ITEM OPPORTUNITY SYNOPSIS

Name of the item to be scouted: Inductively Coupled Plasma Optical Emission Spectrometer (ICP-OES)

State item to be used in: Oklahoma

Describe the Item:

Please describe the item application/the end use of item. Inductively coupled plasma optical emission spectrometer (ICP OES) instrument

Supplier Information:

Type of Supplier being sought (select from list below)

- **Manufacturer**
- **Contract Manufacturer**
- **Distributor**
- **Other (please specify)**

Reason for scouting submission (select from list below)

- **2nd Supplier**
- **Price**
- **Re-Shore**
- **Past supplier no longer available**
- **New Product Startup**
- **Other (please specify)** Research Instrumentation

Summary of Technical Specifications and Performance Requirements:

Describe the manufacturing processes (elaborate to provide as much detail as possible). The ICP-OES system consists of the main instrument, a computer controller assembly, and a suitable chiller. The plasma should have a dual viewing vertical setup with Flat Plate technology. The system should be equipped with a high throughput system consisting of a 7-port valve, 4-channel peristaltic pump and a high-speed vacuum pump. Technology similar to that of PlasmaShear technology should be incorporated with the ICP system and should utilize air. The detector should be a segmented array charge-coupled device detector paired with an echelle-based polychromator. The instrument should utilize multicomponent spectral fitting for greater accuracy. The radio frequency (RF) generator should be a free-running solid state RF generator paired with technology similar to that of Flat Plate technology to generate transversely symmetrical plasma to prevent sample and vapor escape.

Provide dimensions / size / tolerances / performance specifications of the item. The footprint of the ICP-OES should be 76cm X 87cm X 84 cm with a weight of 163 kg and a wattage of 2800. The chiller footprint should be 36.5cm x 61cm x 67.3cm with a weight of 81 kg and a wattage of 2000. The controller should be a Dell Windows 10 computer with Syngistix software. The Argon and nitrogen hoses should be 6 meters (m). The 2 water hoses should be 3.7 m. The air hose for shear gas should be 3.7 m. The power supply cable should be 2.5 m. An IEC 60309 250 V 16/20 A 2-pole plus protective earth plug and it's compatible receptacle must also be included with the instrument.

List required materials needed to make the product, including materials of product components, if applicable. Off the shelf commercial item.

Are there applicable certification requirements?

Yes

No

Please Explain:

Are there any applicable regulations that apply to the production of this item?

Yes

No

Please Explain:

Are there any other standards, requirements?

Yes

No

Please Explain:

Additional Comments:

Additional technical comments: Please see attachments for extra technical specification details.

Volume and Pricing:

Estimated Potential Business Volume (i.e. #Units per day, month, year): This will be a single (1 time) purchase.

Estimated Target Price / Unit Cost Information: $185,000.00

Delivery Requirements:

When is it needed by? (Immediate, 30 days, 6 months, etc) November 1, 2023

Describe packaging requirements (i.e., individually/ group packaging). Instrument must be thoroughly and carefully wrapped as not be damaged in shipping.

Where will this item be shipped? 919 Kerr Research Drive Ada OK 74820

Additional Comments:

Is there other information you would like to include?

PREPARING YOUR LAB

ICP-Optical Emission Spectroscopy

The PerkinElmer **Avio® 550/560 Max ICP-OES** instruments are complete systems, with the exception of the following items: suitable working area, exhaust vents, gases and regulators, cooling water, and a computer table or bench. These items must be provided by the laboratory.

The ICP-OES system consists of the main instrument, the computer-controller assembly, and a suitable chiller, the dimensions of which are given in Table 3 (Page 6).

PREPARATION CONSIDERATIONS

- Suitable Working Area
- Exhaust Vent
- Vent Positions
- Handling of Gas Cylinders and Other Suggested Safety Practices
- Gases for the Avio 550/560 Max ICP-OES
- PlasmaShear
- Drain Vessels
- Location
- Electrical Services
- Cooling Requirements
- Summary: Facilities Required
- Important Accessories and Consumables

Suitable Working Area

The environment in which any instrument is housed is an important consideration. The instrument will operate with a laboratory temperature between 15 and 35 °C (59-95 °F) with a maximum rate of change of 2.8 °C (5 °F) per hour. For optimum instrument performance, the room temperature should be controlled at 20 ± 2 °C. The instrument should be located away from direct sources of heat or cold. The relative humidity should be between 20 and 80%, non-condensing.

In order to minimize contamination problems, a relatively dust-free environment is necessary. Maximum dust levels should not exceed 36 million particles (0.5 mm or larger) per cubic meter of air. Failure to operate the instrument in a relatively dust-free environment will necessitate more frequent maintenance and could, eventually, damage the instrument. As a reference, a normal, clean office environment would be 18 to 36 million particles per cubic meter.

Another important consideration is to locate the instrument in an area free of corrosive fumes and excessive vibration. The Avio 550/560 Max ICP-OES instruments are bench-mounted and may need to be moved for service and preventative maintenance. It is preferred to leave a space of 45 cm (18 in.) between all sides of the instrument and lab walls to facilitate access. If the chiller is located under the instrument table, it must not make contact with any part of the table due to vibration.

The heat dissipated directly into the room air by the Avio 550/560 Max ICP-OES is about 2800 watts (660 BTU/ hr), most of which is removed if the system is properly vented. Additionally, the chiller dissipates about 3000 watts directly into the room.

PerkinElmer®
For the Better

Exhaust Vent

The Avio 550/560 Max ICP-OES instruments require one vent with dampener for the ICP torch connected directly to the top of the instrument. The torch venting system is required to remove combustion fumes and vapors from the torch housing. Exhaust venting is important for a number of reasons:

- It will protect laboratory personnel from toxic vapors that may be produced by some samples.
- It will tend to minimize the effects of room drafts and the laboratory atmosphere on ICP torch stability.
- It will help to protect the instrument from corrosive vapors that may originate from the samples.
- It will remove dissipated heat that is produced by the ICP torch and RF power supply. The venting system should provide a flow rate of 120 CFM ± 10 CFM (3398 L/min ± 283 L/min, 7 m/s ± 0.6 m/s). The temperatures of the exhaust gases upon exiting the instrument are about 80 °C (176 °F) at 1500 watts of RF power.

> **WARNING**
>
> *The use of ICP-OES instruments without adequate ventilation to outside air may constitute a health hazard. For example, the combustion of halogenated hydrocarbon produces toxic vapors. Extreme care should be taken that exhaust gases are vented properly.*

The exhaust duct is connected directly to the top of the Avio 550/560 Max instruments, and it is recommended to use the 4-inch (10.16 cm) I.D. flexible ducting provided to make the final connection to the instrument with stainless steel tubing for the rest of the exhaust ducting. The blower capacity depends on the duct length and the number of elbows or bends used to install the system. If an excessively long duct system or a system with many bends is used, a stronger blower may be necessary to provide sufficient exhaust volume.

Alternatively, smooth stainless steel tubing may be used instead of flexible stainless steel tubing where flexibility is not required to reduce system friction loss or "drag." A length of smooth stainless steel ducting has 20-30% less friction loss than a comparable length of flexible ducting. When smooth stainless steel tubing is used, elbows must be used to turn corners. These elbows should turn at a center line radius of 150 mm with a maximum bend angle of 45 degrees to reduce friction losses, and the number of elbows should be minimized.

