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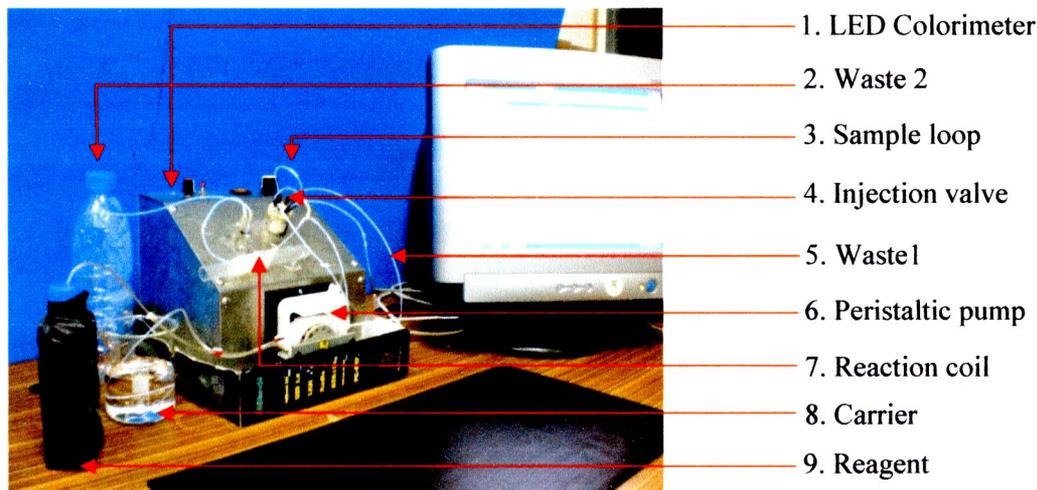
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## **APPENDIX**

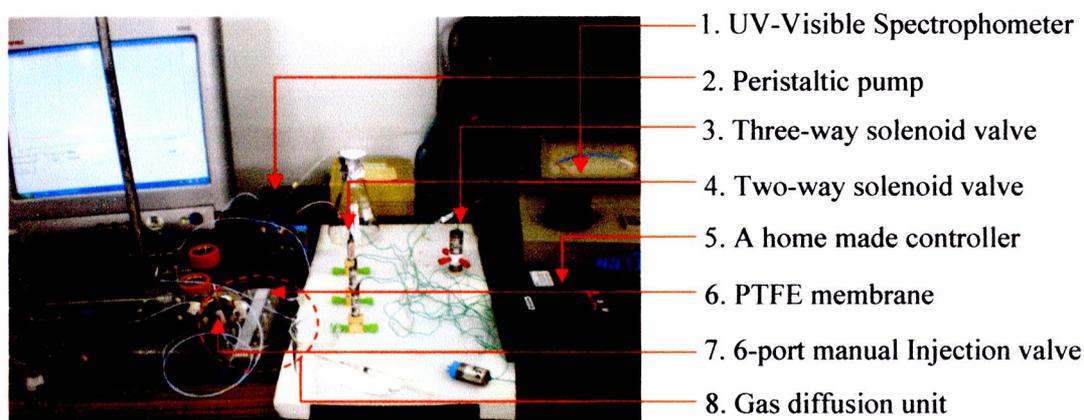
**APPENDIX A THE IMAGE OF THE HOMEMADE FI - COLORIMETRIC AND HSI-SPECTROPHOTOMETRIC SYSTEMS USED IN THIS RESEARCH**

**A.1 The image of a homemade FI-colorimetric system for the determination of ethanol in Thai white distilled liquor**



**Figure 42 Setup of a homemade FI-colorimetric system (constructed by Associate Professor Dr. Jaroon Jakmunee and group)**

**A.2 The image of a homemade HSI - spectrophotometric system for the determination of ethanol in alcoholic beverages**



**Figure 43 Setup of a homemade HSI-spectrophotometric system (constructed by Associate Professor Dr. Jaroon Jakmunee and group)**

## APPENDIX B CALCULATIONS OF DETECTION LIMIT AND T-TEST VALUES

### B.1 Detection limit (LOD)

In this research, the detection limit (or limit of detection (LOD)) was described by using Miller & Miller method [62]. The LOD definition is “the analyte concentration giving a signal equal to the blank signal,  $y_B$ , plus three standard deviations of the blank,  $S_B$ ” as followed equating.

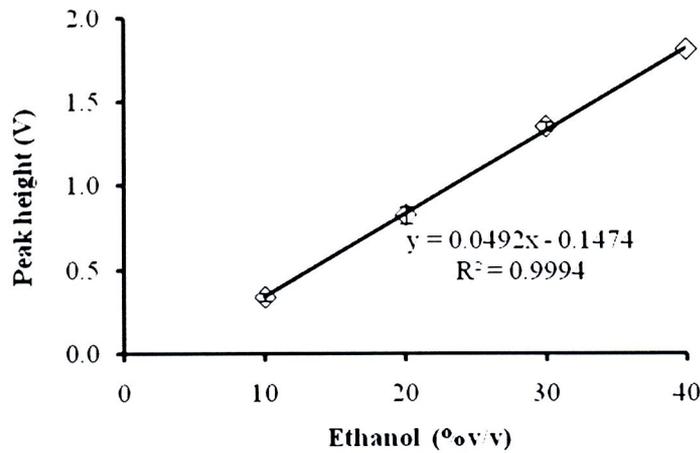
$$y_{LOD} = y_B + 3S_B \quad (1)$$

When  $y_{LOD}$  is limit of detection of calculation.

