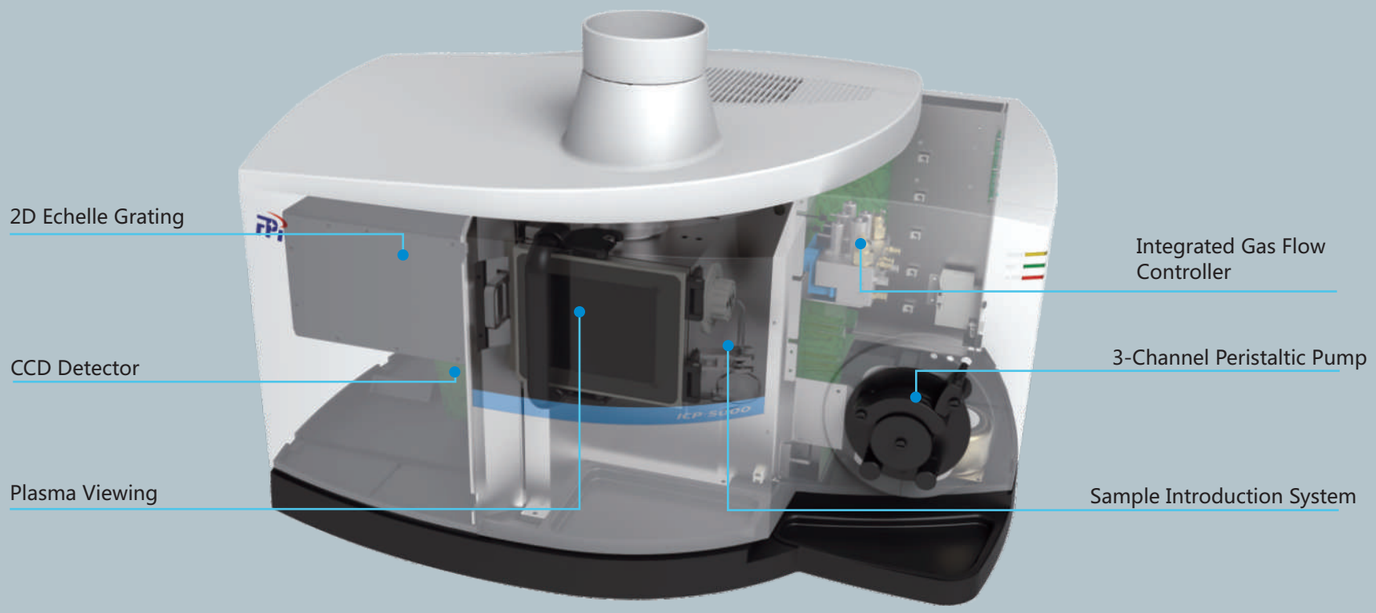
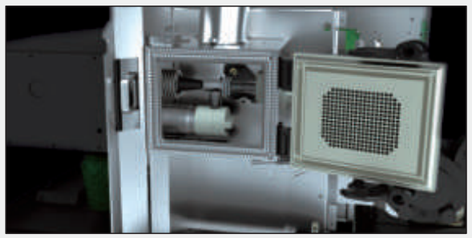


WHAT IS ICP-OES?

Inductively Coupled Plasma Optical Emission Spectroscopy (ICP-OES), is a well-established analytical technique that used to detect the presence of trace metals in an analyte. The analyte sample is introduced into the ICP as an aerosol that is carried into the center of the plasma - ionized argon gas. The superheated argon gas excites ions and atoms of the element in the sample that emits detectable amounts of light at characteristic wavelengths. The intensity of the emission is proportional to the concentration of the element detected.

The ICP-5000 can be programmed for both radial and axial view. The less sensitive radial view was preferred for the higher concentration elements such as aluminum, calcium, iron, magnesium, potassium and sodium in environmental samples while the more sensitive axial view was preferred for the lower concentration elements such as the transition series. The most effective systems of ICP-5000 allow the plasma to work in dual view in a single analysis, providing the highest upper linear ranges and the best detection limits.