Additional recommendations on the venting system include:

- Make sure the duct casing is installed using fireproof construction. Route ducts away from sprinkler heads.
- Locate the blower as close to the discharge outlet as possible. All joints on the discharge side should be airtight, especially if toxic vapors are being carried.
- Equip the outlet end of the system with a backdraft damper and take the necessary precautions to keep the exhaust outlet away from open windows or inlet vents and to extend it above the roof of the building for proper dispersal of the exhaust.
- Equip the exhaust end of the system with an exhaust stack to improve the overall efficiency of the system.
- Verify the length of the duct that enters into the blower is a straight length, at least ten times the duct diameter. An elbow entrance into the blower inlet causes a loss in efficiency.
- Provide make-up air in the same quantity as is exhausted by the system. An "airtight" lab will cause an efficiency loss in the exhaust system.
- Ensure that the system is drawing properly by releasing smoke into the mouth of the vent. Synthetic "smoke" can be generated by placing open bottles of hydrochloric acid and ammonium hydroxide in the proximity of the vent opening.
- Equip the blower with a pilot light located near the instrument to indicate to the operator when the blower is on.

Vent Positions

The venting system for the ICP torch connects directly to the torch compartment chimney located on top of the sample compartment. Four-inch inner diameter tubing is provided with the Avio 550/560 Max ICP-OES for making this connection. For proper instrument venting, order PerkinElmer Venting Kit (Part No. N0790188, 110V; N0790189, 230V). Figure 1 shows the location of the ICP torch exhaust vent.

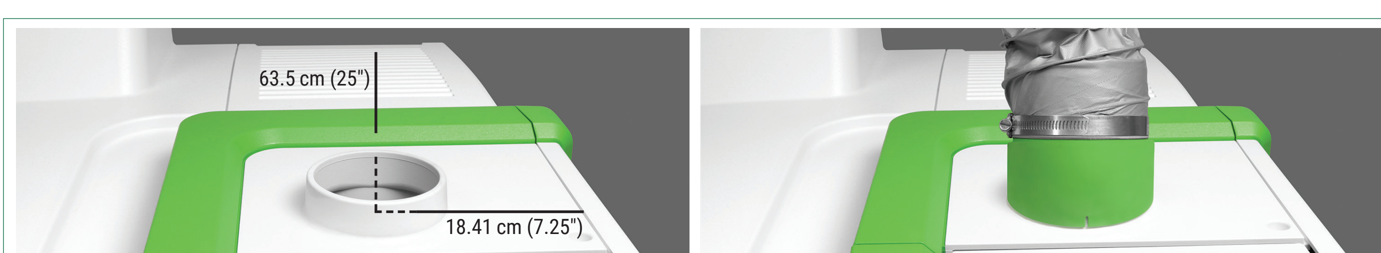


Figure 1: Vent for the Avio 550/560 Max ICP torch.

Handling of Gas Cylinders and Other Suggested Safety Practices

- Fasten all gas cylinders securely to an immovable bulkhead or a permanent wall.
- When gas cylinders are stored in confined areas, such as a room, ventilation should be adequate to prevent toxic or explosive accumulations. Move or store gas cylinders only in a vertical position with the valve cap in place.
- Locate gas cylinders away from heat or ignition sources, including heat lamps. Cylinders have a pressure-relief device that will release the contents of the cylinder, if the temperature exceeds 52 °C (125 °F).
- When storing cylinders external to a building, the cylinders should be positioned so that they are protected against temperature extremes (including the direct rays of the sun) and should be stored above ground on a suitable floor.
- Label gas cylinders clearly to identify the contents and status (full, empty, etc.).
- Do not attempt to refill gas cylinders.
- Arrange gas hoses where they will not be damaged or stepped on and where objects will not be dropped on them.
- Perform periodic gas-leak tests by applying a soap solution to all joints and seals.
- Only view the ICP torch through the safety viewing window or with protective eye wear. Do not view directly as hazardous UV radiation may be emitted. Ordinary safety glasses will, in general, provide sufficient protection, but additional side shields will ensure a further margin of safety. Safety glasses will also provide mechanical protection for the eyes.
- ICP-OES instruments generate high amounts of radio-frequency energy in their RF power supply and torch boxes, which is potentially hazardous, if allowed to escape. Safety devices and screening interlocks should not be bypassed or disconnected.
- The power supply of an ICP-OES is capable of generating potentially lethal voltages. No maintenance beyond what's described in the User Hardware Guide and Service Manual should be performed by anyone other than a PerkinElmer Customer Support Engineer or the customer's own PerkinElmer-trained maintenance personnel.
- Water lines should be located away from electrical connections. Condensation and possible leaks may create an unsafe situation, if in proximity to electrical connections.

The above suggestions do not supersede the safety standards outlined by OSHA or other local state and/or country safety organizations governing safe compressed gas cylinder handling and laboratory safety practices.

Gases for the Avio 550/560 Max ICP-OES

Argon is used as the ICP torch gas with the Avio 550/560 Max instruments. Nitrogen is recommended for the optical purge gas, although argon can be used as well. The quality criteria for the argon and the nitrogen are shown in Table 1.

Table 1: Argon and Nitrogen Quality Criteria.

Specification	Argon	Nitrogen
Purity	≥ 99.996%*	≥ 99.999%
Oxygen	≤ 5 ppm	≤ 5 ppm
Water	≤ 4 ppm	≤ 5 ppm
Nitrogen	≤ 20 ppm	
Hydrogen		≤ 1 ppm
Hydrocarbons		≤ 1 ppm

* A lower purity of 99.99% Ar is acceptable for analysis, however, low-level contaminants may be detected.

Either liquid or gaseous argon can be used with an ICP-OES system. The choice of liquid or gaseous argon tanks is determined primarily by the availability of each and the usage rate. Liquid argon is usually less expensive per unit volume to purchase, but cannot be stored for extended periods. If liquid argon is used, the tank should be fitted with an over-pressure regulator, which will vent the tank as necessary to prevent the tank from becoming a safety hazard. Gas transfer lines from the argon tank should be contaminant-free and not made of plastic.

It is highly recommended that the optical path be purged with either nitrogen or argon. Nitrogen is the recommended purge gas due to its lower cost. Normal purge gas usage is user-selectable at either 1.5 L/min (low purge) or 8 L/min (high purge) for nitrogen (1.4 L/min or 7 L/min if argon is used) at 365 kPa (50 psig) pressure.

Gaseous argon tanks do not require venting and consequently can be stored for extended periods without loss. The available argon pressure should be between 550 and 825 kPa (80-120 psig). Liquid argon and nitrogen may be purchased from your gas supplier. The Avio 550/560 Max ICP-OES instruments include the hoses necessary for connecting the argon and nitrogen to the instrument (0.25-inch Swagelok® connection).

For the Avio 550/560 Max, typical argon consumption for the torch gas is 9 SLPM while the plasma is running in low-flow condition and 1 SLPM for detector purge at all times while the instrument is powered on; for an instrument running 8 hours per day and 5 days per week at low flow, this would result in a consumption rate of approximately 32,000 SL per week. At that rate, a typical 160-liter liquid argon tank would last approximately four weeks, depending on storage conditions; a typical 8000 liter compressed argon cylinder would last approximately 1.8 days.

The argon gas regulator should provide a delivery pressure between 80 and 120 psi (550 to 825 kPa). The nitrogen purge gas regulator should provide a delivery pressure between 40 and 120 psig (275 to 825 kPa). A cylinder regulator that can be used with argon and nitrogen is available from PerkinElmer (Part No. 03030284). The regulator can be used with CGA 580 or CGA 590 fittings.

PlasmaShear™

The Avio 550/560 Max ICP-OES instruments use a shear gas to remove the plasma plume and to keep the heat away from the optics. Either clean air or nitrogen can be used for the shear gas. The shear flow is 28 L/min (1 cubic foot/min) at a minimum of 550 kPa (80 psig). While cylinders of compressed air can be used, an air compressor is more practical. However, because the shear gas must be clean and dry, the Avio 550/560 Max include an installable air-dryer assembly. The air hoses are supplied with 0.25-inch Swagelok® fittings and the assembly mounts on the lab wall. In humid environments, this may not be adequate to ensure that the compressed air is dry. Additional filters or condensers may be a necessary part of the air supply system.

