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MONITORING OF PARTICULATE MATTER EMISSIONS IN STATIONARY SOURCES.

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1.-Introduction

Atlantic Copper is one of the foremost global producers of copper (5th in the world and 1rst in Europe). Its production capacity increased to 310 000 t of copper anodes, 260 000 t of copper cathodes, 180 000 t of wire rod and 180 000 t of wire and cable, which generate 900 000 t of sulphuric acid, 20 t of gold and 60 t of silver as subproducts.

Freeport-McMoran Copper and Gold, Inc. (FCX), sole shareholder of Atlantic Copper, is one of the leading world producers of copper and gold. They have the largest copper and gold reserves on the planet at the Grasberg Mine in Irian Jaya. The operations of FCX are carried out through their affiliates PT Freeport Indonesia (mining exploration & development and copper, gold and silver minerals and global export and import of their concentrates), PT Iria Eastern Minerals (mining exploration) and Atlantic Copper, S.A. (copper smelting and refinement).

Atlantic Copper has production sites located in three Spanish cities (Huelva, Córdoba and Barcelona). Each one of these factories constitutes an important link in the chain, from the transformation of the raw materials to the production of copper rod and copper wire, which supports the downstream integration strategy of our sole shareholder.

Atlantic Copper's Environment Policy establishes its obligations with the Environment, and the implementation of an integrated environmental management system (SIGMA) is the means of guaranteeing their fulfilment. This environmental management system stated AENOR certification in April 1998, according to the UNE-EN ISO 14001 standard, with the registration number CGM-98/016. This certification placed Atlantic Copper, as the leading company in the metallurgical sector.

In addition to this, Atlantic Copper, S.A. validated the first Environmental Declaration conforming to Eco-Management and Audit Scheme (EMAS) in December of the same year, being the first company in the sector to have this distinction.

The major pollutants in copper metallurgy are SO_2 and particulate matter (PM). Before the compliance period of the new IPPC Directive requirements, regarding to the monitoring of industrial emissions, Atlantic Copper, was monitoring SO_2 emissions and is now carrying out the monitoring of PM emissions.

2. Aim

This document presents the protocol followed by Atlantic Copper, in its factory in Huelva to monitor the particulate matter emission. Atlantic Copper has chosen an optical continuous analyser whose working principle is based on the measurement of a physical property called SCINTILLATING. This scintillating, consists of a lack of light which provokes, in a receptor, the moving particulate matter crosses the beam of light from the LED produced by an emitter.

3. Experimental Development

The results and conclusions obtained from the work carried out up to the present time, document the phases of calibration, which were obtained following the steps which constitute the Six Sigma Methodology (define, measure, analyse, improve, control).

The selected continuous analyser was installed in the stack of a mineral concentrate rotary dryer. The emissions from this stack consist of gases generated during the process of drying the mineral, after passing through an electrostatic precipitator.

We chose to locate the analyser in an area of the stack according to a plan where the PM concentration was homogenous, according to ISO 9096:1992 criteria.

In order to obtain information regarding to the PM emissions given by this analyser, in accordance with UNE–EN– ISO/IC 17025 standard quality guarantees criteria is necessary, at least, to calibrate the equipment, study its stability and estimate the analyser's measurement uncertainty.

3.1.- Calibration of a continuous optical particulate matter standard analyser.

The calibration of this kind of analyser consists of stablishing the mathematical algorithm or the analytical function wich correlates to the physical property SCINTILLATING with [MP](mg/m^3, B.H). This conforms with the requirements of the ISO 1055:1995/C or 1:2002 standard.

In order to reach this, measurements of the concentration of particulate matter ([MP]) were made, using the ISO 9096:1992 reference method, whose results were matched with the average value of "scintillating", corresponding to the PM sampling period.

The analyser was calibrated to read the range between 0 mg/m^3 (W.B) and 225 mg/m^3 (W.B). 22 Pair of values (SCINTILLATING, [PM](mg/m^3, W.B)) were obtained, and a statistical analysis of their correlation concluded that both parameters are linked by a second order polynomial equation. This is shown in figure 1:

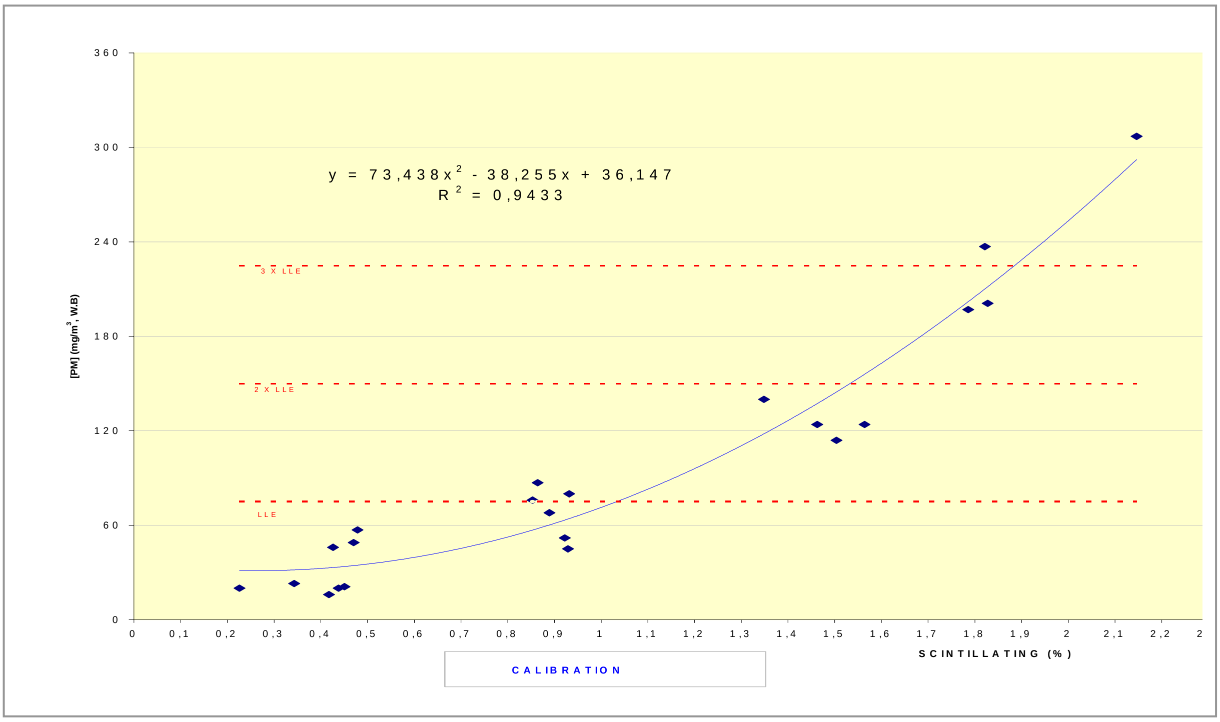

Figure 1: Measurements for calibration

3.2.- Analytical Function Verification

In order to verify the analytical function other measurements were made under operating conditions which allowed us to obtain values of [PM] distributed throughout the calibration range.

With the aim of verifying the maxima working range we released, in a controlled manner, high emissions of PM. These high values of [PM] were obtained by progressively reducing of the electrical efficiency (voltage) in the field 3 of the electrostatic precipitator. The results obtained during this verification measurements are shown in figure 2:

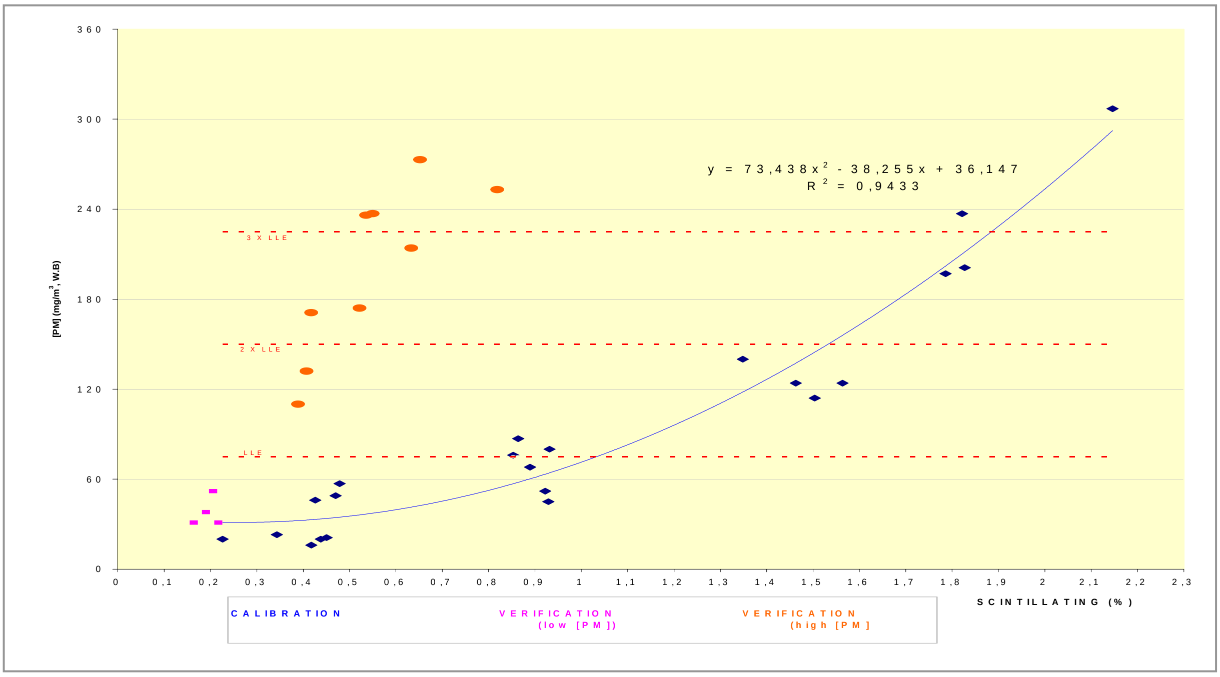

Figure 2: Measurements for verification

Other verification measurements were carried out , without modifying the electrical efficiency in the electrostatic precipitator fields. They proved that the correlation between the points also respond to the second order polynomial equation, which is shown in figure 3:

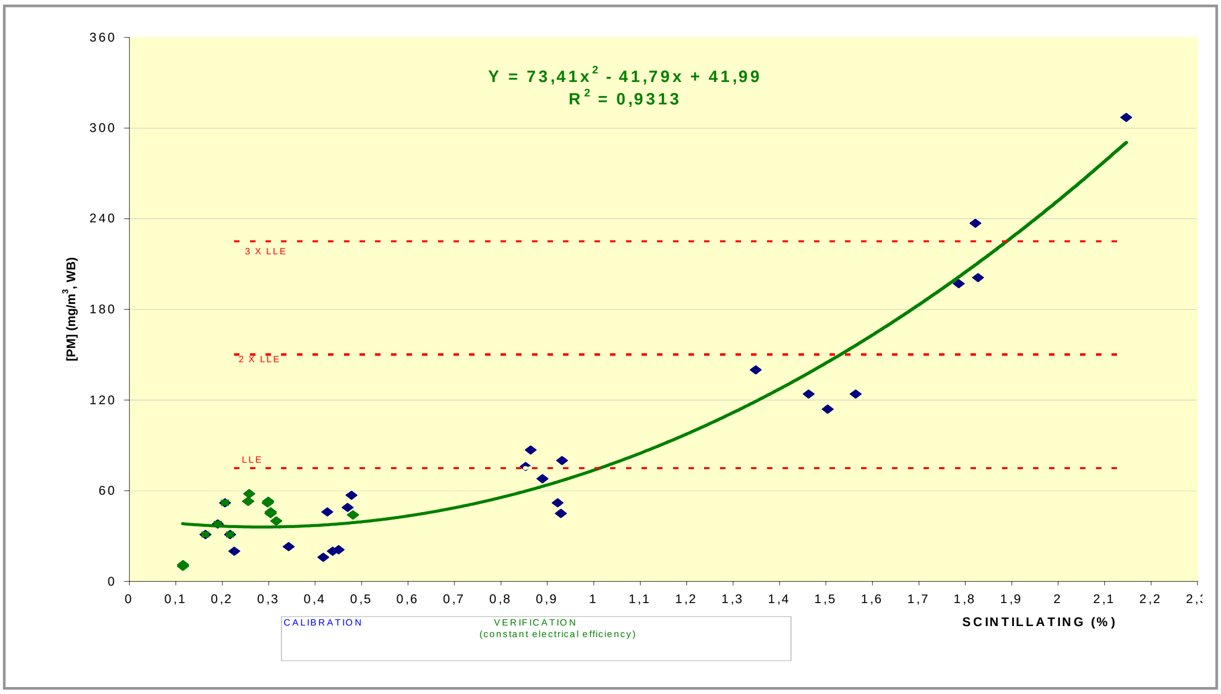

Figure 3: Verification with constant electrical efficiency

The causes of this behaviour were investigated using Scaning Electron Microscopy (SEM-EDAX) in the analysis of the PM retained on the used filters throughout the verification sampling. The research concluded that the PM increased in size, as a result of reducing the electrical efficiency of the field 3 in the electrostatic precipitator, although they generated the same scintillating.

The deed of a low electrical efficiency in one of the electrical precipitator fields modifies the correlation between SCINTILLATING and [MP] values announces that we have to identify an electrical parameter which is relation directly with PM emission. This electrical parameter is the 3 FIELDS INTENSITY ADDITION in the electrostatic precipitator, because it informs about the total amount of PM which is collected.

