



Comparative Study on the Determination Methodology of Total Suspended Solids by Using the Microwave and the Laboratory Standard Methods

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Abstract Total Suspended Solids (TSS) was an important parameter used to control biomass in an aeration tank during the activated sludge process also known as Mixed Liquor Suspended Solids (MLSS). The weighed standard glass-fiber filter and the residue retained on the filter are dried to a constant weight at 103 to 105 °C. There were major steps in a standard method, which take time to analyze. Therefore, microwave method was an attractive technique because rapid determination of total suspended solids. This comparative study was made on the analysis of total suspended solids between the use of microwave and standard method of American Public Health Association, American Water Works Association, and Water Environment Federation (APHA, AWWA & WEF). It was conducted to examine the appropriate condition of microwave power 800-watt at two levels including medium-high and high levels at 10, 15 and 20 minutes. Synthetic wastewater was prepared by Cellulose power of thin layer chromatography at concentrations 100 mg/l. The result show on that the optimum condition was using high level at 10 minutes. Mean of total suspended solids was at 97.39 mg/L. The sample of wastewater was collected from Conventional Activated Sludge, CAS of Sakon Nakhon Hospital. After comparison, it was found that total suspended solids with microwave and standard method had an average concentration at 156.2 and 150.4 mg/L, respectively. There was no significant difference of total suspended solids from the two methods at a 95% confidence level.

Keywords total suspended solids, microwave, standard methods, conventional activated sludge

INTRODUCTION

Total Suspended Solids (TSS) was an important parameter used to control biomass in an aeration tank during the activated sludge process. Also known as Mixed Liquor Suspended Solids (MLSS). The weighed standard glass-fiber filter and the residue retained on the filter are dried to a constant weight at 103 to 105 °C. There were major steps in a standard method of American Public Health Association, American Water Works Association, and Water Environment Federation (APHA, AWWA & WEF)'s long-time analysis but treatment processes require sufficient time for the wastewater to be treated.

For many years, Microwave (MW) techniques have known to offer faster, simpler, and more cost-effective processes, often affording high-yield, high-purity products. (Adam, 2003) The efficiency of the microwave oven heating is internal. In a conventional oven, the substance is heat from the outside, and it must be left to heat until its center has raised to a high temperature. In microwave heating, the molecules with permanent dipole moment absorb the radiation and rotate. As with many other excited states, the excess rotational energy of these molecules is re-emitted as heat and so heating times reduced. (Banwell et al., 2000)

