

Standard range: 0.02 to 1 mg/L Mn

Method

EZ2725



## 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<sup>1</sup>. 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	Formaldoxime colorimetric method
Measurement wavelength	450 nm
Parameter	Long description: Manganese, Total Short description (default): Mn, 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 <a href="#">Table 1</a> .
Cleaning	Automatic or manual; frequency is freely programmable

<sup>1</sup> 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 <b>Note:</b> The manufacturer recommends that a calibration is done when the reagents are replaced.
Validation	Automatic or manual; frequency is freely programmable
Interferences	The ions commonly found in water and wastewater do not interfere. 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
A	10% of standard range	0.004	0.1	3	27	30
B	25% of standard range	0.01	0.25	2	27	30
C	50% of standard range	0.01	0.5	2	27	30
<b>0</b>	<b>Standard range</b>	<b>0.02</b>	<b>1</b>	<b>2</b>	<b>27</b>	<b>30</b>
V	internal dispenser dilution (factor 5)	0.1	5	2	30	30
W	internal dispenser dilution (factor 10)	0.2	10	2	30	30
X	internal dispenser dilution (factor 25)	0.5	25	2	30	30

## Summary of method

### Summary

Manganese ions in the water sample react with formaldoxime in an alkaline solution of ammonium hydroxide to form a strong orange-red color. The absorbance is measured at a wavelength of 450 nm. EDTA and hydroxylamine hydrochloride (reducing reagent) are added to minimize the interference of iron ( $Fe^{2+}$  and  $Fe^{3+}$ ). The sample is first digested with heat and acid to make sure that all forms of manganese 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 manganese 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 color and buffer reagents are then added and a stir period starts.

After the stir period, the color is fully developed. The EDTA and reducing agent reagents are added and the final absorbance value is measured. The analyzer uses the absorbance values and Beer's Law to calculate the concentration of manganese 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	Color	~ 0.5 mL	~ 0.68 L	28 days	Plastic; 2.5 L	10 to 30 °C (50 to 86 °F)
Blue	Reagent 2	Buffer	~ 1 mL	~ 1.4 L	28 days	Plastic; 2.5 L	10 to 30 °C (50 to 86 °F)
Green	Reagent 3	EDTA	~ 0.5 mL	~ 0.68 L	28 days	Plastic; 2.5 L	10 to 30 °C (50 to 86 °F)
Yellow	Reagent 4	Reducing agent	~ 0.5 mL	~ 0.68 L	28 days	Plastic; 2.5 L	10 to 30 °C (50 to 86 °F)
White	Reagent 5	Acid	~ 0.6 mL <sup>2</sup> ~ 0.8 mL <sup>3</sup>	~ 0.81 L <sup>2</sup> ~ 1.1 L <sup>3</sup>	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	71	81	—	REF1
2-point (recommended)	142	162	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 A, B, 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
A - B - C - 0 (no dilution)	—	—	—	—
V - W - X (with dilution)	63 mL	16 mL	79 mL	107 L

<sup>2</sup> A - B - C - 0 (no dilution)

<sup>3</sup> V - W - X (with dilution)

## 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 EZ2725: APPC2003KTO**

Code	Label	Product	Quantity	Item no.
Red	Reagent 1	Color	2 L (1x)	APPC1025-02
Blue	Reagent 2	Buffer	2 L (1x)	APPC1025-01
Green	Reagent 3	EDTA	2 L (1x)	APPC1025-04
Yellow	Reagent 4	Reducing agent	2 L (1x)	APPC1025-03
White	Reagent 5	Acid	1 L (2x)	APPC2003-05
—	Stock solution	1000 mg/L Mn	100 mL (1x)	1279142

