QUANTITY OF PARTICULATE TSP AND PM10 IN CAFETERIA AREA PHUKET RAJABHAT UNIVERSITY, THAILAND USING THE HIGH - VOLUME AIR SAMPLER

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Abstract: *The study of TSP and PM10 dust in the cafeteria area, Phuket Rajabhat University. It is an area where many students and staff come in and close to transport routes. Using the High Volume Air Sampler tool, dust data was collected on Sundays to represent holidays and Mondays to represent working days. TSP and PM10 dust data were collected during July and August 2020 and measured for 24 hours.*

The results of the study showed that the total dust content of Sunday's TSP was 0.0329mg/m³. The highest amount of dust is 0.0362mg/m³. Monday, the mean was 0.0395mg/m³. The highest amount of dust is 0.0532mg/m³. Which is not higher than the general atmospheric air quality standard of the Pollution Control Department, which is determined in 24 hours must not exceed 0.33mg/m³. And PM10 dust on Sunday had an average of 0.0265mg/m³. The highest amount of dust was 0.0289mg/m³. And on Monday, the average was 0.0276mg/m³. The maximum amount of dust is 0.0342mg/m³. Which is not more than the general atmospheric air quality standard of the Pollution Control Department set in 24 hours must not exceed 0.12mg/m³.

Keywords: *TSP, PM10. High Volume Air Sampler, Phuket Rajabhat University.*

1. INTRODUCTION

Nowadays, dust is a significant air pollution problem in Bangkok and large communities. Dust that exist in the atmosphere around us range from 0.002 microns, a group of molecules (Can't look with the naked eyes, requires electron microscope) larger than 500 microns, which is large sand dust and visible by the naked eyes (The visible dust is 50 microns or more). Dust is a diverse substance in physical and composition as it may be in solid or liquid dust appearance. Often small dust can be suspended in the air for a long time (The diameter is less than 10 microns.) due to its low falling speed. If external forces are involved, such as airflow, airflow, etc., it will become suspended in the air for a longer time. Large dust (Diameter larger than 100 microns) may be suspended in the atmosphere for only 2 - 3 minutes, but dust smaller than 0.5 microns can flow in the air for years[2].

Generally, atmospheric dust sources can be divided into two main categories; the 1st category is dust caused by natural (Natural Particle), i.e., soil, sand, rock, water vapor, soot from forest fires, salt dust from the sea, etc. The 2nd category is dust caused by human - made

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2. Pollution Control Department (2020), Air Quality Index (online) data is retrieved from: http://air4thai.pcd.go.th/webV2/aqi_info.php. Information as of February 19, 2020.

activities (Man - made Particle), i.e., dust from transportation and traffic, such as dust, soil, and sand diffused in the road. While the cars pass by, dust, soil, and sand that fall from transport trucks stacking materials on sidewalks or traffic routes, construction dust such as dust from street/ building construction, traffic surface improvement, demolition of buildings and buildings, etc.[1]

Classification of dust particles according to the size of dust particles is divided into three categories; Total Suspended Particulate (TSP) is dust particles smaller than 100 microns at all as 1 micron is 0.000001 meters. Dust particles smaller than 10 microns (PM10) are dust particles smaller than 10 microns. Dust particles smaller than 25 microns (PM2.5) are dust particles smaller than 25 microns at all, which is very small as a comparison of dust particles smaller than 2.5 microns with human hair[2]. The cafeteria area is serviced for many students, staff, and outsiders since it is the center of food and beverage shops, snacks, and stationery stores. Besides, there is traffic for both internal and external people who use the road around Phiromrat Circle. Inside Phuket Rajabhat University is a thoroughfare to pass through in this area. There are also construction buildings at various points within the Phuket Rajabhat University area, causing dust. Dust can cause health hazards, such as danger to the lungs, respiratory tract, brain, and heart, and can adversely affect the health of students and staff who use the cafeteria in the interior cafeteria area. Therefore, the survey of TSP and PM10 dust that occurred in the cafeteria is critical. If both types of dust are known and compared with the Air Pollution Control Department's air quality criteria, within 24 hours, whether the amount of dust exceeds the standard. If it exceeds the standards, it will be useful information in management planning for students and staff. And it will be helpful in the health of students and any person who comes to use the service is in the cafeteria. For this reason, we are interested in studying total dust quantity, TSP, and PM10 dust in the cafeteria area.

