APPENDIX A

Table A.1 Standard quality of tap water defined by metropolitan waterworks authority (WHO 2006) [84]

Parameters	Units	WHO 2006 (Guideline Value)
1. Bacteriological Quality		
Bacteria E. coli	Found - no found/ 100 mL	No found/ 100 mL
2. Physical and Chemical Quality		
Apperance colour	True colour unit	15
Turbidity	NTU	5
Taste and odour	-	
Arsenic	mg L^{-1}	15
Cadmium	mg L^{-1}	0.003
Chromium	mg L^{-1}	0.05
Cyanide	mg L^{-1}	0.07
Lead	mg L^{-1}	0.01
Inorganic Mercury	mg L^{-1}	0.006
Selenium	mg L^{-1}	0.01
Fluoride	mg L^{-1}	1.5
Chloride	mg L^{-1}	250
Copper	mg L^{-1}	2
Iron	mg L^{-1}	0.3
Manganese	mg L^{-1}	0.4

Note 1 mg = 1000 μg

Table A.1 (Continued).

Parameters	Units	WHO 2006 (Guideline Value)
Sodium	mg L^{-1}	200
Sulfate	mg L^{-1}	250
Zinc	mg L^{-1}	3
Aluminium	mg L^{-1}	0.1
Sodium	mg L^{-1}	200
Hydrogen sulfate	mg L^{-1}	0.05
Total dissolved solids	mg L^{-1}	1,000
Nitrate as NO_3^-	mg L^{-1}	50
Nitrite as NO_2^-	mg L^{-1}	3
Free residual chlorine	mg L^{-1}	> 0.2
Trichloroethene	mg L^{-1}	0.02
Tetrachloroethene	mg L^{-1}	0.04
Microcystin-LR	mg L^{-1}	0.001
3. Pesticides		mg L^{-1}
Aldrin/Dieldrin	mg L^{-1}	0.03
Chlordane	mg L^{-1}	0.2
DDT	mg L^{-1}	1
Heptachlor and Heptachlor epoxide	mg L^{-1}	0.03
Hexachlorobenzene	µg L^{-1}	1
Lindane	µg L^{-1}	2
Methoxychlor	µg L^{-1}	20
Pentachlorphenol	µg L^{-1}	9

Note 1 mg = 1000 µg

Table A.1 (Continued).

Parameters	Units	WHO 2006 (Guideline Value)
4. Trihalomethanes sum of the ratio		
Chloroform, $CHCl_3$	mg L^{-1}	1
Bromodichloromethane, $CHBrCl_2$	mg L^{-1}	0.06
Dibromochloromethane, $CHBr_2Cl$	mg L^{-1}	0.1
Bromoform, $CHBr_3$	µg L^{-1}	0.1
5. Radioactive		
Gross alpha activity	Bq L^{-1}	0.5
Gross beta activity	Bq L^{-1}	1

Note 1 mg = 1000 µg

Table A.2 Recommended minimum sample numbers for faecal indicator testing in distribution systems *

Population	Total number of samples per year
Point sources	Progressive sampling of all sources over 3 to 5 year cycles (maximum)
Piped supplies	
< 5000	12
5000 - 100000	12 per 5,000 head of population
> 100000 - 500000	12 per 10,000 head of population plus an additional 120 samples
> 500000	12 per 100,000 head of population plus an additional 180 samples

* Parameters such as chlorine, turbidity and pH should be tested more frequently as part of operational and verification monitoring.

APPENDIX B

The student t-Test [79]

$$t = \frac{\bar{x}_d \sqrt{n}}{S_d}$$

$$S_d = \sqrt{\frac{\sum(x_i - \bar{x})^2}{n-1}}$$

$$\bar{x}_d = \frac{\sum x_d}{n}$$

Where; x_d the difference between two method

$\bar{x}_d$ the mean difference

S_d the standard deviation

n number of sample

n-1 number of degree of freedom

The Table B.1 gives the concentration of aluminium (mg L^{-1}) determined by the proposed rFIA and ICP-MS methods for each eight test portions.

Table B.1 Calculation of *t*-test for aluminium (III) determination of rFIA.

Water samples	Concentrations (mg L^{-1})		$\bar{x}$	s_d	$\bar{x}_d$	$t_{calculated}$
	rFIA*	ICP-MS*				
Jomthong	0.270	0.273	0.270	0.00173	-0.00300	-3.000
Doi Saket	0.079	0.081	0.079	0.00252	-0.00233	-1.606
Hangdong	0.077	0.075	0.077	0.00153	0.00167	1.890
Mae Rim	0.183	0.189	0.183	0.00200	-0.00600	-5.196
Mae Wang	0.120	0.120	0.120	0.00153	-0.00033	-0.378
Mueang	0.083	0.087	0.083	0.00208	-0.00433	-3.606
Sansai	0.050	0.048	0.051	0.00200	0.00300	2.598
Chaing Mai University	0.224	0.228	0.224	0.00306	-0.00367	-2.079

