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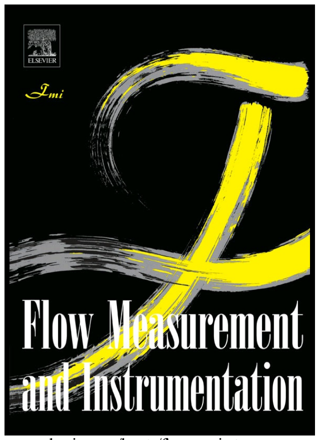

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Novel Application of Gas Chromatography in Measurement of Gas Flow Rate

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ABSTRACT: Real-time volume flow rate of gas component for slowly changing composition mixtures is of chief importance for some special research applications. However, it is always difficult for us to achieve the goal by sophisticated gas flowmeter. In this study, we demonstrate two methods for the problem solution by the flow measurement of acetylene in unsteady gas flow based on online gas chromatography accompanying with a gas mass-flowmeter. For Method 1, high purity methane is applied as an internal standard and the volume flow rate of acetylene is obtained via coherent equations. Method 2 makes fully use of the online gas chromatography automated integration under fixed gas chromatography work conditions. Results have shown that both methods are feasible and effective, and Method 2 is more accurate than Method 1 with relative error less than 0.7%.

Keywords: online gas chromatography; gas flowmeters; gas flow rate; changing composition; methane; acetylene.

1. Introduction

Gas chromatography (GC) is a technique for separation based on the interaction differences between mobile phase and stationary phase. Nowadays, GC has been a mature separation methodology with high separation efficiency, sensitivity and well performed selectivity for decades[1-3]. As a successful and economical method, GC is widely used in petroleum chemistry, herbal medicines, fermentation broth identification and other important analysis area[4-9]. Especially, the highly integrated online gas chromatography (OLGC) has accomplished the combination of on-line sample preparation and sample injection. Its automation frees researchers from tedious sample preparation work and largely reduces analysis time. Besides, OLGC has also made a deep improvement in the problems encountered with human errors, contamination, sample loss and possible degradation of the analytes [10].

Traditionally, on-line gas mixture analysis by OLGC is confined to component identification and specific content detection. In some special research work, flow rate of each component in the gas mixture should be known at the same time. Percentage of each component can be achieved by GC independently except for the flow rate. The total gas flow might be determined by sophisticated gas flowmeters, while the medium to be measured should be of constant composition or the medium composition changes little during the whole measure process. Sometimes the gas composition may change apparently in a few hours, but it changes little in tens of minutes. Flow rate for a certain short time period can be considered as the instantaneous flow value. Commonly used instruments for flow-rate measurement, such as rotameters or pressure-drop devices, are based on steady-flow principles or experimental correlations and they are trustworthy only for the most slowly changing of unsteady flows. Pressure-drop devices such as orifice plate flowmeters, venturimeters and rotameters work on the theory of Bernoulli's equation and the gas velocity shown by the meters are connected with flow coefficients and gas mixture density ρ. Above reasons make it impossible to display the changing gas flow value correctly by pressure-drop devices [11, 12]. Another kind of widely used instruments such as gas mass-flowmeters (GMFM) are based on the principle that the output voltage of the sensor element is related to the rate of heat transfer between the sensor and the gas. The rate of heat transfer depends not only on the gas flow