A rapid and green determination of ammonia in indoor air

Chenjing Li, Hao Yuan*, Jie Guan*

School of Environmental and Materials Engineering, Shanghai Polytechnic University. 2360 Jinhai Road, Shanghai
* Corresponding author: 1136527875@qq.com, yuanhao@sspu.edu.cn, guanjie@sspu.edu.cn

Sodium hypochlorite-salicylic acid spectrophotography method, Nessler's reagent spectrophotography method, ion selective electrode method and ion chromatography method are the common methods for detecting ammonia content of indoor air. This study compares the advantages and disadvantages of these methods in experiments. The sodium hypochlorite-salicylic acid spectrophotometry method has good correlation when the ammonia concentration is 0.5～5 μg/10mL, the result of the uncertainty evaluation is 0.792±0.132 mg/L, which is more close to the standard value. Moreover, the pre-treatment of this method is rapid and green. This study confirms the sodium hypochlorite-salicylic acid spectrophotography method as a rapid and green method for the determination of ammonia in indoor air.

1. Introduction

Generally, there are various sources of indoor ammonia pollution, including interior drainage pipes, indoor decoration materials and concrete admixtures etc. (Yang et al., 2007; Wei et al., 2015). Ammonia in sewage pools or septic tanks escapes into the indoor air through the water channel. A lot of furniture with additives and whitening agent use ammonia. Common concrete admixture contains some ammonia stuff that increases indoor ammonia concentration. Sodium hypochlorite-salicylic acid spectrophotometry (GB/T18883-2002), Nessler's reagent spectrophotometry (GB50325-2010), ion selective electrode (HJ534-2009) and ion chromatography (GB/T18204.25-2000) are the common environmental monitoring methods of ammonia in indoor air. There are also the acetylacetone spectrophotometry method (Liu et al., 2010), the ninhydrin spectrophotometry method (Li et al., 2008), the field measurement method (Wang et al., 2014) and other methods. A previous study has demonstrated that ion selective electrode method and ion chromatography are simple and with high selectivity (Deng et al., 2006). But these methods require high accuracy apparatus and high cost. Nessler's reagent spectrophotography method (Li et al., 2007; Mei et al., 2000) is simple and convenient, but its sensitivity is lower. As the standard limit value of the ammonia concentration in indoor air is 0.2 mg/m^3, the daily detection of the concentration of ammonia in indoor air by Nessler's reagent spectrophotography method is not suitable (Hu et al., 2000). On the other hand, the sodium hypochlorite-salicylic acid spectrophotography method has a higher sensitivity, a lower detection limit and a better correlation than Nessler’s reagent spectrophotography.

2. Methods

A preliminary experiment is carried out to determine the dilution ratio according to the comparison of the depth of the colour of air samples with that of the ammonia standard series samples. That is different from the traditional pre-treatment. In this way, experimental reagents are reduced and testing time is saved since repeated dilution is

Citation: Li C., Yuan H., Guan J. (2017): A rapid and green determination of ammonia in indoor air. Austrian Contributions to Veterinary Epidemiology. Vol. 9, 57-61.

avoided. Finally, standard curves are drawn according to the national standard methods, as shown in Figure 1.

