DEVELOPMENT OF FLOW SYSTEMS FOR THE DETERMINATION OF ETHANOL IN ALCOHOLIC BEVERAGE

WANPEN KHONGPET

A Thesis Submitted to the Graduate School of Naresuan University
in Partial Fulfillment of the Requirements
for the Master of Science Degree in Chemistry
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This thesis entitled "Development of Flow Systems for the Determination of Ethanol in Alcoholic Beverage" submitted by Wanpen Khongpet in partial fulfillment of the requirements for the Master of Science Degree in Chemistry is hereby approved.

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ABSTRACT

Continuous-flow systems, namely flow injection (FI) and hydrodynamic sequential injection (HSI), have been designed, constructed and developed for determination of ethanol.

Homemade flow injection (FI) system with a simple and low cost of colorimetric detector using light-emitting diode (LED) as light source were investigated for determination of ethanol. Two reagent solutions including an acidic potassium permanganate and an acidic potassium dichromate were used in the proposed systems, in which ethanol reduces potassium permanganate and potassium dichromate in sulfuric acid solution. Decrease in color intensity of potassium permanganate and increase in color intensity of chromium-(III) were monitored using green-LED and red-LED light sources, respectively. Common FI operating parameters such as potassium permanganate and potassium dichromate concentrations, sulfuric acid concentrations, flow rates of carrier and reagent streams, reaction coil lengths and sample volumes were optimized. Under optimum conditions of the system that used acidic potassium permanganate as reagent, a linear calibration graph in the range of 10-40 %v/v ethanol and relative standard deviation (RSD) of 1.7-3.7 % were obtained. The detection limit was 1.2 %v/v ethanol. The sample throughput was 72 injections per hour. With the optimum conditions of acidic potassium dichromate system, a

linear calibration graph in the range of 4-8 %v/v ethanol and RSD of 1.4-2.5 % were obtained. The detection limit was 0.3 %v/v ethanol. The sample throughput was 80 injections per hour. Both the methods were successfully applied for ethanol determination in Thai white distilled liquor samples and results obtained agreed well with those obtained by other methods, namely, FI-spectrophotometry, AOAC redox titration and micro-scale potentiometric redox titration.

A homemade hydrodynamic sequential injection (HSI)-spectrophotometric system was developed for determination of ethanol and on-line gas diffusion (GD) unit was used for ethanol extraction prior introduction into the HSI system. This system was also investigated for ethanol determination employing a simple redox reaction, in which ethanol reduces potassium dichromate in sulfuric acid solution. Increase in color intensity of chromium-(III) was spectrophotometrically monitored at 600 nm. Under optimized conditions, a linear calibration graph in the range of 2-10 %v/v ethanol and RSD of 0.7-2.3 % were obtained. The detection limit was 0.4 %v/v ethanol. The sample throughput was 15 injections per hour. The developed method was successfully applied for ethanol determination in alcoholic beverage samples and results obtained also agreed well with those obtained by FI-spectrophotometric, AOAC redox titrimetric and micro-scale potentiometric redox titrimetric methods.

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ABBREVIATIONS

ATP	Adenosine tri phosphate
ABV	Alcohol percentage by volume
FI	Flow injection
HSI	Hydrodynamic sequential injection
SV	Solenoid valve
GD	Gas diffusion unit
LED	Light emitting diode
PTFE	Polytetrafluoroethylene
mol/L	Mole per liter
mg/L	Milligram per liter
g	Gram
mL	Milliliter
nm	Nanometer
i.d.	Inner diameter
LR	Linear range
DL	Detection limit
SP	Sample throughput
No.	Number
mL/min	Milliliter per minute
r^2	Square of correlation coefficient
%v/v	Percentage volume by volume
%w/v	Percentage weight by volume
SD	Standard deviation
RSD	Relative standard deviation
Ref.	Reference
UV	Ultraviolet
s	Second
blk	Blank value