GEE PackTest Kits
FOR CHEMICAL ANALYSIS

Operation Manual

Model GE Lab Int Water Quality Analyzer

Model GE Lab Int02

Model GE Lab Int02+

Corporation Web Site | Operation Video | GEE Analyst app. | Purchase from TaoBaoWeb

Shanghai GreenEmpire Environm. Technol. Corporation, China

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Supplementary Materials

1 Operation of Water Quality Analyzer

Fig. 1 Water Quality Analyzer and its HomePage

1.1 Operation Procedures

(1) Zero Calibration

- ✓ Turn on the analyzer to appear from the power logo (**Fig. 2a**) to the initial HomePage (**Fig. 2b**).
- ✓ In most cases, distilled water is used as a reference for zero calibration. Take 5 – 10 mL of distilled water into a colorimetric bottle and place it in the measuring well.
- ✓ Click the icon 

2 - 3 times. The RGB signals will be updated within seconds (**Fig. 2c**).

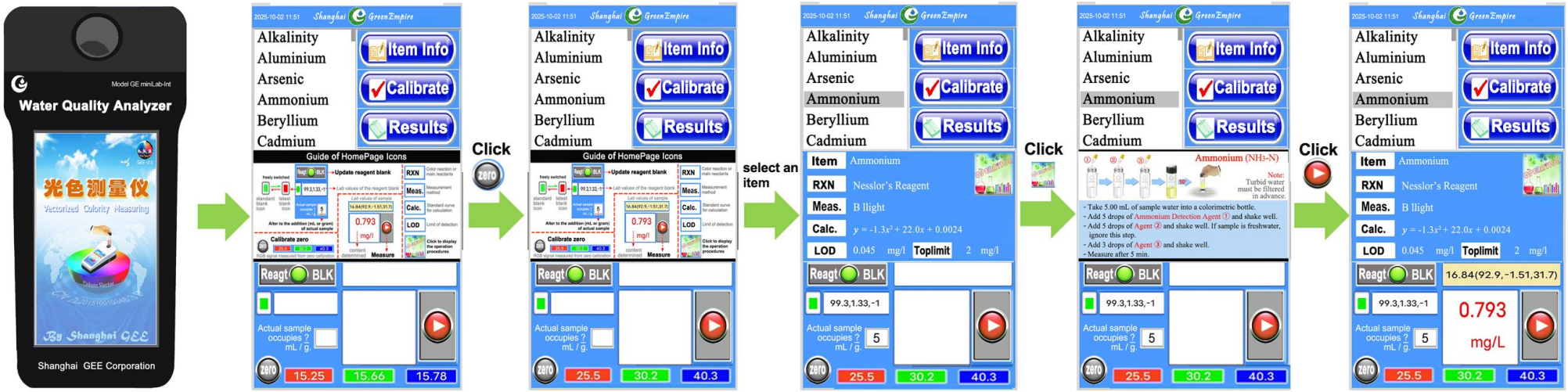


Fig. 2 Illustration of the Analyzer's Operation

(2) Measurement

✓ Prepare the chromogenic reaction of the water sample in a colorimetric bottle according to the operation procedures listed in **Table 1**.

✓ Select the item (e.g. Ammonium) to be tested from the HomePage's menu. The analyzer will load its basic information automatically, including reagent blank signal, coloring reaction or main reactants, measuring method, calibration curve, limit of detection (LOD), and top limit (**Fig. 2d**). Click the icon  to display the operation procedures (**Fig. 2e**).

- ✓ Insert the prepared colorimetric bottle into the measurement well of the analyzer. Click icon  to measure the colorized water sample. The result will be displayed within seconds (**Fig. 2f**). All results, containing measurement time, location (NL/EL), item name, and result, will be automatically saved in an Excel file. Results can be viewed by clicking 

, and copied to a U disk, or sent remotely *via* Email (Internet access should be connected in advance *via* WiFi by clicking  to perform the setting.).

Kind Tips

- ✓ All examinations must be performed using the GEE Test Kits. Store the Test kits in a cool, dry site, and out of the reach of children. If the conditions permit, they may be stored in a refrigerated cabinet at 4 - 8℃.
- ✓ It is recommended that the qualified users regularly calibrate the standard curve of the tested item（see '**Calibration curve',** pages 18 - 19）to improve the accuracy of results.

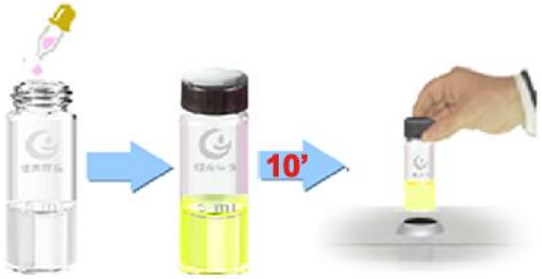
Table 1 Operation of sample water colorizing using GEE Test kits

- Physical parameters and nonmetal compounds

Items	Preparation of Chromogenic Solution	Illustration of Operation Procedures	Notes and Suggestion
Transparency	– Take 5 -10 mL of sample water into a colorimetric bottle. – Measure three times and take the average.		● Repeat thrice for mean
Colority			● Turbid water must be filtered in advance.
Suspended solids (SS) / Turbidity			● Before measuring, click "**Calibrate**" to open a window. Accurately select the corresponding parameters. ● Click "**Confirm**" and "**Exit**".
pH	– Take 5.00 mL of sample water (pH range: 4 - 10) into a colorimetric bottle. – Add 2 drops of pH Detection Agent and shake well. – Measure after 2 min.		● Suitable for clean water ● Turbid water must be filtered in advance.

Ammonium (NH_3-N)	– Take 5.00 mL of sample water (< 2 mg/l NH_3-N) into a colorimetric bottle. – Add 5 drops of Ammonium Detection Agent ① and shake well. – Add 5 drops of Agent ② and shake well. – Add 3 drops of Agent ③ and shake well. – Measure after 5 min.		● Turbid water must be filtered in advance. ● If the water sample shows serious interference, use a heating digester (see Table S1).
Nitrite (NO_2^--N)	– Take 5.00 mL of sample water (< 0.1 mg/l NO_2^--N) into a colorimetric bottle. – Add 6 drops of Nitrite Detection Agent and shake well. – Measure after 15 min.		● Turbid water must be filtered in advance.
Nitrate (NO_3^--N)	– Take 5.00 mL of sample water (< 2 mg/l NO_3^--N) into a colorimeric bottle. – Add Nitrogen Detection Agent ① powder (capsulated) and shake vigorously for 1 min. – After precipitation is complete, transfer 0.500 mL of the supernatant into another colorimetric bottle and dilute to 5 mL with distilled water. – Add 6 drops of Agent ② and shake well. – Measure after 15 min.		● Nitrate content = measured content – nitrite

