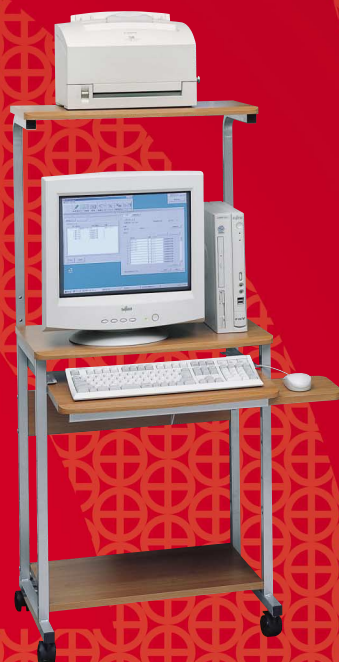Access to **your** success

⊕ SHIMADZU

MXF-2400

Shimadzu
Multi-Channel X-ray
Fluorescence Spectrometer

An X-ray tube that supports
the use of a 4 kW (Thin Window)
has been installed
to further enhance performance.
MXF-2400

MXF-2400

Shimadzu Multi-Channel X-ray Fluorescence Spectrometer

Simultaneous determination of up to 36 major and impurity elements in nondestructive analysis.
(Analysis range: $_4$Be, $_5$B, $_6$C to $_{92}$U)

The Shimadzu MXF-2400 is an improved version of the Shimadzu Multi-Channel X-ray fluorescence spectrometer, which has been rated highly in the overseas market as well as in the domestic market.

The latest hardware designed to fully utilize the principle of X-ray fluorescence spectrometry and the data processing unit that uses various software programs to permit automatic management of analysis data combine to provide high analytical productivity both in R&D and production control.

Up to 36 elements can be simultaneously determined by the fixed monochromator and up to 48 elements can be determined sequentially by the optional scanning monochromator. High analytical precision is provided even in high sensitivity analysis of a few ppm quantity level.

High level of automation and labor saving

Impurity elements as well as major elements in various types of samples can be readily determined, for the purpose of quality control and R&D. About 36 elements in a sample can be determined in a minute.
The operation is stable enough to permit unattended operation to save labor and running cost.
The optional scanning monochromator is convenient for automated qualitative analyses in R&D.

Quality control

The MXF-2400 presents analytical results in a short time with excellent stability in quality control. This minimizes the number of off-grade products.

Production control

Samples may be taken form the production line and analyzed without delay. The data are fed back to control the material mixing properly. The result is stable and high quality.

Applications

Iron and steel industry

Pig iron, stainless steels, low-alloy steels, slag, sintered ores, ferroalloys, special steels, surface-treated steel plates, plating solutions.

Nonferrous metal industry

Copper alloys, aluminum alloys, aluminum ingot, lead, zinc, magnesium alloys.

Ceramic industry

Cement raw mix, clinker, limestone, clays, glasses, bricks.

Electric and electronic materials

Semiconductors, ceramics, magnetic disks, magnets batteries, PCBs.

Chemical industry

Synthetic fibers, catalyzers, paints, dyes, pharmaceuticals, cosmetics, cleanser, other organic and inorganic products.

Petroleum and coal industry

Heavy oils, lubrication oils, polymers, coals, cokes.

Agriculture and food industry

Soils, fertilizers, pasture, leaves, plants.

Pollutants

Factory waste water, sea water, river water, airborne dust, industrial wastes.

Papers and pulps

Contents

Principle & Construction

Principle

When X-rays hit a sample, atoms in the sample are excited and release the secondary X-rays, which are also called fluorescent X-rays. Since the wavelength of secondary X-rays is peculiar to the element concerned, the sample can be qualitatively determined by measuring that wavelength. Also, since the fluorescent X-ray intensity is proportional to the concentration of the element, quantitative determination is made by measuring the fluorescent X-ray intensity of the wavelength peculiar to each element.

Concentration (%)		X-ray intensity (kcps)	
Si	3.1182	Si	34.79725
Mn	0.2011	Mn	6.30588
P	0.0209	P	0.45881
S	0.0173	S	1.11912
Mg	0.0185	Mg	0.11576
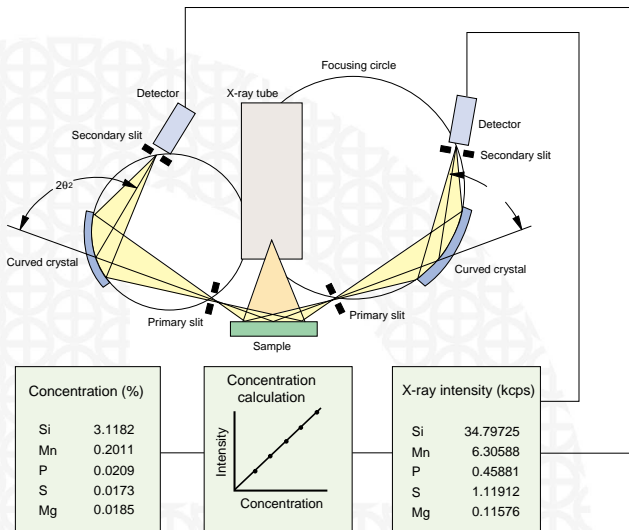
Spectrometer Unit

This unit disperses the fluorescent X-rays generated from the sample, measures the intensity of the X-rays of the particular wavelength, and converts that intensity into electric signals. High quality curved crystals are used for dispersion.
The MXF-2400 uses one monochromator for one element, and up to 36 monochromators can be installed together to permit simultaneous determination of up to 36 elements. Use of the optional scanning monochromator provides automatic qualitative analysis and allows up to 30 elements to be preset for quantitative analysis.

Measuring Electronics

The electric pulses corresponding to the number of X-ray photons are counted and recorded. — The output pulse signal of the detector is amplified and its interfering spectrum signals are removed by the pulse height analyzer. Then the signal is measured by the scaler, processed by the microprocessor, and then transmitted to the data processing unit.

X-ray Power Source

This unit supplies power to the X-ray tube which emits the excitation X-rays (primary X-rays). It consists of a high-voltage transformer and an X-ray power controller.

Data Processing Unit

X-ray intensities are converted into concentration values of the elements concerned through the use of the conversion equations (calibration curves) predetermined using standard samples. The results are presented on the display or the printer.
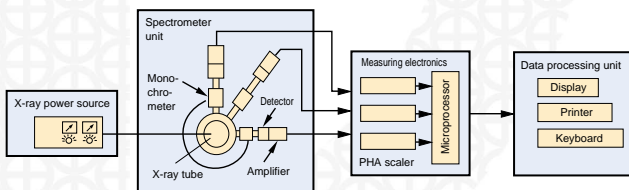
❶ X-ray Spectrometer (Installed in the case)

Up to 36 monochromators are radially arranged around the X-ray tube. The case of the X-ray spectrometer is temperature-controlled.

❷ Sample Turntable (with dust-proof cover)

Up to eight samples may be loaded together for automated successive analysis. An external automatic sample feeder and/or automatic sample pretreatment unit may be connected to this turntable.

❸ Sample Feeding Unit (Installed behind the panel)

The swing arm system accurately positions the sample.

❹ Maintenance Panel

This unit displays the status of each part and has manual switches for checking.

❺ X-ray Tube Cooling Unit

This unit circulates cool, distilled water to the X-ray tube. The distilled water is cooled externally.

❻ Data Processing Unit

The operation of the MXF-2400 is made via the keyboard of this unit. This unit has various high-level data handling functions, which provides advanced analysis by easy operation.

❼ X-ray Power Control Unit and Processor Unit

The X-ray power control unit controls the output power of the X-ray tube with such a high stability that it is not necessary to use a motor generator in most cases. The processor unit incorporates the X-ray intensity measuring circuit and the microprocessor, which counts X-ray pulses and controls all the other units.

❽ DC Power Source Unit

This unit supplies DC power to the control units.

❾ Switchboard

The necessary power source is one three phase 200 VAC or 220 VAC line.

