added to remove the white precipitation.

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/10 minutes**	**Use life**	**Containers**	**Operation temperature**
Red	Reagent 1	Buffer	~ 1 mL	~ 4.1 L	28 days	Plastic; 5 L	10 to 30 °C (50 to 86 °F)
Blue	Reagent 2	Barium chloride	~ 1 mL	~ 4.1 L	28 days	Plastic; 5 L	10 to 30 °C (50 to 86 °F)
Green	Reagent 3	EDTA	~ 0.5 mL	~ 2.1 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	30	38	—	REF1
2-point (recommended)	60	76	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 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 15 minutes
0 (no dilution)	—	—	—	—
V - W - X - Y - Z - 5 (with dilution)	51 mL	16 mL	67 mL	180 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 EZ1036: APPC1036KTO

Code	Label	Product	Quantity	Item no.
Red	Reagent 1	Buffer	2 L (2x)	APPC1036-01
Blue	Reagent 2	Barium chloride	2 L (2x)	APPC1036-02
Green	Reagent 3	EDTA	2 L (1x)	APPC1025-03
—	Stock solution	2500 mg/L SO_4	500 mL (1x)	1425249

Table 7 Reagent list

Solutions	Products	Formula	MW (g/mol)	CAS number	For each 1 L solution
Reagent 1: Buffer Code: Red	Hydrochloric acid (37%)	HCl	36.46	7647-01-0	41.5 mL
	Sodium chloride	NaCl	58.44	7647-14-5	50 g
Reagent 2: Barium chloride Code: Blue	Barium chloride dihydrate[2]	$BaCl_2$ * $2H_2O$	244.28	10326-27-9	24.428 g
	Tween 80	—	—	9005-65-6	2.0 g
	Ethanol, pure	CH_3CH_2OH	46.07	64-17-5	20 mL
Reagent 3: EDTA Code: Green	EDTA disodium salt dihydrate	$C_{10}H_{14}N_2Na_2O_8$ * $2H_2O$	372.24	6381-92-6	74.4 g
	Sodium hydroxide	NaOH	40.00	1310-73-2	40 g
Stock solution	Sodium sulfate	Na_2SO_4	142.04	7757-82-6	29.57 g
REF1 calibration standard	20000 mg/L SO_4 stock solution	—	—	—	Refer to Table 8 on page 6.
REF2 calibration standard	20000 mg/L SO_4 stock solution	—	—	—	Refer to Table 9 on page 6.
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: Buffer

1. Add 400 mL of deionized water to a beaker.
2. Add 50 g of sodium chloride (NaCl).
3. Mix until fully dissolved.

[2] Sigma aldrich (1.01719) recommended

4. Add 41.5 mL of hydrochloric acid, 37% (HCl).
5. Fully mix the solution.
6. Pour the solution into a 1000-mL volumetric flask.
7. Add deionized water to the mark.
8. Fully mix the solution.

Reagent 2: Barium chloride

1. **Solution A:**
   a. Add 500 mL of deionized water to a beaker.
   b. Add 24.428 g of barium chloride dihydrate ($BaCl_2$ * $2H_2O$).
   c. Mix until fully dissolved.
2. **Solution B:**
   a. Add 20 mL of ethanol to a beaker.
   b. Add 2.0 g of Tween 80.
   c. Mix until fully dissolved.
3. Add Solution B to Solution A.
4. Fully mix the solution.
5. Pour the solution into a 1000-mL volumetric flask.
6. Add deionized water to the mark.
7. Fully mix the solution.

   The concentration of the barium chloride reagent is 0.1 M $BaCl_2$.

Reagent 3: EDTA

1. Add 500 mL of deionized water to a beaker.
2. Add 40 g of sodium hydroxide (NaOH).
3. Mix until fully dissolved.
4. Add 74.4 g of EDTA ($C_{10}H_{14}N_2Na_2O_8$ * $2H_2O$).
5. Mix until fully dissolved.
6. Pour the solution into a 1000-mL volumetric flask.
7. Add deionized water to the mark.
8. 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

Prepare a 20000-mg/L SO_4 stock solution as follows. Refer to Necessary reagents on page 4 to collect the applicable items.

1. Add 900 mL of deionized water to a beaker.
2. Add 29.5716 g of sodium sulfate (Na_2SO_4).
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.

REF1 calibration standard

Dilute the stock solution to prepare the REF1 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 8.
2. Add deionized water to the mark.
3. Fully mix the solution.

Table 8 REF1 calibration standard preparation

Range code	Description	REF1 concentration (mg/L SO_4)	Quantity (mL) of stock solution
0	Standard range	10	0.5
V	internal dispenser dilution (factor 5)	50	2.5
W	internal dispenser dilution (factor 10)	100	5
X	internal dispenser dilution (factor 25)	250	12.5
Y	internal dispenser dilution (factor 50)	500	25
Z	internal dispenser dilution (factor 75)	750	37.5
5	internal dispenser dilution (factor 100)	1000	50

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 SO_4)	Quantity (mL) of stock solution
0	40	2
V	200	10
W	400	20
X	1000	50
Y	2000	100
Z	3000	150
5	4000	200

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 Necessary reagents on page 4. 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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