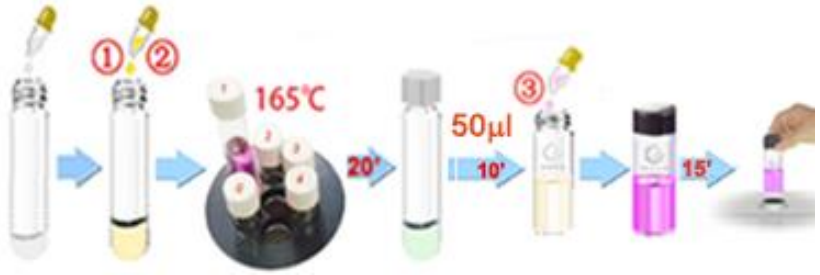
Total nitrogen (TN)	– Use a heating digester to prepare the sample according to standard procedures.		● See also Table S1
Phosphate (PO_4^{3-}-P)	– Take 5.00 mL of sample water (< 0.7 mg/l PO_4^{3-}-P) into a colorimetric bottle. – Add Phosphorus Detection Agent ① powder (capsulated) and shake until dissolved. – Add 0.30 mL of Agent ② and shake well. – Measure after 10 min.		● Turbid water must be filtered in advance.
Total phosphorus (TP)	– Use a heating digester to prepare the sample according to standard procedures.		● See also Table S1
Dissolved oxygen (O_2)	– Immerse a DO tube- sampling under the water surface until it is full. – Place 2 glass beads and add 1 drop each of DO Detection Agtens ① and ② respectively. – Tighten the bottle cap and shake well for 5 min. Add 2 drops of Agent ③ and 1 drop of Agent ②, shakeing until the precipitate dissolved. – Transfer all solution into a colorimetric bottle, dilute to 10 mL, and shake well. – If the solution is turbid, perform filteration. – Measure immediately.		● Suitable for natural water

Hydrogen peroxide (H_2O_2)	– Take 5.00 mL of sample water (< 30 mg/l H_2O_2) into a colorimetric bottle. – Add 6 drops of Hydrogen Peroxide Detection Agent and shake well. – Measure after 10 min.		● Turbid water must be filtered in advance.
Ozone (O_3) / Chlorine dioxide (ClO_2)	– Take 5.00 mL of sample water (< 1 mg/l O_3 or < 3 mg/l ClO_2) into a colorimetric bottle. – Add the O_3/ClO_2 Detection Agent powder (capsulated) and shake until dissolved. – Measure after 5 min.		● Turbid water must be filtered in advance.
Sulfide (S^{2-})	– Take 5.00 mL of sample water (< 1 mg/l S^{2-}) into a colorimetric bottle. – Add 3 drops of Sulfide Detection Agent and shake well. – Measure after 10 min.		● The serious interference in sample water requires the use of a Sample Processor (see also Table S2).
Sulphate (SO_4^{2-})	– Take 5.00 mL of sample water (< 100 mg/l SO_4^{2-}) into a colorimetric bottle. – Add Sulphate Detection Agent powder (capsulated) and then shake for 1 min. – After 5 min, measure three times and take the average.		● Turbid water must be filtered in advance.

Dissolved silica (SiO_2)	– Take 5.00 mL of sample water (< 30 mg/l SiO_2) into a colorimetric bottle. – Add 0.40 mL of Silica Detection Agent ① and shake well. – After 5 min, add Agent ② powder (capsulated) and shake until dissolved. – Measure after 5 min.		● Turbid water must be filtered in advance.
Alkalinity	– Take 10.0 mL of sample water (< 100 mg/l $CaCO_3$) into a colorimetric bottle. – Add Alkalinity Detection Agent powder (capsulated) and mix for 1 min. – After 10 min, measure three times and take the average.		● Turbid water must be filtered in advance. ● The reagent blank should be prepared and measured on the same day.
Free carbon dioxide (CO_2)	– Take 5.00 mL of sample water (< 30 mg/l CO_2) into a colorimetric bottle. – Add 0.20 mL each of Carbon Dioxide Detection Agents ① and ② respectively. Shake well after each addition. – Measure after 2 min.		● The reagent blank should be prepared and renew as follows. Add 1 drop of 2 mol/l NaOH into a colorimetric bottle filling with 5.00 ml of distlled water. The successive procedure accords with that of the sample water.
Fluoride (F^-)	– Take 5.00 mL of sample water (< 0.40 mg/l F^-) into a colorimetric bottle. – Add 0.20 mL of Fluoride Detection Agent ① and 0.80 mL of Agent ②, respectively. Shake well after each addition. – Measure after 15 min.		● Turbid water must be filtered in advance. ● The reagent blank should be prepared and measured on the same day.

Chloride (Cl^-)	– Take 5.00 mL of sample water (< 5 mg/l Cl^-) into a colorimetric bottle. – Add 5 drops each of Chloride Detection Agents ① and ②, respectively. Shake well after each addition. – Measure after 10 min.		● Turbid water must be filtered in advance.
Residual chlorine (Cl_2)	– Take 5.00 mL of sample water (< 1 mg/l Cl_2) into a colorimetric bottle – Add 3 drops of Chlorine Detection Agent and shake well. Measure immediately for free chlorine. – Measure again after 10 min for total chlorine.		● Turbid water must be filtered in advance.
Total cyanide (CN^-)	– Use a multifunctional sample processor to prepare the sample according to standard procedures.		● see **Table S2**
Methanal	– Take 5.00 mL of sample water (< 0.3 mg/l methanal) into a colorimetric bottle. – Add 5 drops each of Methanal Detection Agents ① and ② in sequence and shake well. – After 20 min, add 0.20 mL of Agent ③ and shake well. – Measure after 5 min.		● Turbid water must be filtered in advance.

Volatile phenols	– Take 5.00 mL of sample water (< 2 mg/l Phenol) into a colorimetric bottle. – Add Phenol Detection Agent powder (capsulated) and shake until dissolved. – After 10 min, filter and measure the filtrate.		● Turbid water must be filtered in advance. ● If the water sample shows serious interference, use a heating digester（see **Table S1**）.
Hydrazine	– Take 5.00 mL of sample water (< 0.4 mg/l hydrazine) into a colorimetric bottle. – Add 0.80 mL of Hydrazine Detection Agent ① and shake well. – Add Agent ② powder (capsulated) and shake until dissolved. – Measure after 10 min.		● Turbid water must be filtered in advance.
Trinitro compound (TNC)	– Take 5.00 mL of sample water (< 4 mg/l TNC) into a colorimetric bottle. – Add TNC Detection Agent powder (capsulated) and shake until dissolved. – Measure after 5 min.		
Cyanuric acid	– Take 5.00 mL of sample water (< 70 mg/l cyanuric acid) into a colorimetric bottle. – Add Cyanuric Acid Detection Agent powder (capsulated) and mix for 1 min. – After 5 min, measure three times and take the average.		

