Detection of sulfate and sulfite in wastewater

Introduction:

The industrial wastewater from chemical plants has complex components. This article determines the degree of wastewater pollution by measuring sulfate and sulfite ions in the wastewater. Ion chromatography has a unique advantage in anion detection

Table 1: Detection items

Anion	Sulfate	Sulfite

Keywords: Sulfate and sulfite,wastewater, Ion Chromatograph.

Instruments and equipment

- **Ion chromatograph**: CIC-D160^{+}
- **Ultra pure water machine**:EU-20

Qingdao Shenghan Chromatograph Technology Co., Ltd

Requirements

Reagents

Unless otherwise specified, all reagents used are superior grade. Commercially available certified standard solutions for sulfate and sulfite (1000 mg/L).

Deionized Water

When preparing standard samples manually or diluting real samples, please use ASTM filtration and deionization requirements that meet the specifications listed in the table 2.

Table 2: Deionized water specification.

Specification	
Ions Resistivity	≥18.25MΩ·cm
Organics-TOC	<10ppb
Iron/Transition Metals	<1ppb
Pyrogens	<0.03Eu/mL
Particulates（>0.2μm）	<1unit/mL
Colloids-Silica	<10ppb
Bacteria	<1cfu/mL

Chromatography conditions

Table 3: Analysis conditions

Instrument	CIC-D160^{+}
Eluent	15 mM KOH
Flow rate	1.0 mL/min
Injection volume	25 μL
Analytical column	SH-AC-23
Column oven temperature	35℃
Conductivity detector temperature	35℃
Suppressor current	50 mA

Sample preparation

After diluting the sample, analyze it on the machine after passing through a 0.22um filter membrane.
(Note: Dilute waste ammonia water 1 by 100 times, desulfurization wastewater 2 by 1000 times, and desulfurization wastewater 3 by 10000 times).

Standard chromatogram

Standard chromatogram, As shown in below:

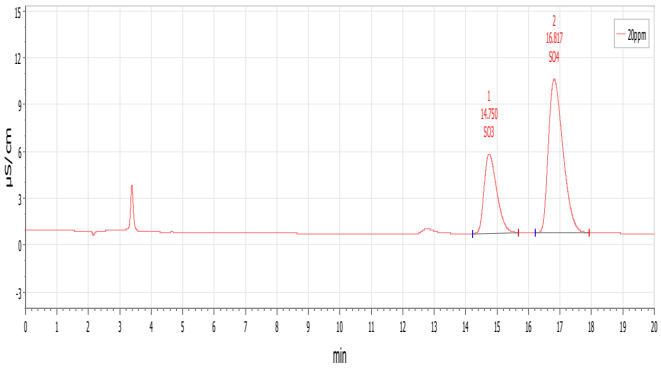


Figure 1. Chromatogram of standard sample.
(20mg/L SO_3^{2-} and SO_4^{2-})

Sample chromatogram

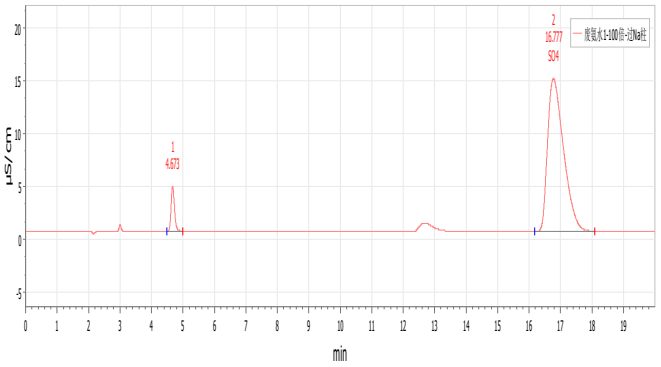


Figure 2. Chromatogram of sample 1#
(Waste ammonia water 1-100 times)

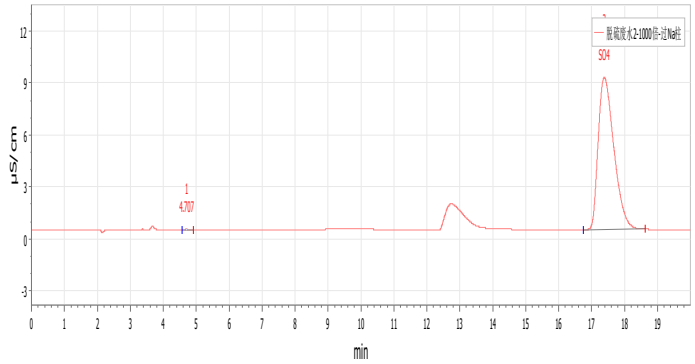


Figure 3. Chromatogram of sample 2#
(Desulfurization wastewater 2-1000 times)

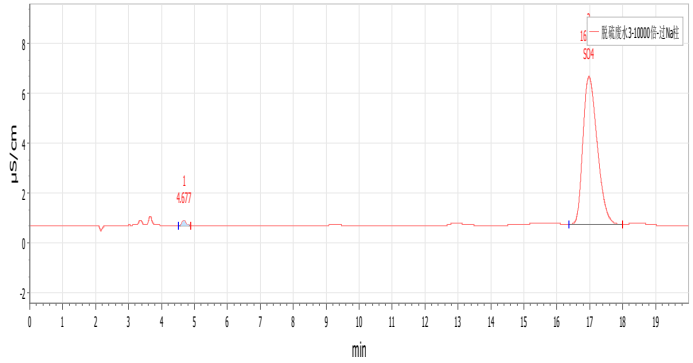


Figure 4. Chromatogram of sample 3#
(Desulfurization wastewater 3-10000 times)

Results and calculations

Table 4: Sample test result (Unit: mg/L)

Sample	SO_3^{2-}	SO_4^{2-}
Waste ammonia water 1	ND	3207.68
Desulfurization wastewater 2	ND	18357.48
Desulfurization wastewater 3	ND	112885.40

Remarks: ① ND indicates not detected or below the detection limit.②During the experiment, it is easy to be contaminated, and experimental personnel are required to strictly follow the operating procedures.

Feasibility analysis and conclusion

The above experiments prove that the detection method has good resolution and is suitable for the determination of the content of the components to be measured in the sample.

Detection of anions in 96% sodium chloride by ion chromatography

Keywords: Ion Chromatograph,Shine,Anion

Abstract. Through this article, we want to show how to determine other ions in high concentration salt samples.

Purpose

Confirm that this method is applicable to the determination of anion content in the sample and the feasibility of this laboratory using this method to determine the anion content in the sample.

Instruments and equipment

Ion chromatograph:CIC-D160
Ultra pure water machine:ECO-S15
Qingdao Shenghan Chromatograph Technology Co., Ltd

Requirements

Reagents
All reagents used are superior grade pure or better,Purchase certified standard solutions F^-, Br^-, NO_3^-, SO_4^{2-}, BrO_3^-, ClO_3^- standard solutions (1000 mg / L)

Deionized Water
When preparing standard samples manually or diluting real samples, please use ASTM filtration and ultra pure water requirements that meet the specifications listed in the table 1.

Table 1: Ultra pure water specification.

Specification	
Ions Resistivity	≥18.25MΩ·cm
Organics-TOC	<10ppb
Iron/Transition Metals	<1ppb
Pyrogens	<0.03Eu/mL
Particulates（>0.2μm）	<1unit/mL
Colloids-Silica	<10ppb
Bacteria	<1cfu/mL

Sample preparation

After the sample is moderately diluted,as shown in Table 2, it passes through the activated C18 on-guard column, and then passes through 0.22 μm filter with filter membrane, discard the 2ml sample

that comes out first, and inject the remaining sample for analysis.
(Activation method of C18 on-guard column: pass 5 ml of methanol through C18, place it for 10 minutes, rinse it with 5 ml of ultra pure water, and the activation is completed)

Table 2: Sample dilution table.

Sample	Weight（g）	Solvent	Dilution volume(mL)
1#	0.2024	Ultra pure water	100
2#	0.2084	Ultra pure water	100

Chromatographic conditions

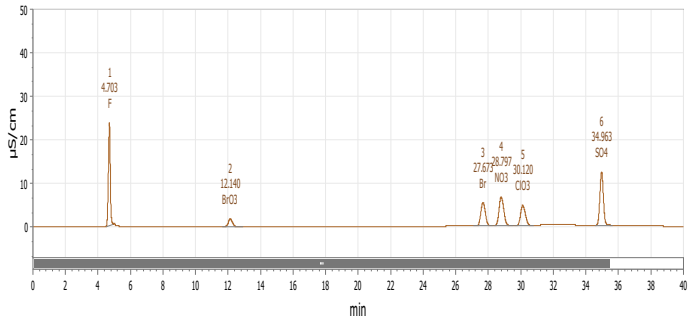
Guard column:SH-G-1
Column: SH-AC-11
Injection volume: 25 μL
Run time: 40 min
Flow rate: 1.0 mL/min
Column oven temperature: 30℃
Conductivity cell temperature: 35℃
Suppressor: SHY-A-6
Suppressor current:75 mA
Conductivity detector:SHD-6

Table 3: Gradient conditions.

Time	Concentration
0-15 min	5 mM KOH
15.1-35 min	5-20 mM KOH
35.1-40 min	5 mM KOH

Calibration curve

Standard chromatogram,As shown in Figure 1.