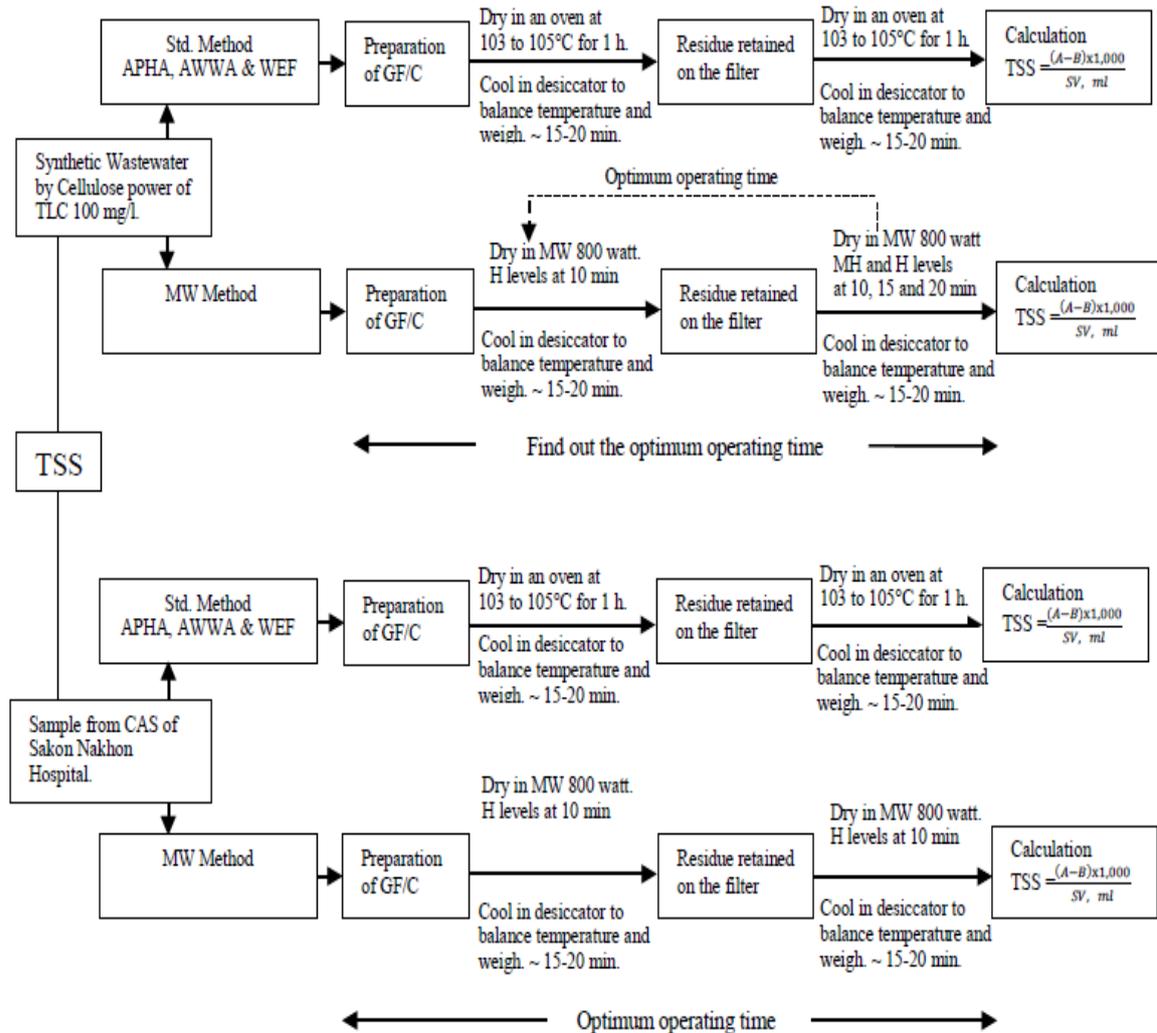
The Microwave has many applications such as determine municipal refuse moisture content compared by APWA method (furnace, 600 degrees °C at least 2 hours). The results revealed that the greatest microwave operating time and power combinations were 11 minutes at 500 watts, 11 minutes

at 600 watts, 10 minutes at 720 watts and 9 minutes at 850 watts. (Marinee, 1998) and determine the total solids content of natural rubber latex. The results revealed that the total solids content values for the same sample determined by using the microwave oven heating method are in good agreement with the values obtained by the conventional hot-air oven method. (Zeena et al., 2008) Some unique properties of microwaves have recognized conventional methods.

OBJECTIVE

Therefore, the objective of this study was to find out the optimum operating time of the microwave for the rapid determination of total suspended solids. The total suspended solids content values obtained from Conventional Activated Sludge (CAS) of Sakon Nakhon Hospital by the microwave method was compared to those values obtained from the standard method of American Public Health Association, American Water Works Association, and Water Environment Federation (APHA, AWWA & WEF).

METHODOLOGY



Note: GF/C = Glass Microfiber Filter grade C, MW = Microwave, TSS = Total suspended solids, TLC =Thin layer chromatography

Fig. 1 Analytical process of TSS between MW and APHA, AWWA & WEF standard

Synthetic wastewater 100 mg/L: Weigh 0.1 g Cellulose powder for TLC, dissolve in distilled water, and dilute to 1000 mL.

Analytical methods: Analysis of the TSS to find out the optimum operating time of microwave power 800-watt at two levels including medium-high and high for 10, 15 and 20 minutes by using Synthetic Wastewater.

