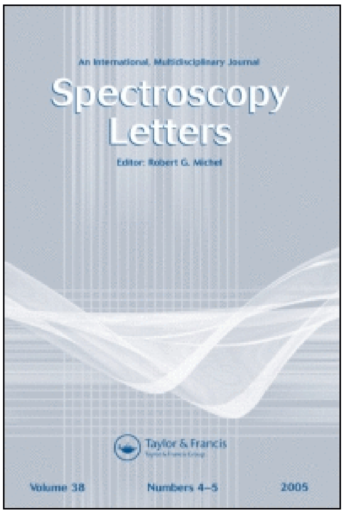

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X-Ray Fluorescence Analysis of Iron in Ore Dressing Processes

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X-RAY FLUORESCENCE ANALYSIS OF IRON IN ORE DRESSING PROCESSES

Key words : EDXRF , Iron ore , Ore dressing , QC dressing process

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Abstract

The investigation of iron using off - line energy dispersive X-ray fluorescence, in iron ore dressing process, is presented. Techniques have been developed to determine the quality control of grinding , homogenization , separation , classification processes and residue material in dry basis of iron deposit . The laboratory trials on a wide variety of iron ores indicated that the range of ore grades is from 28 - 40 % Fe and maximum value is to be found 70 % Fe for processed ore.The results obtained increased the knowledge and performance of the dressing process which is of basic importance for its improvement and future automation.

Introduction

Ores consist of a more or less intimate dispersion of valuable minerals are usually relatively low and, for economic reasons , the minerals are concentrated from their ores by physical means such as grinding , separation and flotation before conversion of mineral to the metallic or non-metallic elements. Mineral processing is mainly limited to ore dressing which involves the operations of crushing , grinding , separating and concentration.

Ore grade and heterogeneity can vary rapidly in the process stream and affect plant operations unless corrective control action is quickly undertaken based on frequent information on concentration of mineral at various stages.Furthermore , quality control in iron ore industry is based on measurement of the chemical constituents of the ore being mined or processed. Conventional analytical techniques rely on chemical analysis in a well equipped laboratory. These procedures are time consuming and often give error in analysis when semi - skilled labor is used.

In response to the need for better quality control of ore dressing , nuclear techniques have the potential to meet this demand [1-2] . The analysis of different kinds of ores by nuclear techniques has been studied and well documented [3-5] . X-ray fluorescence spectrometry is a widely-used technique for the routine determination of the major elements as well as important trace elements in geological samples. In addition , XRF is one of the few analytical methods in which determinations are normally made on solid samples , so avoiding the dissolution stage that is a prerequisite for most other atomic spectroscopy techniques of comparable sensitivity. Easy sample preparation , fast multi - element analysis , good reproducibility , potential accuracy and low cost are the essential advantages. For these reasons , many laboratories favour XRF spectrometry for routine geochemical analysis. Radioisotope EDXRF systems are now installed worldwide in metalliferous mineral processing plants [6-7].This is an established technique in the service of mineral industry. It enables a large number of measurements to be carried out rapidly , and gives immediate information to the mine management of the general changes in ore gradient. XRF technique offers good possibilities for the quality control of processing of grade of iron deposits. Iron ore and iron rich geological samples are usually analyzed by EDXRF as fused powder pellets [8-9].

Furthermore , the basic concepts and analytical procedure developed can be readily applied to the mineral processing industries involved in on - stream monitoring of ore aggregates on moving belts , and ore slurries in pipes or flotation tanks.

This study presents results of the off - line EDXRF investigation on quality control of dressing of high grade iron deposit in Sivas - Divrigi which located in the central part of Turkey .

Material and Method

Iron - rich deposits in the Sivas - Divrigi region are located in the Central of Turkey. Ore appears mostly in the form of hematite and magnetite. Total production of iron ore is approximately 2.10^{6} tonnes per year. The Sivas - Divrigi Establishment is marketing one million ton hematite pellet and 0.7 million ton magnetite powder following ore dressing procedure. This amount is very essential source material of steel industry in Turkey.