ADVANTAGES OF ICP-OES

Previously, trace metals were typically analyzed using atomic absorption spectrometer (AAS) and graphite furnace atomic absorption spectrometer (GFAAS). However, ICP can analyze multiple elements at one time and has longer linear ranges compared to AAS and GFAAS. The linearity for ICP ranges from 4 to 6 orders of magnitude whereas AAS and GFAAS range from 2 to 3 orders of magnitude. ICP has less chemical interference than AAS or GFAAS due to the high temperature of the plasma and also has less matrix interference due to its mode of sample introduction. Furthermore, ICP has a variety of emission lines to choose from to reduce interference from other elements and to increase sensitivity.

ICP-5000 PRODUCT OVERVIEW

Sample Introduction System

Includes a 12-roller 3-channel, computer-controlled peristaltic pump with automatically adjustable speed 0-125rpm. The ICP-5000 is supplied with a standard glass concentric nebulizer and a glass cyclonic spray chamber, while HF-resistant nebulizer and spray chamber are supplied for high HF/salt content analytes.

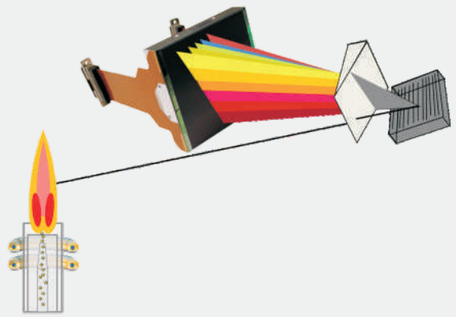
Peristaltic pump

ICP System

The ICP system comprises of a free-running solid-state RF generator, a load coil, a demountable quartz torch and automatically controlled gas flow. The RF generator is continuously adjustable from 750 to 1350 watts (Dual), maximum up to 1600 watts (Radial). The coupling efficiency is greater than 80% with ≤ 0.1% variation in output power stability and ≤0.01% variation in output frequency stability. The RF generator produces an oscillating electromagnetic field at a frequency of 27.12MHz. This radiation is directed to the load coil through which delivered to the torch. The argon gas flowing through the torch will form a plasma in the RF field. Plasma argon, auxiliary argon and nebulizer argon are regulated in a fully integrated gas flow and automatically controlled by MFC in 0.01ml/min increments.

Spectrometer

Polychromator: 2D Echelle Grating, 52.91 lines per mm and a blaze angle of 63.4 degrees.Thermostatted optics: The entire optical system is encapsulated in a thermostatted enclosure 36℃±0.5℃ and purged with argon or nitrogen gas (UV region).Recalibration: Spectra of Carbon, Nitrogen and argon elements are used for automatic wavelength calibration during every ignition if the plasma. Do not require either calibration solution or mercury/neon lamp that is free from calibration consumables or preheating of the lamp.

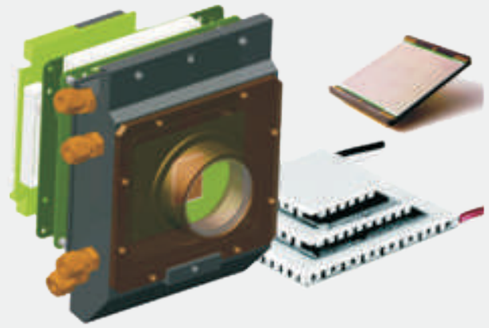


Detector

The ICP-5000 features a megapixel Cryogenic area-array Charge-coupled Device(CCD) detector with unique back-illuminated technique results in average quantum efficiency greater than 75% in UV region.

Three-level Thermo Electric Coolers (TEC) are equipped that can drive the cryogenic temperature down to -45℃, cooling time < 3min.

Anti-blooming of the detector is functioned in pixel level.



Software

Qualitative, Semi-quantitative and quantitative analysis using full spectrum acquisition of all the detected elements and enhanced with a powerful SQL Server database ensuring integrity of raw data and traceability of operations.

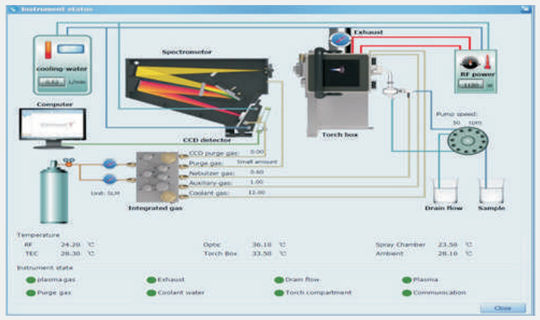
A spectra base of over 50,000 lines, out of each line at least 30 pixels can be selected fordetection.

