LASER INSTRUMENT FOR DETERMINATION OF THE DEGREE OF CLEANLINESS IN COLD-ROLLED STEEL PLATE MANUFACTURING

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Abstract **Cold-rolled steel plate emerges from the manufacturing process with a thin layer of residual dirt that has to be kept under control for two main reasons: it may be indicative of deviations from normal functioning in previous manufacturing stages and it may impair the effectiveness of down-stream operations such as painting, galvani-zing, etc. Standard measurements of this residual dirt are based on not trustworthy laboratory sample measurements, outside the production line. We developed a method that allows on-line determina-tions of the cleanliness degree for the whole manu-factured steel plate bobbin. Based on this method, we designed the first industrial instrument (ELMES I), which is now in operation at the final inspection line of the Siderar's plant at Ensenada (Buenos Aires)**

Keywords— Acousto-optical devices, Lasers applications, Industrial laser applications, Industrial research and development.

I. INTRODUCTION

The determination of the amount of residual dirt (cleanliness) of steel plates after cold rolling is crucial both for the effectiveness of downstream operations such as galvanizing or painting and as a control of possible malfunctioning of prior stages of the process. Existing methods for cleanliness determination are based on laboratory measurements outside the production line. The simplest and most effective method relies on the measurement of the transparency of an adhesive tape that has been stuck and removed from the surface to be tested. Other methods rely on the chemical analysis of the residues whipped (Ford, 1985) or burned off the surface (EUR, 1996). All these methods have three main drawbacks: they cannot be automated, they are performed offline, are time consuming, and they only sample a small portion of the plate.

In this work a new method that overcomes all the above mentioned drawbacks is described. The method relies on the ablation of the dirt film by means of a short laser pulse and the subsequent measurement of the sound emitted. The intensity of the sound turns out to be proportional to the amount of dirt and provides a direct measurement of the cleanliness of the surface. The technique can be used on-line, and automatically measures the cleanliness along the entire plate.

II. DESCRIPTION OF THE METHOD

The new method (Bilmes and Martínez, 1999) allows to measure in real time the dirt present on different types of surfaces. In the case of cold-rolled steel plates this measurement can be made directly on-line on the moving plate, or on samples. A schematic of the technique is shown in Fig. 1. A Nd:Yag pulsed laser is directed towards the surface to be tested and a microphone picks up the emitted noise that is correlated to the amount of dirt present on the sample. Part of the laser pulse is directed towards an energy meter that is used in order to normalize the acoustic signal and hence compensate the pulse-to-pulse fluctuations from the laser.

The method is based on the fact that the dirt on the surface is composed by a thin film of oil, soaps and solid particles. If a laser pulse of enough fluence (energy per unit area) and short duration (about 20 ns) impinges on the surface, a violent heating of the film takes place giving rise to its expulsion without damaging the plate. As a consequence of this interaction between the light pulse and the film, various phenomena