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Application News

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Atomic Absorption

Flame Method Measurement of Na and K in Soy Sauce Using the Burner Angle Adjustment Function

Introduction

While the flame atomic absorption method is a rapid and stable measurement technique, due to the narrow linear range of absorbance, in most cases the dilution factor of the measurement sample must be changed according to the element sensitivity so that absorbance falls within the linear range (usually 0.3 to 0.5 Abs or less). However, as the dilution factor increases, dilution errors and contamination from containers and reagent additives can also become an issue. Although changing the measurement wavelength is one method for adjusting absorbance, there are many instances where there is no other wavelength that allows acquisition of appropriate absorbance. On the other hand, adjusting absorbance by adjusting the burner angle allows for continuous adjustment down to about 1/20 and this method can be used with basically any wavelength. This article introduces an example of measuring Na and K in soy sauce by changing the burner angle.

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Measurement Samples and Method

Two commercially-available soy sauce products diluted with 1 % hydrochloric acid were used as the measurement samples.

A dilution factor of 10,000 times (burner angle of 90°) and 20,000 times (burner angle of 0°) was used for Na and 500 times (burner angle of 90°) and 10,000 times (burner angle of 0°) was used for K. In the K measurement, cesium chloride, which acts as an interference inhibitor, was added to obtain a cesium concentration of 0.1 %

Instrument Configuration and Measurement Conditions

The atomic absorption spectrophotometer AA-7000F was used.

Table 1 lists the main measurement conditions.

Table 1 Measurement Conditions

Measurement element	Na		K	
Analytical wavelength	589.0 nm		766.5 nm	
Slit width	0.2 nm		0.7 nm	
Ignition mode	NON-BGC		NON-BGC	
Burner angle	0°	90°	0°	90°
Standard solution concentration (mg/L)	0	0	0	0
	0.10	2.0	0.10	2.0
	0.25	5.0	0.25	5.0
	0.375	7.5	0.50	10
	0.50	10	0.75	15

Relationship Between Burner Angle and Absorbance

While maximum sensitivity can be obtained by performing analysis with the burner parallel to the optical axis (burner angle of 0°), tilting the burner reduces absorbance because the optical path length that crosses the atomizer unit (flame) becomes shorter (see Fig. 1 to Fig. 3).

Fig. 1 shows the burner angle at 0° and Fig. 2 at 90°. The graph in Fig. 3 shows the relationship between relative sensitivity (absorbance) and the burner angle (θ) calculated when the burner slot is 10 cm and flame thickness is 0.5 cm. There are several absorbance wavelengths of differing sensitivities for Na and K. Table 2 lists the wavelengths and absorbance ratios. Regarding 303.3 nm for Na and 404.4 nm for K, the absorbance ratio tends to vary easily due to low lamp brightness.

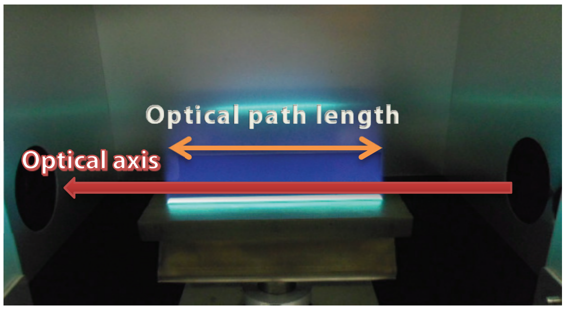

Fig. 1 Burner Angle of 0°

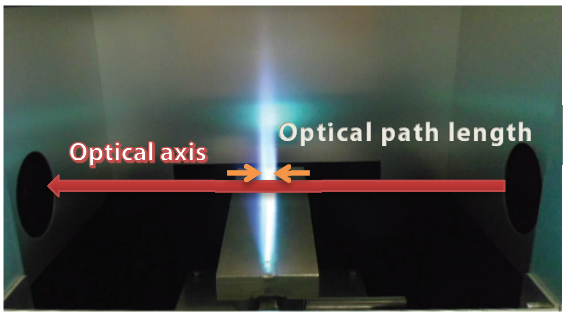

Fig. 2 Burner Angle of 90°

Table 2 Measurement Wavelengths and Absorbance Ratios of Na and K

Na		K	
Wavelength	Absorbance Ratio	Wavelength	Absorbance Ratio
589.0 nm	1	766.5 nm	1
589.6 nm	0.4	769.9 nm	0.4
303.3 nm	0.005	404.4 nm	0.003

