

Atomic Absorption Analysis for Copper

The following table provides some information about possible atomic absorption lines for copper. The column labeled “slit” is the recommended slit width for this line expressed as the effective bandwidth. When the monochromator is set at 327.4 nm, for example, radiation between 326.9 nm and 327.9 nm exits the monochromator. The column labeled “sensitivity” gives the concentration of Cu (in ppm) producing an absorbance of 0.2. The column labeled “intensity” gives the relative power from the hollow cathode lamp as a percentage of the most intense emission line.

wavelength (nm)	slit	sensitivity	intensity
217.9	0.2	15	3
218.2	0.2	15	3
222.6	0.2	60	5
244.2	0.2	400	15
249.2	0.5	200	24
324.8	0.5	1.5	100
327.4	0.5	3	87

Given what you know about atomic absorption linewidths you might reasonably expect that all emission lines would use the same large slit width. Explain why this might be a reasonable expectation and then speculate on why different emission lines actually require different slit widths.

Atomic absorption line widths are exceptionally narrow, typical 10^{-5} nm, and relatively few in number. Resolution, therefore, is not likely to be a concern, but radiant power is likely to be a concern. It seems that larger slits should be better. Resolving two emission lines for the analyte is not a significant concern, but resolving the analyte's emission line from the emission line for another element is a problem since the interfering line's power effectively is a source of stray radiation and will contribute equally to P_0 and P_T .

The preferred wavelength for the analysis of Cu is 324.8 nm. Why do you think this is the optimum choice?

This is the wavelength with the greatest P_0 . The greater the flux of photons, the better the resulting signal-to-noise ratio.

Suppose you decide to use the wavelength of 249.2 nm to analyze a sample of 1 ppm Cu. How will this affect the absorbance relative to the preferred wavelength of 324.8 nm?

If we assume that Beer's law holds (probably not strictly true, but for the purpose of analyzing this problem it is not important), then at 324.8 nm we have

$$0.2 = k(200 \text{ ppm})$$

or a k of 0.001. A sample of 1 ppm Cu, therefore, will have an absorbance of 0.001 (a %T of 99.8%; $P_0 = 24$ and $P_T = 23.95$), which is virtually impossible to detect. In addition, the smaller P_0 at this wavelength means a noisier baseline signal.

Can you think of a circumstance where a wavelength of 249.2 nm might provide a better choice for the analysis of Cu? Explain.

Suppose that we have a solution of 100 ppm Cu. Again, assuming that Beer's law holds, at 324.8 nm we have

$$0.2 = k(1.5 \text{ ppm})$$

or a k of 0.133. A sample of 100 ppm Cu will have an absorbance of 13.3 (a %T of 4.6×10^{-14} ; $P_0 = 100$ and $P_T = 4.6 \times 10^{-12}$), which is virtually impossible to detect.