Features

1.The World's First Multi-Channel Fluorescent X-ray Spectrometer to be Installed with a 4 kW (Thin Window) X-ray Tube

Sensitivity has been enhanced to approximately 1.3 times for heavy elements and 1.7 times or more for light elements (elements lighter than Cl).
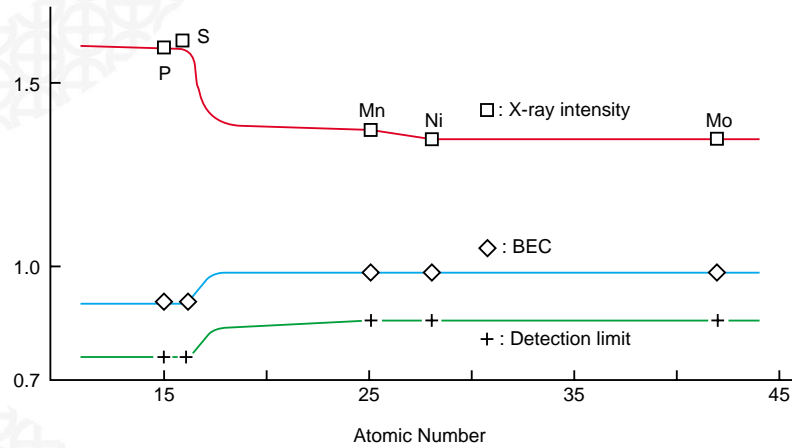
2.Excellent Analytical Accuracy from Minute Regional Areas to Whole Areas

The converging spectrometer system is one of Shimadzu's original designs. The fluorescent X-ray focus doesn't be diverged, and becomes extremely small at the secondary slit so that reflected X-ray intensity is extremely high, and resolution is good in comparison with other systems.
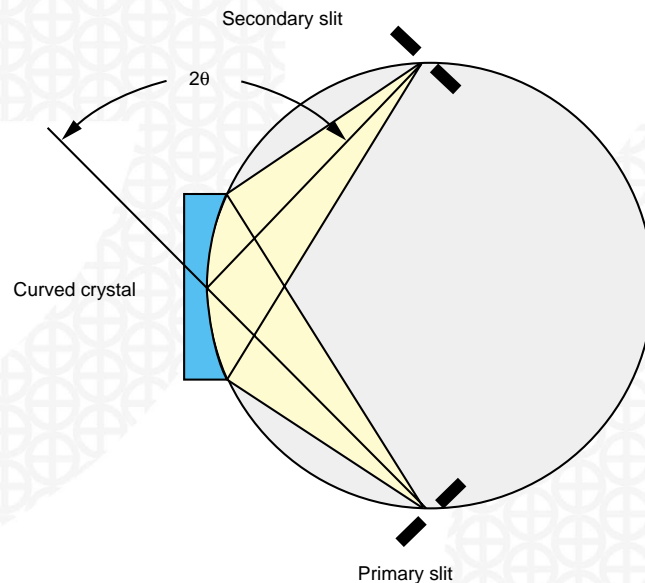
3.Excellent Long-term Stability and Maintenance-free Characteristics

Through the development of original technology by Shimadzu an excellent gas sealed detector (SPC) is used to obtain long-term stability and maintenance-free characteristics over a wide range ($_{11}$Na to $_{92}$U) of light elements including Na which normally only could be analyzed using a gas flow detector (FPC).
Shimadzu's own original gas sealed detector has the following features.
1) Starting up X-ray signals is fast, and a large number of X-ray signals can be counted at a high speed.
2) CO_2 is mixed in with the inert gases (Ne, Ar, Kr) to give good gas stability, and the core wire does not become contaminated as there is no resolution deterioration due to ionization.
3) As there is no gas piping, consideration of the surroundings is not required, and excellent long-term stability is assured. (The device is ideal for process control and automatic analysis as the number of calibration curve adjustments and α/ßcorrection can be minimized.)
4) As the gas is sealed in the device, there is no maintenance, which makes the product extremely permanent.
Moreover, the whole spectrometer unit is kept stable as a thermostat in the device continually maintains the temperature to within ±0.2°C of the set temperature.
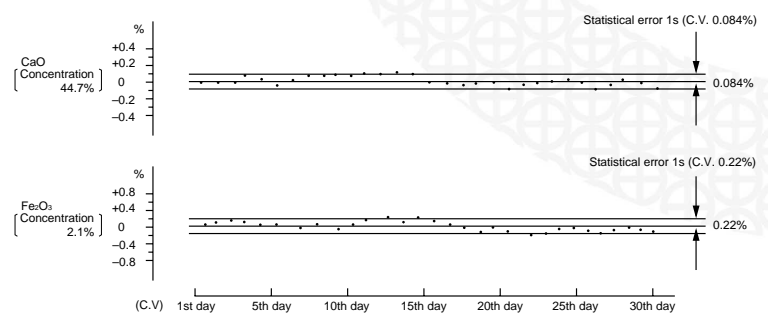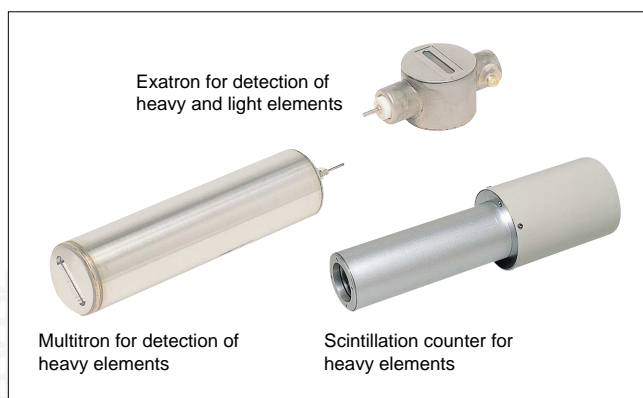
4.The Effect of Nearby or Interfering Elements can be Reduced

A detector suitable for each element can be selected from between the gas sealed detector sealed with gas appropriate for elements such as Ne, Ar and Kr (selection can be made over a broad range from $_{11}$Na to $_{92}$U), the scintillation detector, and the gas flow detector.
The effect of nearby or interfering elements can be minimized as the optimum detector can be selected to provide excellent detection efficiency and good resolution for each element.
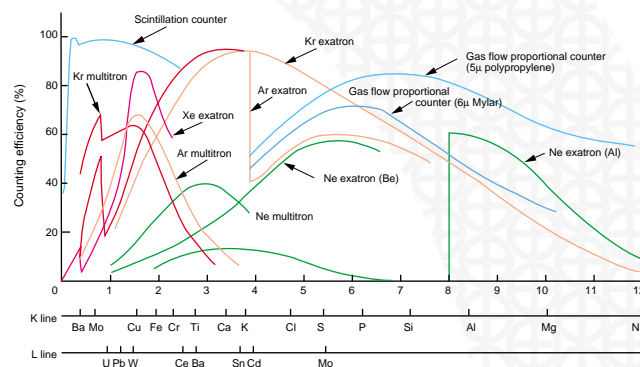

Counting efficiency of detectors

Features

5.Excellent Measuring Reproducibility for Light Elements

Using Shimadzu's original vacuum stabilizer (patented), a constant vacuum can be maintained during measuring. And as the change in X-ray intensity due to the change in the degree of vacuum (change due to air absorption) can be suppressed, excellent measuring reproducibility can be achieved for light elements (such as Al and Si) and superlight elements (such as Be, B and C).
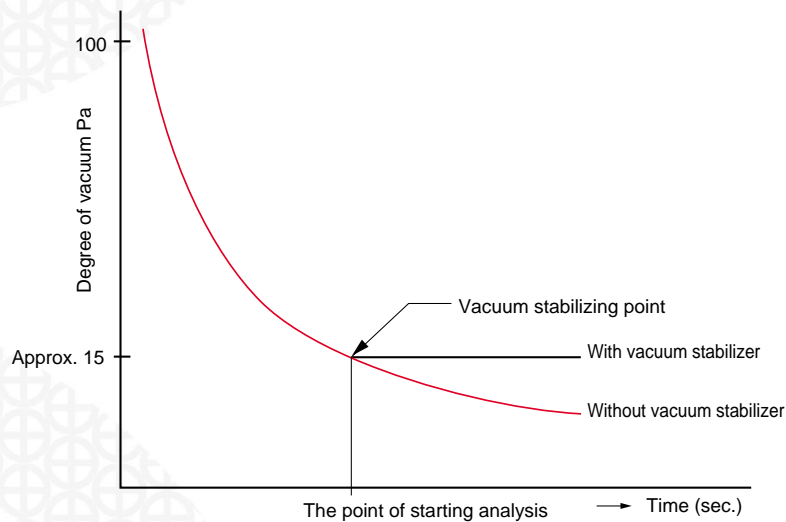
6.Excellent Long-term Stability for Superlight Elements (Be, B, C, N, O, F)

