Comparison of Two Pneumatic Nebulizers for Use in ICP Emission Spectroscopy

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Vergleich zweier pneumatischer Zerstäuber für die ICP-Emissionsspektroskopie


Summary. The connexions between aerosol gas flow and optimal observation height were experimentally illustrated by comparing two pneumatic nebulizers. If we succeed in getting a higher sample flow with lower aerosol gas velocity, the remaining time of the aerosol in the plasma flame will be considerably prolonged. This results in a maximum emission of all elements studied up to now at the lowest possible observation height of the plasma flame. Thus an essential supposition for simultaneous multielement analysis is fulfilled: A height correction between single element measurements does not cause an improvement, the plasma flame can be firmly installed in the optical axis. The detection limits of all studied elements are considerably improved by the prolonged remaining time. The reproducibility of the measurements is ≤ 1% in the concentration range up to 10 ng/ml.

Key words: Spektrometrie, ICP; Multielementanalyse; Aerosolherstellung, pneumatische Zerstäuber.

When we started to work on the ICP emission spectrometry for simultaneous analysis of several elements out of a single solution, we were occupied with the optimization of the operating conditions. At first we had a lot of difficulties with the combination of generator, torch, gas supply and simultaneous spectrometer, so we wanted to start with a well-tried nebulizer from the Eppendorf flame emission spectrometer. The results have been reported [4].

Because of the required gas pre-pressure a height distribution of the elements is characteristic for this type of pneumatic nebulization. The maximum emission of the single elements was distributed over a relatively wide range of the plasma flame (8–36 mm above the coil).

This fact caused the difficulty to find a compromise observation height, which is necessary for simultaneous determination. The sequential operation with an individual height adjustment for each element is not an ideal solution because in each case the emission gets in interaction with a different part of the plasma shell. Fassel et al. [3] already showed that the mutual influences of elements increase with the flame height. We therefore aimed at longer remaining times of the aerosol in the plasma flame and at measuring the emission in the lowest position directly above the silica tube.

The studies were performed with a concentric glass nebulizer that had been given to us by R. H. Scott (CSIR, Pretoria) and that by now is commercially available as well. It consists of an exactly dimensioned system of two
capillar tubes. A relatively high sample flow is reached with a relatively low aerosol gas flow.

The difference between the two nebulizers used up to now becomes apparent in a comparison of effectivity (Fig. 1). While the Eppendorf nebulizer only starts working at an aerosol gas flow of 1.5 l/min, the Scott nebulizer is already operating at about 0.5 l/min. At an aerosol gas flow of 1.0 l/min it already reaches a sample flow of 1.9 l/min, which the Eppendorf nebulizer only achieves with 2.5 l/min.

If the relative intensity (differences between total and background intensity) in relation to the aerosol gas flow (Fig. 2) is considered, there is basically the same result for the Scott and Eppendorf nebulizers [4]. In most cases an increase of the aerosol gas flow causes a decrease of intensity (exception: Cr I 425.43 nm). This is understandable if you imagine that the aerosol is blown through the plasma tunnel with high velocity.

On condition of a stable inrumental system (generator, gas supply, spectrometer), the whole aerosol production is therefore decisive for an analytical success, i.e. the relation aerosol gas flow/sample flow, the constancy of the reflux or of the amount of aerosol actually entering the torch and the size or the velocity respectively of the aerosol droplets.

Kniseley et al. [2] obtained comparable results with a different type of nebulizer with the same aerosol gas flow of 1.0 l/min.