Water sampling: In this study, water samples were collected at Conventional Activated Sludge (CAS) of Sakon Nakhon Hospital and the obtained values of TSS content would compare to those values obtained from the standard method of American Public Health Association, American Water Works Association, and Water Environment Federation (APHA, AWWA & WEF)

Statistical analysis: The comparison was determined by using SPSS, with which statistical significance was set at 95% confidence interval. The obtained TSS values at 10, 15 and 20 minutes were determined using descriptive statistics technic.

Calculation: TSS (mg/L.) = (Residue retain on filter –filter)/volume sample x 1,000.

RESULTS AND DISCUSSION

The Optimum Operating Time of the Microwave

This study used synthetic wastewater prepared from cellulose powder by thin layer chromatography. The TSS at the concentration of 100 mg/L. was analyzed by standard method in the oven which temperature was set at 103 - 105 °C for 1 hour. The analysis was repeated for 5 times resulting the average value of TSS of 95.80 mg/L, SD 3.70, %RSD 3.86, as shown on Table 1.

Table 1 Total suspended solids used synthetic wastewater (cellulose powder) by using standard method

Repetition No.	Total Suspended Solids (mg/L.)	Average	SD	%RSD
1	97.00			
2	90.00			
3	100.00	95.80	3.70	3.86
4	95.00			
5	97.00			

%RSD = Relative Standard Deviation, SD = Standard deviation

The analysis of the TSS to find out the optimum operating time of microwave power 800-watt in 5 repetitions was found that at the medium high temperature for 10 minutes, 15 minutes and 20 minutes, the TSS was found at 90.20 mg/L, (SD 8.35 and %RSD 9.26), 91.80 mg/L. (SD 6.30 and %RSD 6.86) and 93.60 mg/L, (SD 4.72 and %RSD 5.05), respectively. Meanwhile, at high temperature for 10 minutes, 15 minutes and 20 minutes, the TSS was found at 97.40 mg/L, (SD 1.82 and %RSD 1.86), 93.40 mg/L, (SD 2.88 and %RSD 3.08) and 89.60 mg/L, (SD 5.22 and %RSD 5.83), respectively. The TSS analysis at each temperature levels and time used was found that the microwave method at high temperature for 10 minutes yielded the most adjacent value to the 100 mg/L synthetic waste, i.e. 97.39 mg/L with least SD at 1.86 showing the similarity of the data to the mean value. In addition, the value of %RSD < 5 was more than other data set showing the acceptable high precision in TSS analysis. Therefore, it is accepted as the most relevant for TSS analysis by Microwave methods as shown on table 2. The finding was also congruent with the study of municipal refuse moisture by Marinee (1998) who found that the optimum operating time was 9 minutes at the 850-watt microwave power. This research could, therefore, calculate the operating temperature by microwave method for 10 minutes was approximately 253 °C as in the following equation 1.

$$Power (CHU/min) = Power (W) \times 0.031593903989083 \quad (1)$$

Generally, Total Suspended Solids; TSS compose of Volatile suspended solids; VSS) and Fixed suspended solids; FSS. When being heated at the temperature exceeding 550 °C for 15-20 minutes, TSS would be ignited resulting to the volatility of organics matter. The residue dried is called volatile suspended solids. Therefore the microwave with temperature at around 253 °C for 10 minutes cannot cause immediate weight losses due to volatilization of organic matter. However, the very slight loss of organic matter by volatilization can usually be happened. (APHA, AWWA & WEF, 2012).

Table 2 Total suspended solids used synthetic wastewater (cellulose powder) by using microwave method at medium high, and high temperature at 10, 15 and 20 minutes

Repetition No.	Total Suspended Solids (mg/L.)					
	Medium high 10min	Medium high 15 min	Medium high 20 min	High 10 min	High 15 min	High 20 min
1	83.00	99.00	90.00	97.00	96.00	82.00
2	100.00	94.00	97.00	100.00	95.00	89.00
3	90.00	88.00	89.00	95.00	89.00	94.00
4	81.00	83.00	92.00	98.00	95.00	95.00
5	97.00	95.00	100.00	97.00	92.00	88.00
Average	90.20	91.80	93.60	97.40	93.40	89.60
SD	8.35	6.30	4.72	1.82	2.88	5.22
%RSD	9.26	6.86	5.05	1.86	3.08	5.83