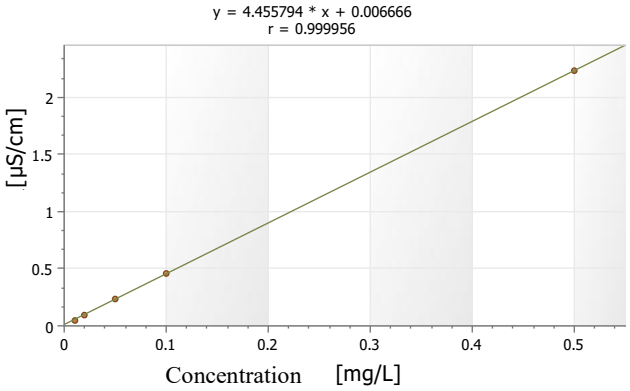


Figure 2. Fluoride linearity

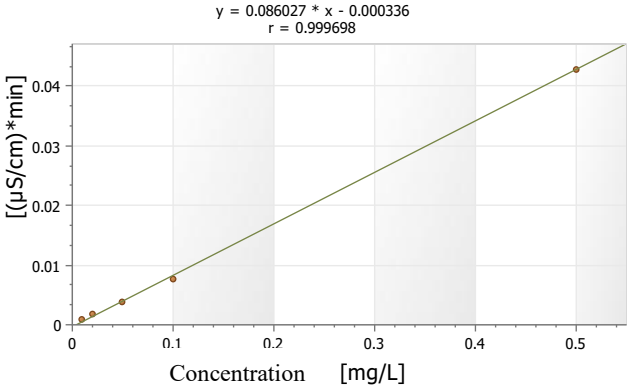


Figure 3. Bromate linearity

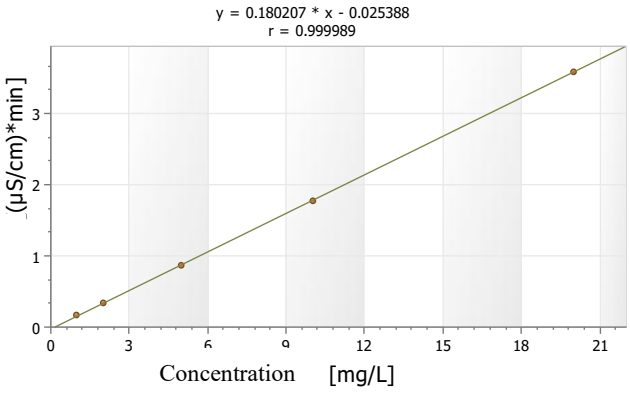


Figure 4. Bromide linearity

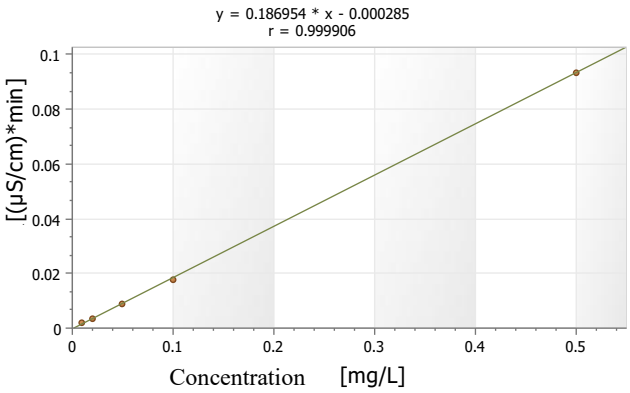


Figure 5. Nitrate linearity

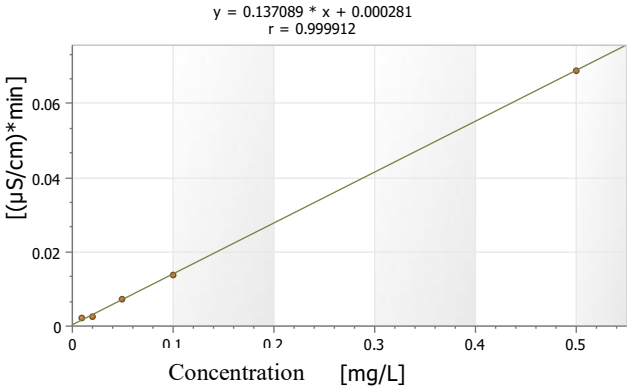


Figure 6. Chlorate linearity

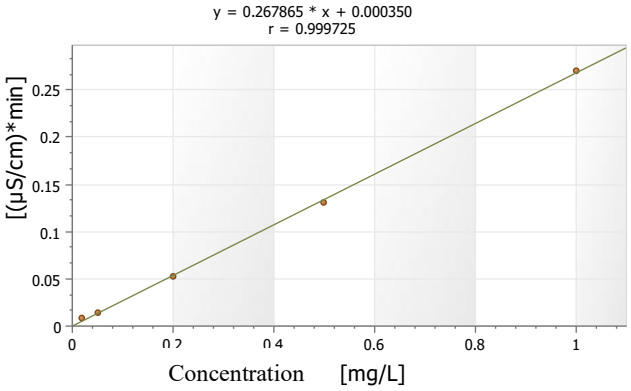
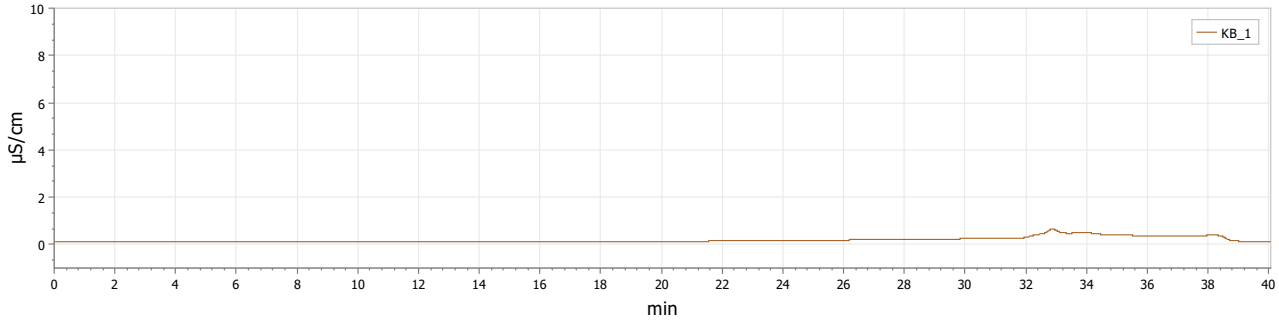


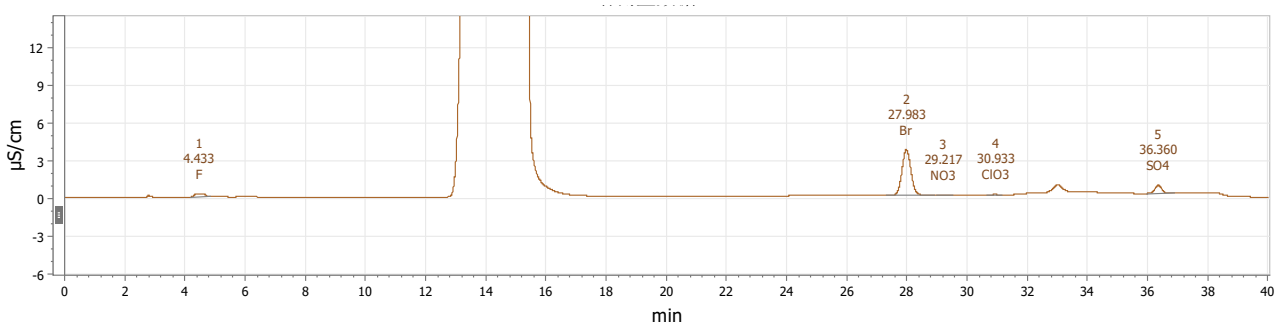
Figure 7. Sulfate ion linearity

Blank sample

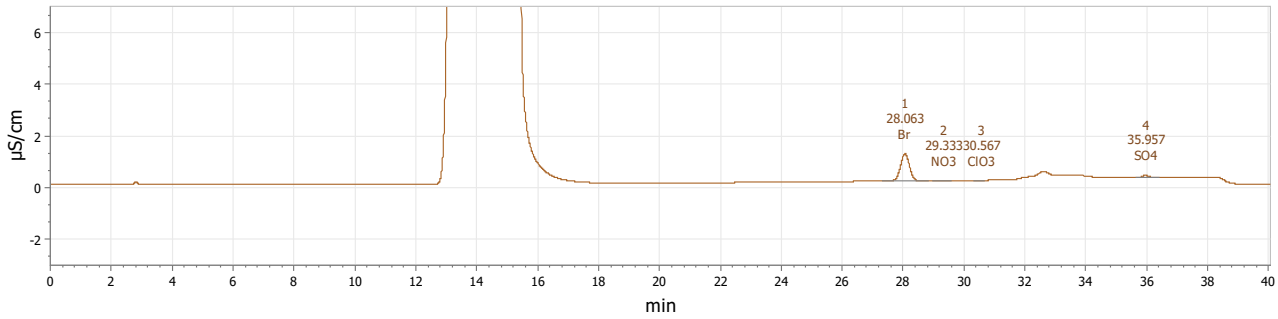


Figurre 8. Chromatogram of blank sample

Sample detection



Figurre 9. Chromatogram of sample 1#



Figurre 10. Chromatogram of sample 2#

Results and calculations

Sample	Concentration (mg/kg)					
	F^-	BrO_3^-	Br^-	NO_3^-	ClO_3^-	SO_4^{2-}
1#	0.05330	ND	3471	6.155	17.41	321.8
2#	ND	ND	1031	2.323	4.042	44.38

Remarks: ① ND indicates that the result is not detected or lower than the detection limit; ② Blank has been deducted from the test results; ③ There will be differences in the test results between different methods and laboratories; ④ Because the separation effect of fluoride ion and Impurity peak ion in sample 1# is not good, the quantitative method of fluoride ion in sample 1# adopts peak height quantitative method.

Feasibility analysis and conclusion

Through the above experiments, it is proved that the detection method has good separation and is suitable for the determination of the content of the components to be measured in the sample.

Determination of chlorite, chlorate and bromate in tap water

Introduction:

At present, the disinfectants used for drinking water disinfection mainly include liquid chlorine, chlorine dioxide and ozone. Chlorite is a by-product of chlorine dioxide disinfection, chlorate is a non-by-product brought by chlorine dioxide raw material, and bromate is a disinfection by-product of ozone. These compounds may cause certain harm to human body.

GB/T 5749-2006 hygienic standard for drinking water stipulates that the limits of chlorite, chlorate and bromate are 0.7, 0.7 and 0.01mg/L respectively.

A high-capacity anion exchange chromatographic column can be used to simultaneously determine chlorite, chlorate and bromate in drinking water by ion chromatography with large volume direct injection.

Keywords: Chlorite, chlorate , bromate.

Instruments and equipment

Ion chromatograph:CIC-D150
Ultra pure water machine:ECO-S15
Qingdao Shenghan Chromatograph Technology Co., Ltd

Requirements

Reagents

All reagents used are superior grade pure or better,Purchase certified standard solutions ClO_2^- , BrO_3^- , ClO_3^- standard solutions (1000 mg / L).

Deionized Water

When preparing standard samples manually or diluting real samples, please use ASTM filtration and deionization requirements that meet the specifications listed in the table 1.

Table 1: Deionized water specification.

Specification	
Ions Resistivity	≥18.25MΩ·cm
Organics-TOC	<10ppb
Iron/Transition Metals	<1ppb
Pyrogens	<0.03Eu/mL

Particulates（>0.2μm）	<1unit/mL
Colloids-Silica	<10ppb
Bacteria	<1cfu/mL

Sample preparation

The samples were sequentially overactivated by Ag pretreatment column, Na pretreatment column, and 0.22 μ M filter membrane and then injection analysis.
(Activation method of Ag and Na pretreatment column: pass 10 ml of deionized water, place it for 10 minutes)
Please note that the first 2ml of samples passing through the filter membrane should be discarded, and the remaining samples injected for analysis.

