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Development of Simple, Rapid and Highly Sensitive Determination Method of Halogen Acid such as Bromate and Chlorate

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Summary

Bromate and chlorate are carcinogenic substances produced as by-products of disinfection process in drinking water or electrolysis of common salt solution. Japanese Ministry of Health, Labor, and Welfare have regulated their maximum contaminant level in drinking water as 0.01 mg L^{-1} and 0.6 mg L^{-1}, respectively. In this study, we have developed a small fluorometric detector using an ultraviolet light-emitting diode (UV LED) as an excitation light source and its analytical performances were evaluated. It was then combined with a flow system for the fluorometric determination of halogen acids which contained the oxidation reaction of thiamin (vitamin B_1) with the assistance of ammonium vanadate, and the equipment and reaction condition were optimized in order to develop simple, rapid highly sensitive determination method of halogen acids.

The developed detector is compact and its dimensions are 150×110×65 mm. Calibration curve for solution of sodium lignin sulfonate which is fluorescent substance was built in order to verify the analytical performance of the detector. As a result, its correlation coefficient *r* is 0.9999 and the relative standard deviation of fluorescent light intensity at 10 mg L^{-1} is less than 2%, thus its good analytical performance was confirmed.

It was used as a detector for the flow system of halogen acids determination and several conditions were optimized. Optimum wavelength for the excitation and fluorescence detection was 360 nm and 420 nm, respectively. On the other hands, improvement of optical system, the volume of a flow-cell which would affect the dispersion of sample zone, and so on, did not markedly change the sensitivity. Optimum temperature for a mixing and reaction coil was 70°C.

Under the optimized conditions, a peak for the bromate at 0.20 mg L^{-1} level could be identified, and 1 mg L^{-1} bromate could be determined with a good reproducibility. The limit of detection (LOD), however, was 0.10 mg L^{-1} due to the noisy flow signal. The sensitivity was improved to 0.031 mg L^{-1} by using moving average process for the signal. Further improvement of the detector, development of portable flow system, and the application to real samples will be studied in the future.