Drain Vessels

A drain vessel (Part No. 09200486) and an end cap (Part No. N0690271) are supplied with the Avio 550/560 Max ICP-OES systems. The vessel is made of plastic, is 38 cm in height and has a circumference of 91 cm, and is used to gather the effluent from the ICP torch. The drain vessel should be placed on the floor in front of the ICP-OES and should not be stored in an enclosed storage area. The drain system should be checked regularly and replaced when necessary. Should it become necessary to replace the drain vessel, it should be made from a material not likely to be impacted by samples being analyzed. Glass or other brittle materials must not be used. Separate drain vessels must be used for acid-containing aqueous and organic samples.

Location

Typically, the Avio 550/560 Max ICP-OES are positioned with the computer and printer on the bench next to the instrument or on an adjacent table. The computer and printer must not be placed on the instrument. A bench for the instrument is available (Part No. N0782060). The dimensions are listed below (Figure 3). If not purchasing this bench, utilize the dimensions (Figure 4) to determine minimum requirements for the laboratory surface to be used.

The instrument must be placed under the exhaust vent for the torch compartment and near the electrical, water, and gas supply points.

The instrument is supplied with a power cord 2.5 m (8 ft.) long and the following hoses:

- Argon and nitrogen hoses: 6.0 m (20 ft.)
- Water hoses (2): 3.7 m (12 ft.)
- Air hose for shear gas*: 3.7 m (12 ft.)

** The air dryer filter should be located within the 3.7 m (146 in.) length of the air hose.*

Electrical Services

NOTICE: A means of electrically grounding the instrument must be available.

The Avio 550/560 Max instruments are equipped with a 2.5 m (8 ft.) power cable that supplies both the spectrometer and the RF generator. Under full instrument load, the Avio 550/560 Max require a 200-230 V, 2800 VA, 50/60 Hz (± 1%) line with a separate dedicated circuit breaker. Only single-phase power is needed.

NOTICE: The Avio 550/660 Max ICP-OES must not have a ground fault circuit interrupter (GFCI) protected outlet. The instrument will trip the interrupter if this type of outlet protection is used.

The Avio 550/560 Max ICP-OES are equipped with an IEC 60309 250 V 16/20 A 2-pole plus protective earth plug (Walther Part No. 211306, PerkinElmer Part No. 09997530) that inserts into a receptacle (Walther Part No. 410306, PerkinElmer Part No. 09290304). Alternative surface mount receptacle (Walther Part No. 111306, PerkinElmer Part No. 09290305). Both receptacles are shipped with the instrument.

NOTICE: Do not replace the IEC 60309 instrument power plug.

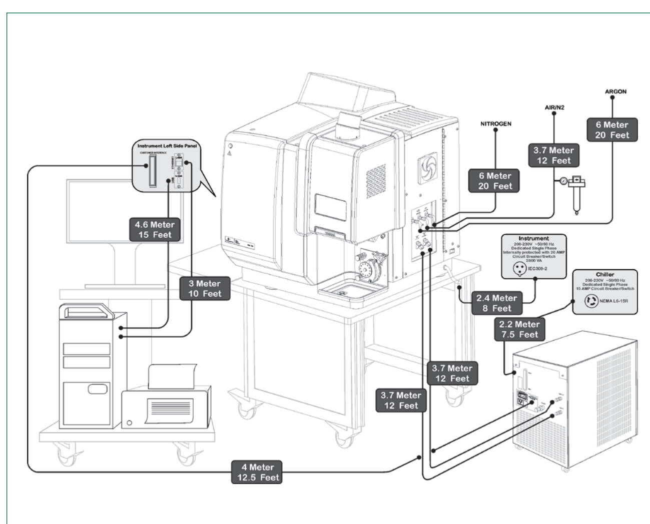


Figure 2: Location and length of connections.

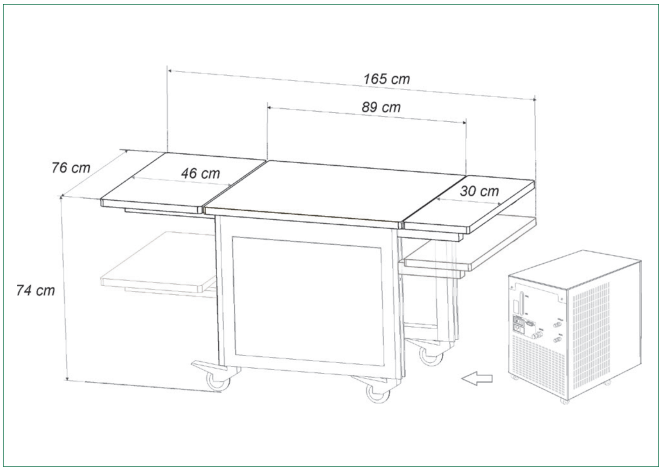


Figure 3. Bench for the Avio 550/560 Max ICP-OES (Part No. N0782060).

Cooling Requirements

The Avio 220 Max ICP-OES requires a recirculating cooling system (chiller) to dissipate heat from the oscillator. The requirements for the chiller are:

- Cooling Capacity at 20 °C: 2850 watts
- Temperature Stability: ± 0.5 °C
- Pump Rate: 4 gal/min between 55 and 75 psi max

The chiller coolant formulation used must be PolyClear coolant (Part No. N0776200 for half-gallon bottles).

An additional 200-240 V line is required for the chiller. The chiller requires its own electrical circuit; DO NOT run the chiller on the same circuit as the Avio Max ICP-OES. Most chiller vendors provide the required electrical receptacle with the chiller.

Summary: Facilities Required

Tables 2 and 3 provide the power requirements and dimensions, respectively, for the Avio 550/560 Max ICP-OES and its major accessories. The Avio 550/560 Max will operate normally at a range of 200-230 V and within 1 Hz of the specified frequency. If the power line is unstable, fluctuates in frequency, or is subject to surges, additional control of the incoming power may be required. The following line conditioners are available: PerkinElmer Part No. N9307512 with input plug C320P and output receptacles C320R (qty 1) and 5-20R (qty 4); and PerkinElmer Part No. N9307522 with input plug IEC and output receptacles IEC320R (qty 6).

The ANSI-IEEE C62.41* recommends the noise level to be < 10 volts normal mode (signal to ground) and < 1/2 volt common mode** (neutral to ground) for the AC power input. This can be verified by an oscilloscope or power meter.

* *American National Standards Institute (ANSI) is a private, non-profit organization that administers and coordinates the U.S. voluntary standards.*

* *Institute of Electrical and Electronics Engineers (IEEE) is a professional association with its corporate office in New York City.*

** *Excessive common mode (neutral to ground) noise can be caused by a poor building ground. The NEC (National Electrical Code) requires that the building ground resistance does not exceed 25 ohms. This can be verified with an earth ground test.*

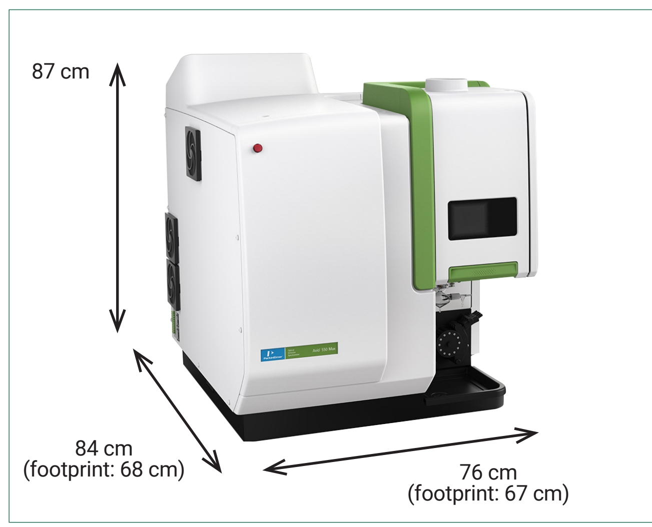


Figure 3. Avio 550/560 Max ICP-OES spectrometer dimensions. Footprint dimensions (black base) of 67 cm width and 68 cm depth.