Chromatographic conditions

Eluent:4.5 mM Na_2CO_3+0.8 mM $NaHCO_3$
Flow rate: 1.0 mL/min
Injection volume: 500 μL
Guard column:IonPac AG 23
Column: IonPac AS 23
Column oven temperature: 30℃
Conductivity cell temperature: 35℃
Suppressor current:75 mA

Table 2: 4.5 mM Na_2CO_3+0.8 mM $NaHCO_3$ Configuration method

Name	Weight or volume
Na_2CO_3	0.4770 g
$NaHCO_3$	0.0672 g
Constant volume	1 L

Calibration curve

Standard chromatogram,As shown in below:

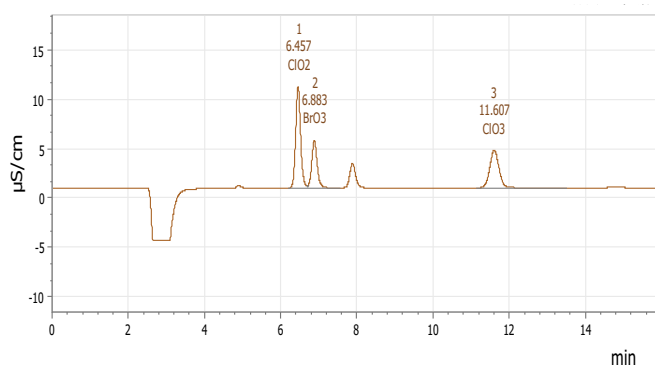


Figure 1. Chromatogram of chlorite, bromate and chlorate standard sample.

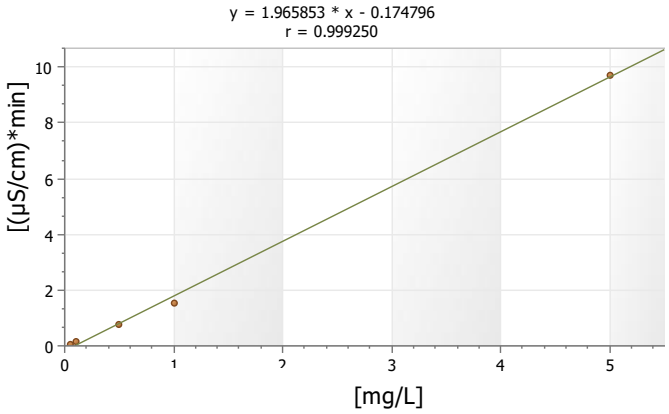


Figure 2. Chlorite ion linearity

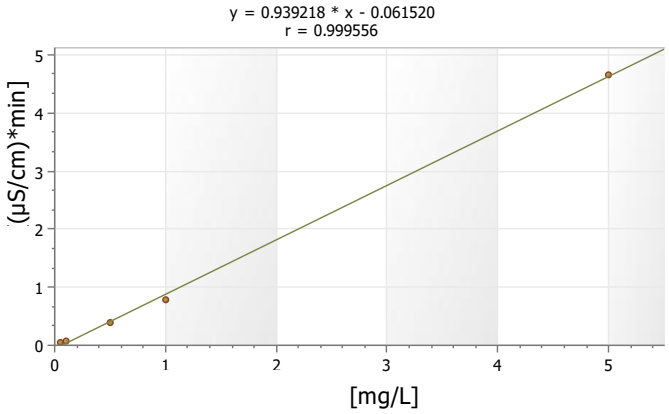


Figure 3.Bromate ion linearity

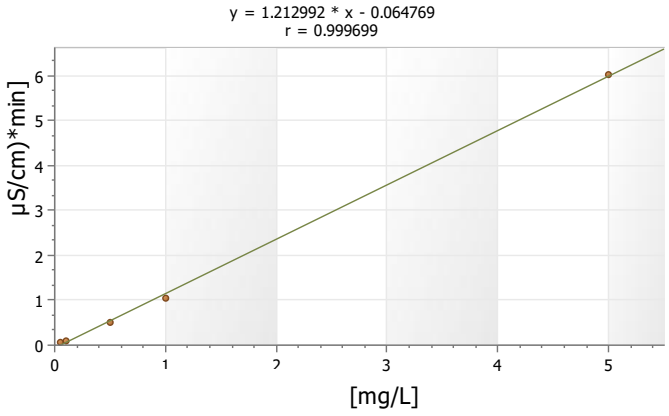


Figure 4.Chlorate ion linearity

Sample detection

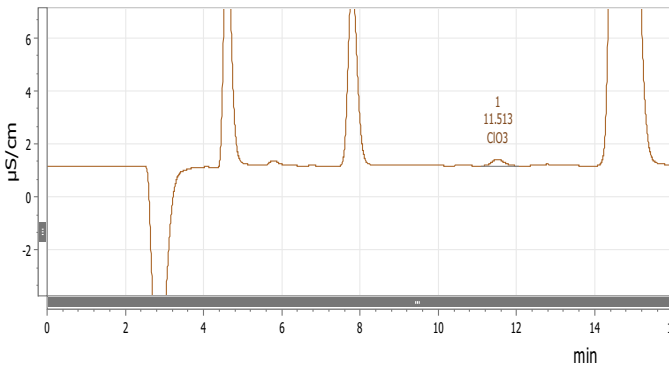


Figure 5. Chromatogram of tap water sample

Table 3.Sample test results

Compound	Retention time [min]	Concentration [mg/L]	Area [(μS/cm)*min]	Peak height [μS/cm]	Separation	Tailing factor
ClO_2^-	ND	ND	ND	ND	ND	ND
BrO_3^-	ND	ND	ND	ND	ND	ND
ClO_3^-	11.513333	0.086648 mg/L	0.088443	0.247118	0.000000	1.168675

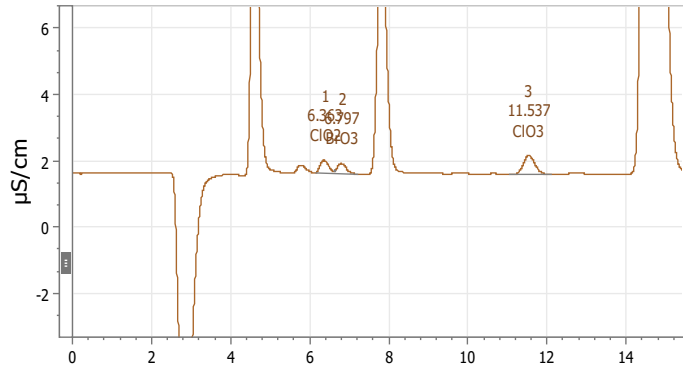


Figure 6.Chromatogram of standard added to tap water sample

Table 4.Results of standard added to tap water

Compound	Retention time [min]	Concentration [mg/L]	Area [(μS/cm)*min]	Peak height [μS/cm]	Separation	Tailing factor
ClO_2^-	6.363333	0.068675	0.093836	0.371927	1.048005	1.258576
BrO_3^-	6.796667	0.103905	0.076244	0.301615	9.820346	1.442076
ClO_3^-	11.536667	0.192692	0.196684	0.575646	0.000000	1.128959

Results and calculations

Concentration (mg/L)			
Anions	ClO_2^-	BrO_3^-	ClO_3^-
Sample	ND	ND	0.09
RSD%	/	/	1.40

Note: ① The test results will be different between different methods and different laboratories.② only examines the feasibility of the test method and the stability of the results. Others are for reference only.

Feasibility analysis and conclusion

Through the above experiments, it is proved that the detection method has good separation and is suitable for the determination of the content of the components to be measured in the sample.

Detection of fluoride, chloride and sulfate in solid waste

Introduction:

Solid waste refers to the solid, semi-solid substances placed in containers that lose their original value at a certain time and place and are discarded. Incineration can minimize the volume and weight of solid waste. However, in the process of treating solid wastes by combustion, sulfur, chlorine and fluorine in the form of organic or inorganic substances will be converted into corrosive or harmful gaseous substances such as hydrogen chloride, hydrogen fluoride, sulfur dioxide and sulfur trioxide. The suitability of incineration of solid wastes can be evaluated by measuring the contents of sulfur, chlorine and fluorine.

In this experiment, we combust the solid waste through the oxygen bomb combustion device and absorb it with sodium hydroxide solution, and then determine the concentration of fluoride, chloride and sulfate by Ion chromatography.

Keywords: Solid waste, Ion chromatography, fluoride, chloride and sulfate.

Instruments and equipment

- **Ion chromatograph**: CIC-D120
- **Ultra pure water machine**:ECO-S15

Qingdao Shenghan Chromatograph Technology Co., Ltd

Requirements

Reagents

All reagents used are superior grade pure or better,Purchase certified standard solutions F^-、Cl^-、SO_4^{2-} standard solutions (1000 mg / L).

Deionized Water

When preparing standard samples manually or diluting real samples, please use ASTM filtration and deionization requirements that meet the specifications listed in the table 1.

Table 1: Deionized water specification.

Specification	
Ions Resistivity	≥18.25MΩ·cm
Organics-TOC	<10ppb
Iron/Transition Metals	<1ppb
Pyrogens	<0.03Eu/mL
Particulates（>0.2μm）	<1unit/mL

Colloids-Silica	<10ppb
Bacteria	<1cfu/mL

Sample preparation

Weigh an appropriate amount of sample, as shown in Table 2, and put it in the oxygen bomb for combustion absorption, add 10mL of 20mM NaOH, then flush with oxygen and set the combustion program. After the combustion is completed, shake every 5 minutes for 30 seconds. After 6 cycles, release the gas and transfer the absorbent solution with deionized water to a 100mL volumetric flask. After completion, filter with a 0.22um filter membrane and enter IC analysis.

Table 2:Sample preparation

Sample name	Weight（g）	Absorbent	Constant volume(mL)	Test items
1#	0.0338	NaOH aqueous solution	100	F^-、Cl^-、SO_4^{2-}
2#	0.0536	NaOH aqueous solution	100	F^-、Cl^-、SO_4^{2-}

Chromatographic conditions

Eluent: 2.4 mM Na_2CO_3+6.0 mM $NaHCO_3$
Flow rate: 1.3 mL/min
Injection volume: 25 μL
Guard column:SH-G-1
Analytical Column: SH-AC-4
Column oven temperature: 35℃
Conductivity cell temperature: 35℃
Suppressor current: 50 mA

Table 3: 2.4 mM Na_2CO_3+6 mM $NaHCO_3$ eluent configuration method.

Name	Weight or volume
Na_2CO_3	0.2544 g
$NaHCO_3$	0.5040 g
Constant volume	1 L

Standard chromatogram

Standard chromatogram,As shown in below:

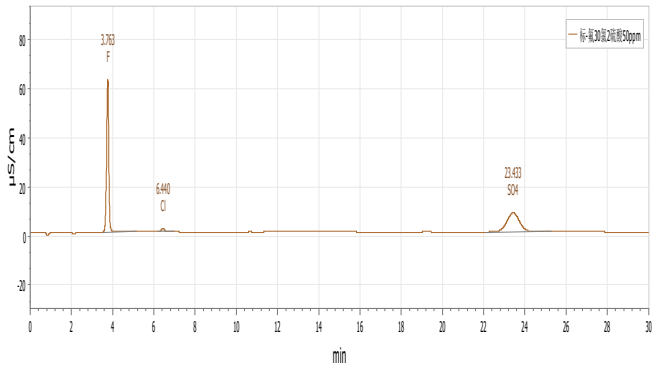


Figure 1. Chromatogram of fluoride, chloride and sulfate standard sample.

