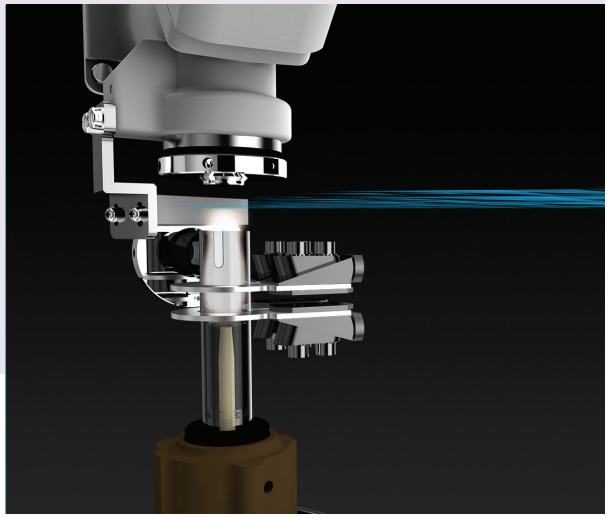
TECHNICAL NOTE

ICP-Optical Emission Spectroscopy

The Advantages of PerkinElmer's PlasmaShear Technology for ICP-OES



Introduction

ICP-OES is a rugged, robust technique capable of analyzing complex matrices containing percent levels of dissolved solids without the need for dilution. Nevertheless, to ensure accurate, robust analyses several challenges must be overcome. Two important obstacles are self-absorption by the plasma and dealing with the dissolved solids which are not vaporized in the plasma. To overcome both of these challenges, PerkinElmer has developed PlasmaShear™ technology.

What Is PlasmaShear Technology?

PlasmaShear is a thin jet of air traveling perpendicular to the plasma several centimeters above the torch, which cuts off the top of the plasma, as shown in Figure 1. The tail of the plasma is removed, which provides analytical benefits, increases method robustness, and decreases the amount of instrument maintenance required. Let's look at each of these in more detail.

Analytical Benefits of PlasmaShear Technology

A plasma consists of four separate zones, as shown in Figure 2 for a plasma with 1000 ppm yttrium (Y) being aspirated: the pre-heating zone, the initial radiation zone, the normal analytical zone, and the tail plume.

The pre-heating zone occurs between the end of the injector and the base of the plasma. In this area, particles and droplets exit the injector and are transported to the base of the plasma. Once they enter the plasma, the particles and droplets enter the initial radiation zone, where they undergo heating, desolvation, and begin the process of atomization and/or ionization. The normal analytical zone is where the light is read for most analyses, either perpendicular to the plasma (radial viewing) or co-axially down the torch (axial viewing). In Figure 2, the blue part of the plasma is emission from Y in the normal analytical zone. Finally, non-ionized particles travel through the tail plume (the red part of the plasma in Figure 2), which is much cooler than the normal analytical zone, producing molecular emissions (i.e. Y in Figure 2) which may interfere with analytes.

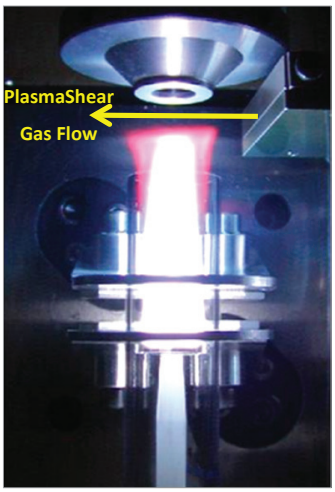


Figure 1. PlasmaShear technology in the Avio family of ICP-OES.

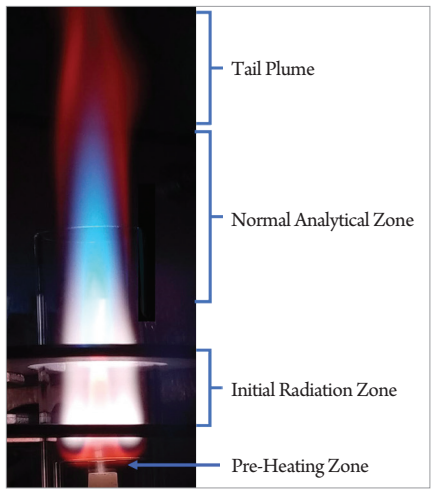


Figure 2. Zones of an inductively coupled plasma aspirating 1000 ppm Y. The blue section (normal analytical zone) is the result of emission from Y.

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One of the advantages of viewing the plasma axially for analysis is increased sensitivity due to the longer path length. However, if the tail plume is present, it can significantly affect the resulting data through self-absorption. Since the tail plume is the coolest part of the plasma, atoms exist in the ground state, and these ground state atoms absorb light emitted from the excited atoms in the normal analytical zone, which results in a non-linear response, as shown in Figure 3a. However, with the tail plume removed (as shown in Figure 4), there is no opportunity for self-absorption, leading to an extended linear range with an axially viewed plasma, as shown in Figure 3b. On the Avio® family of ICP-OES instruments, the tail plume of the plasma is removed with PlasmaShear.

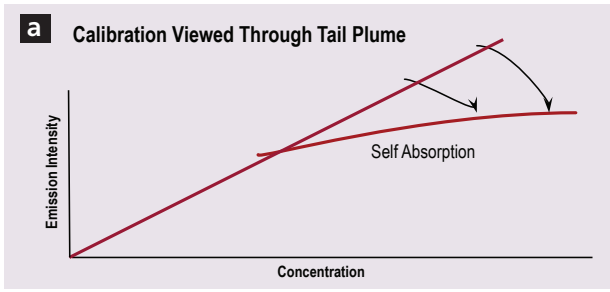

Figure 3 Axial view calibration curves with the tail plume (a) and with the tail plume removed (b).

Instrumental Benefits of PlasmaShear Technology

Another option available to remove the tail plume of the plasma is through the use of cones or orifices which are placed at the end of the normal analytical zone of the plasma. However, the non-vaporized species can then enter the spectrometer and deposit on and/or corrode the optics. To prevent this, a counter-flow of argon through the cones towards the torch is required. While preventing particles from entering the spectrometer, the counter-flow must be argon (as opposed to air) so as not to absorb light, requiring a larger daily consumption of argon. The extra use of argon will also

Figure 4. Inductively coupled plasma aspirating 1000 ppm Y, with the red tail plume removed with PlasmaShear.

increase the cost per analysis. But where do the non-ionized species go? They are blown back towards the torch, which can decrease torch lifetime. In addition, deposits on the cones can eventually fall off, back into the plasma, which affects stability, contributes to contamination, and can generate inaccurate/false determinations. Furthermore, the cones must be cleaned and changed occasionally, which is additional maintenance.

These issues are not a concern with PlasmaShear technology. Because PlasmaShear is a thin jet, air can be used (instead of argon) without absorbing emission from the plasma, thereby lowering the daily argon consumption without affecting sensitivity. In addition, particles are blown into the torch box and carried away in the exhaust, away from the torch, so they will not affect signal stability, produce contamination, or lead to inaccurate results, as there is no danger of them falling into the plasma during analysis. With PlasmaShear technology, there is no extra maintenance required.

Summary

The PerkinElmer Avio ICP-OES systems' unique PlasmaShear technology runs on air. It is a fully integrated, fully automated interference-removal system that delivers problem-free axial analysis while protecting the optics from corrosion and deposition. The result: extended linear range for axially viewed plasma with decreased maintenance requirements and improved robustness.

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