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Correlation between analytical signal and rate of sample atomization in electrothermal atomic-absorption spectrometry

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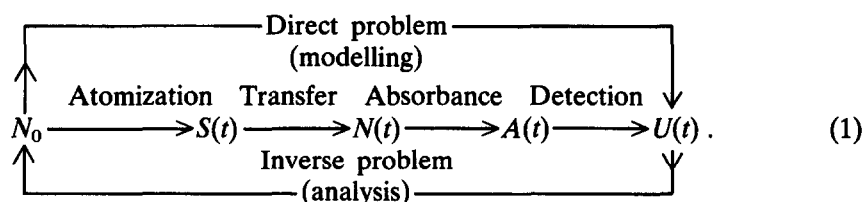
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Abstract—The relationship between an analytical signal, recorded at the spectrophotometer output, and the rate of sample atomization in the furnace has been analysed theoretically. The atomic transfer in the gas phase and the time constant of the recording system are shown to cause the broadening, the shift and the decrease in the peak height of the output signal, compared with the atomization pulse. These distortions can cause smoothing in the multiple peak of atomization. A simple criterion of their negligibility has been proposed. A solution of the inverse problem has been obtained, allowing reconstruction of the initial sample atomization rate from the recorded analytical signal. An efficient algorithm allowing the on-line processing of signals in the spectrophotometer microcomputer has been proposed. The distorting influence of transfer processes and of the recording system upon the shape of Arrhenius plots have been analysed.

1. INTRODUCTION

THE THEORY of any method of investigating material composition is mainly intended for establishing the relationship between an analytical signal and the number of analyte atoms N_0 in samples [1]. In electrothermal atomic-absorption analysis this relationship is found to be complicated including at least four stages. The sample involved in the process of thermal atomization is transferred to the gas phase at a rate of $S(t)$ atoms per second transported over all the space of the atomizer, thus forming a non-stationary absorbing layer with the number of atoms $N(t)$. The exposure of the resulting atomic cloud to line radiation of the same element gives variable absorbance $A(t)$ at the atomizer output, which is then converted to the output signal $U(t)$ in the spectrophotometer recording channel. Thus, the relationship discussed above can be presented as the following sequence:



The analysis of this sequence requires two problems to be stated [2]: (1) the direct problem of investigating the evolution in the spectrophotometer of the given atomization peak by means of modelling the formation of analytical signals; and (2) the inverse problem of deducing sample atomization rates $S(t)$ from recorded output signals $U(t)$. Both problems can be reduced to the analysis of the sequence (1) in the forward and backward directions. The second problem is actually, more important, because atomic absorption determinations, just like any other kind of instrumental analytic methods, essentially require the inverse problem to be solved: knowing the effect, i.e. the analytical signal, the cause has to be found, i.e. the unknown quantity of the element being determined in the sample. In the case of complete sample atomization it is obvious that $N_0 = \int_0^{\infty} S(t)dt$, i.e. the necessary analytical information is given by the supply function $S(t)$, while the integral of the output signal $Q = \int_0^{\infty} U(t)dt$, is a value