Table 2: Services required for the Avio 550/560 Max ICP-OES system. The Avio 550/560 Max are computer-controlled, bench-mounted instruments, with one exhaust vent.

Gases	Argon	550-825 kPa (80-120 psig)	1-25 L/min	
	Nitrogen	220-825 kPa (32-120 psig)	1.5-8 L/min	
Shear Gas	Air or Nitrogen	550-825 kPa (80-120 psig)	25 L/min	
Coolant		310-550 kPa (45-80 psi)	4 L/min (1 gal/min)	15-25 °C (59-77 °F)
Power	Avio 550/560 Max ICP-OES	200-230 V (under full instrument load)	50/60 Hz	16/20-amp single-phase
	Computer and Printer	115 V	60 Hz	
		230 V	50 Hz	
	Chiller	208-230 V	60 Hz	15-amp single-phase
		208-230 V	50 Hz	15-amp single-phase or 13-amp single-phase (U.K.)

Table 3. Dimensions of Avio 550/560 Max ICP-OES and Accessories.

Product	Width	Height	Depth	Power	Weight
Avio 550/560 Max ICP-OES	76 cm (29.9 in.) footprint: 67 cm (26.4 in.)	87 cm (34.4 in.)	84 cm (33.1 in.) footprint: 68 cm (26.8 in.)	2800 watts	163 kg (360 lb)
Note: Depth with lifting handles is 96 cm (37.8 in.); Weight with lifting handles is 235 kg (518 lb) in shipping container with accessories					
S23 Autosampler	57 cm (22.4 in.)	45 cm (17.7 in.)	53 cm (20.9 in.)	80 watts	9.5 kg (21 lb)
S25 Autosampler	79 cm (31.1 in.)	45 cm (17.7 in.)	53 cm (20.9 in.)	80 watts	13.6 kg (30 lb)
HP® LaserJet® Printer*	42 cm (16.5 in.)	38 cm (14.8 in.)	45 cm (17.8 in.)	330 watts	20.4 kg (45 lb)
Computer Keyboard	48.3 cm (19 in.)	4.3 cm (1.7 in.)	21.6 cm (8.5 in.)	–	2 kg (4 lb)
Computer CPU (minitower)*	18 cm (7.1 in.)	42.6 cm (16.8 in.)	44.7 cm (17.6 in.)	200 watts	10 kg (22 lb)
Computer Monitor 24" flat panel	56.0 cm (22 in.)	43.6 cm (17.2 in.)	17.2 cm (6.8 in.)	300 watts	6.8 kg (15 lb)
Typical Chiller	36.5 cm (14.5 in.)	61 cm (24 in.)	67.3 cm (26.5 in.)	2000 watts	81 kg (178 lb)

* Typical dimensions for printers and computers, based on an HP® LaserJet® 4250 printer and a Lenovo® ThinkCentre® M58p computer system.

Important Accessories and Consumables

Line Conditioners and UPS Systems

Description	Part No.
Line Conditioners	
3.8 KVA Line Conditioner 60 Hz (Input Plug C320P and Output Receptacles C320R (Qty 1) and 5-20R (Qty 4))	N9307512
3.6 KVA Line Conditioner 50 Hz (Input Plug IEC and Output Receptacles IEC320R (Qty 6))	N9307522
UPS Systems	
5.2 KVA True On-Line Power Conditioned UPS 50/60 Hz	N0777511
Probe	
Power Probe 0-250 V Input 50/60 Hz	N3151391

Compressors

Each completely oil-free compressor comes assembled on an internally and externally coated air tank and includes a self-purging regenerative dryer with aftercooler. The tank and complete compressor package come with a manufacturer's warranty. The enclosure model can be ordered which will help silence the compressor while still providing controls on the front for easy access. If customers choose to supply their own compressors, they must meet specifications in the following table (Page 7) to guarantee performance and minimal maintenance.

Description	Part No. (115 V/60 Hz)	Part No. (220 V/50 Hz)	Part No. (220 V/60 Hz)
Compressor	N0777602	N0777603	N0777604
Compressor with Enclosure	N0777605	N0777606	N0777607

Product meets both U.S. and Canadian CSA standards. ASME® Certified tank.

Compressor Specifications

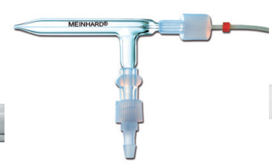
Parameter	Value
Horse Power (Hp)	1.5
Output (CFM)	6.0
Output (m/s)	0.35
Output (L/min)	170
Max Pressure (psi)	120
Max Pressure (bar)	8
Operating Pressure (psi)	90-120
Operating Pressure (bar)	6-8
Noise Level (dB/A)	75 – with Enclosure: 55
Oil (ppm)	0.01
Dust (ppm)	0.01
Pressure Dew Point (°C)	-40
Tank Size (gal)	13
Noise Level (dB/A)	75 – with Enclosure: 55
Tank Size (gal)	13
Tank Size (L)	50
Dimensions (in.)	16 x 26 x 35 – with Enclosure: 29 x 23 x 30
Weight (lb)	119 – with Enclosure: 207
Packed Dimensions (in.)	33 x 28 x 43 – with Enclosure: 33 x 28 x 3
Packed Weight (lb)	135 – with Enclosure: 264

Replacement Parts

Description	Part No.
Replacement Air Intake Filter	N0777608
Micron Dryer Filter Element	N0777609
Replacement Piston Assembly	N0777610
Replacement Reed Valve	N0777611
Replacement Head Gasket	N0777612

Every day, you can count on PerkinElmer to provide you with solutions that deliver reliable performance, control operating costs, and maximize operational time. Our complete portfolio of consumables, parts, supplies, training, and service helps you meet both routine and demanding measurement challenges. We invest heavily in testing and validating our products to ensure you receive guaranteed compatibility and performance – on-time, for every instrument in your laboratory.

Always keep spares on hand!


For a complete listing of ICP consumables, please visit www.perkinelmer.com/supplies

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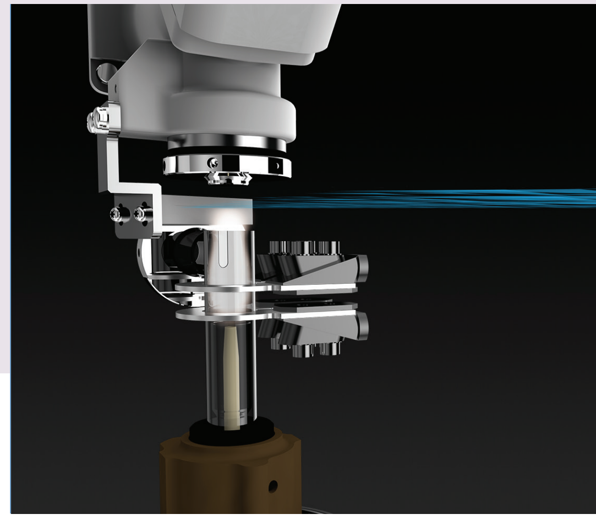
TECHNICAL NOTE

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.

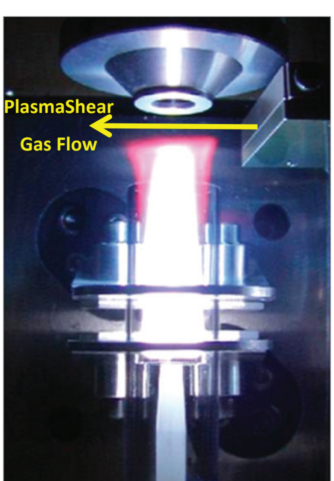


Figure 1. PlasmaShear technology in the Avio family of ICP-OES.