The gas flow detector (FPC) has excellent long-term stability as pulse height distribution is stabilized through the use of an automatic core wire winding system (Shimadzu patent) and a gas density stabilizer with CPU control system. The automatic core wire winding system is different to the previous core wire cleaning system and manual core wire winding system in that core wire winding is continuously automatic (5 mm per day) so that the core wire does not become contaminated, analysis can be conducted always with a new core wire, and maintenance is not needed. Furthermore, the PR gas flow and density necessary for the gas flow detector achieves stability in the gas density stabilizer with CPU control system.
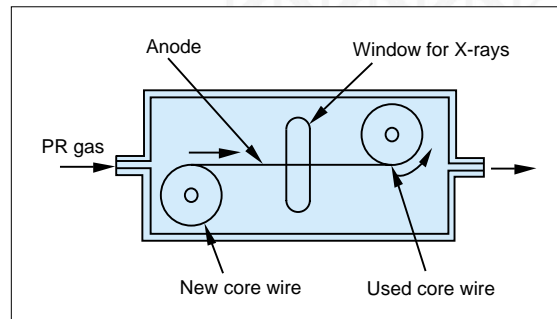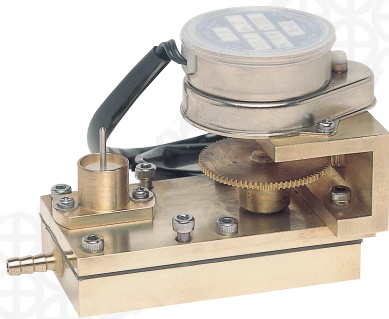
7.Enhanced Sensitivity for Superlight Elements

The layered structure analyzer (LSA), which uses curved crystals for convergence, provides almost ten times higher sensitivity for X-rays than conventional detectors.
Unlike the conventional dispersing crystals, the LSA has synthetic multilayer structures.
The spacer is made of the material and has the thickness that gives the best lattice constant to sense X-ray intensities at the highest sensitivity for such elements as Be, B, C, N, O, F, Na, and Mg.

LSA dispersing element

Monochromator for LSA
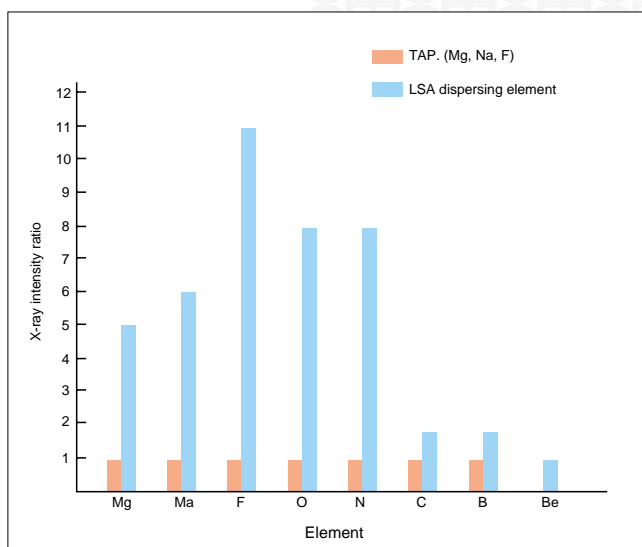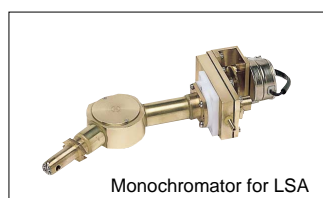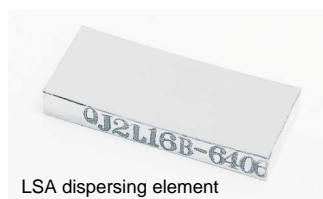
X-ray Intensity Comparison between LSA Dispersing Element and TAP Crystal Total Reflection

8.Wide Dynamic Range

The Shimadzu's original pulse counting circuit and the counting error correcting circuit combine to provide a wide dynamic range: one calibration curve can cover the concentration range more than 3,000,000 cps, from 0% to 100%. High accuracy is ensured even in high concentration region where the X-ray intensity is very high.

X-ray tube voltage: 40 kV
X-ray:　　　　　CuKα
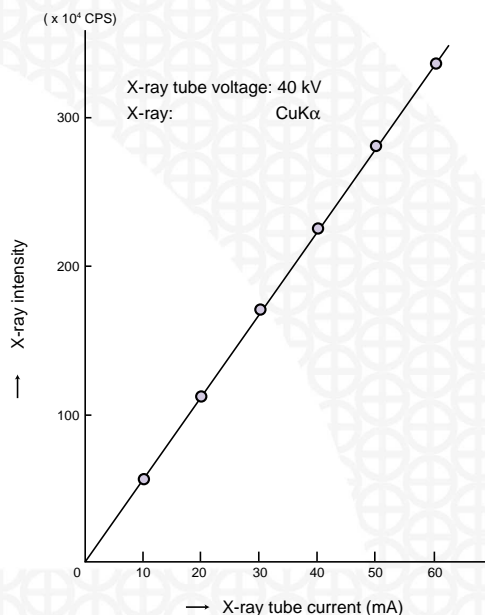
Linear Calibration Curve more than 3,000,000 cps

Features

9. Analytical Information can be set for Each Individual Sample Form and Each Individual Element

Analytical conditions such as optimal X-ray output and PHA (pulse height analyzer) range can be freely set for each individual sample form and element.
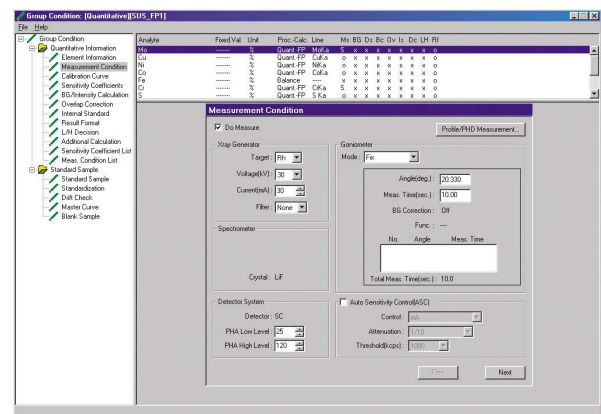
Also, an automatic sensitivity correction function (counting loss correction) can be used.
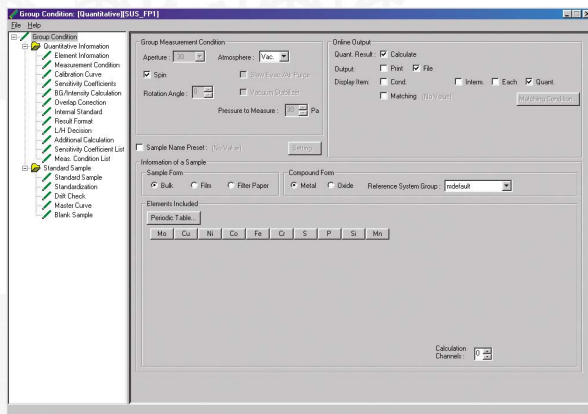
10. Simultaneous Determination of up to 36 Major and Impurity Elements

The 36 fixed monochromators detect impurity elements as well as major elements with high reliability. The detection limit is a few ppm concentration level.

The scanning monochromator permits automatic qualitative determination and may also be used for quantitative determination.

There is a strong demand for the method to analyze not only major elements but also impurity elements, in order to enhance the quality of the final products. The technique of X-ray fluorescence spectrometry has detection limits of a few ppm concentration level and is applicable to various types of samples.

11.Automatic Startup and Stop (Standby) of Device is Possible

The X-ray unit can be automatically started up by registering the device startup date and time in advance.
Automatic stop (standby) can be set in the same way.
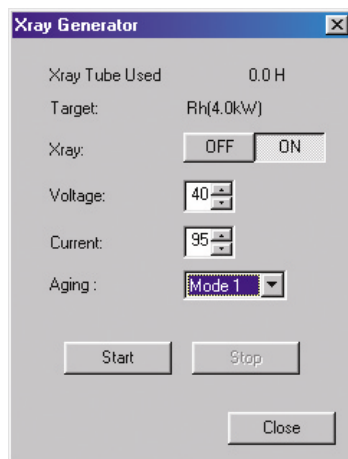
12.Good Operability from Eight Sample Turrets with Dust-proof Cover

Standard samples and control samples can be safely set on the turrets for long periods as the device comes with a dust proof cover.

Features

13.High Sensitivity and High Precision

The adoption of the new X-ray tube of the end-window type and the short distance between the X-ray output port of the X-ray tube and the sample provides high intensity of the fluorescent X-rays; this enhances the sensitivity for trace elements and improves the detection limits.

The use of curved crystals and curved dispersion elements enhances the resolution, while the adoption of a gas sealed proportional counter, an automatic core wire winding type detector, temperature control unit for the spectrometer, and the high-performance counting circuit provides high precision.

The degree of vacuum is controlled and stabilized by the CPU, which also enhances the stability of light-element analysis.

Typical Detection Limits and Repeatability

Low-alloy steel — Integration time: 40 sec.