<table>
<tr><td>TOC</td><td>– Use a heating digester to prepare the sample according to standard procedures.</td><td> 
</td><td>● see Table S1</td></tr>
<tr><td>COD</td><td>– Use a heating digester to prepare the sample according to standard procedures.</td><td> 
</td><td rowspan="3">● see Table S1</td></tr>
<tr><td>CODMn</td><td rowspan="2">– Use a heating digester or a water bath device to prepare the sample according to standard procedures.</td><td> 
</td></tr>
<tr><td>Urea</td><td> 
</td></tr>
</table>

● Metal ions

Items	Preparation of Chromogenic Solution	Illustration of Operation Procedures	Notes and Suggestion
Sodium (Na)	– Take 1.00 mL of sample water (< 30 mg/l Na^+) into a colorimetric bottle. – Add 5 mL of anhydrous ethanol and shake well. – Add 0.20 mL of Sodium Detection Agent and shake well. – After 5 min, measure three times and take the average.		● Turbid water must be filtered in advance. ● The reagent blank should be prepared and measured on the same day.
Potassium (K)	– Take 5.00 mL of sample water (< 3 mg/l K^+) into a colorimetric bottle. – Add Potassium Detection Agent powder (capsulated) and mix for 1 min. – After 5 min, measure three times and take the average.		
Magnesium (Mg)	– Take 5.00 mL of sample water (< 10 mg/l Mg^{2+}) into a colorimetric bottle. – Add 0.20 mL each of Magnesium Detection Agents ① and ② in sequence. Shake well after each addition. – Measure after 5 min.		
Hardness	– Take 5.00 mL of sample water (< 500 mg/l $CaCO_3$) into a colorimetric bottle. – Add 5 drops of Hardness Detection Agent ① and 0.20 mL of Agent ②. Shake well after each addition. – Measure after 2 min.		

Beryllium (Be)	– Take 5.00 mL of sample water (< 0.1 mg/l Be^{2+}) into a colorimetric bottle. – Add 0.20 mL each of Beryllium Detection Agents ① and ② respectively, and shake well. – Measure after 20 min.		● Turbid water must be filtered in advance. ● The reagent blank should be prepared and measured on the same day..
Aluminium (Al)	– Take 5.00 mL of sample water (< 0.2 mg/l Al^{3+}) into a colorimetric bottle. – Add 0.20 mL each of Aluminium Detection Agents ① and ② respectively and shake well. – Measure after 10 min.		
Manganese (Mn)	– Take 5.00 mL of sample water (< 5 mg/l Mn^{2+}) into a colorimetric bottle. – Add Manganese Detection Agent powder (capsulated) and mix until dissolved. – Measure after 10 min.		● Turbid water must be filtered in advance.
Hexavalent chromium (Cr^{6+})	– Take 5.00 mL of sample water (< 0.5 mg/l Cr^{6+}) into a colorimetric bottle. – Add 3 drops of Chromium Detection Agent and shake well. – Measure after 15 min.		● Turbid water must be filtered in advance. ● Total amounts of the metal must use a heatng digestor to prepare the sample according to standard procedures (see Table S1).

Iron (Fe)	– Take 5.00 mL of sample water (< 5 mg/l **Fe**$^{2+/3+}$) into a colorimetric bottle. – Add Iron Detection Agent powder (capsulated) and mix until dissolved. – Measure after 10 min.		● Turbid water must be filtered in advance. ● Total amounts of the metal must use a heatng digestor to prepare the sample according to standard procedures (see Table S1).
Nickel (Ni)	– Take 5.00 mL of sample water (< 2 mg/l Ni^{2+}) into a colorimetric bottle. – Add 3 drops each of Nickel Detection Agents ①, ② and ③ in sequence. Shake well after each addition. – Measure after 10 min.		
Copper (Cu)	– Take 5.00 mL of sample water (< 1 mg/l Cu^{2+}) into a colorimetric bottle. – Add 5 drops of Copper Detection Agent ① and shake well. – Add Agent ② powder (capsulated) and mix until dissolved. – Measure after 10 min.		
Zinc (Zn)	– Take 5.00 mL of sample water (< 0.2 mg/l Zn^{2+}) into a colorimetric bottle. – Add 0.20 mL of Zinc Detection Agent ① and shake well. – After 5 min, add 5 drops of Agent ② and shake well. – Measure after 5 min.		● Turbid water must be filtered in advance. ● Total amounts of the metal must use a heatng digestor to prepare the sample according to standard procedures (see Table S1). ● The reagent blank should be prepared and measured in advance.

Cadmium (Cd)	– Take 5.00 mL of sample water (< 0.3 mg/l Cd^{2+}) into a colorimetric bottle. – Add 3 drops of Cadmium Detection Agent ① and 0.20 mL of Agent ②. Shake well after each addition. – Measure after 5 min.		● Turbid water must be filtered in advance. ● Total amounts of the metal must use a heatng digestor to prepare the sample (see Table S1). ● A reagent blank should be prepared and measured on the same day.
Lead (Pb)	– Take 5.00 mL of sample water (<5 mg/l Pb^{2+}) into a colorimetric bottle. – Add 0.40 mL of Lead Detection Agent and shake well. – Measure after 5 min.		
Metals mixture	– Take 5.00 mL of sample water (< 1 mg/l metals) into a colorimetric bottle. – Add 5 drops of Metals Mixture Detection Agent ① and 0.20 mL of Agent ② respectively. Shake well after each addition. – Measure after 5 min. Note: As a precheck method, it indicates one or several metals ions mixing of Fe^{2+}, Co^{2+}, Ni^{2+}, Cu^{2+}, Zn^{2+} and Cd^{2+}.		
Arsenic (As)	– Use a multifunctional sample processor to prepare the sample according to standard procedures.		● see Table S2 and Fig. S3

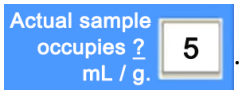
1.2 Notes and Suggestions

Battery status

- ✓ After turning on the analyzer, check the status of light-indicator on the top panel:
  - If "Green" or "Yellow", Analyzer can be used normally.
  - If "Red", Analyzer needs to be charged using a 12 V DC power adapter.

Pretreatment and colorization of sample water

- ✓ The analyzer is suitable for rapid detection of natural water and domestic sewage. For complex wastewater, a pretreatment is recommended according to relevant standard methods before color reaction (e.g. decolorization, distillation, extraction, etc).
- ✓ Sample water should be approximately neutral (pH 5 to 8). Industrial wastewater should be tested with pH paper in advance. If necessary, adjust the pH with the diluted sodium hydroxide or sulfuric acid solution.
- ✓ Turbid samples with transparency < 2 m must be filtered using the glass fiber filter (pore size of 0.7 μm), except for determinations of Transparency, Suspended solid, Turbidity, DO, free CO_2 and COD.
- ✓ Color reactions should be performed at 20 - 30℃.
- ✓ Pipette usage: Always use the pipette vertically adding liquids, including liquid etection Agents. For a high-concentration sample, use small volume (*e.g.* 0.5 mL)



. Ajust the added volume according to actual water (e.g. 0.5 mL) so that the measured reflets the actual content.