Using data in Table B.1 and calibration graph in Figure B.1, the example of LOD calculation for ethanol determination in the range of 10-40 %v/v was related as following:

**Table 34 Data as presented in 1.8 (in page 38)**

x	y	$y_i$	$y - y_i$	$(y - y_i)^2$
10	0.34	0.3446	-0.0022	0.00001
20	0.83	0.8366	-0.0092	0.00008
30	1.35	1.3286	0.0224	0.00050
40	1.81	1.8206	-0.0136	0.00019
			$\Sigma (y - y_i)^2$	0.000777
			$\Sigma (y - y_i)^2 / N - 2$	0.000389
			$S_B$	0.0197104
			$y_B$	-0.1474000
			$y_{LOD} = y_B + 3S_B$	-0.0882688
			$y_{LOD} = 0.0492X - 0.1474$	
			$x_{LOD} = (y_{LOD} + 0.1424) / 0.0492$	1.2



**Figure 44 Calibration graph of ethanol determination in the range of 10-40 %v/v**

From a regression line equation;

$$y = ax + b = 0.0492x - 0.1474 \quad (2)$$

$$y_B = -0.1474$$

From equation (1);

$$y_{LOD} = y_B + 3S_B = (-0.1474) + 3S_B \quad (3)$$

The statistic  $S_B$  calculates by:

$$S_B = \sqrt{\frac{\sum(y-y_i)^2}{N-2}}$$

$$= \sqrt{\frac{0.000777}{4-2}}$$

$$= 0.0197104 \quad (4)$$

The  $y_B = -0.1474$  and  $S_B = 0.0197104$  are inserted into the equation (3):

$$y_{LOD} = (-0.1474) + 3(0.0197104)$$

$$y_{LOD} = -0.0882688$$

For the calculation of LOD concentration ( $x_{LOD}$ ), the  $y_{LOD} = -0.0882688$  is inserted into the equation (2):

$$y_{LOD} = 0.0492(x_{LOD}) - 0.1474$$

$$-0.0882688 = 0.0492 (x_{\text{LOD}}) - 0.1474$$

$$x_{\text{LOD}} = 1.2$$

Hence, the detection limit of ethanol determination is 1.2 %v/v.

## B.2 T-test value

The t-test value calculates by:

$$t = \frac{\bar{D}}{S_d} \sqrt{N} \quad (1)$$

When;

$$S_d = \text{Standard deviation} \left[ S_d = \sqrt{\frac{\sum (D_i - \bar{D})^2}{N-1}} \right]$$

N = Number of sample

$D_i$  = Calculate from the difference value between two techniques

$\bar{D}$  = Average of  $D_i$  ( $\bar{D} = \sum D_i / N$ ) values

Using data in Table 30, the example of t-test calculation are as following:

**Table 35 Data of ethanol determination in some Thai white distilled liquor samples by FI-colorimetric system (using acidic  $K_2Cr_2O_7$  as reagent) and AOAC redox titration**

Sample No.	Ethanol (%v/v)		$D_i$	$D_i - \bar{D}$	$(D_i - \bar{D})^2$
	FI-colorimetric	AOAC redox titration			
1	30.1	30.4	0.3	0.3	0.1
2	39.9	40.4	0.5	0.5	0.3
3	45.0	45.2	0.3	0.3	0.1
4	38.3	36.6	-1.7	-1.7	2.9
5	39.6	40.0	0.4	0.4	0.2
6	39.0	39.7	0.7	0.7	0.5
7	38.8	40.3	1.6	1.6	2.4
8	39.1	37.3	0.3	0.3	0.1

**Table 35 (Cont.)**

Sample No.	Ethanol (%v/v)		Di	Di-D	(Di-D) <sup>2</sup>
	FI-colorimetric	AOAC redox titration			
9	33.5	32.5	-1.5	-1.5	2.4
10	40.2	40.2	-1.9	-1.9	3.4
11	39.6	40.9	1.3	1.3	1.7
12	35.5	35.2	0.5	0.5	0.3
		Σ	0.8	0.8	14.3

$$\text{Then, } \bar{D} = \frac{0.8}{12} = 0.07$$

$$S_d = \sqrt{\frac{14.3}{12-1}} = 1.14$$

Thus, the t-test value is as following:

$$t = \frac{0.07 \sqrt{12}}{1.14} = 0.2$$

The calculation of t-test value is 0.2. The critical value of t-test is 2.2 (where t has 11 degrees of freedoms) at the confidence interval of 95%. From the result, the calculated value is less than the critical value. Thus, FI-colorimetric and the AOAC redox titration methods are not significant difference for the ethanol concentration found at 95% confidence interval.

## **BIOGRAPHY**

## BIOGRAPHY

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### Publications

- Khongpet, W., Thanakulkij, P., Pencharee, S., Grudpan, K., Jakmunee, J. and Kritsunankul, O. (2010). A compact flow injection-colorimetry system for determination of ethanol in distilled liquor. In the Sixth Naresuan Research Conference (p. 138). Phitsanulok: Naresuan University.
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