		Si	Mn	P	S	Ni	Cr	Cu	Mo
	Detection limit	0.0013	0.0006	0.00045	0.0004	0.0008	0.0002	0.0006	0.00045
Repeatability	Concentration	0.223	0.66	0.015	0.017	1.99	0.69	0.042	0.19
	Standard deviation	0.0011	0.0008	0.0002	0.00022	0.0016	0.0007	0.0003	0.00025
	Coefficient of variation	0.5	0.13	1.3	1.3	0.08	0.1	0.7	0.13

Cast iron — Integration time: 40 sec.

		C	Si	Mn	P	S	Mg
Repeatability	Concentration	3.57	1.7	0.503	0.047	0.042	0.041
	Standard deviation	0.017	0.17	0.0004	0.00025	0.0002	0.0008
	Coefficient of variation	0.49	0.1	0.08	0.55	0.47	2

Copper alloy — Integration time: 40 sec.

		Cu	Zn	Mn	Si	Al	Sn	Pb	Fe
Repeatability	Concentration	57.0	38.0	0.26	0.014	0.06	0.17	0.011	0.019
	Standard deviation	0.01	0.01	0.00035	0.00068	0.00042	0.0007	0.00033	0.00027
	Coefficient of variation	0.018	0.026	0.13	4.8	0.7	0.4	3	1.4

Ceramic cement — Integration time: 40 sec.

		SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	SO_3	Na_2O	K_2O
Repeatability	Concentration	14.0	3.0	2.0	43.0	0.8	2.0	1.0	0.4
	Standard deviation	0.0063	0.0024	0.0008	0.006	0.004	0.0014	0.006	0.0005
	Coefficient of variation	0.045	0.08	0.04	0.014	0.5	0.07	0.6	0.13

14.Rapid and Precise Sample Setting

The swing arm system sets a sample precisely within 5 seconds, in a single motion. This simple design minimizes down time and ensures stable performance even in high-duty operation.
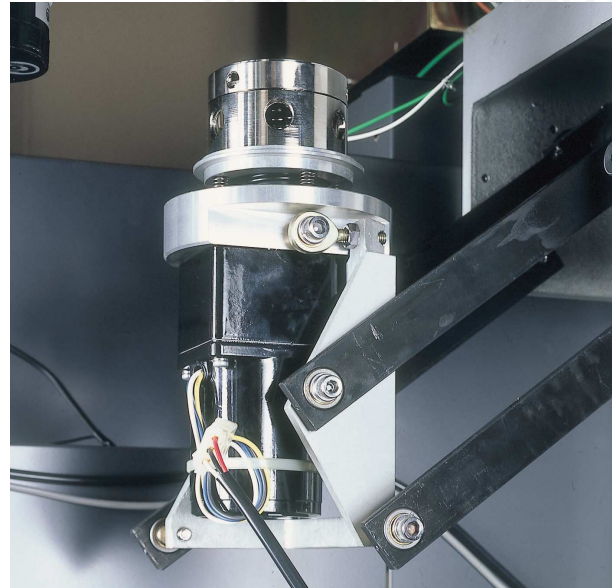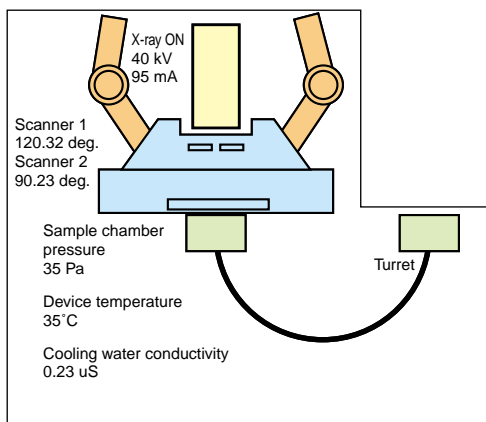
## 15.Automatic Qualitative Determination

The scanning monochromator permits automatic qualitative analysis.
The 2θ-PHA linkage system (detector high voltage linkage system) excludes the influence of higher-order lines to provide easy-to-read profiles.
In qualitative analysis, 8 samples many be continuously analyzed, and then the peaks are identified and the results are displayed and printed out.
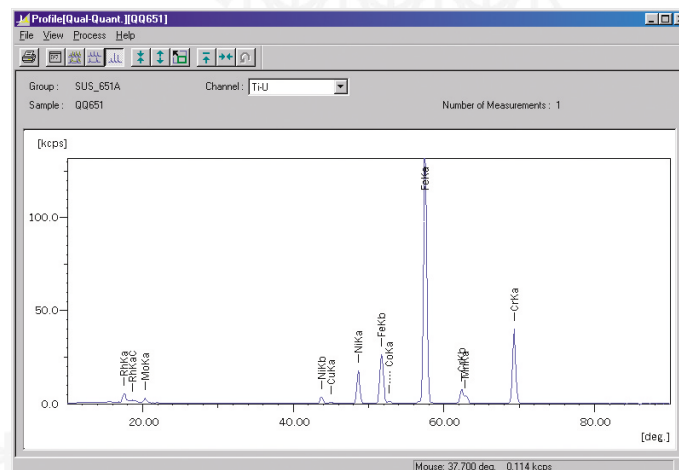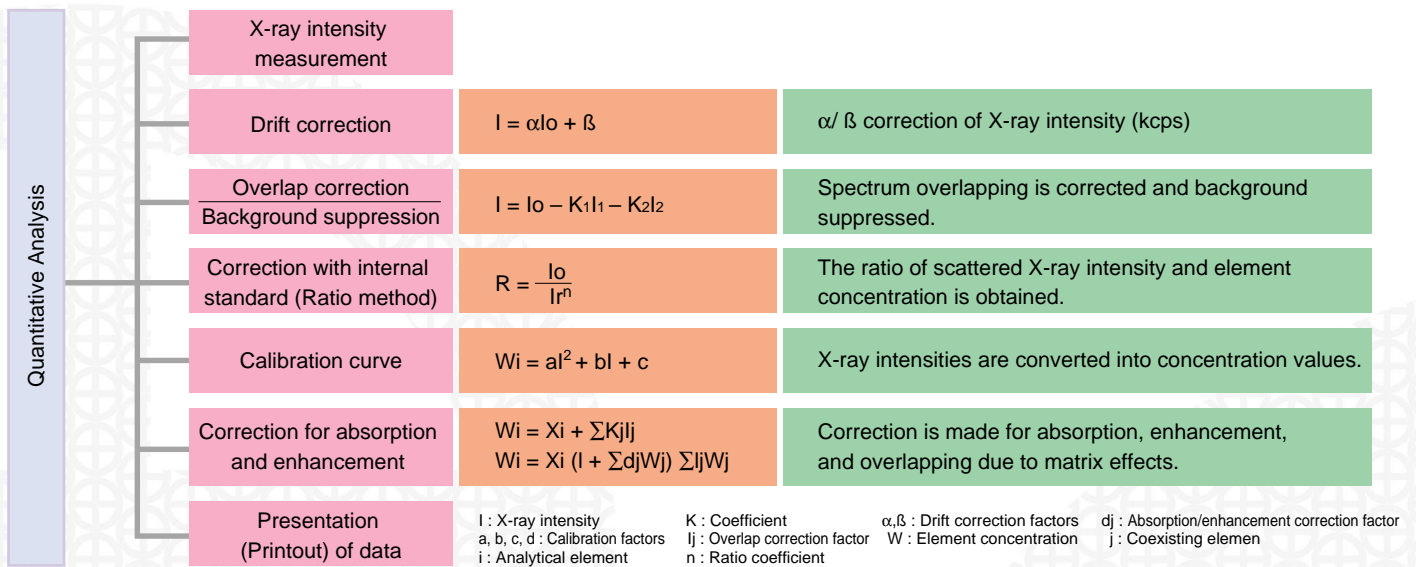
High Level Data Processing

The data processing unit, which uses an IBM PC/AT compatible personal computer, performs all of the control, operation, and processing of data of the MXF-2400.

The operation is all carried out through a personal computer. The available functions include control and operation of the instrument, calculation of concentrations, and filling of analysis data.

Quantitative Calculation

Various calculation methods are selectable; you can select the method that is most suitable for your sample type and purpose of analysis.

