Why and How to Use the Sheath Gas

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Introduction

Each element exhibits unique characteristics. Both ionic and atomic lines can be characterized into hard and soft. The shorter the wavelength, the more energy is required for the transition to the excited state. To achieve this, low wavelength elements, which need more energy to become excited, need to reside in the plasma for a longer time. The opposite is then also true that higher wavelength elements, i.e. Ca 393 nm and in particular the Group I elements such as Na 589 nm can move through the plasma quickly and obtain optimum excitation.

Figure 1: Line classification

![Line classification diagram](image1.png)

1 What is the sheath gas

The argon sheath gas enhances performance and stability in all types of matrices, but especially high solids or salts. This device provides an additional argon stream that isolates the sample from the walls of the injector by means of producing a laminar flow, thereby reducing contact and sample deposition in the injector tube and tip. The sheath gas was originally developed and patented by Jobin Yvon.

Figure 2: Sheath gas device

![Sheath gas device](image2.png)

Figures 3a and 3b show the sample aerosol without and with the sheath gas attachment. Notice the focused laminar flow in Figure 3b produced by the use of sheath gas at typically 0.2 L/min.

2 Advantage of sheath gas for high salt solutions

The addition of sheath gas allows for the aspiration of solutions containing up to 30% salt directly into the plasma without blockage or drift. It also allows for the improvement of the Alkali detection limits via computer control.
3 Influence of sheath gas on plasma properties

A relatively high sheath gas flow rate such as 0.5 L/min leads to an increase in transport speed and a decrease of the energy transfer. This results in four consequences:

- A reduction of the intensity of the lines of higher energy (ionic lines), and of the Mg II/Mg I ratio (see Figure 5 below),
- An improvement of lines with low energy, e.g. the alkaline group 1 elements,
- A higher sensitivity to matrix effects,
- A change of line intensities may necessitate a change of the observation height for radial viewing.
4 How to optimize the sheath gas

As shown in Figure 6 above, the intensity is greatly effected by the sheath gas flow rate. This can be used for optimum excitation conditions for multiple elements in a method.

- Low flow rate for most of the elements (e.g., 0.1 to 0.2 L/min)
- High flow rate for the alkaline elements (e.g., 0.8 L/min), for the best detection limits. A normal flow rate (e.g., 0.1 L/min) is sufficient for the measurement of concentrations higher than 5 mg/L.

For solutions with high salt content, the sheath gas flowrate can be raised to 0.3 to 0.4 L/min. To compensate the loss of power available in the plasma, the incident RF power should be raised, for example to 1100 W.

5 Conclusion

The use of sheath gas combined with the large 3 mm injector tube allows for the analysis of high dissolved solids over long periods of time without clogging the injector tube. Detection limits for Group I elements are also improved by computer control increasing the flow to 1.1 L/min. When robust plasma conditions for maximum accuracy work is required, it is recommended that a typical flow of 0.2 L/min is used. At a typical flow rate of 0.2 L/min the sheath gas offers unique benefits without increasing operating costs.