2. METHODOLOGY

Methods of conducting a study of internal dust particles using the High Volume Air Sampler divided into two parts; Laboratory and field. As the following steps:

2.1. Apparatus and equipment used in field research

1. TSP and PM10 type sampler High Volume Air Sampler
2. Motor for sucking air to flow through the filter paper
3. Airflow rate recorder
4. Air Control flow device
5. Timer on - off device of sampler
6. Manometer water
7. Barometer

1. Pollution Control Department (2020), Air Quality Index (online) data is retrieved from: http://air4thai.pcd.go.th/webV2/aqi_info.php. Information as of February 19, 2020.
2. Varawut Sueadee (2003), A guide to atmospheric dust measurements. (Online) data is retrieved from: http://infofile.pcd.go.th/air/DustinAmbient.pdf?CFID=17690991&CFTOKEN=61119767, Access information on February 4, 2020.

2.2. Laboratory instruments and equipment

1) Balance with a resolution of 0.1 milligrams

2) Desiccator with a device to measure the relative humidity (Hygrometer)

3) Silica gel desiccant

4) Forceps coated with Teflon

5) Vinyl non powdered gloves for picking up the filter paper

6) Zip plastic bag for packing filter paper

7) Glass and Quartz fiber filter, size 8 x 10 - inch

2.3. Preparation of filter paper

1) Check the integrity of the filter paper.

1.1) Use an 8 x 10 - inch glass fiber filter for TSP and PM10 sampling.

1.2) Check for imperfections of the filter paper, such as tear marks, porosity, changed in the color of the filter paper, and unevenness of the filter paper. If found that the filter paper has such defects, it will not be used to collect samples.

1.3) Set the filter paper number code by setting in numbers to show details of the filter paper, such as the year the filter paper was used, filter paper type, and the code number of the filter paper.

1.4) Stamp the filter paper number by stamping the number on the back of the filter paper. (The side that is not used for sampling)

2) Drying the filter paper before collecting the samples.

2.1) Ambient conditions for drying filter paper before sampling as relative humidity is less than 50% by controlling the change with no more than ± 5% variation.

2.2) Room temperature between 15 - 30 degrees Celsius without change over ± 3 degrees Celsius.

2.3) Before drying the filter paper, always clean the dehumidifier.

2.4) Put the silica gel in the desiccator (Silica gel that is extremely hygroscopic will turn the color from blue to purple. It can be dried at 150 - degrees Celsius for 1 - 2 hours to reuse)

2.5) Place the filter paper on the shelf of the dehumidifier with the sampling side facing up.

2.6) Dry the filter paper for at least 24 hours.

2.7) After 24 hours, put the filter paper in the zipper bag and store it in a desiccant for another 2 - 3 hours to allow the zipper bag to be absorbed again.

3) Weighing the filter paper before sampling

3.1) Leave the scale on for at least 2 hours.

3.2) Adjust the scale to 0.000 grams (4 decimal places).

3.3) Calibrate the scale with a standard pendulum. By standard pendulum, weight must

be different from the original weight of not more than 0.5 milligrams. If different, cancel weighing on that day.

3.4) Weigh the drying filter paper and leave the scale open for at least 2 hours.

3.5) Adjust the scale to 0.0000 grams (4 decimal places).

3.6) Calibrate the scale with a standard weight pendulum by standard weights must be different from the original weight of not more than 0.5 milligrams. If different, cancel weighing on that day.

3.7) Weigh the dried filter paper.

3.8) Record the weight of the filter paper on the zipper bag and a brown paper envelope with a pen.

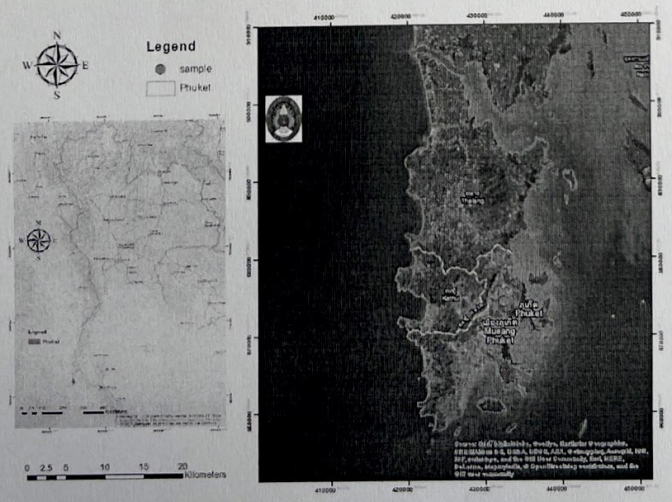
3.9) Put the filter paper in the zipper bag and take the zippered bag together with the filter paper to record the airflow rate. Put in a brown paper envelope to prepare for further field sampling.