**Table 7 Reagent list**

Solutions	Products	Formula	MW (g/mol)	CAS number	For each 1 L solution
Reagent 1: Color Code: Red	Hydroxylamine hydrochloride	H <sub>3</sub> NO * HCl	69.49	5470-11-1	40 g
	Formaldehyde (37%)	CH <sub>2</sub> O	30.03	50-00-0	20 mL
Reagent 2: Buffer Code: Blue	Ammonium hydroxide solution (25%) <sup>4</sup>	NH <sub>4</sub> OH	35.05	1336-21-6	100 mL
Reagent 3: EDTA Code: Green	EDTA <sup>5</sup>	C <sub>10</sub> H <sub>14</sub> N <sub>2</sub> Na <sub>2</sub> O <sub>8</sub> * 2H <sub>2</sub> O	372.2	6381-92-6	37.22 g
Reagent 4: Reducing agent Code: Yellow	Hydroxylamine hydrochloride	H <sub>3</sub> NO * HCl	69.49	5470-11-1	10 g
Reagent 5: Acid Code: White	Nitric acid (65%)	HNO <sub>3</sub>	63.01	7697-37-2	69 mL
Stock solution	Manganese (II) nitrate tetrahydrate	MnN <sub>2</sub> O <sub>6</sub> * 4H <sub>2</sub> O	251.01	20694-39-7	4.5688 g
	Nitric acid (65%)	HNO <sub>3</sub>	63.01	7697-37-2	35 mL
REF1 calibration standard	Deionized water (Type I or better)	—	—	—	—
REF2 calibration standard	1000 mg/L Mn stock solution	—	—	—	Refer to <a href="#">Table 8</a> on page 6.
Validation standard (optional)	REF2 calibration standard	—	—	—	Refer to <a href="#">Validation standard</a> on page 6.
Cleaning solution (optional)	Hydrochloric acid (36%)	HCl	36.46	7647-01-0	41.5 mL

<sup>4</sup> Density: 0.91 g/mL (20 °C)

<sup>5</sup> Ethylenediaminetetraacetic acid disodium salt dihydrate

## 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: Color

1. Add 500 mL of deionized water to a beaker.
2. Add 40 g of hydroxylamine hydrochloride ( $\text{H}_3\text{NO}^+ \text{HCl}$ ).
3. Mix until fully dissolved.
4. Add 20 mL of formaldehyde solution, 37% ( $\text{CH}_2\text{O}$ ).
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.

The reagent is stable for 2 weeks.

### Reagent 2: Buffer

1. Add 500 mL of deionized water to a beaker.
2. Add 100 mL of ammonium hydroxide solution, 25% ( $\text{NH}_4\text{OH}$ ).
3. Fully mix the solution.
4. Pour the solution into a 1000-mL volumetric flask.
5. Add deionized water to the mark.
6. Fully mix the solution.

The reagent is stable for 1 month.

### Reagent 3: EDTA

1. Add 500 mL of deionized water to a beaker.
2. Add 37.22 g of EDTA (ethylenediaminetetraacetic acid disodium salt).
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.

The concentration of the EDTA reagent is 0.1 M EDTA.

### Reagent 4: Reducing agent

1. Add 500 mL of deionized water to a beaker.
2. Add 10 g of hydroxylamine hydrochloride ( $\text{H}_3\text{NO}^+ \text{HCl}$ ).
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.

### Reagent 5: Acid

1. Add 500 mL of deionized water to a beaker.
2. Slowly mix in 69 mL nitric acid ( $\text{HNO}_3$ , 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

Prepare a 1000-mg/L Mn stock solution as follows. Refer to [Necessary reagents](#) on page 4 to collect the applicable items.

1. Add 300 mL of deionized water to a beaker.
2. Add 4.5688 g manganese (II) nitrate tetrahydrate ( $\text{MnN}_2\text{O}_6 \cdot 4\text{H}_2\text{O}$ ).
3. Mix until fully dissolved.
4. Slowly add 35 mL of concentrated nitric acid ( $\text{HNO}_3$ , 65%).
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.

### 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 8](#).
2. Add deionized water to the mark.
3. Fully mix the solution.

**Table 8 Calibration standard preparation**

Range code	REF2 concentration (mg/L Mn)	Quantity (mL) of stock solution
A	0.1	0.1
B	0.25	0.25
C	0.5	0.5
0	1	1
V	5	5
W	10	10
X	25	25

## 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.

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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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