Table 4:Data of standard solution

Compound name	Retention time[min]	Concentration [mg/L]	Area[(μS/cm)*min]	Height[μS/cm]
F^-	3.76	30.00	7.588281	62.031424
Cl^-	6.44	2.000	0.258363	1.362501
SO_4^{2-}	23.43	50.00	5.636823	7.739647

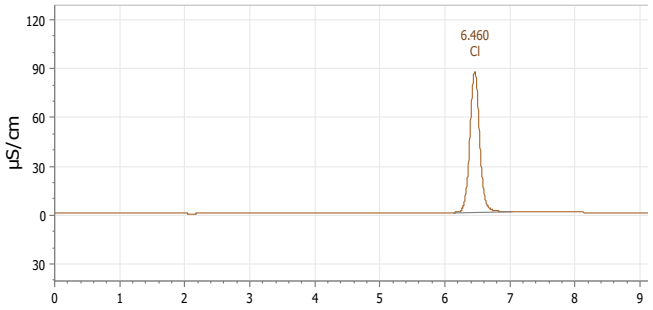


Figure 2. Chromatogram of Single-point chloride

Table 5:Single-point chloride

Compound name	Retention time[min]	Concentration [mg/L]	Area[(μS/cm)*min]	Height[μS/cm]
Cl^-	6.46	80.00	15.169921	81.835332

Comparison testing (blank)

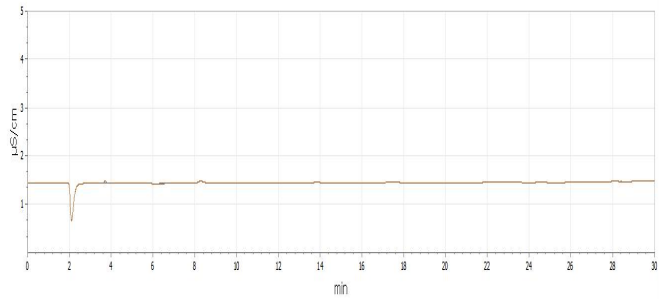


Figure 3.Blank chromatogram

Sample chromatogram

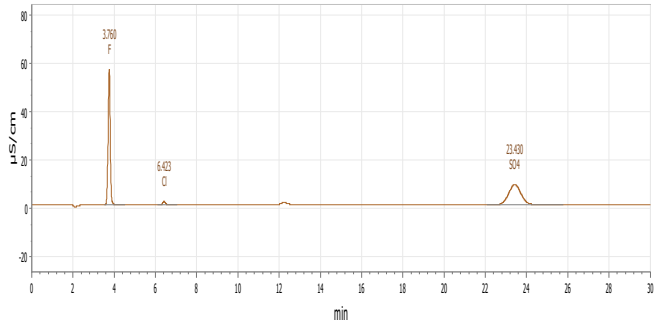


Figure 4. Chromatogram of sample 1#

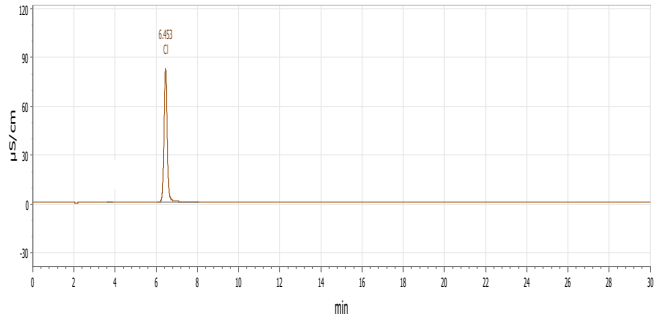


Figure 5. Chromatogram of sample 2#

Results and calculations

Table 6:Sample test results

Sample	F^-	Cl^-	SO_4^{2-}
1#	7.91	0.62	16.20
2#	ND	14.35	ND

Remarks: ① the blank value has been deducted from the measured value; ② Nd indicates that the result is not detected or lower than the detection limit; ③ Different methods and different laboratories may have different test results.

Feasibility analysis and conclusion

Through the above experiments, it is proved that the detection method has good separation and is suitable for the determination of the content of the components to be measured in the sample.

Detection of sulfur ion and cyanide in solid waste

Introduction:

Solid waste refers to the solid and semi-solid waste materials produced by human beings in production, consumption, life and other activities (the definition could be more extensive, and the wastes produced by animal activities also belong to this category). The hazardous solid waste refers to the waste listed in the national hazardous waste list or identified as hazardous waste according to the national hazardous waste identification standards and methods.

Hazard characteristics refer to corrosiveness, acute toxicity, leaching toxicity, reactivity, infectivity, nuclear radioactivity, etc. Hazardous waste has a serious impact on the environment and even human body, so it must be disposed safely and properly. According to the national and local environmental protection laws and regulations, enterprises producing hazardous waste must conduct centralized treatment of hazardous waste, arrange special personnel to be responsible for collection and management, set up special containers for storage of hazardous waste to be transported, and submit hazardous waste to qualified enterprises for collection, transportation and treatment.

Detection items (Table 1):

S^{2-}	CN^-

Keywords: Solid waste,Ion chromatograph

Instruments and equipment

- **Ion chromatograph:** CIC-D100E
- **Ultra pure water machine**:ECO-S15

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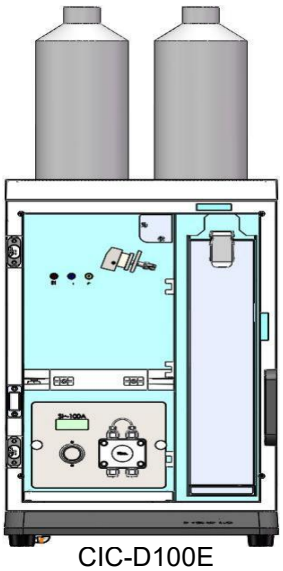


CIC-D100E

Requirements

Reagents

Unless otherwise specified, all reagents used are of superior purity.

Sodium acetate: anhydrous, GR, 99.9%, McLean;

50% sodium hydroxide solution: Sigma;

Cyanide ion standard solution (50 mg/L) sold in the market, and sulfur ion reference solution (100 mg/L) prepared by the laboratory.

Deionized Water

When preparing standard samples manually or diluting real samples, please use ASTM filtration and deionization requirements that meet the specifications listed in the table 2.

Table 2: Deionized water specification.

Specification	
Ions Resistivity	≥18.25MΩ·cm
Organics-TOC	<10ppb
Iron/Transition Metals	<1ppb
Pyrogens	<0.03Eu/mL
Particulates（>0.2μm）	<1unit/mL
Colloids-Silica	<10ppb
Bacteria	<1cfu/mL

Sample preparation

Weigh 5g (accurate to 0.001g) of representative solid waste sieved through a 180um sieve into a 250mL beaker, add 80mL of water, and extract with ultrasound for 30 minutes. Then transfer all of it to a 100mlLvolumetric flask and dilute with water. After shaking well, take a portion of the solution and centrifuge at 3000rpm for 15 minutes, then take the supernatant. Add concentrated sulfuric acid to the supernatant, distill it using a still, and then absorb it with 1mol/L NaOH concentrated alkaline solution to determine the content of the water-soluble portion.

Chromatographic conditions

Table 3:

Instrument	CIC-D100E
Eluent	100mM NaOH+ 50mM sodium acetate+ 0.5% ethylenediamine
Flow rate	1.0 mL/min
Injection volume	25 μL
Analytical Column	SH-AC-14
Column oven temperature	35℃
Conductivity cell temperature	35℃
Apply voltage	0.1 V

Calibration curve

Standard solution chromatogram,As shown in below:

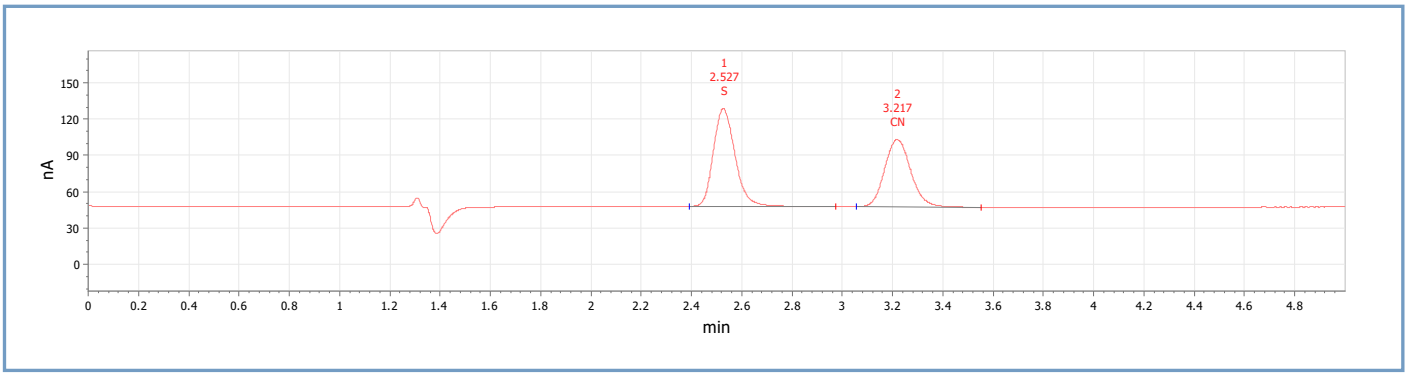


Figure 1. Standard solution chromatogram

Sulfur ion linearity

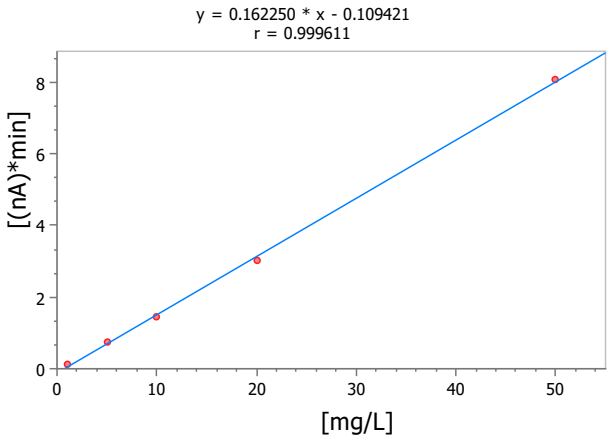


Figure 2. Sulfur ion linearity

Cyanide linearity

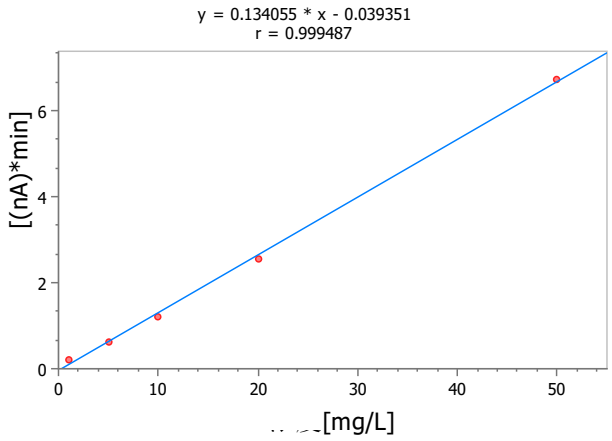


Figure 3. Cyanide linearity

Repeatability

Figure 4:1 ug/L chromatogram and repeatability results

选择	化合物名称
☑	S
☑	CN

添加谱图 删除谱图

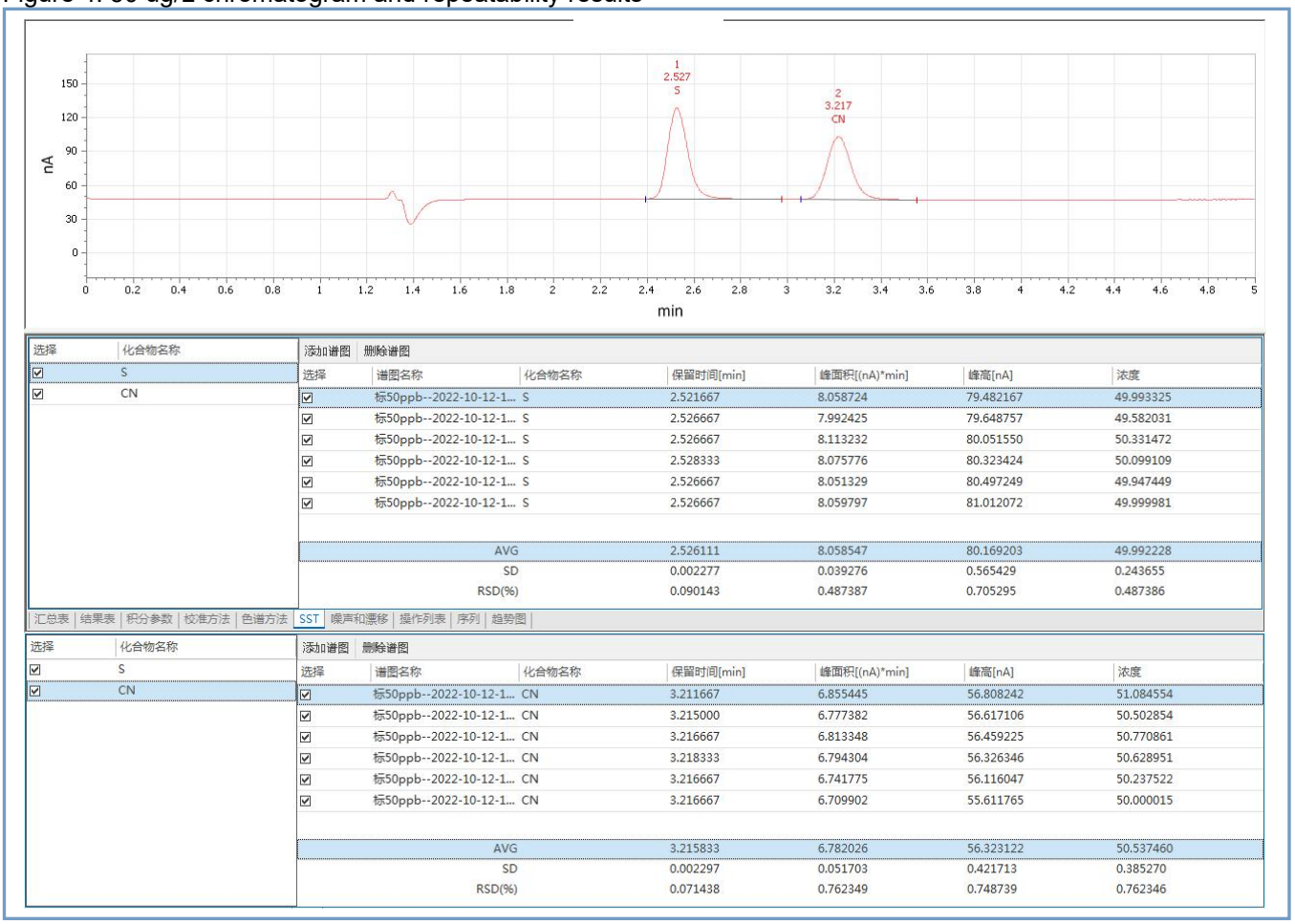
选择	谱图名称	化合物名称	保留时间[min]	峰面积[(nA)*min]	峰高[nA]	浓度
☑	标1ppb--2022-10-12-10:...	S	2.536667	0.142170	1.343932	0.988143
☑	标1ppb--2022-10-12-10:...	S	2.535000	0.140443	1.361100	0.976139
☑	标1ppb--2022-10-12-10:...	S	2.530000	0.150045	1.388000	1.042877
☑	标1ppb--2022-10-12-10:...	S	2.531667	0.140867	1.361718	0.979086
☑	标1ppb--2022-10-12-10:...	S	2.536667	0.140427	1.354477	0.976028
☑	标1ppb--2022-10-12-09:...	S	2.540000	0.146719	1.335927	1.019760
	AVG		2.535000	0.143445	1.357525	0.997006
	SD		0.003651	0.004017	0.017998	0.027918
	RSD(%)		0.144043	2.800243	1.325791	2.800194

选择	化合物名称
☑	S
☑	CN

添加谱图 删除谱图

选择	谱图名称	化合物名称	保留时间[min]	峰面积[(nA)*min]	峰高[nA]	浓度
☑	标1ppb--2022-10-12-10:...	CN	3.223333	0.196988	1.604080	0.944796
☑	标1ppb--2022-10-12-10:...	CN	3.220000	0.199841	1.605911	0.958479
☑	标1ppb--2022-10-12-10:...	CN	3.215000	0.206233	1.597065	0.989137
☑	标1ppb--2022-10-12-10:...	CN	3.216667	0.194858	1.564195	0.934580
☑	标1ppb--2022-10-12-10:...	CN	3.221667	0.201345	1.617024	0.965693
☑	标1ppb--2022-10-12-09:...	CN	3.225000	0.200613	1.607842	0.962182
	AVG		3.220278	0.199980	1.599353	0.959144
	SD		0.003861	0.003913	0.018390	0.018769
	RSD(%)		0.119897	1.956910	1.149847	1.956857

Figure 4: 50 ug/L chromatogram and repeatability results



选择	化合物名称
☑	S
☑	CN

添加谱图 | 删除谱图

选择	谱图名称	化合物名称	保留时间[min]	峰面积[(nA)*min]	峰高[nA]	浓度
☑	标50ppb--2022-10-12-1...	S	2.521667	8.058724	79.482167	49.993325
☑	标50ppb--2022-10-12-1...	S	2.526667	7.992425	79.648757	49.582031
☑	标50ppb--2022-10-12-1...	S	2.526667	8.113232	80.051550	50.331472
☑	标50ppb--2022-10-12-1...	S	2.528333	8.075776	80.323424	50.099109
☑	标50ppb--2022-10-12-1...	S	2.526667	8.051329	80.497249	49.947449
☑	标50ppb--2022-10-12-1...	S	2.526667	8.059797	81.012072	49.999981
	AVG		2.526111	8.058547	80.169203	49.992228
	SD		0.002277	0.039276	0.565429	0.243655
	RSD(%)		0.090143	0.487387	0.705295	0.487386

汇总表 | 结果表 | 积分参数 | 校准方法 | 色谱方法 | SST | 噪声和漂移 | 操作列表 | 序列 | 趋势图

选择	化合物名称
☑	S
☑	CN

添加谱图 | 删除谱图

选择	谱图名称	化合物名称	保留时间[min]	峰面积[(nA)*min]	峰高[nA]	浓度
☑	标50ppb--2022-10-12-1...	CN	3.211667	6.855445	56.808242	51.084554
☑	标50ppb--2022-10-12-1...	CN	3.215000	6.777382	56.617106	50.502854
☑	标50ppb--2022-10-12-1...	CN	3.216667	6.813348	56.459225	50.770861
☑	标50ppb--2022-10-12-1...	CN	3.218333	6.794304	56.326346	50.628951
☑	标50ppb--2022-10-12-1...	CN	3.216667	6.741775	56.116047	50.237522
☑	标50ppb--2022-10-12-1...	CN	3.216667	6.709902	55.611765	50.000015
	AVG		3.215833	6.782026	56.323122	50.537460
	SD		0.002297	0.051703	0.421713	0.385270
	RSD(%)		0.071438	0.762349	0.748739	0.762346

Detection limit

1 μg/L control sample was injected 7 times continuously, and the sulfur ion detection limit was 0.08 μg/L calculated according to the formula $\mathrm{MDL} = \mathrm{t}_{(\mathrm{n-1},0.99)} \times \mathrm{S}$, detection limit of cyanide is 0.07 μg/L.

选择	化合物名称
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☑	CN

添加谱图 | 删除谱图

选择	谱图名称	化合物名称	保留时间[min]	峰面积[(nA)*min]	峰高[nA]	浓度
☑	标1ppb--2022-10-12-10:...	S	2.536667	0.142170	1.343932	0.988143
☑	标1ppb--2022-10-12-10:...	S	2.535000	0.140443	1.361100	0.976139
☑	标1ppb--2022-10-12-10:...	S	2.530000	0.150045	1.388000	1.042877
☑	标1ppb--2022-10-12-10:...	S	2.531667	0.140867	1.361718	0.979086
☑	标1ppb--2022-10-12-10:...	S	2.536667	0.140427	1.354477	0.976028
☑	标1ppb--2022-10-12-09:...	S	2.540000	0.146719	1.335927	1.019760
☑	标1ppb--2022-10-12-09:...	S	2.533333	0.146667	1.380734	1.019399
	AVG		2.534762	0.143905	1.360841	1.000205
	SD		0.003392	0.003864	0.018625	0.026854
	RSD(%)		0.133832	2.684897	1.368633	2.684879

选择	化合物名称
☑	S
☑	CN

添加谱图 | 删除谱图

选择	谱图名称	化合物名称	保留时间[min]	峰面积[(nA)*min]	峰高[nA]	浓度
☑	标1ppb--2022-10-12-10:...	CN	3.223333	0.196988	1.604080	0.944796
☑	标1ppb--2022-10-12-10:...	CN	3.220000	0.199841	1.605911	0.958479
☑	标1ppb--2022-10-12-10:...	CN	3.215000	0.206233	1.597065	0.989137
☑	标1ppb--2022-10-12-10:...	CN	3.216667	0.194858	1.564195	0.934580
☑	标1ppb--2022-10-12-10:...	CN	3.221667	0.201345	1.617024	0.965693
☑	标1ppb--2022-10-12-09:...	CN	3.225000	0.200613	1.607842	0.962182
☑	标1ppb--2022-10-12-09:...	CN	3.231667	0.207240	1.599000	0.993966
	AVG		3.221905	0.201017	1.599302	0.964119
	SD		0.005563	0.004505	0.016788	0.021605
	RSD(%)		0.172677	2.240973	1.049728	2.240941

Precautions

During the experiment, the experimenters are required to operate in strict accordance with the operating procedures. Since sulfur ions are particularly easy to be oxidized, it is recommended to use 20 mmol/L sodium hydroxide solution prepared with highly pure water after decompression and degassing as the diluting solvent to minimize the oxidation of sulfur ions.

Feasibility analysis and conclusion

Through the above experiments, it is proved that the separation of this method is good, and this method is suitable for the determination of the content of components to be measured in samples.