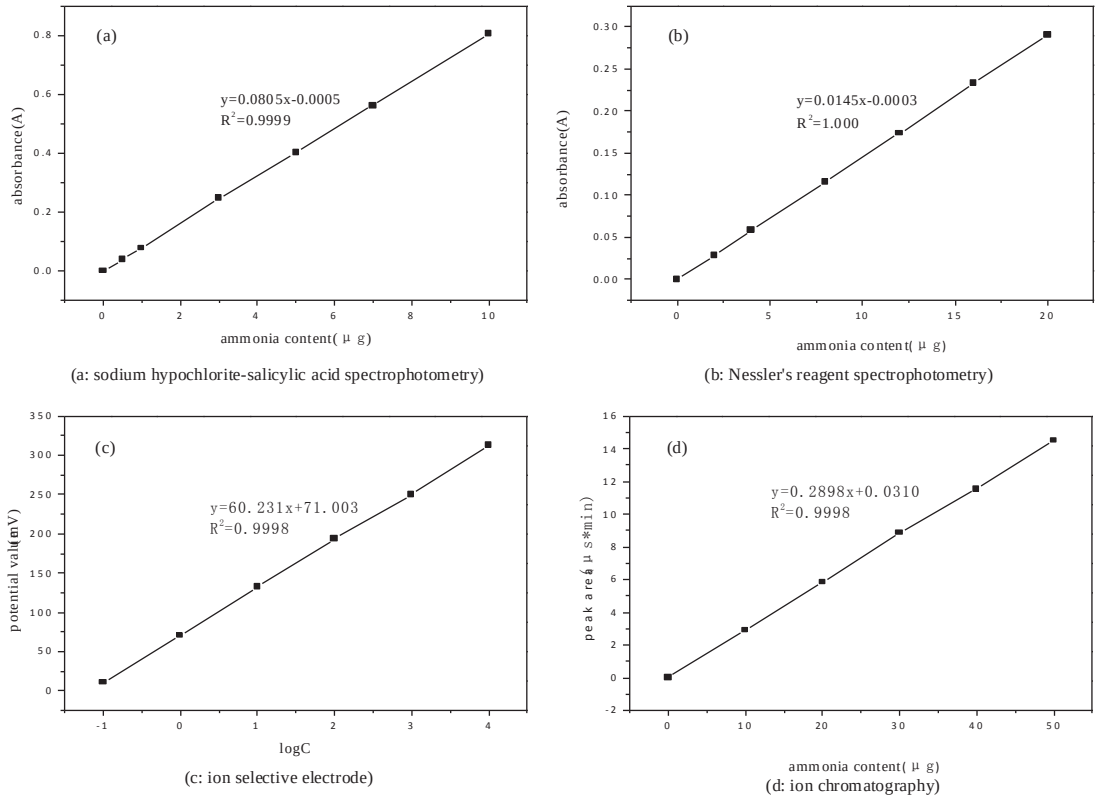

Figure 1: The standard curves of the four methods.

3. Results

The methods are tested by the same standard sample of ammonia which is used in the CNAS qualification determination, and the concentration of ammonia in the standard sample is 0.796 ± 0.038 mg/L. The determination results are shown in Table 1.

Table 1: Results of the determination of ammonia by the four methods.

No.	Sodium hypochlorite-salicylic acid - spectrophotography	Nessler's reagent spectrophotography	Ion selective electrode	Ion chromate-graphy
1	0.792	0.792	0.795	0.797
2	0.801	0.806	0.796	0.796
3	0.796	0.778	0.796	0.795
4	0.796	0.792	0.796	0.796
Average	0.796	0.792	0.796	0.796

The ion selective electrode method and the ion chromatography method have merits of simple operation, high sensitivity and good reproducibility. However, ion chromatography needs expensive instruments and high cost (Xiong et al., 2005). Table 1 shows that the four methods have no significant difference within the scope of quality control. The measurement of ammonia in indoor air in the laboratory is just state-of-the-

art. Considering the cost and accuracy, the labs usually use the two spectrophotometry methods.

The experimental contrast of linear correlation: the standard curves of the two spectrophotometry methods are shown in Fig. 2. The experiment is carried out by the same group of experiment personnel.

As shown in Figure 2, for 10 mL absorption liquid containing 1 μg ammonia, the absorbance is 0.0781 for the sodium hypochlorite-salicylic acid spectrophotography method, and the absorbance is only 0.0146 for Nessler's reagent spectrophotography method. This indicates that the first method is more sensitive than the second one. Nessler's reagent (Li et al., 2007) contains large amounts of mercury salt. its toxicity and potential of secondary pollution is larger. The sodium hypochlorite-salicylic acid spectrophotography method has a good correlation when the ammonia content is 0.5～ 5μg/10 mL in Fig. 2.

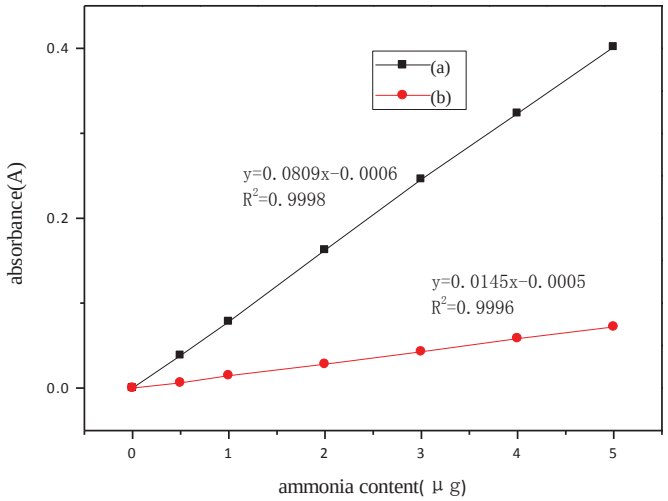

Figure 2: The standard curves of two kinds of spectrophotography methods.

The experimental contrast of uncertainty: on the basis of the analysis of the detection process and the calculation of the concentration of ammonia, the uncertainty is mainly from the volume of the standard sample (Li et al., 2008) and the quality of ammonia in the sample. The uncertainty is analysed using the latest national standard CNAS-GL34 "Guidance for the evaluation of uncertainty based on quality control data in environmental testing" approved by the China National Accreditation Committee for conformity assessment. The result of the sodium hypochlorite-salicylic acid spectrophotography method is 0.792±0.132 mg/L. Nessler's reagent spectrophotography method is 0.796±0.061 mg/L by the same analysis method of uncertainty.