- ✓ Powder- capsulated agents: Hold the capsule upright, gently flick the capsule shell with fingers, and unscrew the capsule cap, and pour all the powder into the

colorimetric bottle.

Introduction of the HomePage

The meanings of all the icons displayed on the HomePage are marked in **Fig. 3**.

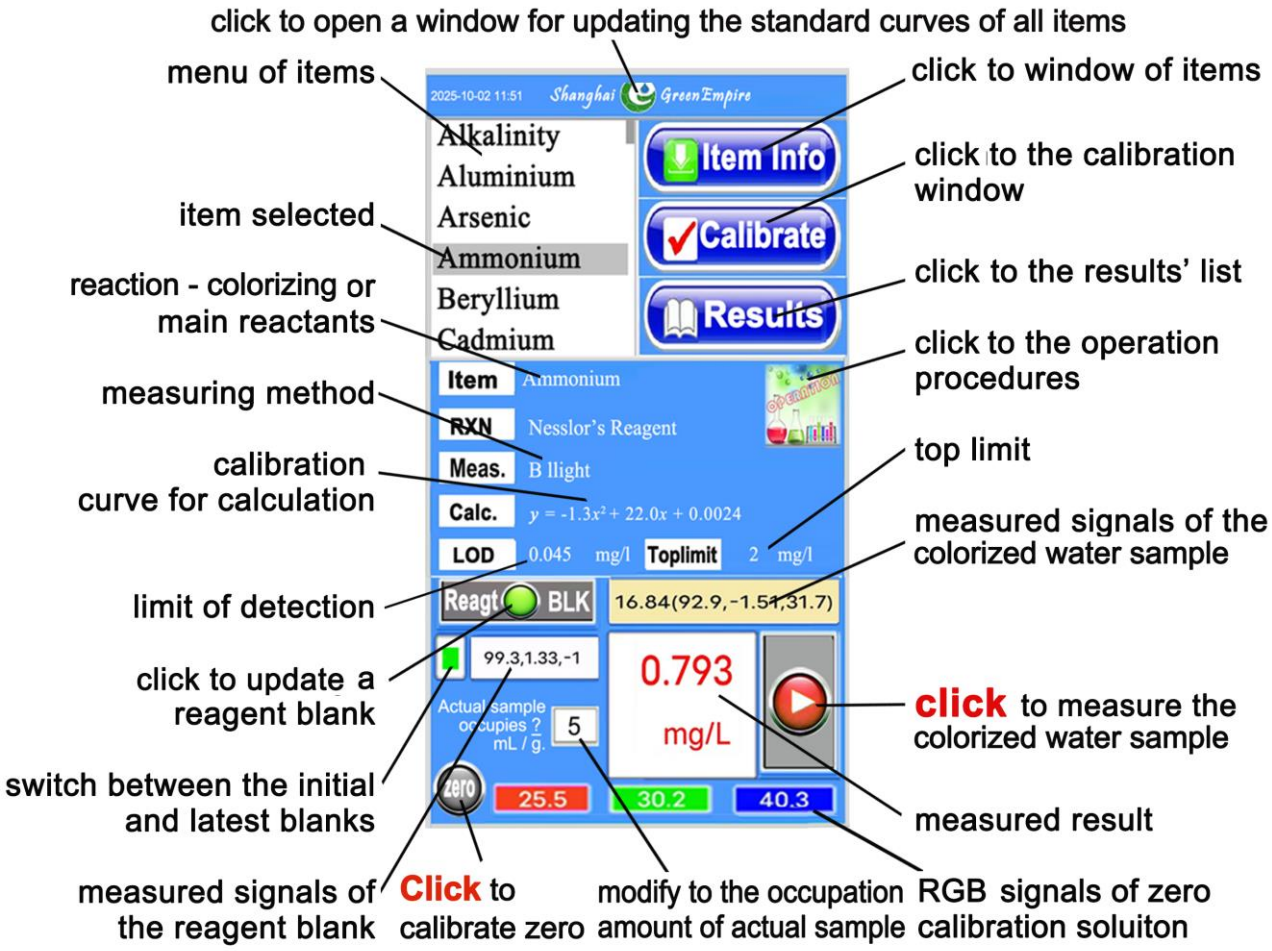


Fig. 3 Introduction of the HomePage

clickable icon (frequently used for zero calibration): Click to display the RGB parameters of a reference solvent (*e.g.* distilled water, organic solvent), zero calibration can be performed immediately after turning on the analyzer.

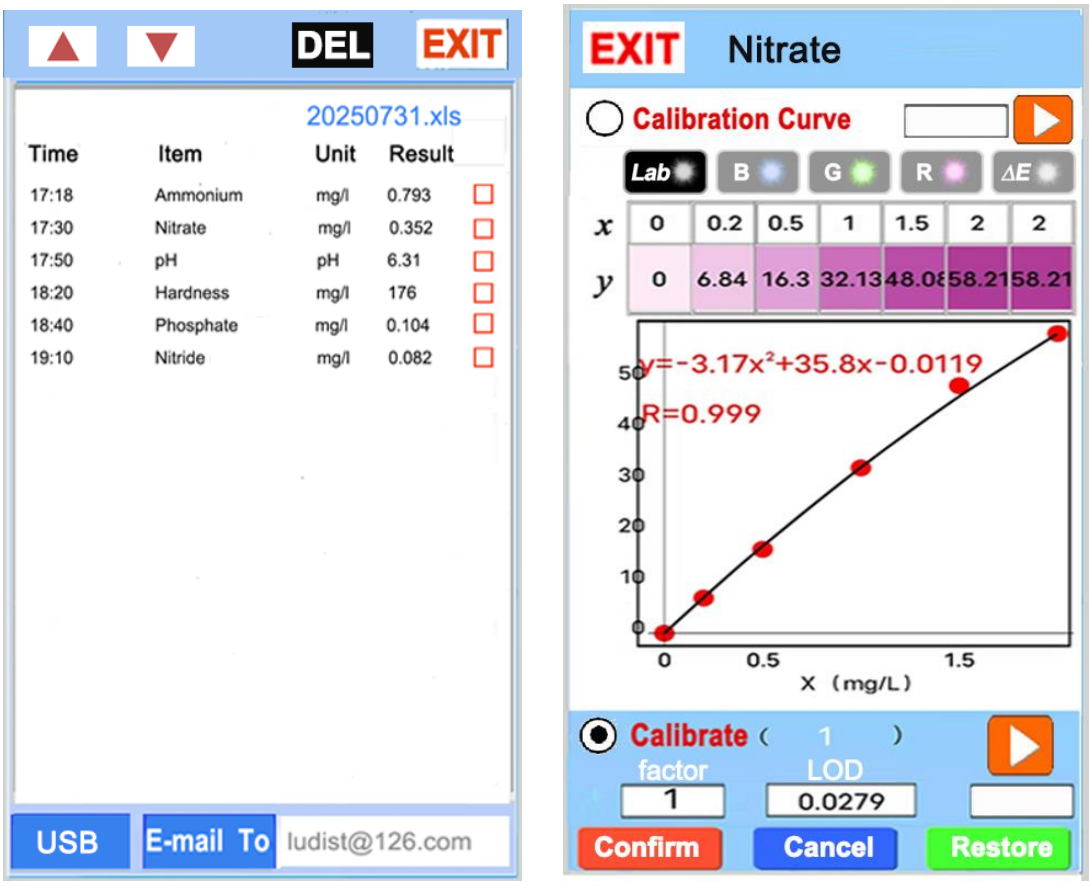
clickable icon (frequently used for measuring the chromogenic solution of sample water): Click to display the *Lab* parameters in the top bar, while the calculated result will appear in the left panel.