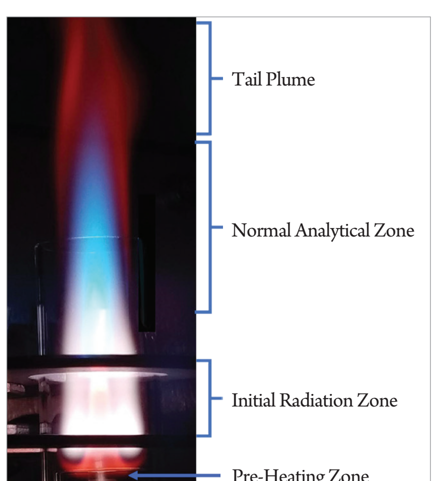


Figure 2. Zones of an inductively coupled plasma aspirating 1000 ppm Y. The blue section (normal analytical zone) is the result of emission from Y.

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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.

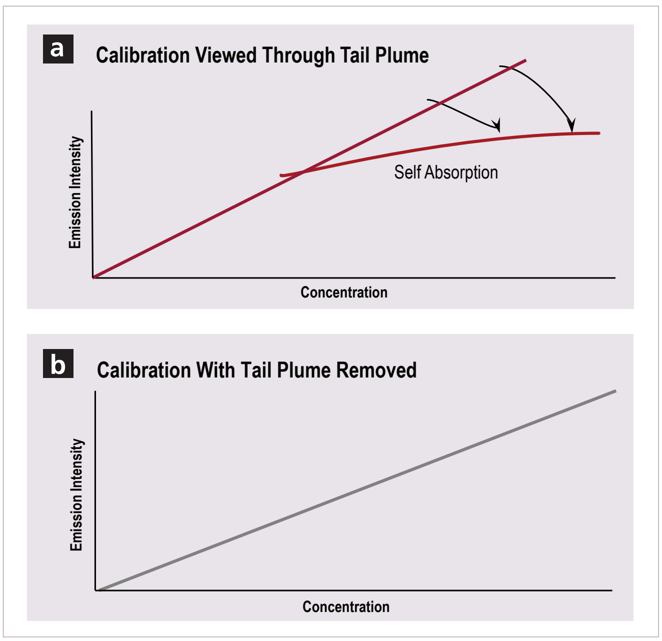

Figure 3 Axial view calibration curves with the tail plume (a) and with the tail plume removed (b).

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 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.

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

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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TECHNICAL NOTE

ICP-Optical Emission Spectroscopy

Avio 550/560 Max ICP-OES Optical System and SCD Detector

The optimized optical system of the Avio® 550/560 Max ICP-OES centers on a unique high-performance solid-state detector – the segmented-array charge-coupled device (SCD) detector. An echelle-based polychromator was designed to fully utilize the capabilities of the SCD. Using a PerkinElmer echelle grating optimized for UV performance and a free-form optic, the Schmidt cross-disperser, the Avio 550/560 Max ICP-OES systems have exceptional optical throughput and excellent resolution, providing you with superior detection limits and line selection.

Key Benefits:

- Unparalleled analytical speed
- Exceptional long-term stability
- Excellent spectral resolution
- Small footprint

Why an SCD? Flexibility, Simultaneity and Low Noise

PerkinElmer experts engineered patented detector technology with our SCD, which offers maximum flexibility, providing thousands of emission lines with fully simultaneous analyte and background measurement. This technology was created specifically for plasma emission spectroscopy.

Superb UV quantum efficiency, dynamic range, and negligible read-out noise make it the ideal detector for the ideal spectrometer. This solid-state detector provides exceptional long-term performance and reliability. Each silicon-based detector consists of hundreds of discreet subarrays which have from 20 to 80 photosensitive areas or "pixels" per subarray. The subarrays are strategically positioned to take advantage of the best emission lines for all of the elements. The position and size of each subarray are engineered carefully to match each wavelength order produced by the echelle polychromator.

Next to each subarray on the detector are the output electronics for that subarray. The positioning of the electronics adjacent to the subarray provides extremely low readout noise, much lower than any other charge transfer device. This eliminates the time-consuming multiple readouts needed to reduce detector noise. Each subarray is individually addressed through the adjacent interface logic. This provides the capability to read any subarray without the necessity of reading out an entire detector, thereby reducing the analysis time.

The SCD detector, unlike many charge-coupled devices (CCDs), is designed to prevent charge "blooming". "Blooming" occurs when a pixel fills up with electrons and the excess electrons spill into an adjacent pixel, much like an overfilled bucket. Should a pixel on the SCD exceed its capacity during an integration, the excess electrons flow into the output register where they are electronically swept away. For secondary protection, a guard band also surrounds each subarray. This anti-blooming design helps to ensure the integrity of your results.

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The subarrays capture different portions of the wavelength spectrum at the same time, allowing simultaneous measurement of thousands of emission and background wavelengths. The peak emission and the spectral background are measured simultaneously (with user-selectable background parameters), reducing data-acquisition time and increasing your sample throughput. Analytical precision and detection limits are also improved, since simultaneous measurement of analyte and background can compensate for signal variations attributable to the sampling system.

The Avio 550/560 Max ICP-OES Optical Platform

Energy from the plasma enters the spectrometer and is focused on the entrance slit by two flat mirrors and two toroidal mirrors, all considered off-axis optics which reduce the stray light to the detector, providing excellent detection limits (Figure 1). The first toroid is computer-controlled and can be automatically positioned to optimize the plasma viewing position in the axial view. For radial viewing, a separate toroid moves into the place of the first toroid and the shutter is moved into the radial viewing position blocking light from the axial view. The second toroidal mirror directs the plasma energy to the entrance slit and onto a flat mirror. The light then travels to a parabolic mirror, which collimates the energy onto the echelle grating, separating the light into high dispersion, overlapping orders.

The next component is a free-form optic, the Schmidt cross-disperser, which serves three purposes. First, with dual-detector configurations, a hole in the center of the optic is used to split the light into separate UV and visible channels. Light passing through the hole is dispersed by the prism and is focused onto the surface of the visible wavelength detector. The energy reflected off the surface of the cross-disperser is sent through the UV channel. The use of separate UV and visible channels effectively doubles the detector area. This ensures there are no compromises in spectral range, resolution or energy throughput and that analyses at all wavelengths can be performed simultaneously.

The second purpose of the Schmidt cross-disperser is to serve as a grating that separates the light by order. The dispersed light is sent to the camera sphere optic and then onto the UV wavelength detector via the fold flat mirror, the size and shape of which are matched to the hole in the cross-disperser so that no energy is lost.

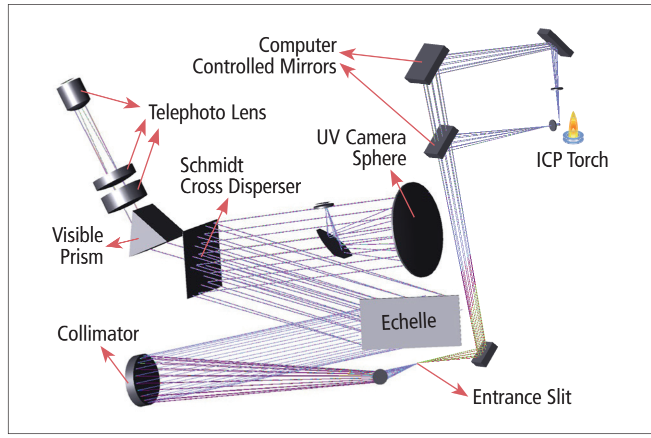

Figure 1. Optical diagram of Avio 550/560 Max ICP-OES systems.