2.4. Sampling point

The sample collection is planned as follows: One sample point was collected 24 hours at the cafeteria. Sundays represent holidays. And Monday represents the working day. Samples were collected six times as shown in Table 1 and Figure 1.

Table 1: **Shows the collection dates of TSP and PM10 total particulate matter**

TSP			PM10		
No.	Day / month / year		No.	Day / month / year	
1	Sunday	July 12, 2020	4	Sunday	August 9, 2020
	Monday	July 13, 2020		Monday	August 10. 2020
2	Sunday	July 19, 2020	5	Sunday	August 16, 2020
	Monday	July 20. 2020		Monday	August 17, 2020
3	Sunday	July 26, 2020	6	Sunday	August 30. 2020
	Monday	July 27, 2020		Monday	August 31, 2020



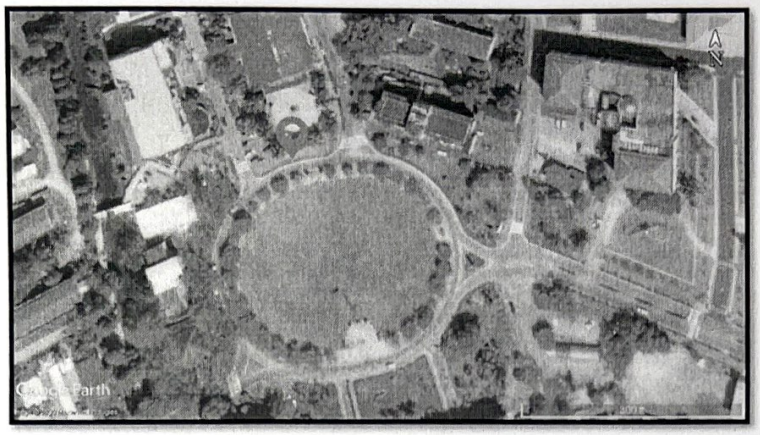


Figure 1: **Satellite image showing the sampling point Octagonal cafeteria area**

Source: Google Earth, 2020. Note: ■ sampling point.

2.5. Calibration of the High Volume TSP Sampler

The High Volume TSP Sampler is a TSP with a Volumetric Flow Controller (VFC) sampler that has been calibrated with the primary standard (Primary standard) and has been certified by the manufacturer called Orifice flow rate Transfer Standard Calibration or Calibration Orifice the Orifice Calibration kit has important components including:

1) Orifice is a metal cylinder, diameter 7.6 centimeters, length 15.9 centimeters, has an opening hole at one end with diameter 5.1 centimeters.

2) Resistance plates are five resistance plates, each with a different number of holes, from 5, 7, 10. 13 and 18, or 10. 13, 18, 22, and 24.

Calibration of the TSP Sampler with Air Flow Control. The calibration of this type of TSP sampler verifies the validity of the VFC's certified true airflow Table (Lookup Table) against the Critical Venturi status used to control the rate of airflow in the sampler. The device used for calibration is the Orifice Calibration Kit.

3) Calibration procedure

3.1) Install the calibration system with an Orifice calibration kit without filter paper.

3.2) Place the first airflow resistance pad down in the middle between the orifice with at least 4 points of calibration filter paper handle.

3.3) Leave the motor on for 3 - 5 minutes.

3.4) Check for air leaks in the whole system by covering the Orifice air inlet with a hand ceiling by using your thumb to cover the end of the hose for connecting to the manometer and turn on the motor.

3.5) Observe the air leaking through the motor cylinder at the bottom of the machine.

3.6) Check the connector of the meter by turning the pipe end of the manometer to allow air to pass through. Observe the liquid flow in the pipe. Slide the centimeter on the meter to align with the liquid level in the pipe, connect the first set of manometers to the Orifice, and connect the other set of the manometer to the pressure tap under the filter paper rack.