Detection of phosphate in sewage

Introduction:

In the water environment, phosphorus exists in granular and dissolved forms. If it exceeds a certain limit, it will lead to the rapid proliferation of algae and plankton in the water, cause eutrophication, reduce dissolved oxygen in the water, and lead to deterioration of water quality. How to effectively control and prevent the eutrophication process of water body is still an important topic for the remediation of water environment pollution. The first step is to detect the phosphorus content. Ion chromatography has the advantage of fast and convenient detection of phosphate

Detection items (Table 1):

Anion	PO_4^{3-}

Keywords: Ion chromatography,phosphate,sewage

Instruments and equipment

- **Ion chromatograph**: CIC-D100
- **Eluent generator:** SHRF-10
- **Ultra pure water machine**:ECO-S15

Qingdao Shenghan Chromatograph Technology Co., Ltd

CIC-D100 **SHRF-10**

Requirements

Reagents

All reagents used are superior grade pure or better,Purchase certified standard solutions PO_4^{3-} (1000 mg / L).

Deionized Water

When preparing standard samples manually or diluting real samples, please use ASTM filtration and deionization requirements that meet the specifications listed in the table 2.

Table 2: Deionized water specification.

Specification	
Ions Resistivity	≥18.25MΩ·cm
Organics-TOC	<10ppb
Iron/Transition Metals	<1ppb
Pyrogens	<0.03Eu/mL
Particulates（>0.2μm）	<1unit/mL
Colloids-Silica	<10ppb
Bacteria	<1cfu/mL

Sample preparation

Accurately measure about 1000 μL high phosphorus sewage sample (weighing 0.9941g), place it in a 10 mL volumetric flask, and add water to dilute it to the scribe line. Pass H column, C18 column, pass 0.22 μm filter membrane, and conduct sample injection analysis.

Precisely measure about 2000 μL low phosphorus sewage sample (weighing 2.0105 g), place it in a 10 mL volumetric flask, and add water to dilute it to the scribe line. Pass H column, C18 column, pass 0.22 μ m filter membrane, and conduct sample injection analysis.

Chromatographic conditions (Table 3):

Instrument	CIC-D100
Eluent	0-5min 8mM KOH 5-10min 50mM KOH 10-18min 50mM KOH 18-23min 8mM KOH
Flow rate	1.0 mL/min
Injection volume	100 μL
Analytical Column	SH-AP-1
Column oven temperature	30℃
Conductivity cell temperature	35℃
Suppressor current	150 mA

Standard chromatogram

Standard chromatogram,As shown in below:

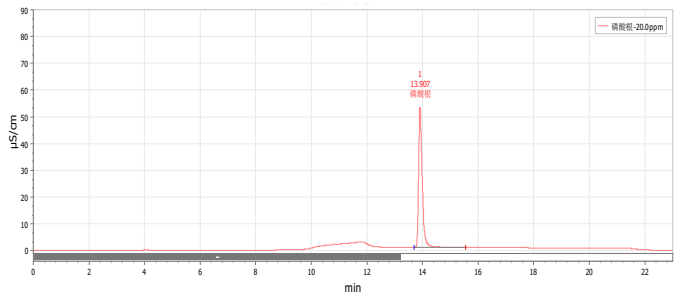


Figure 1. Chromatogram of phosphate standard sample.

Comparison testing (Blank)

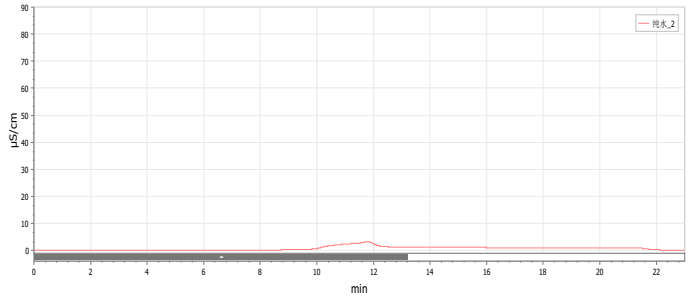


Figure 2. Chromatogram of Anion blank.

Sample chromatogram

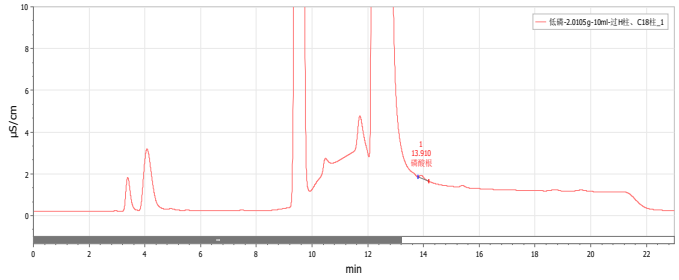


Figure 3. Chromatogram of low phosphorus sample

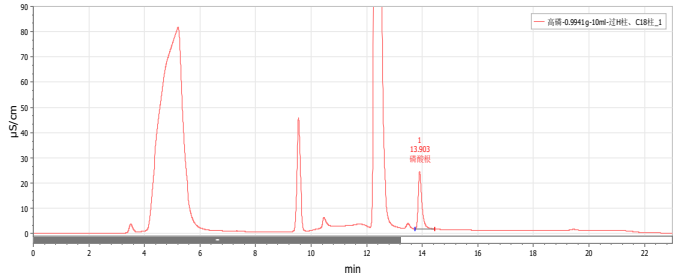


Figure 4. Chromatogram of high phosphorus sample

Results and calculations

Table 4:Sample test result

Sample	Weight(g)	Concentration	
		mg/L	%
Low phosphorus sample	2.0105	4.95	0.00049
High phosphorus sample	0.9941	94.4	0.00950

Remarks:

① ND indicates no detection or below the detection limit;

② The blank value has been deducted from the measured value;

③ The test results of different methods and laboratories will be different.

Precautions

It is easy to be polluted during the experiment, so the experimenter is required to operate in strict accordance with the operating procedures.

Feasibility analysis and conclusion

Through the above experiments, it is proved that the separation of this method is good, and this method is suitable for the determination of the content of components to be measured in samples.

Detection of multiple phosphates in food

Introduction:

Phosphorus is widely found in animal and plant tissues, and it is also one of the elements with more content in human body, accounting for about 1% of human body weight. The adult body contains about 600-900g of phosphorus. 85.7% of phosphorus in the body is concentrated in bone and teeth, and the rest is scattered in various tissues and body fluids, half of which is in muscle tissue. It not only constitutes human body components, but also participates in very important metabolic processes in life activities, and is a very important element of the body.

Therefore, it is necessary to determine the content of phosphate in food. Ion chromatography has the advantages of rapid and accurate determination of different phosphates.

Detection items (Table 1):

Anion	Phosphate	Pyrophosphate	Tripolyphosphate	Trimetaphosphate

Keywords: Ion chromatography,phosphate

Instruments and equipment

- **Ion chromatograph**: CIC-D180
- **Ultra pure water machine**:ECO-S15

Qingdao Shenghan Chromatograph Technology Co., Ltd

Requirements

Reagents

All reagents used are superior grade pure or better,Purchase certified standard solutions Phosphate, pyrophosphate, tripolyphosphate, trimetaphosphate (1000 mg / L).

Deionized Water

When preparing standard samples manually or diluting real samples, please use ASTM filtration and deionization requirements that meet the specifications listed in the table 2.

Table 2: Deionized water specification.

Specification	
Ions Resistivity	≥18.25MΩ·cm
Organics-TOC	<10ppb
Iron/Transition Metals	<1ppb
Pyrogens	<0.03Eu/mL
Particulates（>0.2μm）	<1unit/mL
Colloids-Silica	<10ppb
Bacteria	<1cfu/mL

Sample preparation

Weigh 2.5 g (accurate to 0.0001 g) of sample into a 150 mL conical flask, add 100 mL of sodium hydroxide solution (50 mmol/L), ultrasound in a 80 ℃ water bath for 30 min, place it at room temperature, centrifuge at 10000 r/min for 10 min, take the intermediate clear solution and pass it through C18 pretreatment column and 0.22 μM membrane injection analysis.

Chromatographic conditions (Table 3):

Instrument	CIC-D180
Eluent	KOH gradient
Flow rate	1.0 mL/min
Injection volume	25 μL
Analytical Column	SH-AC-16
Column oven temperature	30℃
Conductivity cell temperature	35℃
Suppressor current	120 mA

Standard chromatogram

Standard chromatogram,As shown in below:

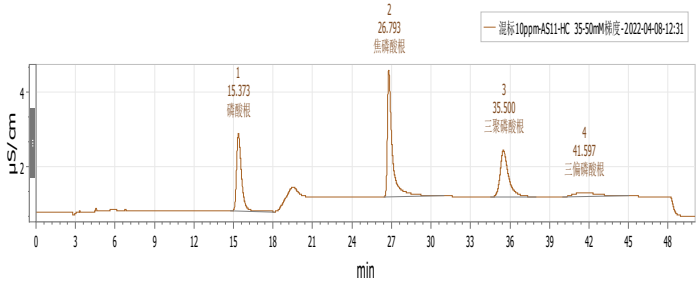


Figure 1. Chromatogram of standard sample.

Table 4: Concentration and area of standard.

Anion	Concentration（mg/L）	Area（μS/cm*min）
Phosphate	10	0.9136
Pyrophosphate	10	1.496
Tripolyphosphate	10	0.9091
Trimetaphosphate	10	0.2585

Sample chromatogram

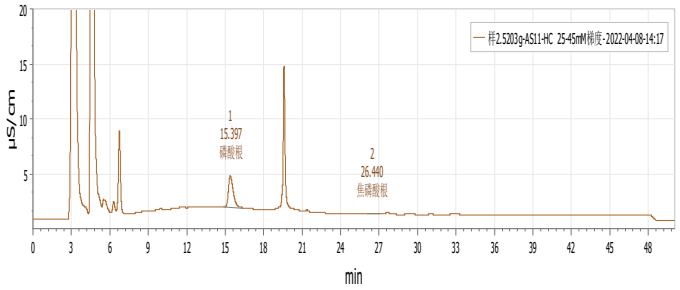


Figure 2. Chromatogram of sample

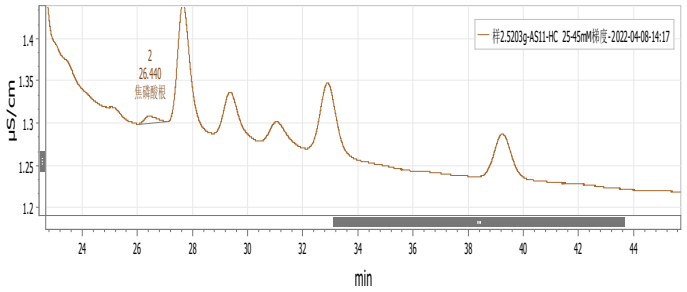


Figure 3. Enlarged view of sample

Results and calculations

Table 5:Sample test result

Phosphate	Pyrophosphate	Tripolyphosphate	Trimetaphosphate
539.0	0.8700	ND	ND

Unit:mg/kg

Note: The test results of different methods and laboratories will be different.