The third use of the Schmidt cross-disperser is to optically correct for spherical aberrations, distortions of the optical image. This is because the Schmidt cross-disperser is a free-form optic, meaning that the shape of its surface is customized to correct for aberrations, which gives the Avio 550/560 Max ICP-OES outstanding resolution and increased sensitivity. By correcting for these aberrations, the Avio 550/560 Max spectrometer produces clean, sharp images at the detector for highest resolution. To provide long-term stability, the entire optical system of the Avio 550/560 Max instruments is enclosed in a thermostatted housing. This isolates the optical system from the ambient environment and ensures exceptional wavelength stability. Better stability means better productivity because less time is required for recalibration.

Exceptional Results, Fast

Even if you don't need to reach the trace detection limits that the Avio 550/560 Max ICP-OES provides, that power translates into improved precision, accuracy, and speed, supplying clearly better analytical results, faster. You can rest assured that if your requirements change, you have a system that has the ability to grow with you.

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TECHNICAL NOTE

ICP-Optical Emission Spectroscopy

Vertical Dual View on the Avio Max Series ICP-OES

The PerkinElmer Avio® Max series ICP-OES incorporates a vertically oriented plasma with complete dual-viewing optics under computer and software control. Any wavelength can be used in the radial, axial, or mixed viewing modes in a single method.

Radial or Axial Plasma Viewing?

Radial viewed plasmas have been utilized for many years for analytical measurements in ICP-OES. The radial view emission of interest occurs in the central channel of the plasma and the spectrometer views the analyte emission from the side of the plasma through the background argon emission. The viewing height is a very important parameter with radially viewed plasmas because elements undergo emission at various heights in the plasma (usually expressed as height above the load coil).

The Avio Max series ICP-OES provides automated optimization for individual emission line viewing height. For use with radially viewed plasmas, a spectrometer normally is designed to image a vertical slit in the plasma (Figure 1a). This vertical slit has the effect of averaging the analyte emission intensity over the height of the slit. In comparison, an axially viewed plasma system looks down the central channel of the plasma (Figure 1b) and collects all the analyte emission over the entire length of the plasma. The net effect is that the emission pathlength is increased relative to a radially-viewed plasma. This increases the measured analyte emission and improves sensitivity. However, axial viewing does not extend the dynamic measurement range available - it merely shifts the range downward to encompass lower concentrations. Radial viewing of the plasma complements axial viewing by providing an equivalent working range at higher concentrations. A system that provides both radial and axial viewing offers the advantages of both.

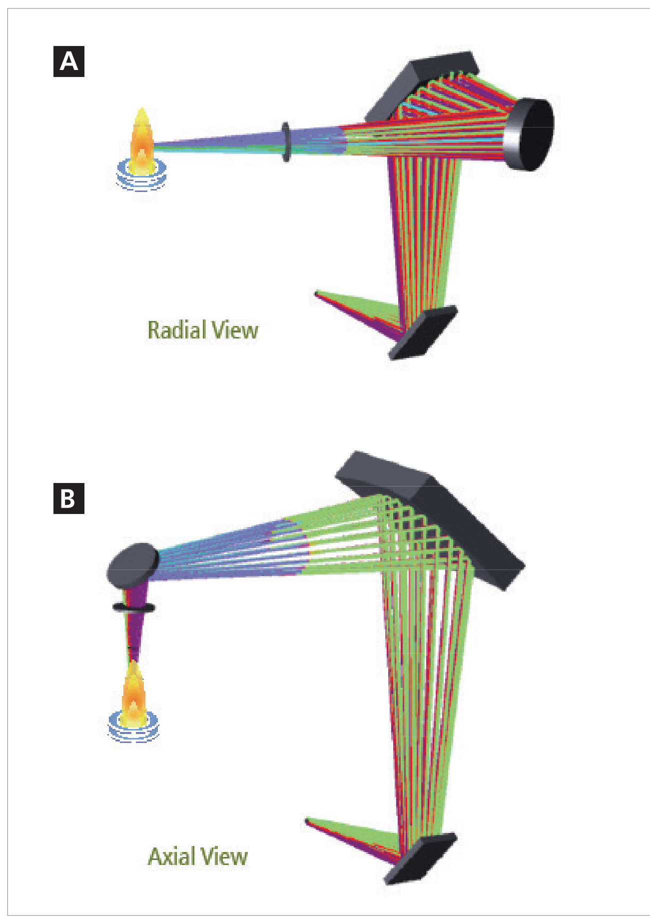

Figure 1. (A) Radially viewed plasma with a vertical slit image in the plasma. (B) Axially viewed plasma with a circular slit image in the plasma.

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Why Not Use Alternate Wavelengths to Extend the Working Range?

The use of alternate, less sensitive wavelengths to extend the working range is a viable alternative in some instances. However, the use of multiple wavelengths for the same element also has potential drawbacks:

- Regulatory methods frequently specify that the analysis must be performed at a prescribed wavelength. Use of an alternate wavelength could mean that the analysis was non-compliant.
- Even with methods that allow the use of alternate wavelengths, those wavelengths must be evaluated for each sample matrix, increasing method development time. For example, the alternate line should be examined for potential interferences not found at the normal wavelength.
- Not all elements have multiple usable wavelengths with appropriately different sensitivities, e.g., sodium. What do you do when a satisfactory alternate wavelength isn't available?
- The use of alternate wavelengths requires extra calibrations to be performed at each additional wavelength, potentially increasing analysis times.

The use of a system that can conveniently provide both axial and radial viewing eliminates these limitations.

Detection Limit Improvements

The improvement in sensitivity with an axially-viewed plasma typically yields a 5- to 10-fold improvement in detection limits. This provides a powerful tool for environmental analysis, including many U.S. Environmental Protection Agency (EPA) and DIN methods. In fact, the Avio Max series ICP-OES systems in their axially viewed plasma mode meet the U.S. EPA Contract Required Quantitation Limits (CRQL) for all 22 elements in the protocol (CERCLA Statement of Work ILM05.3/ILM05.4 or ISM01.1). Without axial viewing, the detection limits for some of these elements previously required the use of graphite furnace atomic absorption (GFAA) or ICP mass spectrometry (ICP-MS).

With the Avio Max series ICP-OES and axial viewing, laboratory productivity is greatly improved because the number of sample preparations is reduced, data reduction is simplified, and operator training is minimized. A single sample preparation is all that is required, saving time, minimizing reagent usage, and reducing waste generation. Also, since all the results are acquired on a single instrument, report generation is simplified.

PlasmaShear™ Reduces Axially Viewed Plasma Interferences

To remove interferences during axial viewing, you need to eliminate the cool tail plume of the plasma. No instruments do it more effectively, reliably, or economically than the Avio Max series ICP-OES.

While other ICPs use as much as 4 L/min of argon to remove the plume, the Avio system's unique PlasmaShear technology runs on air. No need for ionization suppressants. No high-maintenance, high-extraction systems or cones. Just a fully integrated, fully automated interference-removal system that delivers problem-free axial analysis.

Figure 2 shows a plasma with 1000 ppm yttrium being aspirated. The blue color is from normal emission, and the red zone of the plasma is the cooler tail plume. Self-absorption occurs in this cooler part of the plasma. That is, emission from excited state atoms in the blue zone will be absorbed by the ground state atoms in the cooler red zone of the plasma. With the radially viewed plasma, this is not a problem since the tail plume is not in the optical path.

To eliminate the adverse effects of this cooler tail plume, the axially-viewed Avio configurations use an air shear gas to displace the tail plume out of the optical path (Figure 3). This simple solution provides a number of real advantages. First, compressed air is normally available in most laboratories, so no additional costs are incurred. Second, the plume is displaced before it approaches the entrance to the optical system, minimizing the possibility of corrosion to, or sample deposition on, any optical system component.