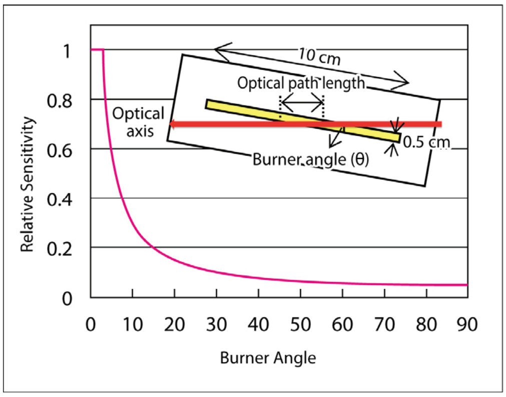

Fig. 3 Relationship Between Burner Angle and Relative Sensitivity

Measurement Results

Fig. 4 and Fig. 5 show the Na calibration curve for burner angles 0° and 90°. Fig. 6 and Fig. 7 show the K calibration curves. For both elements we can see a sensitivity difference of about 20 times between burner angle 0° and 90°.

Table 3 lists the measurement results for each sample. The values are converted back to reflect the original concentration in each soy sauce product. We can see that almost the same values were obtained regardless of the dilution factor. The concentration of Na and K in soy sauce 2 was about 20 % lower compared to soy sauce 1.

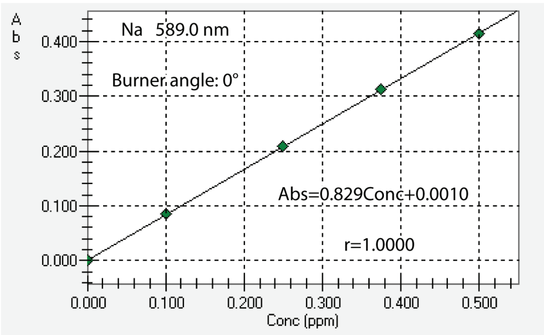

Fig. 4 Na Calibration Curve at Burner Angle of 0°

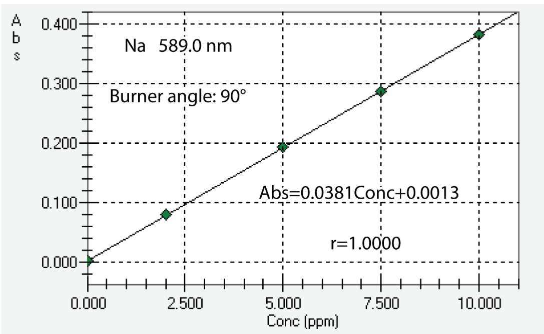

Fig. 5 Na Calibration Curve at Burner Angle of 90°

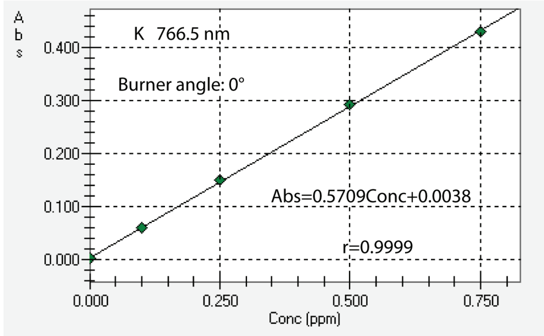

Fig. 6 K Calibration Curve at Burner Angle of 0°

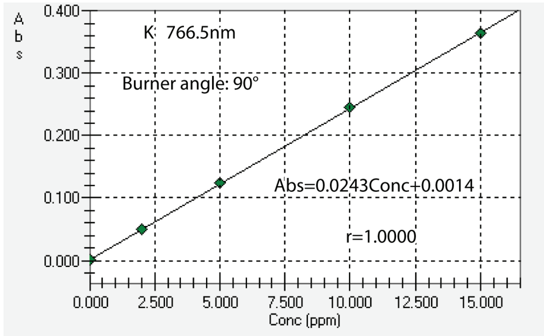

Fig. 7 K Calibration Curve at Burner Angle of 90°

Table 3 Measurement Results of Samples

	Na 589.0 nm		K 766.5 nm	
Burner angle	0°	90°	0°	90°
Dilution factor	200,000	10,000	10,000	500
Upper concentration limit of standard solution	0.5 mg/L	10 mg/L	0.75 mg/L	15 mg/L
Soy sauce 1	6.24 %	6.21 %	0.538 %	0.545 %
Soy sauce 2	5.08 %	5.01 %	0.446 %	0.457 %

Conclusion

Adjustment of the burner angle allows absorbance to be reduced when measuring elements at high concentrations with the flame method. This enables measurement at high concentrations up to about 20 times and helps to prevent the influence of dilution errors and contamination of the measurement element from containers and reagents. It also saves the trouble of changing the dilution factor for each element when it is possible to measure multiple elements at the same dilution factor by adjusting the burner angle for each element. For the samples presented here, we were able to measure Na (burner angle of 90°) and K (burner angle of 0°) at the same dilution factor of 10,000 times by adjusting the burner angle.

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