3.7) Read and record other information on the form for VFC calibration such as date, location, operator, VFC number / model, temperature, barometric pressure and the number of Orifice.

3.8) Turn on the motor for 3 - 5 minutes. Record the air pressure through the Orifice (Pressure drop; ΔH) read from the manometer connected to Orifice and record the air pressure through the filter paper rack (Pf), read from the manometer connected to the Pressure tap under the filter paper rack.

3.9) Turn off the motor and place another anti - flow pad on it and proceed with the side steps to push through all panels.

3.10) Remove the Orifice from the sampler.

2.6. Sample collection

1) Install the TSP sampler in a horizontal plane and tighten the machine stand in order to prevent the machine from falling.

2) Put the filter paper on the sieve for the filter paper. Turn the side used to collect the sample up. Balance the filter paper with the sieve and filter paper handle. Check the connection between the motor and the air flow recorder.

3) Turn on the sampler, record the started time, air pressure temperature and surrounding environment.

4) For samplers equipped with air flow control devices, record the air pressure values that pass through the filter paper rack before sampling (Initial filter pressure; Pf (I)) on brown paper. By reading the values from the manometer that connected to the pressure tap under the filter paper rack.

5) When completed the sampling time, record when the machine stopped working and record the air pressure value through the filter paper racks after collecting the sample (Final filter pressure; Pf (F)) onto brown paper, remove the filter paper from the machine. Fold the filter paper in half lengthwise. Let the dusty sides come together.

6) Put the filter paper in the zipper bag for further analysis of samples at the laboratory later on.

2.7. Drying the filter paper after sampling

1) Ambient conditions for drying filter paper after sampling, relative humidity less than 50%, with control not to change more than ± 5%, room temperature between 15 - 30 Celsius degree, without variation exceeding ± 3 degrees Celsius.

2) Before drying the filter paper, always clean the dehumidifier.

3) Put the silica gel in the dehumidification cabinet.

4) Unfold the fold in half of the filter paper and place it on the shelf of the hygroscopic cabinet by turning the side used to collect the sample up.

5) Dry the filter paper for at least 24 hours.

6) After 24 hours, fold the filter paper in the original direction to prepare for further weighing.

2.8. Weighing the filter paper after sampling

1) Weighing the filter paper after sampling, turn on the scale for at least 2 hours.

2) Adjust the scale to 0.0000 grams (4 decimal places).

3) Calibrate the scale with a standard weight pendulum. The weight of a standard pendulum must not be different from the original weight by no more than 0.5 milligrams. If different, cancel the weighing on that day.

4) Weigh the filter paper after collecting the dried sample.

5) Record the weight of filter paper on the brown paper envelope to be further calculated for dust concentration.

2.9. Calculation of dust concentrations

$$\text{Dust concentration (mg / m}^3\text{)} = \frac{(Wf - Wi)}{V\,std} * 10^3$$

W_f = Weight of filter paper after sampling (g)

W_i = Weight of filter paper before sampling (g)

V_{std} = Standard air volume (m^3)

10^3 = Converting from (g) to (mg)

Source: Pollution Control Department, 2003.

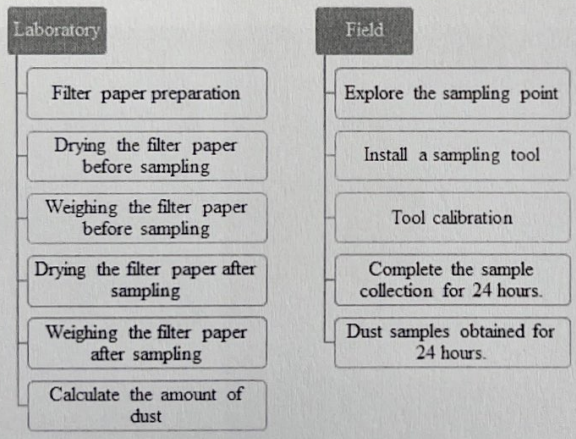


Figure 2: **A diagram of a method for studying total dust in Phuket Rajabhat University using High Volume Air Sampler apparatus**

3. RESULTS

3.1. TSP Dust Sampling Results

From field sampling to study the amount of dust in the cafeteria area, it has the following effect: Total dust with TSP in the cafeteria area on Sunday represents a holiday with an average of 0.0329mg/m3. Monday is a working day; the average value is 0.0395mg/m^3 which is not

higher than the general atmospheric air quality standard of the Pollution Control Department, which is determined as must not exceed 0.33mg/m^3 within 24 hours. Total Suspended Particulate (TSP) from field sampling for studying dust quantity at cafeteria area has the following result shown in Table 2 and Figure 2.