As can be seen in Figure 4, the red tail plume is eliminated, and a very thin boundary is created by the shear gas. By comparing Figures 4 and 6, you can see the differences in the optical path length of the red areas of the two plasmas. The Avio Max series ICP-OES with the air shear path, ensures that you will have the largest linear dynamic range possible with axially viewed plasmas.

While other ICPs use as much as 4 L/min of argon to remove the plume, the Avio system's unique PlasmaShear™ technology runs on air. It is a fully integrated, fully automated interference-removal system that delivers problem-free axial analysis.

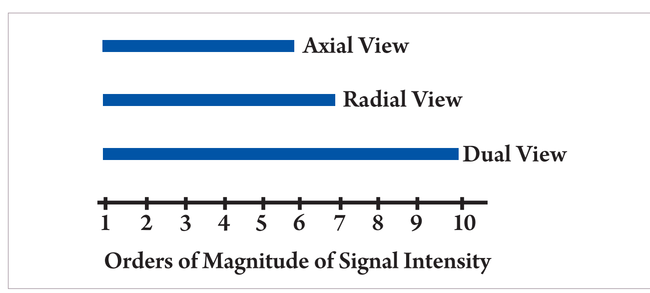

Figure 2. Typical analytical working ranges for the inductively coupled plasma technique.

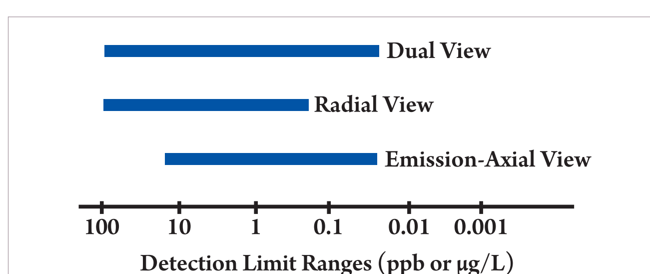

Figure 3. Typical detection limit ranges for inductively coupled plasma viewing modes.

Figure 4. Yttrium plasma with the blue color showing the normal emission and the red color showing the cooler tail plume displaced by the air shear gas.

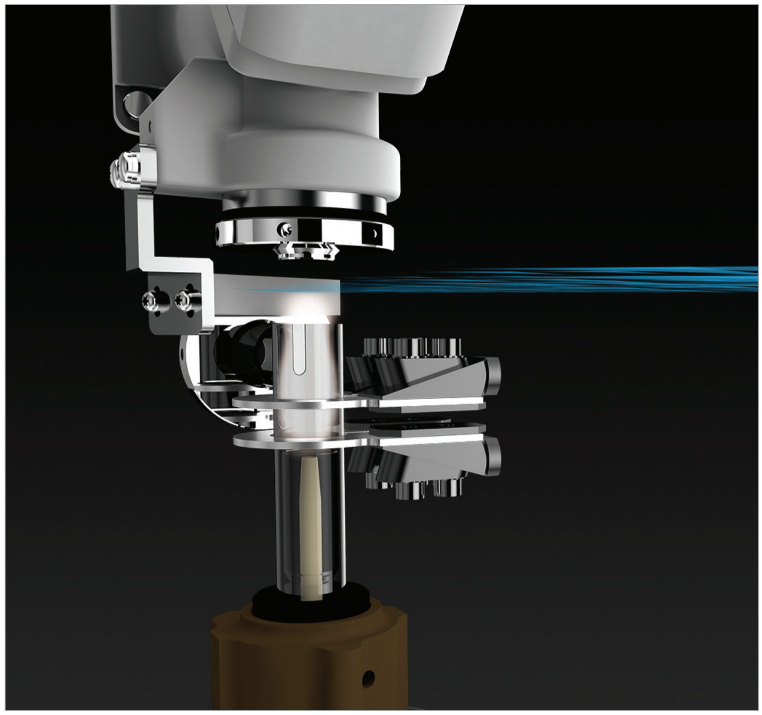

Figure 5. Air shear gas used with the axially viewed plasma of the Avio.

Figure 6. Yttrium plasma with the blue color showing the normal emission and the red color showing the cooler tail plume.

The Best of Both Worlds

Unfortunately, neither viewing configuration – radial or axial – is perfect for all needs. This is why the Avio Max series ICP-OES spectrometers include the dual view (DV) configuration. With the DV system, a software-controlled mirror provides the operator with a simple means of selecting the desired viewing mode. In fact, the viewing mode can be included as a part of the operating method for each analyte. Careful attention has been paid to the size and shape of the slit and the size and location of the viewed image to optimize the analyte intensity and minimize the background emission with both configurations.

The Avio Max series vertical plasma ICP-OES spectrometers with dual view truly offer the best of both worlds.

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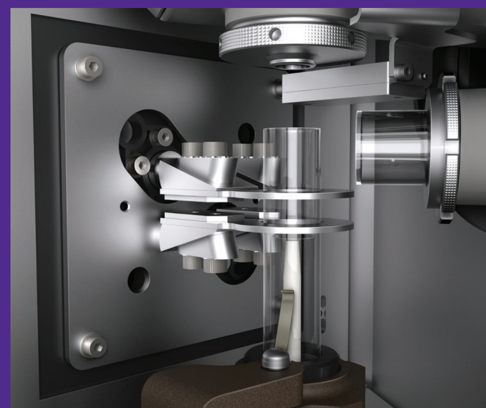
TECHNICAL NOTE

ICP-Optical Emission Spectroscopy

Flat Plate Plasma Technology on the Avio Max Series ICP-OES



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 Avio® Max 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.

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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 Max Series 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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TECHNICAL NOTE

ICP-Optical Emission Spectroscopy

Multicomponent Spectral Fitting

Introduction

Baseline and interfering element correction (IEC) techniques are used with ICP optical emission spectroscopy to correct analytical signals for contributions from the plasma, the matrix, or elements other than the analyte. If the contributions from these components are not corrected accurately, the analytical result will be erroneous. Yet both correction techniques rely on interpolated or extrapolated correction factors.

Baseline correction measurements typically are made at one or two wavelengths adjacent to the analyte wavelength with the assumption that the baseline at the analyte wavelength can be interpolated from the baseline correction measurement. IEC correction relies on the validity of single-point measurements made on each interfering element, assuming that the IEC measurements can be extrapolated accurately to correspond to different concentrations of the interferent. Both techniques rely on the validity of the interpolation or extrapolation. Although the two techniques can improve performance with some types of samples, they are not universally applicable.

Multicomponent Spectral Fitting

For greater accuracy, using a full segment of the spectrum around the analyte wavelength is preferred to using just one or two points. To achieve that goal and to provide superior correction capabilities, PerkinElmer developed Multicomponent Spectral Fitting (MSF). Mathematically, MSF uses a multiple linear least squares model based on an analysis of the pure analyte, the matrix, and the blank (Figure 1). It sounds complicated, but it isn't. Think of it as automatic simultaneous multi-point background correction. Using MSF for spectral overlap correction requires only that a minimum of three solutions are analyzed: the blank, a pure solution of the element being determined, and pure solutions for each of the potentially interfering elements in the matrix. MSF and the computer do the rest – automatically. There are no limits on the number of interfering elements that can be included in a model. In addition, once models are developed for an element, they can be used in many different analytical methods.

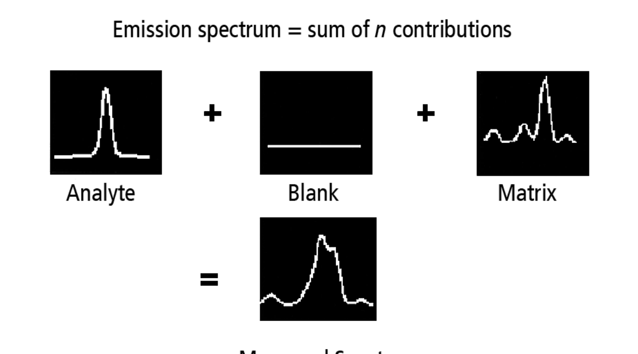

Figure 1. The measured spectrum consists of several components, demonstrating the need for improved spectral fitting techniques like MSF.

