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Analytica Chimica Acta 349 (1997) 377–384

ANALYTICA CHIMICA ACTA

# Determination of gaseous species by monosegmented flow systems. Volumetric determination of oxygen and carbon dioxide

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Received 26 November 1996; received in revised form 21 March 1997; accepted 31 March 1997

**Abstract**

A Monosegmented Flow System was developed to determine the content of gaseous analytes in gaseous samples. The proposed system, in contrast with previous monosegmented systems, employs the gas bubbles as gaseous samples. The volume of the bubbles is assessed indirectly by counting the time elapsed by the passage (at constant flow rate) of the liquid–gas and gas–liquid boundaries, defined for each bubble, through optical switches. Two optical switches are employed for bubble volume measurement: one counts the bubble passage before analyte absorption and the other is positioned after the inlet point of the reagent (added only into the liquid monosegment) and, therefore, can assess the bubble volume after the analyte absorption. The ratio of the elapsed time intervals taken before and after the analyte absorption is used as analytical parameter and inversely related with the content of the gaseous analyte. The instrument is controlled by a micro-computer. The principle has been applied to the determination of $O_2$ and $CO_2$ (including when they are present in mixtures containing both specimens) in gaseous samples together with an inert gas. The results show a mean absolute error of 0.1% and 0.3% for determination of $O_2$ and $CO_2$ present in the range 5–50% and 5–15% (v/v), respectively, when calibration with standard gaseous mixtures is employed. An alternative procedure that employs the volume ratio directly as the volumetric fraction of the gaseous species in the sample was also evaluated. About 40 samples can be processed per hour with the proposed system.

*Keywords:* Monosegmented flow system; Automatic volumetric gas determination; Carbon dioxide; Oxygen

## 1. Introduction

Flow systems as Flow Injection (FI) [1] and Monosegmented (MSFA) [2] have demonstrated that conventional batch methodologies as distillation [3], liquid–liquid extraction [4–6], single-phase extraction [7] and even gravimetry [8] can be adapted to be performed with a high degree of automation. The resulted flow methodologies require lower quantities of sample and reagents, are less time consuming and less prone to human factors of error.

Previous attempts to determine gaseous specimens using flow systems were restrict to samples containing low concentration of the gaseous analyte and were based on the absorption of the gaseous specimens by a reagent solution [9,10]. Spectrophotometric detection of the reaction product was employed for analyte determination. Among a variety of well established analytical methodologies perhaps only the volumetric approach to gas determination, based on the absorp-

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*PII* S0003-2670(97)00278-X