Table 2: **Shows the average amount of dust on the TSP on Sunday in the cafeteria Phuket Rajabhat University**

NO.	Day	Weight of filter paper before sampling (g)	Weight of filter paper after sampling (g)	Dust weight (g)	Dust weight,mg/m3	Number of cars (cars)
1	12/07/2020 Sunday	4.3252	4.3847	0.0595	0.0362	1,810
2	19/07/2020 Sunday	4.3245	4.3797	0.0552	0.0338	2,195
3	26/07/2020 Sunday	4.3335	4.3807	0.0472	0.0289	1,361
Mean		**4.3276**	**4.3817**	**0.0539**	**0.0329**	**1,788**
1	13/07/2020 Monday	4.3348	4.3888	0.0540	0.0331	3,051
2	20/07/2020 Monday	4.3238	4.3762	0.0524	0.0323	3,260
3	27/07/2020 Monday	4.2981	4.3852	0.0871	0.0532	301
Mean		**4.3189**	**4.3834**	**0.0645**	**0.0395**	**2,204**

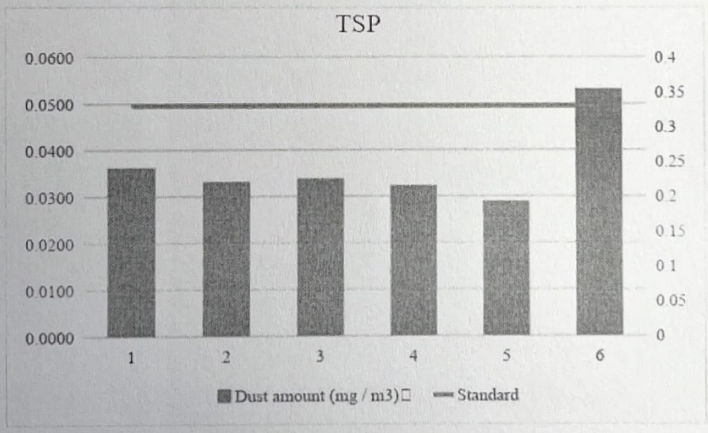


***Figure 3*: showing the results of the study of total particulate matter TSP in the cafeteria at Phuket Rajabhat University**

Total Suspended Particulate (TSP) from field sampling for studying dust quantity at cafeteria area has the following result:

Total Suspended Particulate (TSP) found on Sunday, represented for a holiday, was the average of 0.0329mg/m^3. The maximum amount of dust is 0.0362mg/m^3. The lowest amount of dust is 0.0289mg/m^3. Monday represents the working day, the average value is 0.0395mg/m^3. The highest amount of dust is 0.0532mg/m^3. The lowest amount of dust is 0.0323mg/m^3. Which is not higher than the general atmospheric air quality standard of the Pollution Department, which is determined

in 24 hours must not exceed 0.33mg/m3. This is consistent with the research of[1] that studied dust dispersion in Muang District, Suratthani Province by sampling to consider the crowded areas and heavy traffic. The results of the study of dust samples were found to be in the safety criteria according to the standards set by the Pollution Control Department, 2010. The relation between the quantity of dust with the counted number of cars that were measured in the total dust TSP measurements on Sunday, the mean is 0.0329mg/m3 whereas 1,774 vehicles that counted. And on Monday, the average value is 0.0395mg/m3 whereas 2,204 cars were counted, showing that the number of cars has an effect on the amount of dust generated. When there are a lot of cars, there will be a higher amount of dust. And during the collection of dust samples in the past 6 days, there was rain on the measurement day, thus causing a lot of relative humidity to help wash out pollutants in the atmosphere, resulting in a dust value that does not exceed the standard of the Pollution Control Department, both gas and dust down the ground, conform to the research of[2] to study the assessment of total dust contamination of TSP and PM10 in the area of Muang District, Pathum Thani Province as the concentration levels were found in the range of 0.0293 - 0.3199mg/m^3.