Sampling was made on raw material , grinder unit , concentration unit and residue material. Comparative X-ray fluorescence spectra of raw material and enriched ore are illustrated in Fig.1. A large number of samples were prepared for analysis .Therefore , simple and rapid sample preparation method , with a reasonable cost , is necessary. The pressed - powder pellet method meets this requirements. Representative samples were ground to approximately a 200 mesh particle size , dried in ambient conditions. The amount of the samples was adjusted to the characteristic X - ray peaks of iron , to ensure the highest count rates , independent of the amount of material . This is referred to as the saturation level.

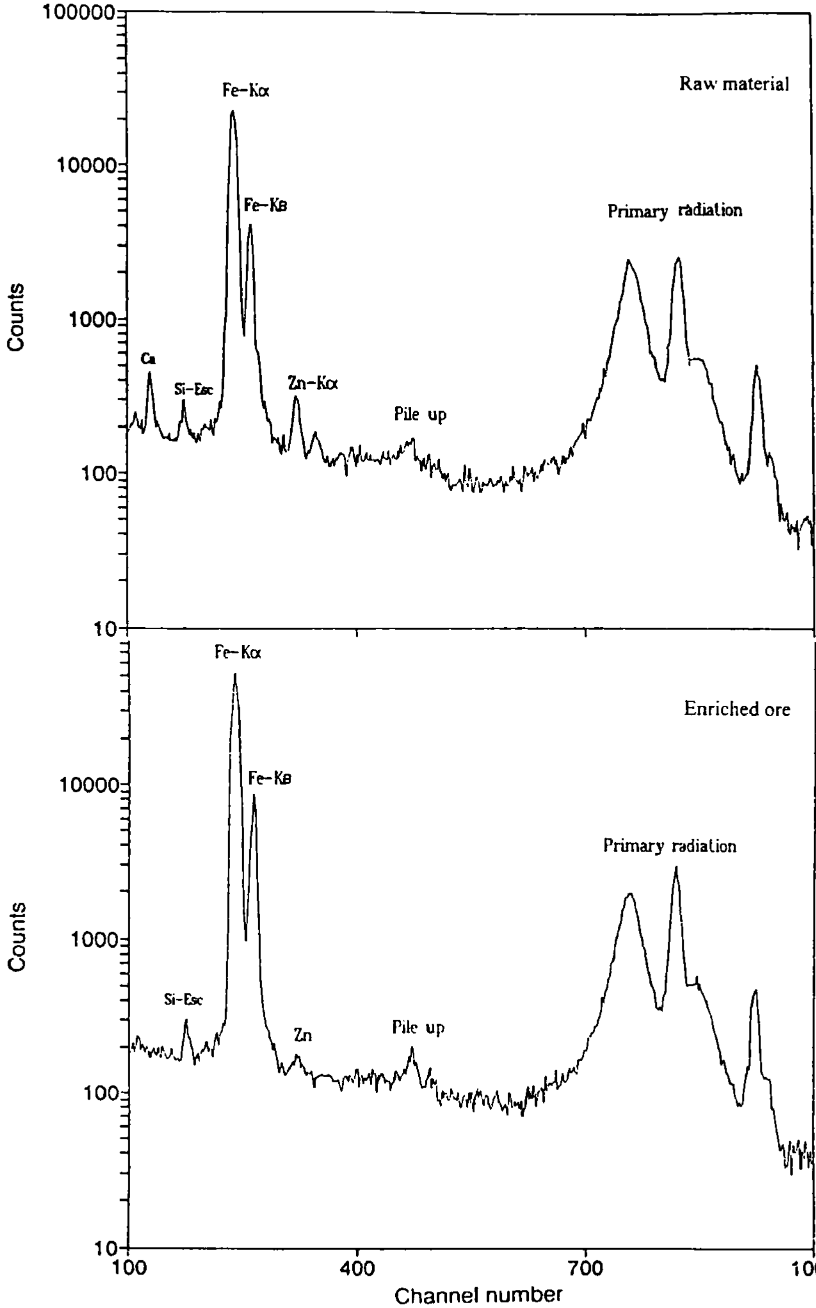

FIG. 1 Comparative XRF spectra of raw material and enriched ore.