clickable icon for renewing the reagent blank: The preparation of a

reagent blank is the same as that of the first solution in the standard series and affects the subsequent calculations. Click this icon to measure the reagent blank. The *Lab* values will be updated and the left green icon ( ) will change to red ( ). You can freely switch between and .

Item Info clickable icon for the detailed information of all the items. Click to open a window where any item can be modified, newly added or deleted.

Results clickable icon for measurement results. Click to access the measurement results list, where all the results are saved as Excel spreadsheet files (one file per day *e.g.* 20250731.xls, **Fig. 4a**). These files can be remotely transmitted *via* Email, or copied to a U disk by clicking icon USB.



(a) (b)

Fig. 4 Result list (a) and calibration curve (b) of the tested item

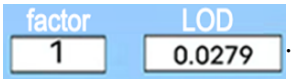
Calibration curve

All calibration curves are fixed, but they can be recalibrated at any time to adapt to different environments and seasonal changes, reducing measurement errors.

clickable icon: Click to open the calibration curve window (**Fig. 4b**), where the calibration curve of the tested item is displayed. The following example uses nitrate – nitrogen.

1. Dilute a 1 mg/l nitrate - nitrogen standard solution as specified in 

and prepare its color reaction solution according to the procedures in **Table 1**.
2. Prepare the reagent blank simultaneously using distilled water instead of the nitrate - nitrogen solution.
3. After measuring the reagent blank, select the nitrate sample 

in **Fig. 4b** and click icon  to measure the solution. The *y*-value will appears within seconds, and the calibration factor and LOD for nitrate - nitrogen are updated in 

.
4. Three action icons - 

, 

and 

can be clicked as needed. If the calibration factor is > 1.2 or < 0.8, serious deviation may occur, or the Detection Agents have lost efficacy. After gruling out all causes, recalibrate if necessary.
5. When the calibration is complete, click icon 

to return to HomePage.

Suspended solid (SS) calibration: Use a 100 NTU standard formazin turbidity liquid.

2 Performance of GEE Test Kits

Table 2 GEE Test Kits Used together and Their Performances

GEE Test Kit	Method Source	Main Reactant	LOD (mg/l)	Toplimit (mg/l)
Transparency (m)	Literature	no	< 5	
Suspending solid (SS)			0.5	100
Turbidity (NTU)			1	200
Colority	ISO7887-1985		5	500
Ammonium (NH_3 -N)*	ISO7150/1-1948	Nessler's reagent	0.05	2
Nitrite (NO_2^- -N)*	ISO6777-1984	N-(1-naphthyl)ethylenediamine dihydrochloride	0.003	0.1
Nitrate (NO_3^- -N)*	GB 17378.4-2007		0.03	2
Total nitrrogen (TN)	GB 17378.4-1998		0.2	10
Phosphate (PO_4^{3-} -P) *	ISO6353/1-82	phosphorus molybdenum blue	0.015	0.7
Total phosphorus (TP)	ISO6878-2004			
Dissolved silica (SiO_2)	SL91.1-1994	molybdisilicic reaction	0.4	30
Fluoride (F^-)	HJ 488-2009	alizarin complexone	0.012	0.4
Total cyanide (CN^-)	HJ 484-2009	isonicotinic - barbituric acid	0.001	0.08
Chloride (Cl^-)	DL/T 1203-2013	mercury thiocyanate	0.1	5
Residual chlorine (Cl_2)	GB/T 5750.11-2023	tetramethylbenzidine	0.03	1
Chlorine dioxide (ClO_2)	GB/T 5750.11-2023	DPD	0.05	3
Sulfide (S^{2-})	GB/T 16489-1996	methylene blue reaction	0.02	1
Sulphate (SO_4^{2-})	Literature	barium chloride	2	100
Ozone (O_3)		DPD	0.02	1
Hydrogen peroxide (H_2O_2)		potassium titanium oxalate	0.4	30
DO (O_2)		EDTA	0.3	15
Free carborn dioxide (CO_2)		phenolphthalein	0.6	30
Alkalinity ($CaCO_3$)*		turbidimetriy	2	100
Hardness ($CaCO_3$)*		calcium ketone	6	500
Magnesium (Mg)		titan yellow	0.2	10
Sodium (Na)		potassium pyroantimonate	0.8	30
Potassium (K)		sodium tetraphenylboron	0.2	3
Aluminium (Al)		chromium cyanide blue R	0.007	0.2
Beryllium (Be)	HJ/T 58-2000		0.003	0.1
Iron (Fe)	HJ/T 345-2007	*o*-phenanthroline	0.02	2

Copper (Cu)	DL/T 502.14-2006	cuprizone	0.01	1
Nickel (Ni)	GB 11910-1989	dimethylglyoxime	0.013	2
Manganese (Mn)	GB 11906-1989	potassium periodate	0.07	5
Chromium (Cr^{6+})	GB/T 7467-1987	diphenylcarbazide	0.009	0.5
Zinc (Zn)	GB 223.51-1987	5-Br-PADAP	0.006	0.2
Arsenic (As)	GB 11900-1989	silver salt	0.0005	0.2
Lead (Pb)	Literature	xylenol orange	0.2	5
Cadmium (Cd)		cadion	0.01	0.3
Metals miture		PAR	0.03	1
TOC		turbidimetry	4	150
Cyanuric acid		melamine	1	70
Urea	GB/T18204.29-2000	diacetyl monoxime	0.02	3
Volatile phenols	HJ 503-2009	4-aminoantipyrine	0.03	2
Methanal	GB/T16129-1995	AHMT	0.01	0.3
Hydrazine	GB/T 15507-1995	*p*-dimethylaminobenzaldehyde	0.006	0.4
Trinitro compound (TNC)	GB/T 4918-1985	sodium sulfite	0.04	4
COD_{Mn}	ISO8467-1993	potassium permanganate	0.4	5
COD	HJ/T 399-2007	potassium dichromate - DPC	3	100

*: The ammonium, nitrite and nitrate are metering in nitrogen, phosphate in phosphorus, and both basicity and hardness in calcium carbonate.