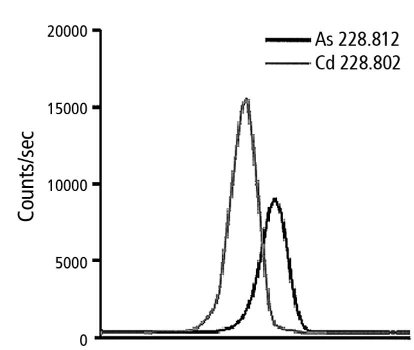

Figure 2. Running the Cd and As standards separately demonstrates the spectral overlap.

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As an example, let's look at the determination of arsenic in the presence of cadmium at the 228.812-nm emission line. The sample spectra for solutions containing 1.1 mg/L Cd and 31 mg/L As are shown in Figure 2.

After creating an MSF model using these spectra, the combined spectrum of the complex matrix can be measured, as shown in Figure 3. Applying MSF, the corrected spectrum for arsenic (Figure 4) shows no evidence of the interfering sample matrix and is easily quantifiable. It's that simple.

Because MSF uses all of the spectral information available, both the analytical accuracy and the detection limits are improved. Figure 5 shows that the detection limits for this group of elements are improved significantly with MSF over those obtained with no background correction, with sequential off-peak background correction, or with simultaneous background correction.

Why does MSF improve detection limits more at longer wavelengths?

Detection limits in the lower UV with a low-noise detector are usually limited by photon shot noise, caused by the random arrival times of the photons as they reach the detector. In contrast, detection limits at higher wavelengths are limited by noise due to the sample introduction system, often called "flicker" noise. Simultaneous background correction (including MSF) can compensate for flicker noise automatically, so the performance improvements are more pronounced at higher wavelengths.

MSF can significantly improve your analytical results – detection limits, accuracy, and precision. Even better, it's included as a standard feature with all PerkinElmer Avio® ICP-OES spectrometers.

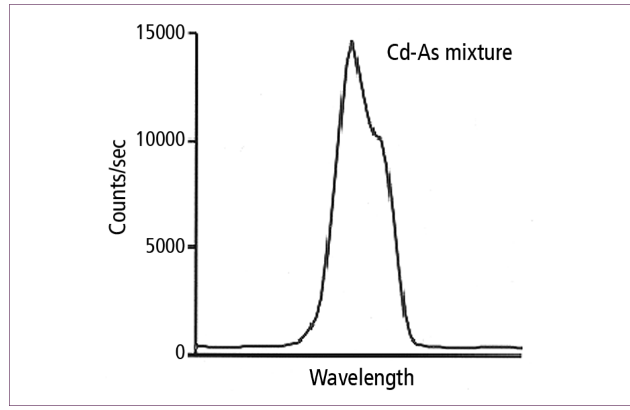

Figure 3. The Cd overlaps the As peak, making it difficult to measure As with conventional background correction techniques and necessitating the selection of an alternate wavelength.

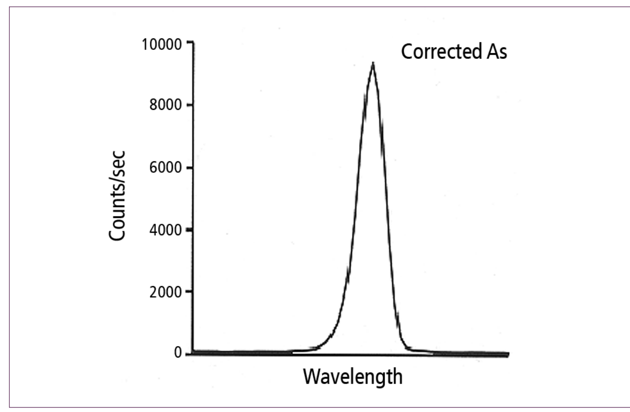

Figure 4. The correct As concentration is determined despite the Cd overlap, making it easier to develop methods using MFS.

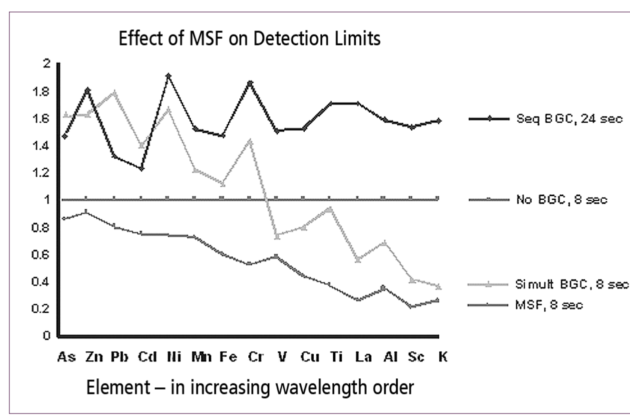

Figure 5. MSF improves detection limits over sequential and simultaneous background correction techniques.

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TECHNICAL NOTE

ICP-Optical Emission Spectroscopy

PerkinElmer's Solid-State RF Generator for Flat Plate Plasma

The radio frequency generator is a critical component in any ICP-OES spectrometer. The RF power it produces must be exceptionally stable, both short-term and long-term, in order to obtain stable, reproducible emission signals. The RF power supply must provide a high coupling efficiency with the sample to generate maximum emission-signal strength. It must instantaneously compensate for any changes in impedance due to variations in the sample or solvent. Historically, RF power supplies have been based on the use of vacuum power tubes. However, power tube-based power supplies do not provide the long-term stability, lifetime, or coupling efficiencies desired for optimal ICP-OES performance.

All solid-state, free-running RF power supply

PerkinElmer continues its tradition of excellence and leadership in ICP technology with our fourth-generation, free-running solid-state RF generator on the Avio® ICP-OES spectrometers. Its unique Flat Plate™ plasma technology, which replaces previous helical-coil induction, generates a transversely symmetrical plasma (U.S. Patents 7,106,438 and 7,511,246). This approach produces a flat-bottom shaped plasma which prevents sample and vapors from escaping around the outside. With Flat Plate technology, the same robust, matrix-tolerant plasma is generated and maintained with approximately half the argon consumption of helical load-coil systems. Maintenance-free, this innovative approach to RF generation minimizes operating costs without compromising performance.

Key Benefits:

- Solid-state electronics eliminate the need for a power amplifier tube, enhancing reliability
- High coupling efficiency produces improved signal-to-background ratios at lower power
- Free-running 40-MHz design eliminates the need for mech-anical matching networks
- Full power range allows the analysis of all sample types
- Maintenance-free Flat Plate plasma technology uses approximately half the argon of traditional systems

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Compact, efficient and with full power

The computer-controlled, compact solid-state RF generator module is approximately 15 cm x 15 cm x 10 cm and is mounted on a single printed circuit board. It provides a full power range, from 1000 to 1500 watts, in 1-watt increments.

RF power supply efficiency is greater than 79% compared to typical efficiencies of 50% to 65% for power tube-based systems. The design is elegantly simple, with no moving parts, adjustments, or alignment for enhanced reliability.

Automatic compensation for sample changes

The free-running 40 MHz design eliminates the need for mechanical matching networks, improving reliability. In addition, the free-running design provides instant compensation for impedance changes. This allows you to analyze samples in organic solution as easily as in aqueous solution or to handle samples with widely varying dissolved salts content with no need for operator adjustment of the plasma.

Long-term stability and enhanced reliability

The components used in the totally solid-state RF generator have rated lifetimes more than 10 times greater than for RF power tubes, glass or ceramic. And the solid-state components don't exhibit the aging characteristics common to power tube-based power supplies, which require recali-bration. These features translate directly to enhanced long-term stability, improved reliability, and lower operating costs.

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