Saturation level by the means of thick region was obtained as 1250 mg ore for iron and this amount was mixed with 250 mg cellulose as binder and diluent , then briquetted under a load of 15 t pressure in 3 cm diameter pellets. The iron ore concentrate from NIST(No. 690) as a standard reference material were prepared in similar way.

The experimental arrangement used in the current investigation was described in a previous study [10]. A ^{109}Cd excitation source was selected, providing a 22 to 25 keV primary beam energy to induce fluorescent X-rays from the samples. Measurements were performed with an energy dispersive XRF spectrometer consisting of an Si(Li) detector with a resolution of 180 eV at 5.9 keV coupled to a Canberra - 85 MCA , and interfaced to an IBM-PS/1 computer. The net peak intensities were calculated using an AXIL software program which was developed by the University of Antwerp group for the deconvolution of complex X-ray spectra. The known reference material and unknown ore samples were analyzed with the instrumental parameters set identically to those mentioned in the above setup.

The iron concentrations were determined in samples employing a common analytical technique as the direct comparison standards. The calibration curve of iron ore standards(NIST-690) was evaluated by the least squares method which is given in Fig.2 with a good correlation coefficient of 0.998 .

Results and discussion

Off-line EDXRF has been presented of the investigation of the iron ore dressing processes. Table 1 lists the average XRF analysis results of iron in samples from dressing process.

It is seen from table, Fe content in raw material was determined with varying value from 28 to 40 %. This Fe value was reached to 56 - 70 % for

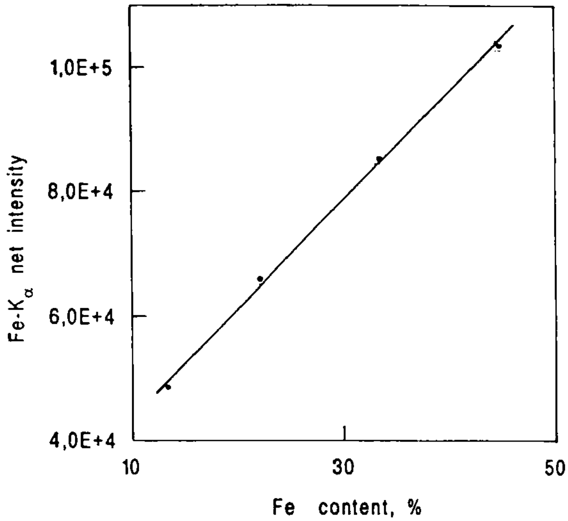

FIG. 2 Calibration curve for iron in quantitative analysis.

TABLE 1

Analysis results of samples from dressing process.

Samples No	Type of samples	Results of Fe, %
1	Raw material	28.15
2	Pyrite	28.81
3	Mixed ore	41.01
4	Crushed ore	48.37
5	Residue (grinder unit)	4.06
6	Residue (concentration unit)	2.90
7a	Concentration unit	56.92
7b	Commercial production	70.00
8a	Soil, nearby mine	12.76
8b	Soil, vicinity of mine	10.23

processed ore. Final products of dressing procedure are being used as one of the main source materials for steel industry in Turkey .

This method of quantitative interpretation was addressed to the quality control of stage of dressing. In consequence for quality control of process, analysis method is very essential. It can be said , the XRF technique is non-destructive and so avoiding time consuming chemical separation. The main advantage of the proposed method is its simplicity. Sample preparation is simple and cheap for powder pellets. Indeed, the technique possesses a number of analytical characteristics that are particularly valuable for routine analysis and meet the requirements of quality control of mine process such as iron ore dressing plant in Sivas - Divrigi. Instrumentation and data processing can be fully automated. This technique can also be adapted to the on-line determination of iron content in mineral processing plant with only a few modifications.

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