Quantitative Analysis

X-ray intensity measurement		
Drift correction	$I = \alpha I_0 + \beta$	α/β correction of X-ray intensity (kcps)
Overlap correction Background suppression	$I = I_0 - K_1 I_1 - K_2 I_2$	Spectrum overlapping is corrected and background suppressed.
Correction with internal standard (Ratio method)	$R = \dfrac{I_0}{I_r^n}$	The ratio of scattered X-ray intensity and element concentration is obtained.
Calibration curve	$W_i = aI^2 + bI + c$	X-ray intensities are converted into concentration values.
Correction for absorption and enhancement	$W_i = X_i + \sum K_j I_j$ $W_i = X_i (I + \sum d_j W_j) \sum I_j W_j$	Correction is made for absorption, enhancement, and overlapping due to matrix effects.
Presentation (Printout) of data		

I : X-ray intensity
a, b, c, d : Calibration factors
i : Analytical element

K : Coefficient
Ij : Overlap correction factor
n : Ratio coefficient

α, β : Drift correction factors
W : Element concentration

dj : Absorption/enhancement correction factor
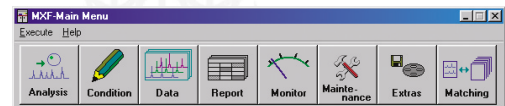j : Coexisting elemen

Operation for Data Processing

All the operation is made via a personal computer. The operation is exceedingly easy. Shown below are some typical display images.
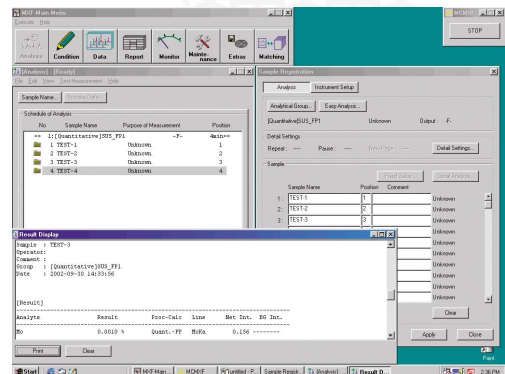
1. Menu

Large icon display makes for excellent operability.

2. Analysis Screen

The analysis screen mainly comprises three windows: sample name input, analysis schedule and result display. Just input the analysis group and sample name and click on the Start button to effortlessly perform analysis.

3. Handy Sample Registering

● In routine analysis there is no need to re-input a sample name once it has been registered along with the analysis conditions.
● Sample names can be simply input with consecutive numbers.
● Automatic operation possible by registering the device halt (standby) and start up in the schedule.
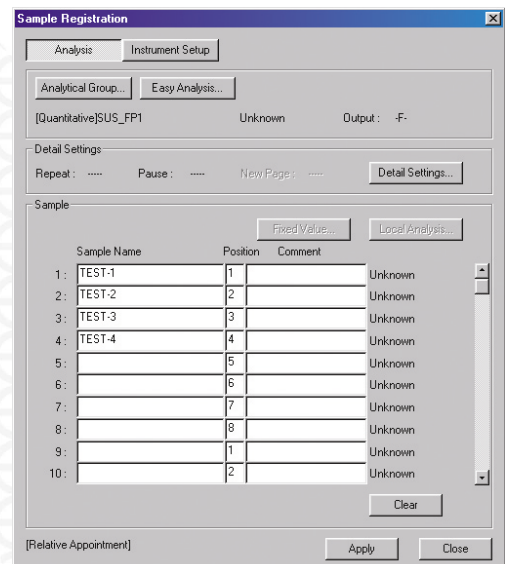
High Level Data Processing

Operation for Data Processing

4. Network Function and Auto Mail Function

- Analysis results can be transmitted via LAN.
- Analysis completion notifications, analysis result transfer and error notifications can be e-mailed to specified addresses using the e-mail notification function.

```
The measurement finished.

Sample   : TEST-A
Operator :
Comment  : TEST-A
Group    : [Quantitative]NBS
Date     : 2002-09-30 14:45:48


[Result]
─────────────────────────────────────────────────────
Analyte          Result        Proc-Calc  Line    Net Int.  BG Int.
─────────────────────────────────────────────────────
Mo               0.0007 %      Quant.-FP  MoKa    0.119 ─────────
Cu               0.0039 %      Quant.-FP  CuKa    0.165 ─────────
Ni               0.0120 %      Quant.-FP
Co               0.0029 %      Quant.-FP
Fe              99.9187 %      Balance
Cr               0.0483 %      Quant.-FP
S                0.0004 %      Quant.-FP
P                0.0046 %      Quant.-FP
Si               0.0055 %      Quant.-FP
Mn               0.0029 %      Quant.-FP
```

Send Automatic e-mail

Content ☐ Error Report ☐ Analysis End Message
☑ Analytical Result

e-mail Address : some@some.com

SMTP Server Information

IP Address : 192 . 168 . 100 . 100

5. Self-Diagnostic Function

A self-diagnostic check corresponding to the alarm in question can be instantaneously displayed to enable speedy countermeasures.

```
[002] 2002/09/30 15:00:12

[Position]
   Temperature Controling Unit
[Type]
   Warning
[Problem]
   Warning for high temperature / low temperature
   in the sample chamber
[Cause]
   A. When the temperature is lower than the preset value.
      * Switch of heater is OFF.
      * The fuse in the heater or the wire of heater is down.
   B. When the temperature is higher than the preset value.
      * The temperature of cooling water is too high.
[Corrective action]
   1. Confirm the switch of heater.
   2. Confirm the temperature of cooling water.
```

6. Report Function

Analysis results (quantitative and qualitative/quantitative)can be easily compiled in daily and monthly report formats.
Also editing is possible through the use of CSV output function to enable reading into spreadsheet software such as EXCEL.

```
Analytical Result
None
                                            Report Date :2002/09/30 15:20
Period :2002/01/01-2002/09/30
Group      :[Quant.]NBS
Sample     :test*

Sample        Mo           Cu           Ni           Co           Fe
TEST-1        0.0011       0.0035       0.0069       0.0038       99.9196
TEST-2        0.0010       0.0045       0.0079       0.0028       99.9328
TEST-3        0.0010       0.0028       0.0103       0.0045       99.9152
TEST-4        0.0010       0.0046       0.0128       0.0026       99.9104
TEST-1        0.0011       0.0038       0.0101       0.0040       99.9315
TEST-A        0.0009       0.0045       0.0123       0.0031       99.9264
TEST-A        0.0007       0.0039       0.0120       0.0029       99.9187
test          0.0010       0.0034       0.0128       0.0042       99.9308

Sample        Cr           S            P            Si           Mn
TEST-1        0.0514       0.0005       0.0029       0.0075       0.0029
TEST-2        0.0375       0.0003       0.0028       0.0077       0.0029
TEST-3        0.0544       0.0004       0.0028       0.0053       0.0034
TEST-4        0.0549       0.0004       0.0043       0.0055       0.0036
TEST-1        0.0360       0.0005       0.0035       0.0071       0.0025
TEST-A        0.0404       0.0003       0.0035       0.0062       0.0024
TEST-A        0.0483       0.0004       0.0046       0.0055       0.0029
test          0.0360       0.0003       0.0038       0.0056       0.0020
```
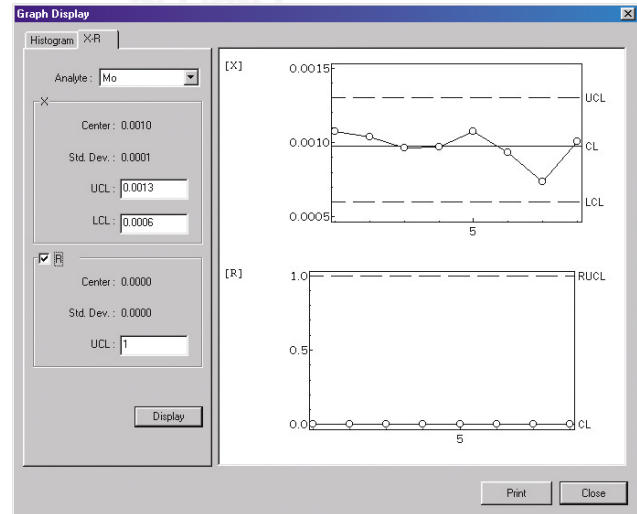
7. X-R Administration Diagram
   ### (α-ß Administration Diagram)

The change in analytical values over time can be displayed graphically to enable observation of whether or not analysis values have stably entered the specified range.