Multi-method interference correction includes standard comparison method, internal standard method, interference element correlation (IEC) and standard additions.Instrument calibration supporting plasma torch collimation, light source optimizing, etc.

Operation procedure & status can be visually supervised in real time through a dynamic simulation display. Integrated functions for the operation of autosampler.

Plasma Viewing

In a dual view type of ICP-5000, viewing of the plasma is accomplished by computer control of a mirror located in the optical path and allows selection of axial, radial or mixed viewing modes and adjustment of the plasma viewing in both the vertical and horizontal planes.



DETECTION LIMIT

Element	Wavelength (nm)	IDL (ug/L)	Element	Wavelength (nm)	IDL (ug/L)	Element	Wavelength (nm)	IDL (ug/L)	Element	Wavelength (nm)	IDL (ug/L)
Ag	328.068	0.26	Sr	407.7	0.01	In	379.478	0.19	W	239.7	4.80
Al	396.1	0.74	Tb	350.917	0.99	Ir	212.681	3.68	Cs	455.5	26.90
As	189	10.90	Te	214.3	3.00	K	766.49	0.60	Zr	343.823	0.27
Au	267.595	0.88	Th	401.913	0.71	La	379.478	0.19	Ta	240.063	1.97
B	249.773	2.33	Ti	334.941	0.11	Li	670.784	0.06	Nb	316.34	1.85
Ba	455.4	0.04	Tl	190.8	8.50	Lu	261.542	0.07	Ge	265.118	1.58
Be	313.1	0.03	Tm	346.22	0.26	Mg	279.553	0.01	Hf	264.141	0.96
Bi	223.061	2.20	U	367.007	8.14	Mn	257.61	0.06	I	178.3	25.00
Ca	393.3	0.05	V	292.464	0.49	Mo	281.615	1.20	Gd	342.247	0.59
Cd	288.8	0.30	Yb	328.937	0.04	Na	588.995	0.09	Rb	780.023	3.29
Ce	404.076	1.25	Zn	213.9	0.27	Nd	430.358	1.28	Re	221.4	3.60
Co	228.6	0.30	Zr	343.823	0.27	Ni	221.647	0.40	Y	371.03	0.08
Cr	283.563	0.35	Ta	240.063	1.97	P	213.618	8.81	W	239.7	4.80
Cu	327.396	0.44	Nb	316.34	1.85	Pb	220.353	1.90	Cs	455.5	26.90
Dy	353.17	0.28	Ge	265.118	1.58	Pd	340.458	1.91	Cs	455.5	26.90
Er	337.271	0.37	Hf	264.141	0.96	Pr	422.535	0.81	Zr	343.823	0.27
Eu	381.967	0.05	I	178.3	25.00	Pt	214.4	2.70	Ta	240.063	1.97
Fe	259.94	0.32	Gd	342.247	0.59	Rh	339.682	2.36	Nb	316.34	1.85
Ga	417.209	1.17	Rb	780.023	3.29	Ru	267.876	1.95	Ge	265.118	1.58
Hg	253.662	3.25	Re	221.4	3.60	S	182.034	15.00	Hf	264.141	0.96
Ho	339.898	0.34	Y	371.03	0.08	Sb	231.1	3.10	I	178.3	25.00
Sc	361.384	0.07	Gd	342.247	0.59	Si	251.611	1.00	Re	221.4	3.60
Se	196.09	10.16	Rb	780.023	3.29	Sm	360.949	0.94	Y	371.03	0.08
Hg	253.662	3.25	Re	221.4	3.60	Sn	283.999	2.96	W	239.7	4.80
Ho	339.898	0.34	Y	371.03	0.08						

All instrument detection limits were determined under the conditions that instruments are functioning properly with standard solutions. Measure the blank solutions 10 times in sequence and establish the working curve. Detection limit (DL) is defined here as 3 times the standard deviation of the blank.