3.2. PM10 dust sampling results

PM10 dust quantity was measured on Sunday, August 2020. is the represented holiday, with an average at 0.0265mg/m^3. And Monday is the representative working day with an average at 0.0276mg/m^3. This is not higher than the Pollution Control Department's general atmospheric air quality standards, which set in 24 hours must not exceed 0.12mg/m^3. Following result shown in Table 3 and Figure 3.

Table 3: **The average amount of dust on the PM10 on Sunday in the cafeteria Phuket Rajabhat University**

NO.	Day	Weight of filter paper before sampling (g)	Weight of filter paper after sampling (g)	Dust weight (g)	Dust weight, mg / m^3	Number of cars (cars)
1	09/08/2563 Sunday	2.6923	2.7207	0.0284	0.0289	251
2	16/08/2563 Sunday	2.6986	2.7412	0.0426	0.0273	401
3	30/08/2563 Sunday	2.6894	2.7279	0.0385	0.0235	365
Mean		**2.6934**	**2.7299**	**0.0365**	**0.0265**	**339**
1	10/08/2563 Monday	2.7001	2.7454	0.0453	0.0278	1,185
2	17/08/2563 Monday	2.6926	2.7487	0.0561	0.0342	2,699
3	31/08/2563 Monday	2.7050	2.7405	0.0355	0.0210	1,718
Mean		**2.6992**	**2.7448**	**0.0456**	**0.0276**	**1,867**

1. Siriporn Uisui (2010), Measurement of Total Dust Distribution in Amphur Muang, Surat Thani. Suratthani Rajabhat University: Surat Thani.
2. Thiphawan PhoThong and Uthumphon Wonghadej (2012), The Assessment of Total Suspended Particulate (TSP) and Particulate Matter less than 10 μm (PM10) at Amphoe Muang Pathumthani Province. Bachelor of Science Thesis Program Department of Environmental Science and Natural Resources Faculty of Science and Technology Rajamangala University of Technology Phra Nakhon.

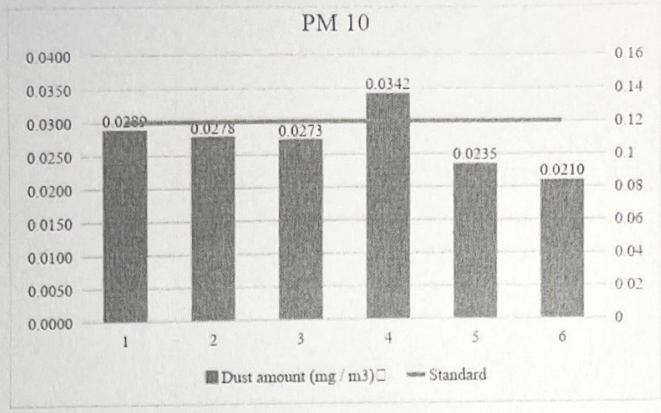


Figure 4: **Showing the results of the study of total particulate matter PM10 in the cafeteria at Phuket Rajabhat University**

PM10 dust quantity was measured in August 2020. on Sunday, it was the represented holiday with an average at 0.0265mg/m^3, whereas the highest dust quantity is at 0.0289mg/m^3 and the lowest dust quantity is at 0.0235mg/m^3. And Monday is the represented working day with an average of 0.0276mg/m^3, whereas the maximum dust quantity is at 0.0342mg/m^3 and the lowest dust quantity is at 0.0210mg/m^3, which does not exceed the general atmospheric air quality standard of the Pollution Control Department in 24 hours must not exceed 0.12mg/m^3. This is conforming to the research of[1] to study the assessment of total dust contamination of TSP and PM10 in Muang District, Pathum Thani Province, which is not higher than the standard of the Pollution Control Department and conform to the research of[2] to study on dust size not more than 10 microns, PM10 and metals in PM10 inside and outside of the building in Ratchaburi Province, it can be seen that the mean concentration of PM10 at every sampling was taken, most of them do not exceed the general atmospheric air quality standard of the Pollution Control Department, which has set the PM10 standard in 24 hours at 0.12mg/m^3. Which in the rainy season, the value does not exceed the standard for every sampling. It was also conforming to[3] to study the situation and estimate PM 10 small dust levels in the school area in Nakhon Ratchasima Municipality. The results of 17 samples in Muang Nakhon Ratchasima School had PM 10 in the range of 29.09 - 89.87mcg./m^3. PM 10 is in the range of 30.40 - 94.90mcg./m^3, with all PM 10 data below 120mcg./m^3. Therefore, during the study of PM 10 levels in the study area does not exceed the air quality standard criteria set by the Pollution Control Department.