%RSD = Relative Standard Deviation, SD = Standard deviation

The Comparison of Method of Analysis by Using Sample from Wastewater Treatment

The five repetition analyses of water sampling collected from an aeration tank of Conventional Activated Sludge (CAS) at SakonNakhon Hospital were found that the average TSS value obtained by standard method was 156.20 mg/L., (SD= 6.76, %RSD = 4.32), compared to the average of 150.40 mg/L., (SD= 8.38, %RSD 5.57) by microwave method, as shown on Table 3. Since the result by standard methods had lower SD, % RSD than that of microwave methods, it was necessary to conduct hypothesis testing for the difference between the two methods by using t-test of independent sample by setting p-value at 0.05 with 95% confidence interval. The result showed no difference at p-value of 0.583, as shown on Fig 2.

Table 3 The comparison of method for determine total suspended solids between microwave (high 10min) and standard method using sample from wastewater treatment

Repetition No.	Total Suspended Solids*	
	Standard methods	Microwave methods (High 10 min)
1	154.00	150.00
2	155.00	145.00
3	165.00	161.00
4	147.00	140.00
5	160.00	156.00
Average	156.20	150.40
SD	6.76	8.38
%RSD	4.32	5.57

* Water samples were collected at Conventional Activated Sludge (CAS) of Sakon Nakhon Hospital

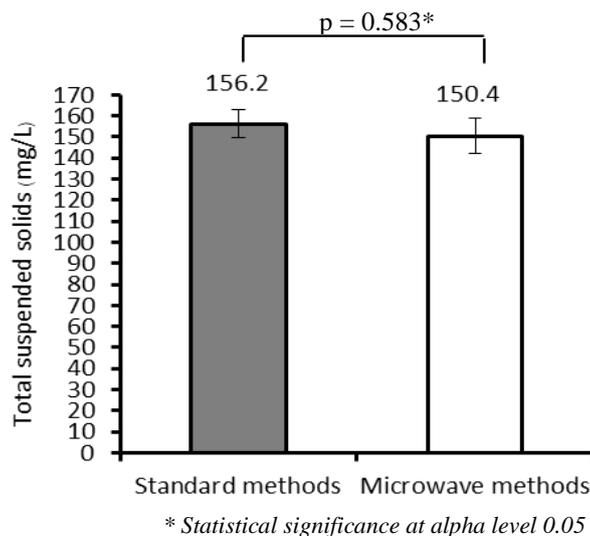


Fig. 2 The hypothesis testing for difference of TSS by standard method and microwave

The Independent Sample t-test

Although the t-test showed no statistical difference of TSS value obtained from both methods, it does not mean that the analysis by Microwave methods could stand for standard method since the residues dried at 103 to 105 °C may retain not only water of crystallization, but also some mechanically occluded water. The loss of CO₂ will result in conversion of bicarbonate to carbonate. Because removal of occluded water is marginal at this temperature, attainment of constant weight may be very slow. Residues dried at 180 ± 2 °C will lose almost all mechanically occluded water. Some water of crystallization may remain, especially if sulfates are present. Organic matter may be lost by volatilization, but not completely destroyed (APHA, AWWA & WEF, 2012). Hence, the result of TSS analysis by Microwave methods can be used for immediate monitoring the operation of wastewater treatment plants and help reducing time for TSS analysis from approximately 2 hours to only about 20 minutes.

CONCLUSION

The TSS analysis by Standard methods and Microwave Methods at high temperature for 10 minutes in 5 repetition analyses revealed no statistical difference at 95% confidence interval. With the precision of the Single-laboratory duplicate analyses of 50 samples of wastewater and data set should have standard deviation of differences of less than 2.8 mg/L. Microwave Methods can be considered replacing the Standard methods. As future work, we will extend this method to other samples such as domestic wastewater, industrial wastewater, and agricultural wastewater for limitation of qualitative analysis. And weight loss during determination analysis of total suspended solids by microwave.

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