Precautions

It is easy to be polluted during the experiment, so the experimenter is required to operate in strict accordance with the operating procedures.

Feasibility analysis and conclusion

Through the above experiments, it is proved that the separation of this method is good, and this method is suitable for the determination of the content of components to be measured in samples.

Detection of nitrite and nitrate in molasses

Introduction:

In the growth process of sugar crops, excessive application of nitrogen fertilizer may lead to the accumulation of nitrate content in sugar raw materials (sugar beets), and in the subsequent processing, nitrate is reduced to nitrite by bacteria. Some sugar factories have started testing nitrate and nitrite in their packaging and factory sugar products to control product quality. This article uses an ion chromatograph to detect the content of nitrate and nitrite in raw materials of sugar products.

Detection items (Table 1):

Anion	NO_2^-	NO_3^-

Keywords: Molasses， Ion chromatography, Nitrite,Nitrate.

Instruments and equipment

- **Ion chromatograph**: CIC-D260
- **Ultra pure water machine**:ECO-S15

Qingdao Shenghan Chromatograph Technology Co., Ltd

Requirements

Reagents

Unless otherwise specified, all reagents used are superior grade. Commercially available certified standard solutions for nitrite and nitrate (1000 mg/L);

Deionized Water

When preparing standard samples manually or diluting real samples, please use ASTM filtration and deionization requirements that meet the specifications listed in the table 2.

Table 2: Deionized water specification.

Specification	
Ions Resistivity	≥18.25MΩ·cm
Organics-TOC	<10ppb
Iron/Transition Metals	<1ppb
Pyrogens	<0.03Eu/mL
Particulates（>0.2μm）	<1unit/mL
Colloids-Silica	<10ppb
Bacteria	<1cfu/mL

Chromatography conditions

Table 3: Analysis conditions

Instrument	CIC-D260
Eluent	0-30 min 6 mM KOH 30-45 min 50 mM KOH
Flow rate	0.7 mL/min
Injection volume	100 μL
Analytical Column	SH-AP-1
Column oven temperature	35℃
Conductivity cell temperature	35℃
Suppressor current	120 mA

Sample preparation

Molasses sample: Accurately weigh 2 g (accurate to 0.0001 g) of the sample and place it in a 50 mL sterilized centrifuge tube. Dissolve it in water and sonicate, make up to the mark, centrifuge at 10000 r/min for 10 minutes. The supernatant passing through a C18 solid-phase extraction column, passed through 0.22 μm nylon filter membrane,inject sample analysis.

Standard chromatogram

Standard chromatogram, As shown in below:

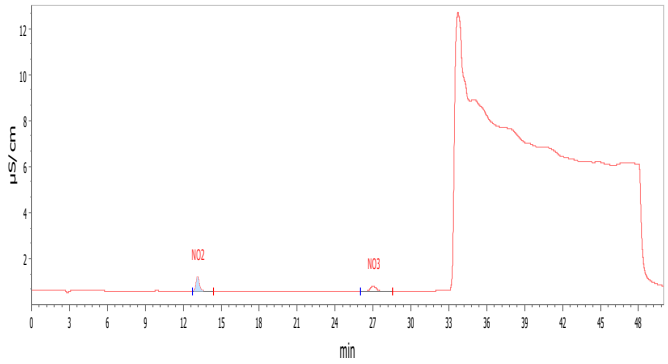


Figure 1. Chromatogram of standard sample.

Sample chromatogram

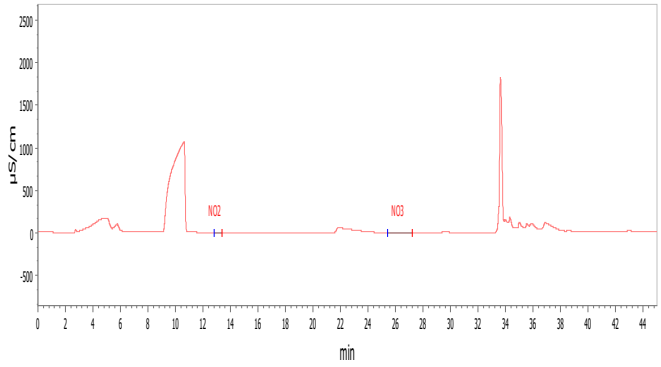


Figure 2. Chromatogram of sample

Results and calculations

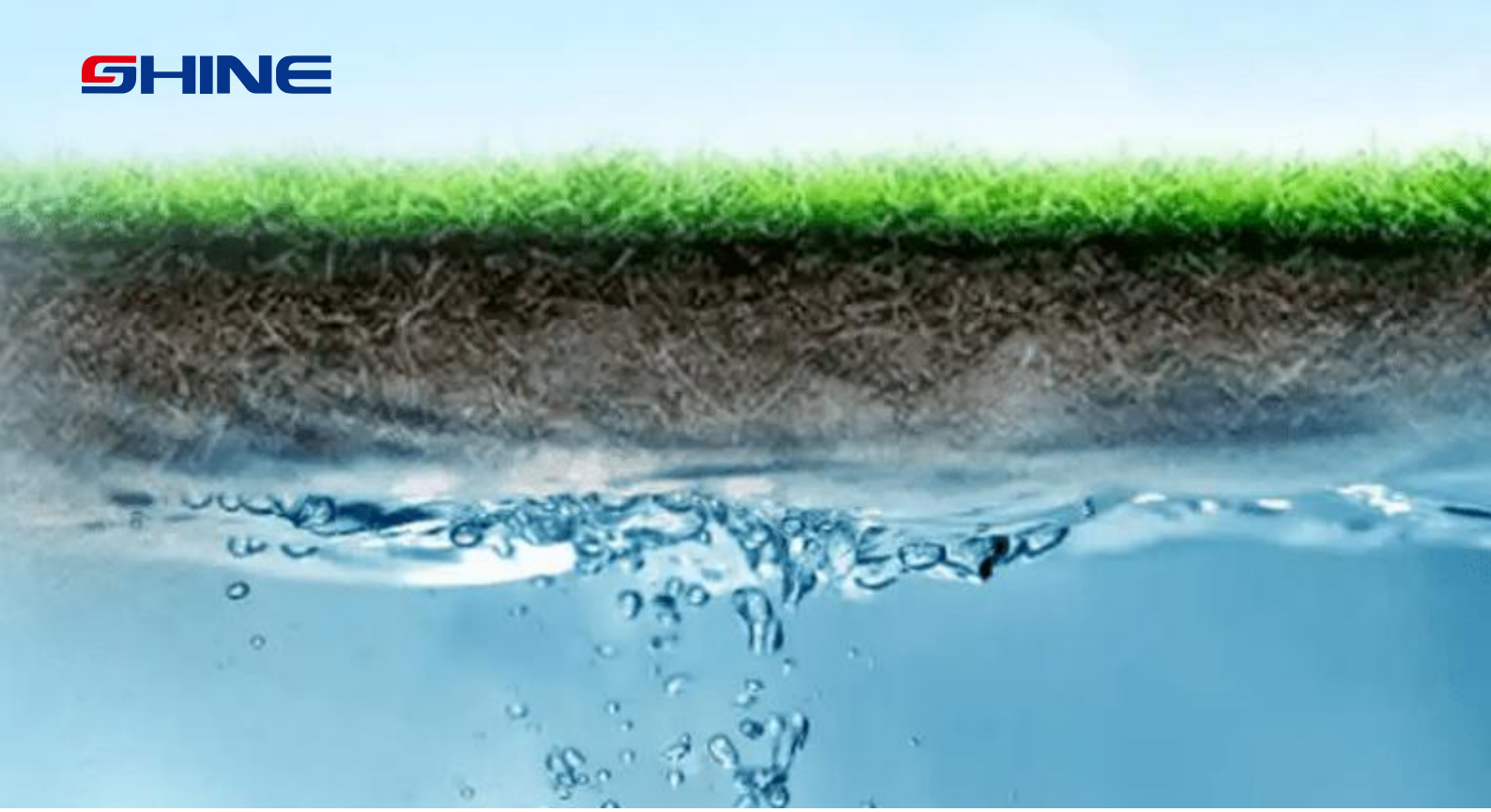
Table 7: Sample test result (mg/L)

Anion	NO_2^-	NO_3^-
	0.65	0.378

Remarks: ① The measured value has been deducted from the blank value; ② There may be differences in testing results between different methods and laboratories;

Feasibility analysis and conclusion

The above experiments prove that the detection method has good resolution and is suitable for the determination of the content of the components to be measured in the sample.



Detection of anions in groundwater

Introduction:

Anions refer to ions with negative charges, commonly including nitrate ions, chloride ions, sulfate ions, etc. Measuring the anion content in groundwater can help us understand the water quality status of groundwater, which is of great significance for environmental protection and water resource management.

Detection items (Table 1):

Anion	F^-	Cl^-	NO_2^-	NO_3^-	SO_4^{2-}

Keywords: Groundwater， Ion chromatography

Instruments and equipment

- **Ion chromatograph**: CIC-D160$^+$
- **Ultra pure water machine**:ECO-S15

Qingdao Shenghan Chromatograph Technology Co., Ltd

Requirements

Reagents

Unless otherwise specified, all reagents used are superior grade. Commercially available certified standard solutions for F^-、Cl^-、NO_2^-、NO_3^-、SO_4^{2-} (1000 mg/L);

Deionized Water

When preparing standard samples manually or diluting real samples, please use ASTM filtration and deionization requirements that meet the specifications listed in the table 2.

Table 2: Deionized water specification.

Specification	
Ions Resistivity	≥18.25MΩ·cm
Organics-TOC	<10ppb
Iron/Transition Metals	<1ppb
Pyrogens	<0.03Eu/mL
Particulates（>0.2μm）	<1unit/mL
Colloids-Silica	<10ppb
Bacteria	<1cfu/mL

Chromatography conditions

Table 3: Analysis conditions

Instrument	CIC-D160⁺
Eluent	0-18 min，15 mM KOH 18-28 min，28 mM KOH 28-33 min，15 mM KOH
Flow rate	0.7 mL/min
Injection volume	25 μL
Analytical Column	SH-AP-1
Column oven temperature	35℃
Conductivity cell temperature	35℃
Suppressor current	60 mA

Sample preparation

After passing through the 0.22um filter membrane, the sample is directly tested on the ion chromatography. And conduct a blank water control experiment.

Standard chromatogram

Standard chromatogram, As shown in below:

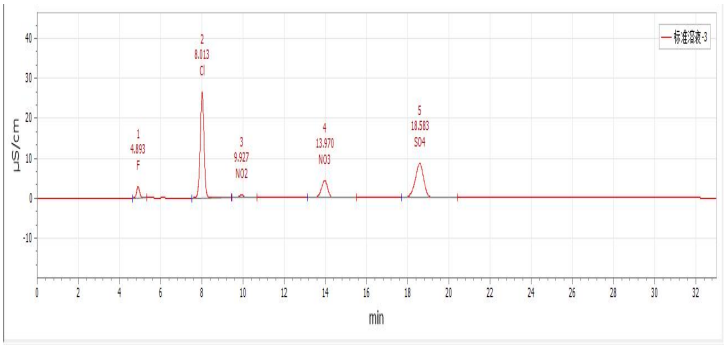


Figure 1. Chromatogram of standard sample.