From the study of the number of cars and the quantity of dust, it was found that the PM10 dust samples collected in all three measurements on Sunday had a mean at 0.0265mg/m^3

1. Thiphawan PhoThong and Uthumphon Wonghadej (2012), The Assessment of Total Suspended Particulate (TSP) and Particulate Matter less than 10 μm (PM10) at Amphoe Muang Pathumthani Province. Bachelor of Science Thesis Program Department of Environmental Science and Natural Resources Faculty of Science and Technology Rajamangala University of Technology Phra Nakhon.
2. Savitri Champahom (2016), Particulate Matter (PM10), and Metals in Indoor and Outdoor in an area of Ratchaburi Province. Master of Science Program Department of Environmental Science Graduate School Silpakorn University.
3. Sudjit Khruchit (2007) (2550), Situation and estimation of PM 10 fine dust levels in school areas in Nakhon Ratchasima Municipality. Suranaree University of Technology.

whereas there were 339 cars that counted. And on Monday, the average value is at 0.0276mg/m^3, whereas there are 1,867 cars that counted, showing that the number of cars affects the quantity of generated dust. When there are a lot of cars, there will be a higher quantity of dust. Due to the measurement day, it does not rain, causing the relative humidity to be low, resulting in dust being measured higher than on rainy days. This is conforming to[1] to study the situation and estimation of PM 10. small dust levels at school areas in Nakhon Ratchasima Municipality to assess the situation of dust levels in schools, studied the variance and correlated the dust levels in schools with other factors such as the quantity of vehicles.

