

Product Information

X-RAY EXCITATION NONDISPERSIVE TYPE X-RAY SPECTROMETER MINI X SERIES

1. Introduction

Nondispersive type X-ray spectrometers using a small-sized X-ray tube are in widely used as table-top compact analyzers because they are safer than analyzers with radioisotope sources. They also assure high precision analysis. There are various applications of this X-ray spectrometer, first, is the analysis of the sulfur content in oil. The analytical procedure has been part of the Japanese Industrial Standard (JIS) since 1984. Another application is the measurement of thickness of a silicon film on paper, zircon film on aluminum cans, etc.. In these applications, the analyzer is used as a handy dedicated unit.

The new models of X/S meter and Mini X series which have been developed recently have improved performance and function, aimed at meeting increasingly diversified needs.

2. New X/S meter (Cat. No. 3576)

The new X/S meter has been designed and perfected based on the JIS K2286 (radiation excitation system for the sulfur content testing method for petroleum products). It is well known that irradiation of a sample with X-rays will generate characteristic X-rays of elements contained in the sample along with scattered rays. The X/S meter is designed for the analysis of the sulfur concentration in oil by detecting the sulfur characteristic X-rays with a sealed proportional counter, selecting these rays with a pulse height

analyzer, and counting the spectrum which corresponds to the sulfur content. To improve the analytical precision, a special filter composed mainly of sulfur is positioned in front of the detector so as to remove the effects of chlorine in oil and argon in-air.

2. 1 Features

(1) Improvement of stability by atmospheric pressure correction

In the analysis of the sulfur content in oil, its value is subject to the influence of variations of the air temperature in the X-ray path as well as variations of the atmospheric pressure. To correct for the influence of temperature variations of the air path, the temperature is monitored and a correction factor applied. In the new X/S meter, variations of the atmospheric pressure are also detected, and an overall correction is made. Table 1 shows the effectiveness of these corrections.

Table 1 Example of the rate of change in the sulfur analysis value due to atmospheric pressure variations. (Δwt.%/10mb)

Sulfur concentration	Not corrected	Corrected
0.21wt %		-0.001 wt %
1.05	-0.0006 wt %	-0.001
2.98		-0.004

(2) Automatic calibration curve by the fundamental parameter method

The change of C/H (concentration ratio between carbon and hydrogen) is one of the factors that affect the X-ray intensity of sulfur. The sulfur concentration, the C/H value, the fluorescent X-ray intensity of sulfur (I_s) that due to Compton scattering are inter-related. The following equations are derived from these relations by using the fundamental parameter method (FP method).

$$I_s = \frac{C_1 C_s (1+R)}{aR(1-C_s) + h(1-C_s) + iC_s(1+R)}$$



$$I_c = K_2 \frac{dR(1-C_s) + e(1-C_s) + fC_s(1+R)}{gR(1-C_s) + h(1-C_s) + iC_s(1+R)}$$

where a ~ i: Constant,

K_1, K_2 : Instrument sensitivity,

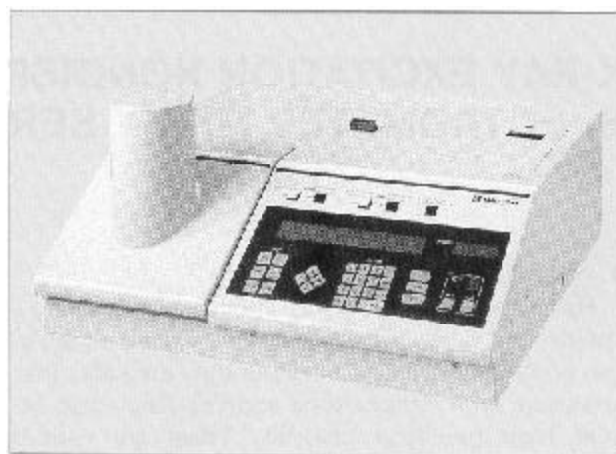
C_s : Sulfur concentration, and

R: C/H ratio.

By using the above equations that express, the X/S meter instrument sensitivity, K_1 and K_2 can be obtained automatically using a regression calculation through measurement of a standard reference sample whose sulfur concentration and C/H ratio is already known. The sulfur concentration, C_s of an unknown can be obtained automatically from the same equations.

3. New Mini X series (Cat. No. 3577)

Like the X/S meter, the new Mini X series is an X-ray tube excitation system X-ray spectrometer also designed to make full use of the principle of the nondispersive type optical system. In this new series, a variety of design ideas are incorporated to improve the signal-to-noise ratio. They include, selectable X-ray tube voltage (kV), selection of the effective wavelength with a primary beam filter, removal of scattered rays and interfering radiation with a secondary beam filter, and a gas discriminator by means of the detector gas. In order to measure an element spectrum the energy of the desired spectrum must be separated from the energy of the interfering spectrum 1/2 times the FWHM or greater. A more severe overlap may be



allowable, however, if the proper filters are selected. Table 2 shows an example of the measurement of various samples.

Three types of calibration curves are available, that is, linear, quadratic and logarithmic. Generally a linear or quadratic calibration curve is used for measuring an analyte element. When measuring the fluorescence X-ray intensity of the base material, a logarithmic calibration curve is employed since the measurement of the absorption due to the film thickness is what is desired.

4. Concluding Remarks

The new Mini X series of X-ray excited, non-dispersive type X-ray spectrometer is already in use as a compact, easy-to-use single-purpose unit. Utilization of its upgraded performance will expand its applications.

Table 2 Example of samples for measurement

Base material	Spectrum for measurement	Example of measurement
Macromolecule		Sulfur (S) content in coke.
Paper	Elements above Al	Silicon (Si) on exfoliation paper Si on polyester
Water, organic solvents		S, chlorine (Cl) in organic solvent
Aluminum	Elements above Cl	Thickness of zircon films on aluminum (Al) can. (With Zr-LX rays). Amount of chromate deposited on Al plate Measurement of the thickness of macromolecule film on Al plate. (Through absorption of Al-KX rays).
Iron	Al ~ Ca Ni ~ Sn	Phosphorus (P) in electromagnetic steel plate Chrome (Cr) in chrome plated steel plate. Nickel (Ni), Zinc (Zn), Tin (Sn) on iron plate
Zinc		Si, Cr on zinc plated plate.