8. Automatic Operation System

Unmanned operation is possible through the use of functions such as a timer to automatically start up the system and halt it (put it on standby) after analysis is completed.
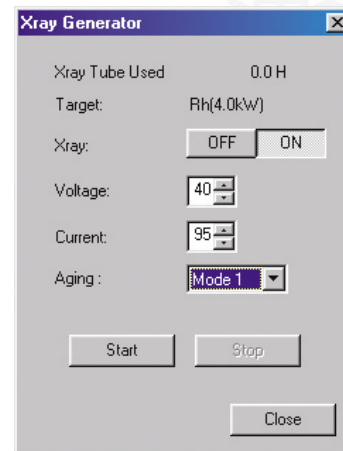
9. Calibration Curve

The optimal calibration curve coefficient is calculated by the method of least squares using the standard sample.
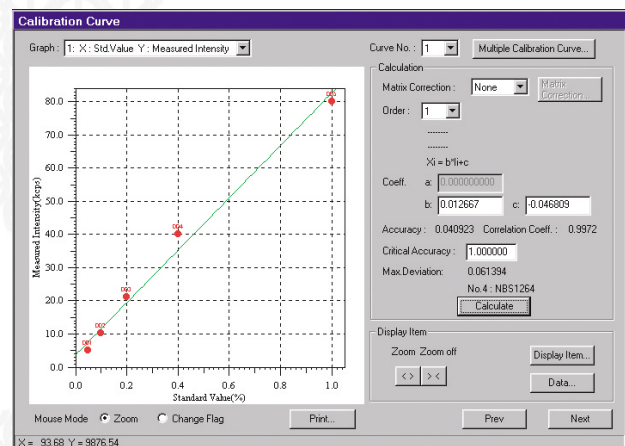
$W = aI^2 + bI + c$

W   : Element concentration
I   : X-ray intensity
a, b, c : Calibration constants

As well as being displayed in graph form, the calibration curve shows the calibration constants, precision and correlation coefficient, etc.
Graph display size also can be freely expanded and reduced.

High Level Data Processing

Operation for Data Processing

10. Matrix Correction

For samples with multiple elements, different measuring X-ray intensities will occur depending on the composition ratio of the main components, which may cause analysis errors. Analysis precision is enhanced if matrix correction is used.
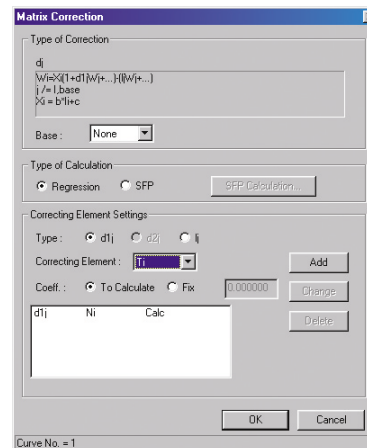
11. Qualitative Analysis

The scanner is used to perform qualitative analysis and the profiles will be displayed and can be printed out. Also, analysis result reports can be created with profile images if the data is combined with a tool like Word Pad.
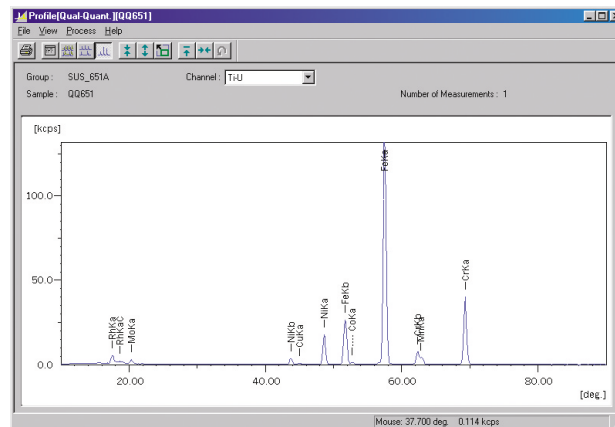
12. Quantitative Analysis Possible using FP Method

Quantitative analysis is possible with the FP method – which does not need a standard sample – using the scanner and fixed beam monochromators.
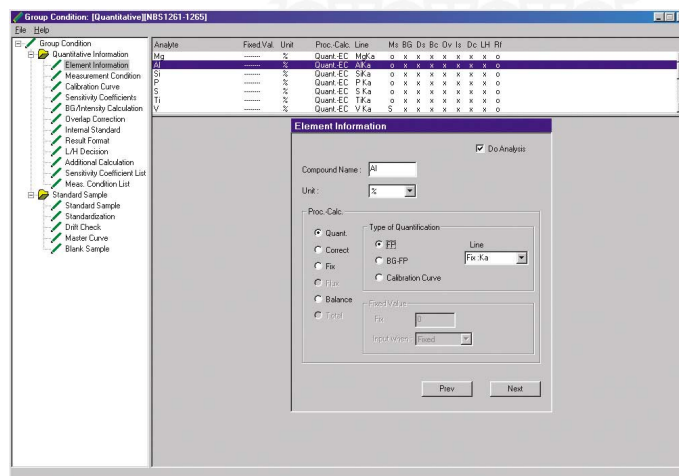
13. Four Types of Matching Functions

1) Impurity Judgment
   Compares the unknown sample with standard sample values to judge whether or not it belongs to the same form.
2) Product Type Classification
   Registers element standard values and tolerance of multiple forms to judge what form the unknown sample is.
3) Form Judgment
   Registers the element content range for multiple forms to judge what form the unknown sample is.
4) Matching Search
   Registers the standard values for multiple forms and searches for a match with the least differences between unknown sample and standard values.
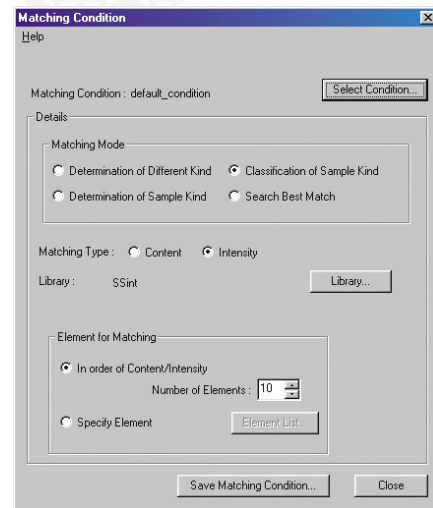
Specifications

1. X-ray Fluorescence Spectrometer

Elements to be determined: $_4Be \sim {_{92}}U$
Elements determined simultaneously: Up to 36 elements
Mode of analysis: Simultaneous determination of many elements
Atmosphere: Vacuum, air, helium (optional)

■Spectrometer Unit

Fixed monochrometer: Converging method with curved crystal.
                     Vacuum type for all the elements.
   Crystal: SX, TAP, PET, Ge, NaCl, LiF
   Detector: Gas sealed detector for $_{11}Na \sim {_{92}}U$
          Ne, Ar, Kr exatron
          Ne, Ar, Kr multitron
          FPC for $_5B$, $_6C$, $_8O$, $_9F$
Scanning monochrometer (optional): Parallel beam method with flat crystal.
                       Used for heavy elements
   Crystal: LiF
   Detector: Scintillation counter (SC)
   Elements to be determined: $_{22}Ti \sim {_{92}}U$ (with crystal for heavy element determination)
   Present mechanism: Up to 30 elements may be preset

■Measuring Electronics

Type: Pulse counting system for all the elements controlled with a microprocessor
Counting capacity: 4×10^9 counts/element
Counting method: integration for the preset time
Integration time: Adjustable for each group, from 1 to 999 seconds
High voltage supply for detector: 1,550 to 2,150 V

■X-ray Generator

X-ray tube: End window type with Rh target.
X-ray window: Beryllium window (Thin Window)
Maximum output: 4 kW
X-ray power controller
   Rectification: Full wave rectification and smoothing with a capacitor
   Control method: Secondary side detection, primary side control, control with the CPU
   Maximum rating: 50 kV, 100 mA, 4 kW
   Stability: ±0.01% (for 10% source fluctuation), both the current and voltage
   Tube voltage setting: 5 kV steps from 20 to 50 kV
   Tube current setting: 50 kA steps form 5 to 100 mA
   Safety circuit: Against overvoltage, overcurrent, overload, and abnormal cooling water supply

■Sample Feeding Mechanism

Type: Accurate sample positioning with a swing arm type sample feeder
Turntable: Accepts 8 samples together
Spinner: 60 rpm (50/60 Hz)
Sample holder: 64 mmf, 43 mm high
Max. sample size: 51 mmf, 38 mm high

■Evacuation System

Oil rotary pump:
   Evacuation rate: About 130 L / 160 L /min. (50/60 Hz)
   Oil mist filter provided
Vacuum gauge: Pirani gauge, constant temperature type
Vacuum stabilizer: Controlled with a microcomputer. The degree of vacuum can
                 be stabilized at an arbitrary point.

■Gas Supply System for Flow Proportional Counter

Use: Used of determination of B, C, N, O, and F
Gas: PR gas (Ar 90% and CH_4 10%)
Gas flow consumption: 10 to 15 mL /min.
Gas density stabilizer: Controlled by a microcomputer
Flow control: Needle valve and flow meter
Gas cylinder: A 6 Nm^3 cylinder (If light elements ($_4Be \sim {_9}F$) are attached)

■X-ray Protection

Warning: Yellow lamp on the front panel and red lamp on the X-ray control panel.
Safety device: If the sample setter and the X-ray shutter are opened at the
           same time, the X-ray tube will be automatically turned off.
           Also the moment the panel is opened the X-ray output is cutoff.