3.3.- Calculation of Confidence Interval and Tolerance Interval for the Analytical Function

Confidence interval of the analytical function was calculated with a 95% confidence level and tolerance interval of the analyitical function was calculated wuth a 75% confidence level, following ISO10155:1995/Cor 1: 2002 standard criteria. The results are shown in figure 5:

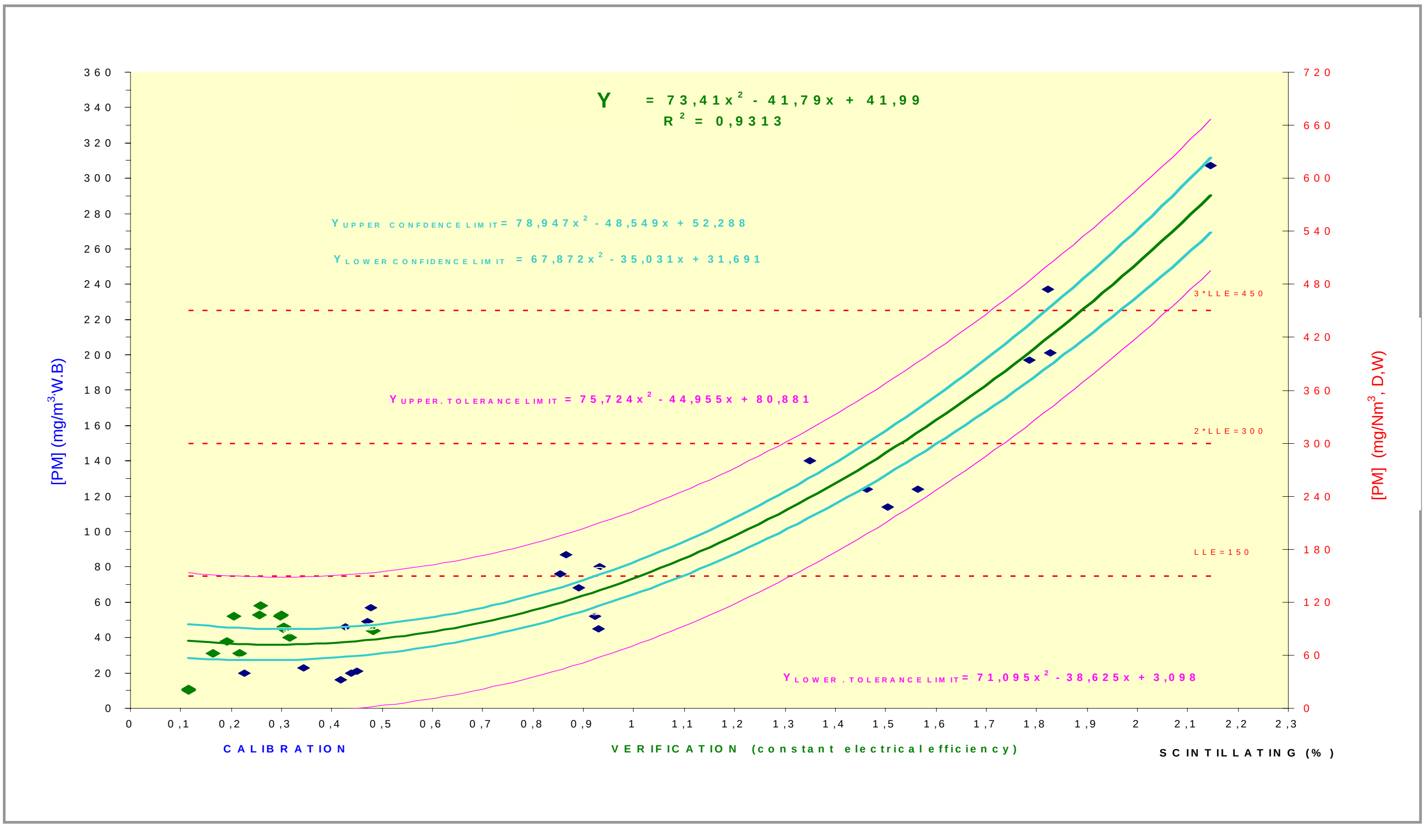

Figure 5: Confidence and tolerance interval

4.-Conclusions

a) The analytical function in this analyser is a second order polynomial function: $Y=73.4X^2-41.8X+41.9$

b) A decrease in the electrostatic precipitator fields modifies the correlation between SCINTILLATING and [PM]. Analysis by SEM-EDAX on the PM retained on the filters used throughout verification sampling made it clear.

c) An “intensity addition” study of the 3 electrostatic precipitator fields reveals the ACCEPTANCE CRITERIA of the analytical function must be INTENSITY ADDITION>700 ma. So whenever intensity addition is minor than 700 ma, the information provided by the analyser, respect to the [PM] is not valid.

d) Stability study of the analyser will allow us to know its drifts and to stablish the periods between calibrations and verifications. Once this study is finished, we will proceed to estimate the analyser’s measurement uncertainty.

References

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