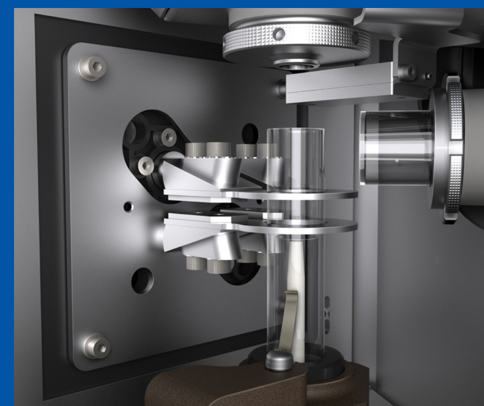
TECHNICAL NOTE

ICP-Optical Emission Spectroscopy

PerkinElmer's ICP-OES Flat Plate Plasma System



A robust and stable plasma is essential when performing analytical analyses by inductively coupled plasma optical emission spectroscopy (ICP-OES). The plasma is traditionally generated by passing argon through a series of concentric quartz tubes (the ICP torch) within a helical, radio frequency (RF) induction coil. Once established, this highly-ionized argon plasma can reach temperatures as high as 10,000 K, allowing for complete atomization of the compounds within a sample and minimizing the potential for chemical interferences.

PerkinElmer's patented Flat Plate™ plasma technology on the Optima® and Avio™ ICP-OES spectrometers provides several advantages over traditional helical induction coil systems. While capable of accommodating the same sample introduction systems and achieving comparable analytical precision, Flat Plate technology achieves greater plasma robustness and stability because of its unique design, leading to less sample loss, greater analytical signal, lower argon consumption, and less maintenance.

A Better Plasma Shape

With the standard helical load coil in horizontal torch configurations, the temperature of the plasma tends to be distributed in a way that is dependent upon the shape of the helix, resulting in non-uniform heating that causes the shape of the plasma to tilt upwards within the torch. This phenomenon provides the opportunity for sample to escape around the outside of the plume, where analyte molecules cannot produce a measurable analytical signal, and can furthermore cause plasma instability.

PerkinElmer's Flat Plate technology, on the other hand, generates a unique, transversely symmetrical plasma. The perfectly symmetrical induction fields from the two Flat Plates are perpendicular to the sample flow, giving the plasma its symmetry and eliminating the upward tilt generated by traditional helical coils. This flat-bottomed plasma helps to create a seal, preventing volatile sample from escaping around the outside of the plasma. This effect also impacts the influence of the auxiliary argon flow; with the Flat Plate technology, the auxiliary flow has little effect on the position of the plasma with respect to the injector tip, but rather, the plasma position is fixed and stable relative to the induction plates.

A More Stable Plasma at Lower Flows

Another advantage to the Flat Plate plasma technology is its ability to be run with normal RF power at both reduced and normal argon plasma gas flows, allowing for maximum versatility and robust plasma conditions. At lower plasma flow rates using the helical coil system, the plasma lifts away from the injector and eventually extinguishes. With the Flat Plate system, however, the plasma is anchored to the plates so that it does not lift up, and is therefore completely stable at plasma gas flows as low as 8 L/min. The ability to operate at lower plasma flow rates results in lower argon consumption. Furthermore, the lower flow allows for a higher plasma temperature to be achieved, thus yielding higher signal intensities for many elements. The plasma can still be run at higher argon flows to accommodate specific methods that may require it, such as the analysis of samples with complex matrices or higher acid content; as a lower plasma gas flow also limits the cooling effects on the torch, it is important to increase this flow in the presence of such matrices to minimize torch wear.

PerkinElmer®
For the Better

A Maintenance-Free Plasma

Traditional load coils are made of copper, and therefore tend to oxidize if they are not properly cooled, resulting in wear and eventual replacement. Conversely, the innovative Flat Plates are made of high-quality aluminum and have a larger surface area than a helical coil, over which to dissipate the heat. Consequently, the Flat Plate system does not require cooling of the induction plates. Even under prolonged operation at maximum power, the plasma Flat Plates look like new, with no sign of aging – no cooling of the load coil and no degradation of the load coil means less downtime and fewer service expenses. Also, the advanced torch geometry better fits the plasma and eliminates the need for a bonnet, thereby simplifying installation and further reducing costs.

Traditional Helical System (views shown with different camera exposures)

Figure 1. The figure on the left shows the angled base of the plasma which coincides with the angled shape of the load coil. The figure on the right shows the upward tilt of the axial channel and plasma tip as well as the differences in plasma density above and below the central channel.

Innovative Flat Plate System on Avio 200 ICP-OES (views shown with different camera exposures)

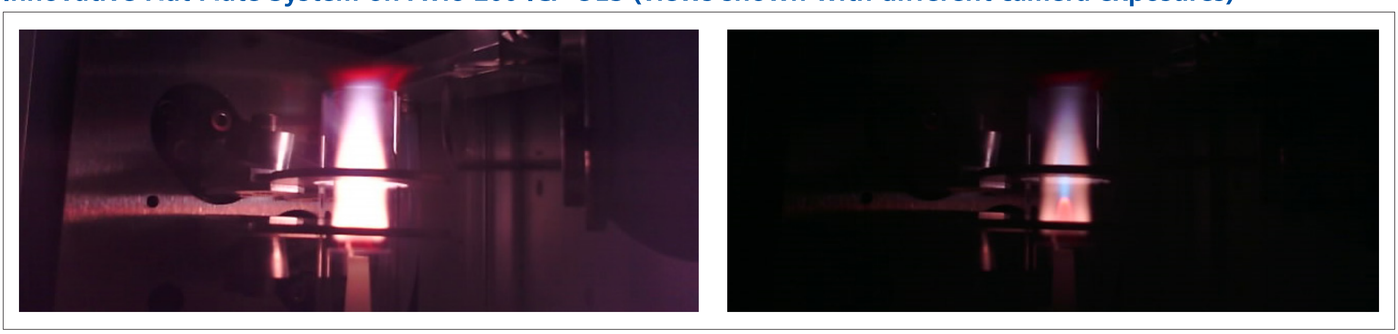


Figure 2. The figure on the left shows the flatness of the plasma base. It is also broader than the rounded helical plasma base (shown above) which prevents sample escape around the edges. The figure on the right shows the symmetry of the plasma around the axial channel with no distortion in shape.

With PerkinElmer's patented Flat Plate plasma technology, the same robust, matrix-tolerant plasma is generated and maintained with almost half the argon consumption of helical load-coil systems. Maintenance-free and requiring no cooling, this unique approach to RF generation minimizes operating costs without compromising performance.

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