RESEARCH ON MEASUREMENT DEVICE FOR NO_3^- ION CONCENTRATION OF NUTRIENT SOLUTION

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PRINCIPLES AND DESIGN

Ion selective electrode is a kind of electrochemistry sensor, whose potential is in proportion to the minus logarithm of ion concentration according to Nernst formula:

$$E_{\mathrm{M}} = E_0 \pm \frac{2.303RT}{Z_i F} \lg a_i$$

where α_i is the concentration of ion í, Z_i is the charge number of ion í, F is Faraday constant (96487c/mol), R is gas constant (8.31J/mol·K), T is absolute temperature, and E_0 is standard electrode potential.

The overall structure of this measurement equipment is shown in Fig. 1. Firstly, the potential signal of ion concentration collected by ion selective electrode and reference electrode is sent to signal process module for amplification. Then it is sent to MCU after A/D transformation. Meanwhile, MCU sends control signal to DS18B20 to measure current temperature which feedbacks as serial digital signal. MCU calculates ion concentration via these two values. Finally, the outcome is transformed to display codes and shown on LCD screen.

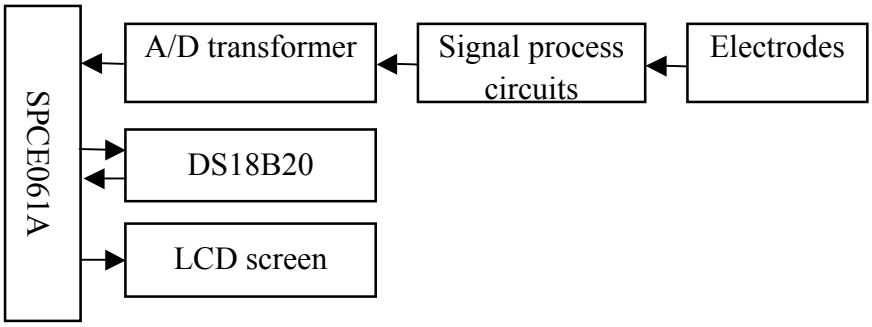

Fig. 1 the overall structure of this measurement equipment for NO_3^- ion concentration

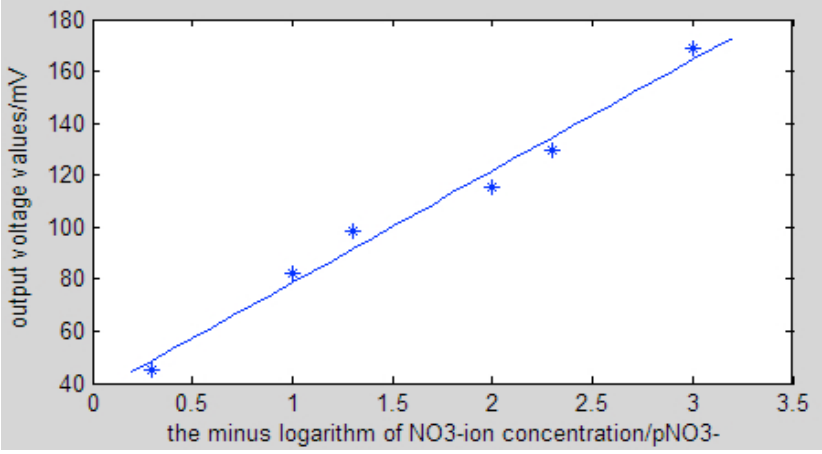

Fig. 2 the fitting line (20□)

CALIBRATION AND EXPERIMENTAL RESULTS

While calibrating, the NO_3^- ion selective electrode and the reference electrode are immersed into 0.001mol/L KNO_3 solution and KCl saturated solution respectively for 2 hours. Then they are linked to the millivoltmeter to measure the NO_3^- ion concentration in 0.5mol/L, 0.1mol/L, 0.05mol/L, 0.01mol/L, 0.005mol/L, and 0.001mol/L KNO_3 solution. The solution's temperature is measured as 20℃. Using MATLAB for linear fitting, the line figure is shown in Fig. 2.

All modules are linked to MCU as Fig. 3 shows. Put 0.5mol/L, 0.1mol/L, 0.05mol/L and 0.01mol/L KNO_3 solution into thermostat at 0℃、10℃、20℃ respectively. Temperature precision is 1℃. Table 1 shows the test data sheet of this measurement equipment with temperature compensation.

According to the standard deviation formula and the maximum relative error formula, with measurement range from 0.01mol/L to 0.5mol/L, the mean standard deviation reduced from 0.019mol/L to 0.005mol/L, which verifies that temperature compensation can improve the measurement accuracy.

Fig. 3 modules linking photo

Table 1 test data sheet (with temperature compensation)

Actual concentration (mol/L)	Output value at 0℃(mol/L)	Output value at 10℃(mol/L)	Output value at 20℃(mol/L)
0.010	0.009	0.010	0.011
0.050	0.048	0.051	0.052
0.100	0.096	0.101	0.103
0.500	0.483	0.498	0.511

CONCLUSION

This paper introduces a measurement equipment for ion concentration with SPCE061A MCU as control core, ion selective electrodes as main sensor and LCD screen to show results. Through the theoretical analysis and experimental data, this design is feasible with the maximum standard deviation of 0.008mol/L and the maximum relative error of 10%.

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