The analysis of uncertainty showed that the result of the sodium hypochlorite-salicylic acid spectrophotography method is more close to the standard value.

4. Summary

The determination of ammonia in indoor air is a routine laboratory testing procedure. Sodium hypochlorite-salicylic acid spectrophotography method, Nessler's reagent

spectrophotography method, ion selective electrode and ion chromatography method have their own advantages and disadvantages.

The analysis of linear correlation and uncertainty showed that Nessler's reagent spectrophotography method is simple and convenient, but is not suitable for the determination of ammonia in indoor air since the standard limit value of the concentration of ammonia in indoor air is 0.2 mg/m^3. The sodium hypochlorite-salicylic acid spectrophotography method has a good linear correlation when the ammonia content is 0.5～5 μg/10 mL. Its pre-treatment is rapid and green. This study confirmed sodium hypochlorite-salicylic acid spectrophotography method as a rapid and green method for the determination of ammonia in indoor air.

Acknowledgements

The authors acknowledge the Graduate Student Funding Program of Shanghai Second Polytechnic University (A01GY16F030) and the financial support from Shanghai Pudong New Area of Science and Technology Development Fund (PKJ2015-C07& PKJ2015-C14).

References

Cai J., Chen M., 2000, Determination of atmospheric ammonia by sensitive electrode method. Shanghai Environmental Science, 19, 137-140.

China E., 2009, Ambient air-determination of ammonia-sodium hypochlorite-salicylic acid spectrophotometry, State Department of Environmental Protection, HJ534-2009.

China P., 2011, Indoor environmental pollution control of civil building engineering. State General Administration of Quality Supervision, GB50325-2010.

China S., 2002, Indoor air quality standard, State Environmental Protection Administration, GB/T18883-2002.

China S., 2005, Methods for determination of ammonia, National Quality and Technical Supervision Bureau, GB/T18204.25-2000,.

China S., 2013, Guidance for measurement uncertainty evaluation based on quality control data in environmental testing, China National Accreditation Committee for Conformity Assessment, CNAS-GL34.

Deng D., Wang J., Wu L., 2006, Comparative analysis of standard methods for determination of ammonia in indoor air. Beijing Union University, 20, 69-72.

Hu J., Chen G., Wang X., 2012, The uncertainty evaluation of ammonia determination in ambient air by nessler' s reagent spetcrophotometry. Arid Environmental Monitoring, 26, 235-236.

Hu M., Zhang X., 2015, Investigation on indoor air quality standards and its inspection methods, China Health Standard Management, 27, 9-10.

Li S., Chen G., Guan L., 2007, Study on influential factors in determination of ammonia in air by nessler's reagent spectrophotometry. Environmental Science and Management, 23, 144-146.

Li S., Tian X., Liu H., 2008, Study on the indophenol blue spectrophotometric determination method of ammonia concentration in the air. Heilongjiang Science and Technology Information, 22, 15-16.

Li Y., Liu Y., Sun C., 2008, Determination of trace ammonia in indoor air by ninhydrin spectrophotometry. Sichuan University, 39, 664-666.

Liang B., Zhu T., 2005, Collection technology of ammonia in atmosphere. Analytical Chemistry, 33, 1192-1198.

Liu H., Ma D., Liang G., 2010, Determination of ammonia in workplace air by acetylacetone and formaldehyde in spectrophotometry, Chinese Journal of Health Laboratory Technology, 3, 514-515.

Mei X., 2007, Two chemical methods' comparison to detect ammonia of indoor air. Guangzhou Architecture, 2, 27-29.

Song Y., Liu S., Qi Q., 2007, Development and performance evaluation for a solid phase adsorption gas sampler ammonia in indoor air. Health Research, 36, 289-291.

Wang L., Liang Y., 2014, Comparative Analysis of test of ammonia density in air with standard and field methods, Quality Test, 32, 3-5.

Wei W., Ramalho O., Mandin C., 2015, Indoor air quality requirements in green building certifications, Building and Environment, 92, 10-19.

Xiong K., Zhao G., Lu Q., 2005, Determination of ammonia in indoor air by ion chromatography. Modern Instrument, 11, 37-38.

Yang J., Leng X., Li Z., 2007, Control of ammonia pollution in indoor air. Environment Health, 24, 214-242.

Yang M., 2012, Indophenol blue spectrophotometric determination of ammonia in the indoor air. Guangdong Chemical Engineering, 39, 165-166.

Zhang D., Wei S., Kaila C., Su X., Wu J., Karki B., Young P., Guo Z., 2010, Carbon-stabilized iron nanoparticles for environmental remediation. Nanoscale, 2, 917-919.

Zhang G., Xu C., Chen H., 2010, The evaluation of uncertainty in measurement of ammonia nitrogen in indoor environment with nessler's reagent spectrophotometry, 37, 269-271.

Zhang R., 2005, Influence factors of determination of ammonia in air by spectrophotometry. Guangdong Building Materials, 8, 61-62.