Supplementary Materials

S1 Operation of the heating Digester

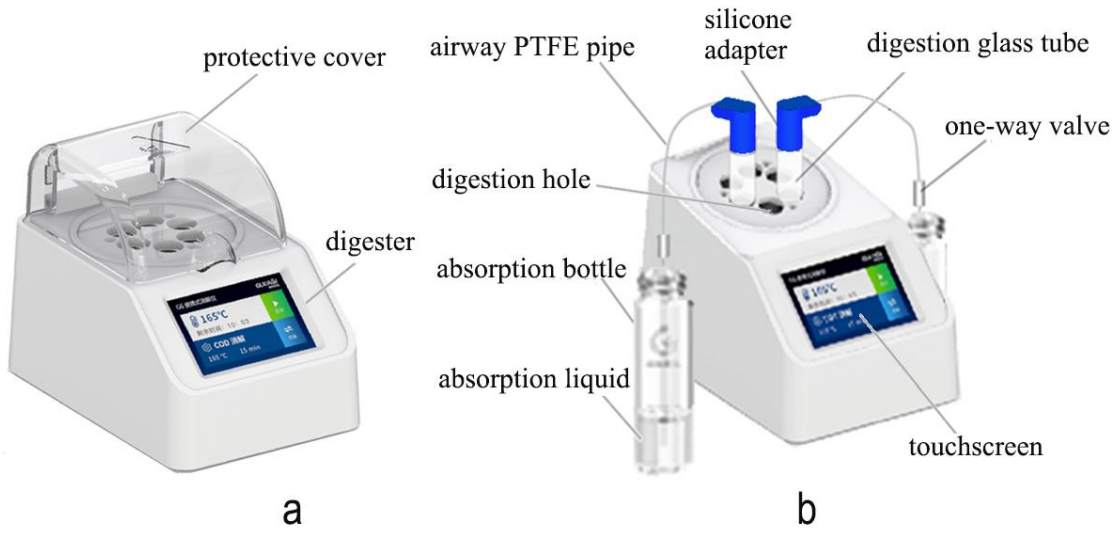


Fig. S1 The heating digester (a) and using for seperation of TOC, ammonia and volatile phenols from wastewater (b)

- Take the digester (**Fig. S1**a) out of the instrument box and place it on an experimental bench. Connect the power and turn on it.
- On the touchscreen, click  to select the tested item. The set temperature and time appear automatically. Insert the digestion tubes prepared with water sample according to **Table S1,** and cover the protective shield.
- Click  to begin the digestion. When the temperature rises to the set point, a reminder ringtone will sound. The temperature will remain constant until the ringtone sounds again. Remove the digestion tubes and allow them cool in air.

Notes

- In the separation of TOC, ammonia and volatile phenols from wastewater, it is essential to have a unidirectional airway accessory ready in advance. This consists of the silica gel adapter, PTFE airway pipes and one-way valve (**Fig. S1**b).
- A conventional thermostat water bath device can be used as a substitute for digestor when pretreating COD_{Mn} and urea water samples.

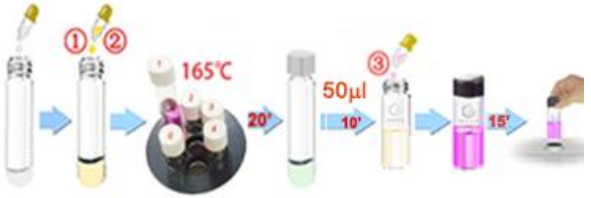
Table S1 The digestion and detection procedures of water sample

<table>
<tr><th>Item</th><th colspan="2">Digestion, colorization and measurement</th><th>Operation procedure illustration / notes</th></tr>
<tr><td>Total nitrogen (TN)</td><td rowspan="3">(1) Take 5.00 mL of sample water into a digestion tube. Add TN or TP // Metals Digestion Agent powder (capsulated) and shake until dissolved. Tighten the tube cap, insert the digestion hole, and cover with the protective cap.
(2) Turn on the digester and click  to select “TN // TP // Metals” (125℃, 30’). Click  to begin until countdown ends. Take out all of the digestion tubes and cool in air (can be placed in flowing water later on).</td><td>(3) Take 1.00 mL of the digestion soluiton（< 10 mg/l TN）into a colorimetric bottle and add distilled water to 5.0 mL. Add Nitrgen Detection Agent ① powder (capsulated), shake vigorously for 1 min and waiting for sedimentation. Transfer 0.50 mL of the supernatant into another colorimetric bottle and add distilled water to 5.0 mL. Add 6 drops of Agent ② and shake well. Measure after 15 min.</td><td> 

● Do not leak steam during the digestion process.</td></tr>
<tr><td>Total phosphorus (TP)</td><td>(3) The digestion solution (< 0.7 mg/l TP) is transferred into a colorimetric bottle. Add the Phosphorus Detection Agent ① powder (capsulated) and shake until dissolved. Add 0.30 mL of Agent ② and shake well. Measure after 10 min.</td><td> 

● Do not leak steam during the digestion process.</td></tr>
<tr><td>Metals</td><td>(3) The digestion solution is transferred into a colorimetric bottle. Drip 2 mol/L NaOH to adjust pH 5 - 7. The successive operation accords to the corresponding metal ions (see also Table 1)</td><td> 

● Suitable for Al, Cr, Fe, Ni, Cu, Zn, Cd and Pb.</td></tr>
</table>

COD	(1) Take 1.00 mL of sample water (<100 mg/l COD) into a digestion tube. Add 1.00 mL of COD Detection Agent ①, 0.20 mL of Agent ② and shake well. Tighten the tube cap, place into the digestion hole, and cover with the protective cap. (2) Turn on the digester and click ⇌ to select "COD" (165℃, 20'). Click ▶ to begin until countdown ends. Take all the tubes out of the digestion holes and cool in air for 10 min. (3) Accurately transfer 50 μL of the supernatant into a colorimetric bottle. Dilute to 10 mL with distilled water and shake well. Add 5 drops of Agent ③ and shake well. Measure after 15 min.	 ● Suitable for water containing less than 2000 mg/L Cl^- ● A new reagent blank is prepared synchronously and measured by clicking Reagt BLK;.
TOC	(1) Take 5.00 mL of sample water (< 150 mg/l TOC) into a colorimetric bottle. Add 6 drops of 1 mol/L sulfuric acid, shake for 30 sec and transfer into a digestion tube. Add the TOC Detection Agent ① powder (capsulated) and shake until dissolved. Insert the digestion hole and connect a set of unidirectional airway accessory as **Fig. S1**b. (2) Take 10.0 mL of distilled water into another colorimetric bottle. Add 1 drop of 1 mol/L sulfuric acid and Agent ② powder (capsulated), respectively and shake until dissolved. Add 6 drops of 2 mol/L NaOH as the sorption solution. Insert the pipe end of the airway accessory into the bottle bottom. (3) Turn on the digester and click ⇌ to select "TOC" (110℃, 15'). Click ▶ to begin until countdown ends. Take out the sorption bottleand shake well. Measure three times and take the average..	 ● The unidirectional airway device must be checked to ensure unobstructed flow of pipelines. ● A new reagent blank is prepared synchronously and measured by clicking Reagt BLK .
Urea	(1) Take 5.00 mL of sample water (< 3 mg/l urea) into a digestion tube. Add 0.40 mL of Urea Detection Agent ①, 0.20 mL of Agent ② amd shake well. Tighten the tube cap, insert into the digestion hole, and cover with the protective cap. (2) Turn on the digester and click ⇌ to select "CODMn // Urea" (105℃, 20'). Click ▶ to begin until countdown ends. Take out the digestion tube and cool in flowing water for 5 min. Transfer the solution to the colorimetric bottles and measure.	 ● Can use a boilling water bath replacing the digester, and the colorimetric bottles replacing the digestion tubes.