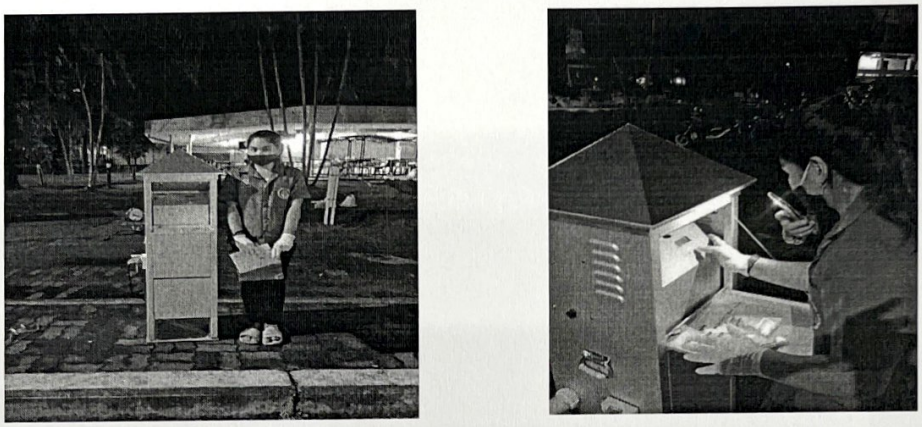


Figure 5: **TSP dust collection**

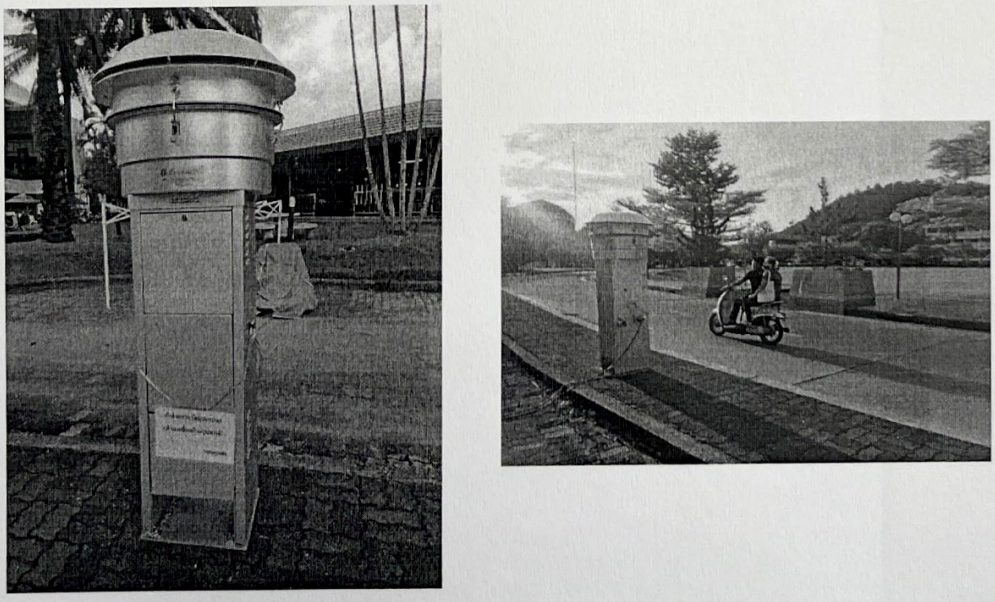


Figure 6 - 7: **Dust collection area PM10**

1. Sudjit Khruchit (2007) (2550), Situation and estimation of PM 10 fine dust levels in school areas in Nakhon Ratchasima Municipality. Suranaree University of Technology.

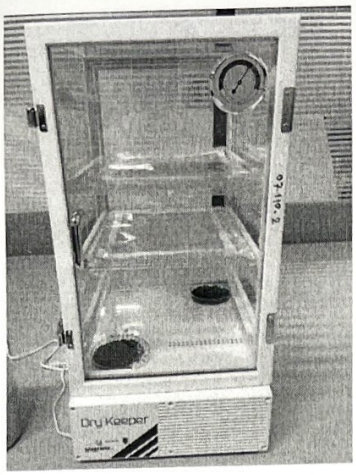


Figure 8: **TSP dust load conductivity Go hygroscopic for 24 hours**

Figure 9: **shows TSP particulate matter weighing**

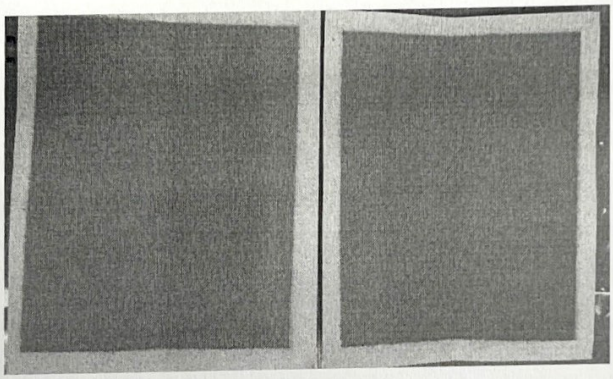


Figure 10: **Total dust volume TSP**

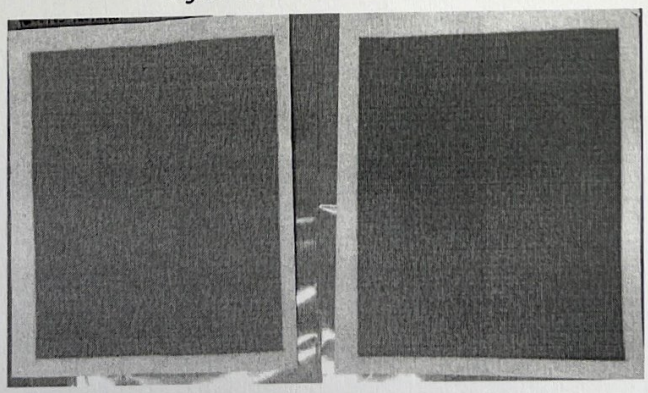


Figure 11: **Total dust volume PM 10**

3.3. Problems and obstacles of research

Due to the sampling period of the research, there was a situation of the COVID - 19 epidemic, so the research sample had to be postponed. During the rainy season causes the

leaching of dust and there is an uncontrollable factor involved in storms so due to the weather conditions, causing the unsuiTable for collecting dust samples.

3.4. Suggestion

1) There should be a continuous study of the quantity of dust around the cafeteria area which is the basic data for monitoring air quality in the dust factor.

2) There should be a study of the quantity of dust at the cafeteria area in summer to compare the results between seasons.

4. CONCLUSION

From the study of the amount of dust at the cafeteria Phuket Rajabhat University found that within 24 hours of the total particulate matter measurement, TSP and PM 10. the amount of particulate matter did not exceed the general atmospheric air quality standard of the Pollution Control Department set by the TSP Total Dust Standard. Equal to 0.33mg/m^3 and PM10 dust was defined at 0.12mg/m^3.

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