Blank chromatogram

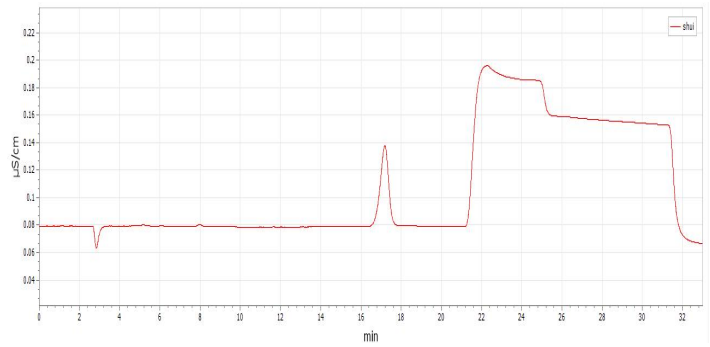


Figure 2. Chromatogram of blank

Sample chromatogram

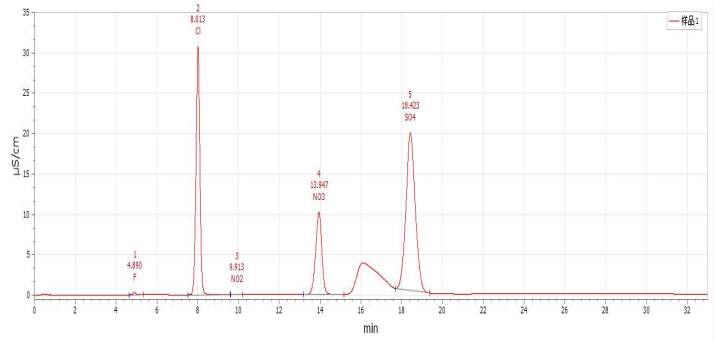


Figure 3. Chromatogram of sample 1#

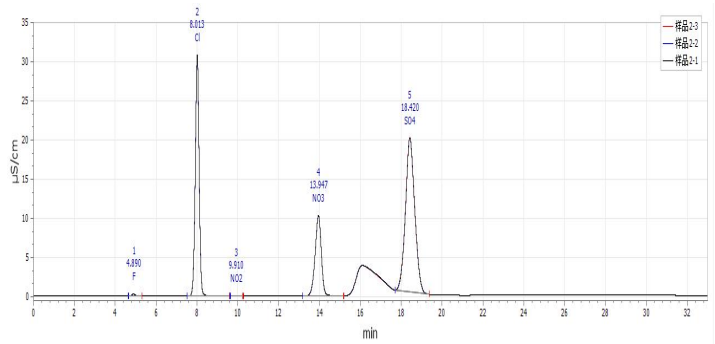


Figure 4. Overlay 3 times of sample 2#

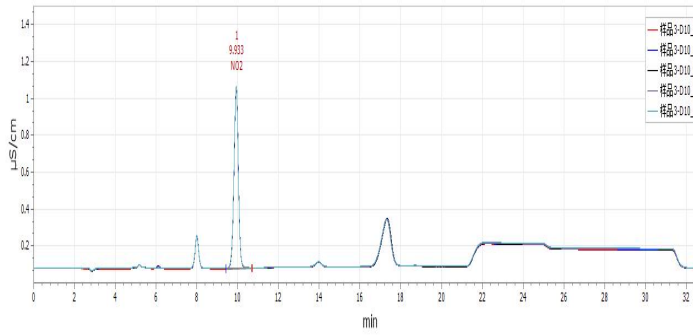


Figure 2. Overlay 5 times of sample 3#

Results and calculations

Table 4: Sample test result (mg/L)

Anion	F^-	Cl^-	NO_2^-	NO_3^-	SO_4^{2-}
1#	0.0553	11.778	0.0272	11.331	24.628
2#	0.0524	11.803	0.0270	11.358	24.808
3#	0.0136	0.695	6.392	0.411	0.134

Remarks: ① The measured value has been deducted from the blank value; ② There may be differences in testing results between different methods and laboratories;

Feasibility analysis and conclusion

The above experiments prove that the detection method has good resolution and is suitable for the determination of the content of the components to be measured in the sample.

Detection of chlorate and perchlorate in milk

Introduction:

Chlorate is a byproduct produced during the disinfection process. If chlorine containing disinfectants are used in milk production, it may lead to excessive levels of chlorate. Secondly, chlorine containing cleaning agents used in milking and milk processing plants may also be sources of pollution. In addition, if animal feed contains perchlorates, these substances may enter milk.

Perchlorate has certain hazards to the human body, such as hindering the absorption of iodine by the thyroid gland, damaging red blood cells, and affecting the function of blood in transporting oxygen. This article uses ion chromatography to determine the content of chlorate and perchlorate in milk.

Detection items (Table 1):

Anion	ClO_3^-	ClO_4^-

Keywords: Chlorate，Perchlorate，Milk， Ion chromatography

Instruments and equipment

- **Ion chromatograph**: CIC-D180
- **Ultra pure water machine**:ECO-S15

Qingdao Shenghan Chromatograph Technology Co., Ltd

Requirements

Reagents

Unless otherwise specified, all reagents used are superior grade. Commercially available certified standard solutions for ClO_3^- ,ClO_4^- (1000 mg/L).

Deionized Water

When preparing standard samples manually or diluting real samples, please use ASTM filtration and deionization requirements that meet the specifications listed in the table 2.

Table 2: Deionized water specification.

Specification	
Ions Resistivity	≥18.25MΩ·cm
Organics-TOC	<10ppb
Iron/Transition Metals	<1ppb
Pyrogens	<0.03Eu/mL
Particulates（>0.2μm）	<1unit/mL
Colloids-Silica	<10ppb
Bacteria	<1cfu/mL

Chromatography conditions

Table 3: Analysis conditions

Instrument	CIC-D180
Eluent	0-14 min 8 mM KOH 14.1-45 min 35 mM KOH 45.1-50 min 8 mM KOH
Flow rate	1.0 mL/min
Injection volume	500 μL
Analytical Column	IonPac AG19+IonPac AS19
Column oven temperature	30℃
Conductivity cell temperature	35℃
Suppressor current	100 mA

Sample preparation

Weigh about 2 mL of milk sample, add 2 mL of acetonitrile, and flocculent precipitate will be found. Then add 4 mL of ultrapure water, vortex for 30 seconds, centrifuge at 8000 r/min for 5 minutes, take 1 mL of supernatant and make up to 10 mL, vortex well,pass through activate C18 pre-treatment column with 0.22 μm filter membrane, and perform ion chromatography test.

Standard chromatogram

Standard chromatogram, As shown in below:

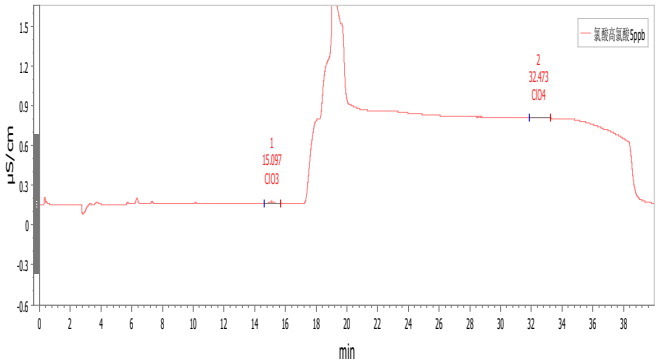


Figure 1. Chromatogram of standard sample.

Table 4: Standard sample result

Ions	Time[min]	c[mg/L]	Area[(μS/cm)*min]
$ClO3^-$	15.096667	0.005000	0.004547
$ClO4^-$	32.473333	0.005000	0.003449

Blank chromatogram

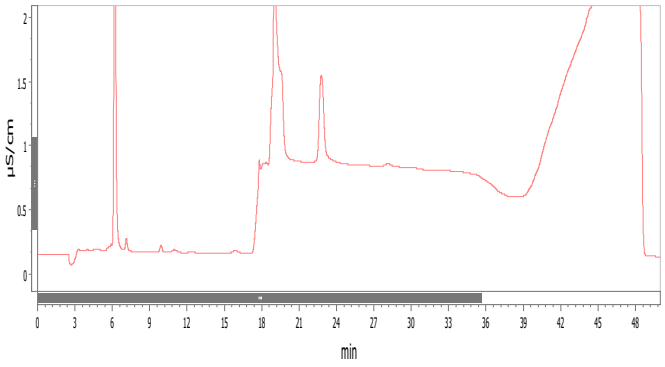


Figure 2. Chromatogram of blank

Sample chromatogram

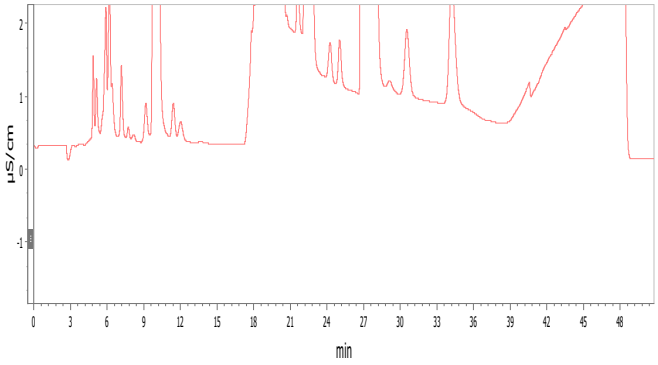


Figure 3. Chromatogram of sample

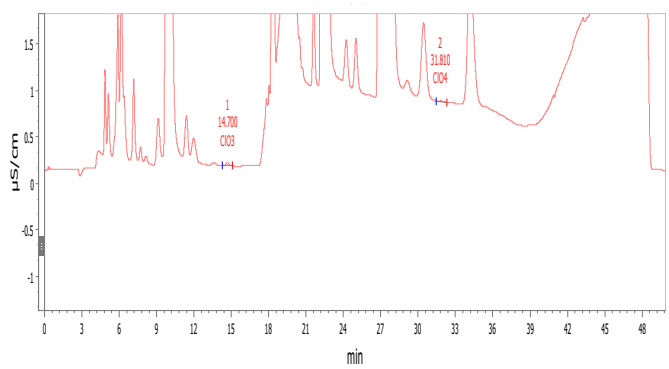


Figure 4. Chromatogram of sample add standard

Results and calculations

Table 5: Sample test result (unit: mg/L)

Sample	ClO_3^-	ClO_4^-
1	ND	ND

Remarks: ① ND indicates that the result was not detected or was below the detection limit. ② There may be differences in testing results between different methods and laboratories.

Feasibility analysis and conclusion

Through the above experiments, it has been proven that the detection method has good separation and is suitable for the determination of the content of the components to be tested in the sample. After testing, the detection limit of the method for chlorates and perchlorates in actual sample milk is 0.5 mg/kg.