<table>
<tr><td rowspan="2">CODMn</td><td>(1) Take 5.00 mL of sample water (< 5 mg/l CODMn) into a digestion tube. Add each 0.20 mL of CODMn Detection Agents ① and ② in sequence. Shake well. Tighten the tube cap, insert into the digestion hole, and cover with the protective cover.
(2) Turn on the digester and click ⇌ to select “CODMn // Urea” (105℃, 20’). Click ▶ until countdown ends. Take out the digestion tube and cool in flowing water for 5 min. Filter and transfer the filtrate into a colorimetric bottle. Measure immediately.</td><td> 

Suitable for freshwater containing less than 300 mg/L Cl^-
Can use a boilling water bath replacing the digester, and the colorimetric bottles replacing the digestion tubes.</td></tr>
<tr><td>(1) Take 5.00 mL of sample water (< 5 mg/l CODMn) into a digestion tube. Add 5 drops of 2 mol/L NaOH amd 0.20 mL of Urea Detection Agent ①. Shake well. Tighten the tube cap, insert into the digestion hole, and cover with the protective cap.
(2) Turn the digester on and click ⇌ to select “CODMn // Urea” (105℃, 20’). Click ▶ to begin until countdown ends. Take out the digestion tube and cool in flowing water for 5 min. Add 0.20 mL of Agent ② and shake well. Filter and transfer the filtrate into a colorimetric bottle. Measure immediately.</td><td> 

Suitable for highly salt water e.g. sea water
Can use a boilling water bath replacing the digester, and the colorimetric bottles replacing the digestion tubes.</td></tr>
<tr><td>Ammonia / Volatile Phenols</td><td>(1) Take 5.00 mL of wastewater (< 2 mg/l NH3-N or < 2 mg/l Volatile Phenols) into a digestion tube. Add about 2 g of sodium sulphate (no ammonia grade) and 2 drops of 2 mol/L NaOH, and shake well. Insert the digestion hole and connect a set of unidirectional airway accessory as Fig. S1b.
(2) Take only 3 mL of distilled water into another colorimetric bottle. Add 1 drop of 1 mol/L sulfuric acid and shake well as the absorption liquid. Insert the pipe end of the airway accessory into the absorption bottle bottom.
(3) Turn on the digester and click ⇌ to select “Ammonia // Volatile Phenols” (125℃, 10’). Click ▶ to begin until countdown ends. Take out the absorption bottle and add distilled water to 5 mL scale line. The successive operation accords to the corresponding item (see also Table 1).</td><td> 

Suitable for wastewater with serious interference
The unidirectional airway device must be checked to ensure unobstructed flow of pipelines.</td></tr>
</table>

S2 Operation of multifunctional sample processor

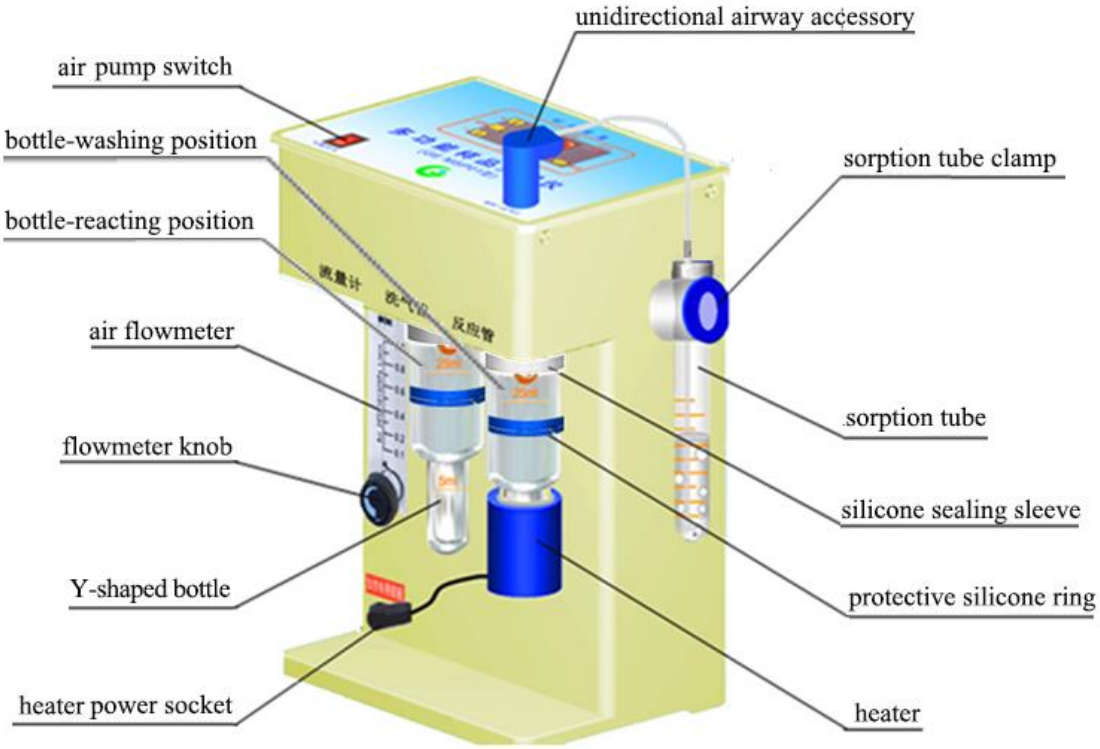
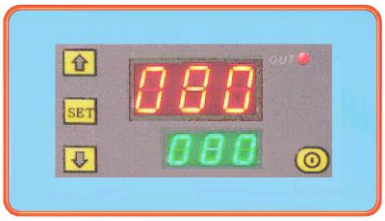


Fig. S2 Assembly of Model GE MSP01 Multifunctional Sample Processor

Time Setting and Work Status



1. Turn on the power, press SET on the top panel, and then use ⇧ or ⇩ to set the desired time (0 - 999 min) displayed in 000 window.
2. Press SET to enter the work state. The indicator light will turn on, and timer 000 countdown begins.
3. When the countdown ends, the indicator light turns off and reminder ringtone sounds simultaneously.
4. Press ◎ to begin the next cycle if needed.