*average of triplicate results

For example: **Jomthong**

$$\bar{x} = \frac{\sum x_i}{n}$$

$$= \frac{0.271 + 0.268 + 0.271}{3}$$

$$= 0.270$$

$$S = \sqrt{\frac{\sum(x_i - \bar{x})^2}{n-1}}$$

$$= \sqrt{\frac{0.000000666}{3-1}}$$

$$= 0.00173$$

$$\bar{x}_d = \frac{(0.271-0.273)+(0.268-0.273)+(0.271-0.273)}{3}$$

$$= -0.00300$$

$$T = \frac{\bar{x}_d\sqrt{n}}{S_d}$$

$$= \frac{-0.00300\sqrt{3}}{0.00173}$$

$$= -3.000$$

The aluminium (III) content found in water sample by the proposed rFIA procedure and ICP-MS was compared and then the results were given in Table B 1. The calculated value of *t* are less than the *t* value from Table B.3 (4.30) for two degrees of freedom indicating that results obtained by both methods show no significant difference at 95% confidence intervals.

Table B.2 Calculation of *t*-test for aluminium (III) determination of rFIA.

Water samples	**Concentrations (mg L^{-1})**		$\bar{x}$	s_d	$\bar{x}_d$	$t_{calculated}$
	rFIA*	**ICP-MS***				
Jomthong	0.264	0.273	0.264	0.00306	-0.00867	-4.914
Doi Saket	0.078	0.081	0.078	0.00100	-0.00300	-5.196
Hangdong	0.077	0.075	0.077	0.00252	0.00167	1.147
Mae Rim	0.185	0.189	0.185	0.00231	-0.00367	-2.750
Mae Wang	0.122	0.120	0.122	0.00231	0.00233	1.750
Mueang	0.085	0.087	0.085	0.00153	-0.00167	-1.890
Sansai	0.048	0.048	0.048	0.00252	-0.00033	-0.229
Chaing Mai University	0.223	0.228	0.223	0.00351	-0.00467	-2.302

*average of triplicate results

For example: **Jomthong**

$$\bar{x} = \frac{\sum x_i}{n}$$

$$= \frac{0.261 + 0.267 + 0.265}{3}$$

$$= 0.264$$

$$S = \sqrt{\frac{\sum(x_i - \bar{x})^2}{n-1}}$$

$$= \sqrt{\frac{0.000000666}{3-1}}$$

$$= 0.00306$$

$$\bar{x}_d = \frac{(0.261 - 0.273) + (0.267 - 0.273) + (0.265 - 0.273)}{3}$$

$$= -0.00867$$

$$T = \frac{\bar{x}_d \sqrt{n}}{S_d}$$

$$= \frac{-0.00867\sqrt{3}}{0.00306}$$

$$= -4.914$$

The aluminium (III) content found in water sample by the proposed SIA procedure and ICP-MS was compared and then the results were given in Table B 1. The calculated value of *t* are less than the *t* value from Table B.3 (4.30) for two degrees of freedom indicating that results obtained by both methods show no significant difference at 95% confidence intervals.

Table B.3 Values of *t* for various levels of confidence interval.

Degrees of freedom	Confidence interval			
	80%	**90%**	**95%**	**99%**
1	3.08	6.31	12.70	63.7
2	1.89	2.92	4.30	9.92
3	1.64	2.35	3.18	5.84
4	1.53	2.13	2.78	4.60
5	1.48	2.02	2.57	4.03
6	1.44	1.94	2.45	3.71
7	1.42	1.90	2.36	3.50
8	1.40	1.86	2.31	3.36
9	1.38	1.83	2.26	3.25
10	1.37	1.81	2.23	3.17
15	1.34	1.75	2.13	2.95
20	1.32	1.72	2.09	2.84
30	1.31	1.70	2.04	2.75
60	1.30	1.67	2.00	2.66
α	1.29	1.64	1.96	2.58

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List of publications

1. Poachanee Norfun, Teraboon Pojanakaroon and Saisunee Liawruangrath, **"Development of Reverse Flow Injection Spectrophotometry for Determination of Aluminium (III)"** *PERCH-CIC Congress VI, Chonburi, 2009*

2. Poachanee Norfun , Jirayu Makchit and Saisunee Liawrunangrath, **Reversed Flow Injection Spectrophotometric for Determination of Chromium (III) in dietary supplement samples,** *The 35th Congress on Science and Technology of Thailand, Bangkok*, 2009.

THE RELEVANCY OF THE RESEARCH WORK IN THAILAND

In the recent years, the development of science and technology and population growths leads to the ever-increasing demand for analyses in pharmaceutical, clinical, agricultural, industrial, process analytical control and environmental led to the development of automatic and user-friendly analytical method. An increasingly great demand for small and powerful analytical systems concerns, particularly application in field measurements of environmental analysis. In such analyses analytical tasks usually take up a lot of time owing to a large number of samples to be analyzed. Therefore, analytical techniques with high sample throughput and minimum consumption of reagent/sample are required. This research group has been terms "α-flow" group since 1990 as soon as most of our on-going researches are based on flow analysis which are greener analytical methods and application to real samples such as water, food and pharmaceutical.

The aims of this research are to develop a reverse flow injection and sequential injection methods for determining aluminium in water samples. In term of economic and environmental point of view, this research consume little reagent with minimum waste release and reduce cost of analytical instrumentation and sample analysis. This would be able to help the Thai Government to improve the economy and environmental problem of Thailand in the near further.