■X-ray Tube Cooling Unit (CWC-16, incorporated in the main body)

Type: Circulation of distilled water (a 18-liter tank is attached.)
Method of heat exchange: Carried out in a dual tube between external
                    cooling water and the distilled water.
Heat exchange capacity: 4 kW (3.440 kcal / hour)
Water purity maintenance: By ion exchange
Alarm: Temperature, flow rate, and electric conductivity
External cooling water: Necessary (Not necessary if using HYCOOL 30)

2. Data Processing Unit

■Hardware (IBM PC / AT compatible)

OS: Windows XP
Main Memory: 256MB or more
Keyboard: Full keyboard
Floppy disk: 3.5"double-sided, double density (1.44 MB / disk). Single drive.
Hard disk: 10GB or more
Printer: Laser printer

■Software

Program for quantitative analysis
   Maximum number of elements to be processed: Arbitrary number of elements
   Maximum number of elements to be simultaneously determined: 36 per sample
   Number of analysis groups: Arbitrary number of groups
   Repeated analysis: Arbitrary number of times
   Priority interrupt analysis: Possible, automatic return to sequential analysis
   Printout: Printout order can be specified for each group. Compound names and
         element names may be printed out. Pass and fail marks may be printed out.
   Number of calibration curves: Per each group, per each element
   Type of calibration curve: Second-order polynomial
   Correction for dead time
   Correction for absorption and enhancement: Per each group, per each element
   Maximum number of elements to be corrected for absorption and enhancement: Arbitrary number of elements per equation
   Correction for drift: 2-point method or 1-point method
   Correction for overlapping: 2-point method or 1-point method
   Internal standard method: Available for each group or each element
   Chemical correction: 2-point method or 1-point method
   Number of calculation formula: Arbitrary channels for concentration calculation
   Program for scanner: Arbitrary number of elements
Program for qualitative analysis
   Scanner: For heavy element determination
   Method: Step scanning
   Method of processing: Automatic peak search and automatic peak element determination
   Data output: 0n display and printer
Factor calculation
   Calibration factor: By the method of least squares, up to second-order polynomial
   Factor for correcting absorption and enhancement: By the method of multiple regression
   (concentration correction and sensitivity correction)
Maintenance program
   Pulse height distribution: Graphic display
   Monochromator alignment aid: Graphic display
   Counter unit: Graphic display
   Alarm: Display of alarm number, cause, and measure.
   Manual instrument diagnosis: Parts by part check is possible.
   External transmission program: Analysis data may be transmitted externally, in qualitative analysis.
External transmission (analysis results, errors, etc.)
   LAN and RS-232C (optional)
   Automatic notification via e-mail possible

Accessories

Sample preparation for X-ray fluorescence analysis

Type of sample	Sample	Treatment	Sample Holder	Purpose of treatment
Solid	Iron, cast iron / Steel / High alloy steel / Ferroalloy	Cut — Polish with emery paper	Solid sample holder	Surface smoothing
	Copper alloy / Aluminum alloy	Cut — Lathe	Solid sample holder	
	Amorphous substance	Centrifugal casting — Polish/lathe	Solid sample holder	
Power	Metal powder / Chemicals / High polymers / Plants	Grind — Briquet	Solid sample holder	Density uniforming and surface smoothing
	Ceramic materials / Ores / Soils / Deposits / Oxides	Grind — Melt	Solid sample holder	Suppression of grain size effect and suppression of influence of matrix element
Liquid	Oil / Water	No treatment	Liquid sample holder	(No treatment)
	Oil/water	Drop on filter paper — Dry	Solid sample holder with filter holder	Solidifying
	Water	Collect on ion exchange filter paper — Dry / Settle/concentrate on DDTC — Dry		Concentrating and solidifying

Accessories

Optional Accessories for Sample Preparation

Mill   Sample container

Used to mix or grind samples such as slag, cement, ore, glass, and ferroalloy.

Mill
Sample container

Used to mix or grind samples such as slag, cement, ore, glass, and ferroalloy. Two grinding units can be installed together for simultaneous use.

Pt crucible   Glass bead sample

Crucible polishing unit

Tong for crucible

Effective for minimizing the effects of thermal history and mineralogical effects in ores, rocks, clays, and soils. Also useful for producing glass beads from cement, ceramics, iron ores, and sintered ores.

T-100 Disk Type Vibration Mill

Cat. No. 210-15014

- Standard content:Mill main and timer
- Power requirements:3ø 200V ±10%, 50/60Hz, 5A
- Dimensions and weight:
  435dia. x 558mm high, 120kg
 Any of the following sample containers is
 additionally required:
- Sample Container made of tungsten carbide
  (Cat. No. 210-15016)
  Used for analyses with Fe as a target element.
- Sample Container made of chrome steel
  (Cat. No. 210-15015)
 Used for analyses without Fe as a target element.

TI-100 Vibration Mill

Cat. No. 044-31004-01 for 60 Hz
Cat. No. 044-31004-02 for 50 Hz

- Standard content:Mill main and timer
- Inner volume of grinding unit:100mL x 2
- Power requirements:1ø 100V ±10%, 50/60 Hz,2A
- Dimensions and weight: 580W x 620D x 400Hmm,70kg
  The following sample container is additionally required:
- Sample Container made of tungsten carbide
  (Cat. No. 044-31004-11)
  Mainly used for analyses with Fe as a target
  element.

TR-1000S Automatic Bead Fusion Furnace

Cat. No. 044-33301-01

- Fusion temperature: 1,000°C (1,100°C at the maximum)
- Heating method: Electric furnace with stirrer
- Sample preparation time: 7 to 15 minutes
- Power requirements: 3ø 200V ±10%,50/60Hz,22.5 A
- Dimensions and weight:
  1,215W x 800D x 1,350H mm, about 460kg
The following options are additionally required:
- Platinum crucible with lid (Cat. No. 210-15022)
- Tongs for crucible (Cat. No.044-33301-12)
- Flux (Cat. No.044-40521-01)
- Crucible polishing unit (Cat. No. 044-33301-11)

Flat press head
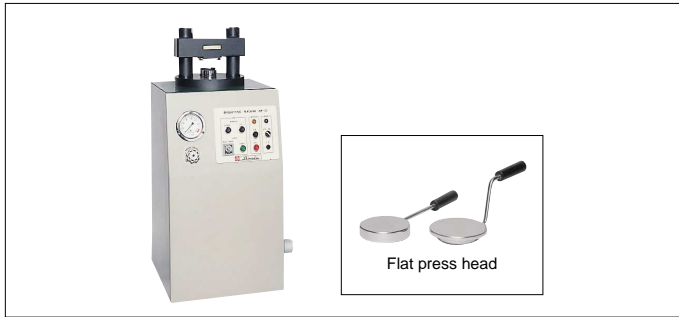
Briquets samples using a cup or a ring.

MP-35-02 Briquet Press

Cat. No. 210-15062-02

- Operation: Automatic
- Press: Hydraulic
- Maximum pressure: 35 tons
- Pressure setting: Arbitrary with a valve
- Method: Place the sample in the cup or the ring and press it.
- Press head: Plane type
- Power requirements: 3ø 200V ±10%, 50/60 Hz, 3 A
- Dimensions and weight:
  500W x 500D x 1,210Hmm,240kg

MP-35-01 Briquet Press

Cat. No. 210-15062-01

Briquets samples without using a cup or a ring.
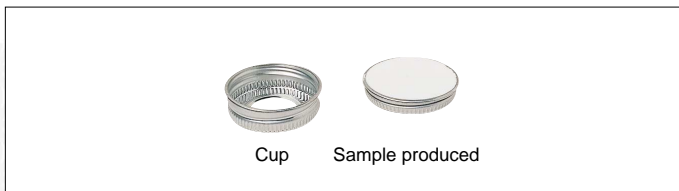
Briquetting Cup (No. 9)

Cat. No. 200-34844-09

Used for briquetting power samples.
- Materials: Steel
- Dimensions: 39.7dia. x 11.3mm high

Cup   Sample produced
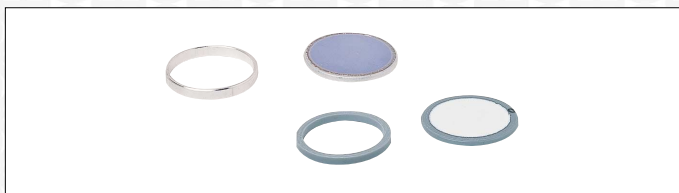
Briquetting Ring

Made of aluminum(Cat. No. 202-82397-03)
Made of vinyl chloride resin(Cat. No. 210-05010-01)

The vinyl chloride resin rings are used for silicate samples, while the aluminum rings are used for other types of samples, such as cement.
- Dimensions: 35dia. x 5mm thick

Sample Polishing Machine (with dust collector)

Cat. No. 085-50201-12

- Power requirements: 3ø 200V ±10%, 4A
- Dimensions and weight: 560W x 750D x 995Hmm,165kg
- Endless polishing belt: 915mm long and 100mm vide (No.136)The following endless polishing belt set (10 pcs./set) is additionally required
- Zirconia No.80 (Cat.No.085-35122-05) (Not applicable to determination of Al and Zr.)