Installation of Y-shaped Bottle

1. To install the Y-shaped bottles to bottle-washing and reacting positions, carefully screw them upward from below.
2. Move the silicone sealing sleeve down to wrap the bottle body, preventing blow-by. If want to remove the bottle, hold the protective silicone ring and slowly unscrew the Y-shaped bottle to avoid burns.

Reminder: Do not pull down the PTFE airway pipes in front of the panel.

Heater

1. When heating, slowly push the heater from below to wrap the thin tube section of the Y-shaped bottle.
2. After heating, slowly pull down the heater away from the bottle.

Table S2 Extraction of volatile substances with Model GE MSP01 Multifunctional Sample Processor

Item	Treatment of sample water and colorization	Operation procedure illustration / Notes
Sulfide (S^{2-})	(1) Add ~10 mL of distilled water, 5 drops of 2 mol/L NaOH into a Y-shaped bottle and install to the bottle-washing position (**Fig. S2**). Add 5.00 mL of distilled water and 1 drop of 2 mol/L NaOH in a sortion tube and place it on the tube clamp. Take 5.00 mL of sample water (< 1 mg/l S^{2-}) to another Y-shaped bottle and install to the bottle-reacting position. Add 2 drops of 1 mol/L sulfuric acid from the top feeding port. Connect a unidirectional airway accessory between the absortion tube and the top feeding tube. (2) Turn on power and set 10 min of work time. Turn air pump on and adjust the air flowmeer to 0.50 L/min of flow rate. (3) When the extraction is complete, pull out the pipe from the sorption tube. Transfer the sorption solution into a colorimetric bottle. Add 3 drops of Sulfide Detection Agent and shake well. Measure after 10 min.	 ● Suitable for surface and waste water
Arsenic (As)	(1) Into a sorption tube, add 5.00 mL of 50% (v/v) ethanol, 5 drops each of Arsenic Absorbent A and B in sequence. Shake well and place it on the tube clamp. (2) Add 25.0 mL of sample water (< 0.2 mg/l As) in a Y-shaped bottle. Place Arsenic Detection Agent ① sinking to the bottle bottom, and place a glass bead pressed on it. Install the bottle to the bottle-reacting position. Add Agent ② powder (capsulated) into 5 mL of distilled water and shake for 30 sec. Pour into the Y-shaped bottle from the top feeding port, and immediately connect a unidirectional airway accessory between the sortion tube and the top feeding tube (**Fig. S2**). (3) When the reaction is complete *i.e.* bubbles become rare, pull the pipe out of the sorption tube. Transfer the sorption solution into a colorimetric bottle. Measure immediately.	

Total cyanide (CN^-)	(1) Add 10 mL of distilled water, 5 drops of 2 mol/l NaOH into a Y-shaped bottle and install it to the bottle-washing position (**Fig. S2**). Add ~ 4 mL of distilled water, 1 drop of 2 mol/L NaOH into a sortion tube and place it on the tube clamp. Connect a unidirectional airway accessory between the sortion tube and the top feeding tube (**Fig. S2**). Take 25.0 mL of sample water (< 0.08 mg/l CN^-) and Cyanide Reaction Agent powder (capsulated) to the other Y-shaped bottle and install to the bottle-reacting position. Push lightly the heater from below to wrap the Y-shaped bottle end and plug in the heater socket. (2) Turn on power and set 20 min of work time. Turn air pump on and adjust the air flowmeer to 0.50 L/min of flow rate. (3) When the extraction is complete, pull the pipe out of the sorption tube. Transfer the sorption solution into a colorimetric bottle. Add 2 drops of 1 mol/L sulfuric acid and dilluted to 5 mL with distilled water. Add Cyanide Detection Agent ① powder (capsulated) and shake until dissolved. Add 6 drops of Agent ② and shake well. React for 20 min around 25℃ and then measure.	 ● If serious foam occurs during the extraction, add drops of liquor into the reaction bottle.

Common Faults and Solutions

Faults		Possible Reasons	Solutions
1	Display '< LOD'	The content in sample water is < LOD.	
	display '> top limit'	The item is over the top limit of method	Reduce the amount of sample water taken, recolorization and measure.
	Display 'over scope'	The parapeter value measured is beyond of the regular scope.	Recalibrate zero with the correct reference solution.
			The solution is turbid. After filteration, again measure it.
			The Detection Agent goes bad. Replace new ones.
2	The bar color displayed has an obvious difference with the actual color of solution.	zero calibration error	Recalibrate zero with the correct reference solution.
		The color solution is turbid.	After filteration, again measure it.
		The color reaction is abnormal.	Perform the pretreatment of sample water to eliminate the interference.
		The ambient temperature is lower than 15 ℃.	Place the reaction bottle in warm water.
3	Notes	● Open the HomePage to automatically upload the latest reagent blank (). If subsequent calculations use the initial reagent blank, click the red icon to switch it into the green icon () ● All auxiliary solvents used in experiments must be providedby the user (e.g. distilled water and ethanol). ● Distilled water may be replaced of deionic water. ● If the indicator light on the top panel of the analyzer remains green or yellow, the analyzer can be used normally. As the light is red, the analyzer needs to be discharged. ● If the analyzer is not used for a long time， it should be discharged once every quarter, and stored in a dry and cool environment.	

Instrument set assembly list

Order	Accessory		Specification / Model	Number		Usage
				Lab02	Lab02+	
1	Rapid Water Quality Analyzer		GE miniLab-Int	1		measure
2	Heating digester		/	0	1	Heating and digestion device
3	Power adapters		12V10A	0	1	Power supply for the digestion instrument
			12V1A	1		The Analyzer is charged.
4	Positioning sleeve		silicone rubber	1		Used only in the COD measurement
5	Agent kits (optional)		24 - 60 testing times per box	4		Reactants
6	Digestion tube		Glass, 10 ml	0	8	Use coordinately with the digester
7	Colorimetric bottle		Glass, 15 ml	8	9	For color reaction and measurement
8	2 mol/l NaOH		20 ml	1		Adjust pH of a liquid
9	1 mol/l sulfuric acid			1		
10	Transferpettors		1 and 5 ml	2		Quantitative liquid transferred
11	Thermometer		-20 to 50 ℃	1		Indication of ambient temperature
12	Timer		0 to 99 min	1		Time control
13	Filters		10 ml	2		Used in filteration
14	Other Tools	pH testing paper	pH 1 to14	1		Used for cid-base adjustment
		Pipette tips	1 and 5 ml	some		Use coordinately with a transferpettor
		Glass globes	ϕ 2 - 3 mm	some		Used only in dissolved oxygen test
		Glass fiber filtraters	hole size ϕ0.7 μm	some		Used in filteration
		Disposable droppers	Plastic, about 3 ml	some		Take the liquid

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