$$S = \frac{\sqrt{\sum_{i=1}^{n}(Xi - \overline{X})}}{n-1}$$

S= Standard Deviation

Xi= Individual Measurement Value

$\underline{X}$= Average Measurement Value

n= Measurement Time, n = 10

$$DL = \frac{3S}{b}$$

DL = Detection Limit, mg/L

S= Standard Deviation

b= Slope of Working Curve

TECHNICAL DATA

Analysis speed	about 200 lines/min
Sample Consumption	minimum 2ml
Linear Dynamic Range (LDR)	up to 105 (Mn257.6nm, relative correlation ≥ 0.999)
Wavelength	165-870nm full spectrum
Focal length	380mm
Optical Resolution (FWHM)	7 pm at 200 nm
RF Generator Power	750-1600w
Power Consumption	≤4.5kw
Environment Humidity	20-80% R.H.
Weight	about 98kg
Warm-up time	< 20 min (standby mode to ignition of the plasma)
Accuracy	RSD≤0.5% (1-10ppm)
Repeatability	RSD≤1% at 2 hours (1-10ppm) RSD≤2% at 8 hours (1-10ppm)
Pixel Resolution	0.002nm
Argon Consumption:	12L/min at normal analysis
Detector Readout Noise	2.0e-rms
Power Supply	220±10% V AC, 50-60Hz
Working Temperature	10-30 ℃
Size	935mm*732mm*659mm

APPLICATION

Pharmaceutical

Impurities in pharmaceutical products are of great concern not only due to the inherent toxicity of certain contaminants, but also due to the adverse effect that contaminants may have on drug stability and shelf-life. This necessitates the monitoring of organic and inorganic impurities throughout the pharmaceutical manufacturing process, from raw ingredients to final products. The United States Pharmacopeia (USP) proposed two new chapters to regulate more strictly the detection of trace elemental impurities in pharmaceuticals. The proposed chapters specify lower limits for trace elements and recommend Inductively coupled plasma–mass spectrometry (ICP–MS) and inductively coupled plasma–optical emission spectrometry (ICP–OES) as the techniques of choice.

Geology and Mining

Mines, mineral processors and geologists involved in mineral exploration require accurate, precise analysis with rapid sample turn-around times. To remain viable in a competitive global environment, geochemical laboratories are analyzing increasing sample loads at lower and lower detection limits, making simultaneous ICP-OES the preferred analytical technique.

Petrochemical

For petrochemical industry, ICP-5000 provides a low-cost solution for the analysis of trace element in the extraction, refining process as well as in finished products and chemicals such as lubrication fluid. ICP-OES can be employed during the extraction and refining process of crude oils, used to analyze drilling muds and for the final analysis of crude oil, focusing on elements that might affect the refining process. Post-refining, it can be used to carry out QA and QC of finished products. ICP-OES can also be used in chemical production of paints, solvents and pigments as a QA and QC tool.

Metallurgy

The analysis of trace major elements in the metal is important for consumers in the metallurgical and engineering industries. The information from an analysis is useful for various purposes, such as the inspection of raw materials, intermediate product and end product; process control on iron and steel manufacturing; environment assessment in the factory; quality control and product research. However, most of the routine analysis instruments involve spark emission spectroscopy and X-ray fluorescence, whose accuracy is highly dependent on the matrix composition and precise matching of samples. Compared to these principle instruments, ICP-5000 has advantages on speed, sensitive and matrix tolerance.

Food

The determination of major elements in nutritive solutions like food is essential for nutritional significance. Also, the ability to identify toxic heavy metals such as lead, cadmium, and mercury in food is essential to food safety and consumer health. For example, mercury in fish limits our recommended fish intake and is contraindicated for pregnant women. This necessitates a reliable technique for good precision and accuracy. ICP-5000 allows the users to run food and nutritive samples with ease of use and reliability.

Environment

Industrial discharge, the use of agricultural chemicals, and vehicle exhaust, as well as natural geological activities such as volcanic eruptions, increase the probability of high levels of metallic contaminants to be found in water. Four metals (lead, arsenic, cadmium, and mercury) raise particular concerns because of their toxicity to humans, especially in cases of chronic exposure. These metals can accumulate in the body and cause serious organ damage. ICP-5000 is suitable to measure trace major elements at both low and high concentrations in a variety of wastewater sources with good accuracy, analysis speed, long term stability and robustness.