Used to polish metal samples.

Accessories

Sample Holders

Mask

Mylar

Holds a liquid sample, such as river water, factory waste water, general waste water, chemical treatment waste water, and plating solution, to be analyzed with an atmosphere of air or helium.
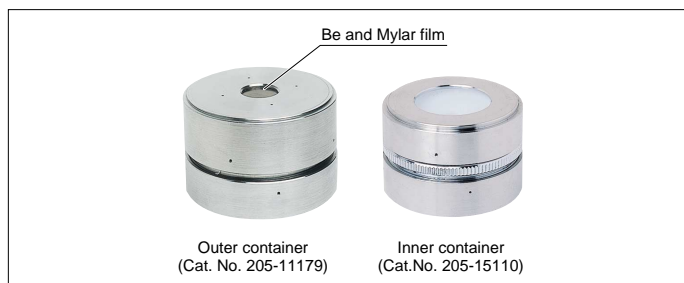

Solid Sample Holder

Cat. No. 212-20890-01

- Mask diameter: 30mm
- Mask material: Stainless steel as standard;titanium and aluminum as optional.
- Dimensions: 64dia. x 38mm high
- Maximum sample size:
  51mm in diameter and 38mm in height.

Note: For a mask of a different material or a diameter, contact us or your local distributor. Masks of smaller diameters are available for samples smaller than the standard.

Liquid Sample Holder (for air or helium atmosphere)

Cat. No. 202-86996-03

- Mylar,6μm thick
  (Cat.No.202-86501-56)(500 sheets/set)
- Material of inner container: Fluoro-resin
- Material of outer container: Stainless steel
- Dimensions: 64dia. x 43mm high

Mask for Solid Sample Holder

Masks for solid sample holder, which is suitable for the sample size or analytical purpose, can be selected.
- Mask diameter: 5, 10, 15, 20, 25, 30, 35mmø
- Mask material: Al, Ti, Ni, Cu, Zr, Mo, Stainless steel

Be and Mylar film

Outer container
(Cat. No. 205-11179)

Inner container
(Cat.No. 205-15110)

Holds a liquid sample in vacuum during analysis. The irradiation surface is covered with beryllium to keep the liquid surface stable, hence high stability of analysis is ensured.

Liquid Sample Holder (for vacuum atmosphere)

Cat. No. 205-11179

- Mask material: Titanium as standard
- Material of inner container: Fluoro-resin and stainless steel
- Material of outer container: Titanium and stainless steel
- Dimensions: 64dia. x 43mm highIt is recommended to use an outer container for each group of analyses, and to use more than one inner container for one outer container; this will enhance the analytical productivity.
- Inner container: Cat. No. 205-15110
- Mylar,6μm thick(Cat.No. 202-86501-56)(500 sheets/set)

Filter paper
(Cat. No. 210-16043-50)

Holder
(Cat. No. 205-15030)

Ion exchange filter paper
(Cat. No. 210-16167-1~3)

Spotting Filter Paper, Ion Exchange Filter Paper, and Holder

Drop a liquid sample on the filter paper, dry, and analyze.
- Filter paper: Cat. No. 210-16043-50; 50 sheets/set
Drop a liquid sample on the ion exchange filter paper, condense, adjust its pH, and analyze. The ion exchange filter paper is available in three types.
Note: A filter paper holder (Cat. No. 205-15030) and a solid sample holder are necessary.

Accessories

Others

	HYCOOL 30
Cooling capacity	4400(50 Hz)
(kcal)	5400(60 Hz)
Cooling system	forced air cooling, refrigerating system
Water supply capacity	40 L / min
	3-phase 200 / 220V ±10%
Required power supply	50 / 60Hz
	17A

Cooling Water Circulation Device HYCOOL 30

Cat. No. 044-01807-05 HYCOOL 30

These are air-cooled water supply devices. These devices are used to supply cooled water to the external unit of the X-ray tube when a suitable tap water supply is not available.
*1 Install HYCOOL30 at a reasonable distance from the main unit as considerable calorific power (4.5 kW) is generated.

Installation Requirements

■ Environment

Temperature: 18 to 28°C
Humidity: 70% or lower
Vibration:
    Displacement (single swing): 80μm or less
    Frequency: 30 Hz or less
Space: 3 x 4 m or larger

■ Power requirements

Main body: Three phase, 200/220 V ±10%, 60 A, 50/60 Hz
Data processing unit: Powered from the main body, as standard. When an independent power line is used, it shall be single-phase 100 V ±10%, 3 A
Optional accessories: Require a power described on pages 18 through 20.
Grounding: 30 ohms or less; and independent grounding line is required.

■ Cooling water

Primary cooling water: For cooling X-ray tube. 18 liters (to be replaced every 4 to 6 months). To be poured into the tank of the X-ray tube cooling unit.
Secondary cooling unit: For cooling the primary cooling water and the high voltage generator. The water shall be tap water or high-purity industrial water.
Supply pressure: 0.15 to 0.3 MPa
Drain: Free flow
Flow rate/temperature: Refer to the following table

Temp(°C)	Below 10	20	30
Flow rate (L/min.)	4	5.5	10

Faucet: 1/2" and 14 mmø hose nipple
Note: The secondary cooling water is not necessary when the HYCOOL30 is attached.

■ Gas

PR gas: 10 to 15 mL /min.
A 6 Nm^3 cylinder (If light elements ($_4$Be~$_9$F)are attached)

■ Heat emission

Main body: 1,960 kcal
Data processing unit: 240 kcal

■ Dimensions and Weight

Main body: 1,130W x 1,160D x 1,672H mm, 600 kg
Data processing unit: 600W x 645D x 1,400H mm, 80 kg (including the table)
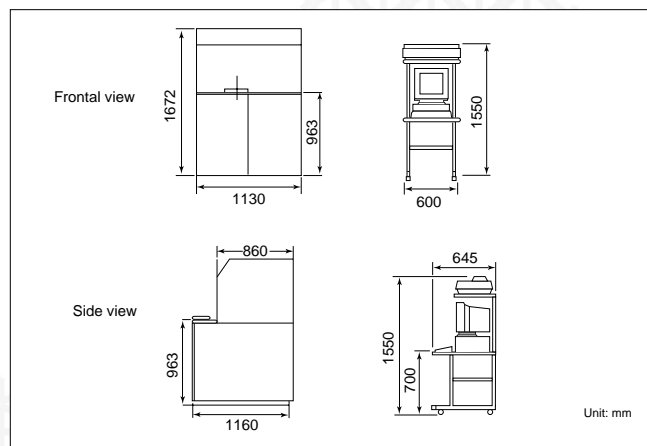
■ Note

Since X-rays are used in the MXF-2400, please check all local laws and regulations, in advance.
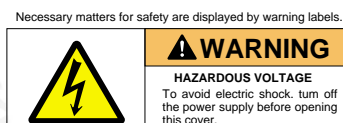
Laboratory
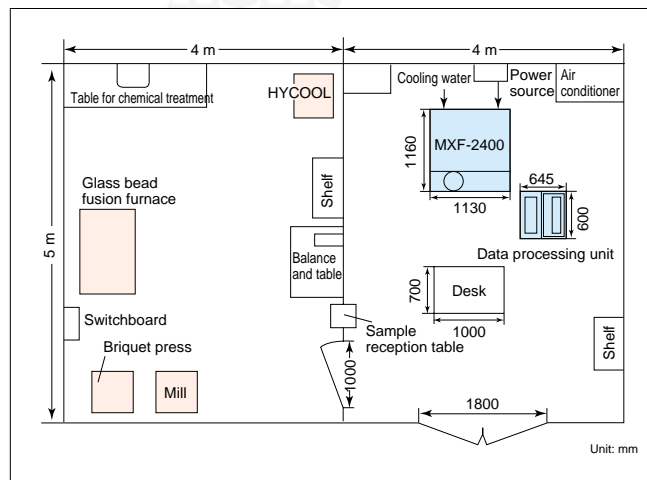
Caution: Entrance size is required more than 1200^W x 1800^H mm.

Dimensions

Main body: 600 kg
Data processing unit: 80 kg

Necessary matters for safety are displayed by warning labels.

⚠ WARNING

HAZARDOUS VOLTAGE
To avoid electric shock. turn off the power supply before opening this cover.

The contents of this catalog are subject to change without notice.

⊕ SHIMADZU

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