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Elemental Characterization of Airborne Particulate Matter (APM) in Parit Buntar and Nibong Tebal

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ABSTRACT

Study had being conducted to investigate the chemical properties of Airborne Particulate Matter (APM) which present in the ambient air of Parit Buntar Town and Nibong Tebal Town. These towns are located in Northen Perak and in southern part of Seberai Perai, Penang respectively. Non-reactive carbon tape was attached onto an aluminium stub to collect APM. The stub was exposed to the air for 24 hours to collect APM which will be deposited naturally due to the gravity action. Stub containing APM was analyzed by Energy Dispersive X-ray (EDX) to obtain elemental components. Results obtained from the analysis have shown that carbon (organic carbon or/ and elemental carbon), O, Al, Si and other species such as Ca, K, Fe and Mg are the common elements present in the APM.

INTRODUCTION

Reports on air pollution always being highlighted by researchers and public since many cases on casualties reported and numbers of patient suffering to respiratory problem rises. An example of haze episode happened in 1997 prove that exposure to excessive concentration of APM could harm people health (Mott *et al.* 2005; Omar *et al.* 2006; Sastry 2002). During the period, it has being reported that the number of patient visited to the Kuala Lumpur General Hospital increased from 250 to 800 per day (Afroz *et al.*, 2001). Although the scenario happens seasonally, people should also concern on their daily air quality which they breathe continuously.

People in urban areas are facing higher possibility of experiencing the bad air quality. It happens because towns are known to be much occupied with peoples, large numbers of vehicles as well as industrial zones (Latif and Othman, 1999; Rashid and Griffiths; 1995). Air quality possibly become worse as the number of vehicles keep increasing every year especially in major cities such as Wilayah Persekutuan, Selangor and Penang (www.jpj.gov.my) and become the second largest contributor of Particulate Matter (PM) into the atmosphere (DOE, Malaysia).

As affects from the APM seems to be so dangerous and can lead to more serious problems, especially to the public, action should be taken to reduce the pollutant extensively. Research should be carried out intensively in order to build our knowledge in this area, thus give us more idea to handle this sort of problems. One of the great issues is whether the chemical or physical properties are important for its effect on health (Harrison and Yin, 2000).

Studies from international researchers have shown that particulate matter can cause bad effects to human health, plants, building and also stone monuments (Dockery *et al.*, 1993; Brimbecombe and Camuffo, 2003). It is believed that the toxicity of particulate matter play the main role to cause bad effect to human health. Harrison and Yin (2000) had listed five factors which may influence the toxicity of airborne particulate matter. The factors are bulk chemical composition, trace element content, strong acid content, sulfate content and particles size distribution.

Only a few number of researches being done to investigate the chemical properties of APM in Malaysia. Most of the research is focus on the concentration of APM rather than the elemental properties. Hence this research is focusing more the chemical content so that it will give some idea on the importance of knowing both of the content as well as the concentration of APM. Experiment Methodology Particle sampling

In this research, APM from both towns is sampled using non-reactive carbon tape. Upper and bottom surface of the carbon tape comprise an adhesive layer. The bottom surface is attached to an aluminium stub. This aluminium stubs are then located 1.5m above the ground level. The upper surface is exposed to the ambient air for 24 hours for the purpose of collecting APM which deposited onto it due to the gravity action. Aluminium stubs which already being exposed to the air for 24 hours are then being kept in the petri dish and ready to be analyzed. Sampling area

Ten sampling sites were chosen for each town. Samples collected from the sampling sites will represent the total APM in that particular town. Map provided by the Department of Town Planning was used to identify the sampling areas.

INSTRUMENTAL TECHNIQUE

In order to analyze the elemental contents of the collected PM, Energy Dispersive X-ray (EDX) model Oxford Inca 400 was used. Before the sample being analyze, it was coated by Aurum (about 20nm thick) using sputter coater, Polaron SC 515.

RESULT AND DISCUSSION

Table 1 and Table 2 show the elemental composition of the APM collected from Nibong Tebal and Parit Buntar respectively. It is believes that heavy metal would be the main content of the APM but the analysis shows the hypothesis is wrong. Greatest contribution of coarse particles in urban and rural area are organic carbon, elemental carbon, sulphate, nitrate, ammonium, Na, Cl and geological species such as Si, Ca, Al, Fe, K and Mg (Wu *et al.* 2003).

Results show that most of the APM are from the earth crust. It happens because most of the elements in the APM are strongly the same with the elements present in the earth crust materials. Most abundant elements in the earth crust are oxygen, silicon, aluminium, iron, calsium, sodium, magnesium, potassium, titanium and hidrogen.

From the result in Table 1 and Table 2, about 83% of the samples contain Al and approximately 91.7% of the samples contain Si while 100% of them contain O. While other crustal elements mentioned above also present randomly in the APM.

Table 1 Elements Present in the PM collected in Parit Buntar, Perak.

LOCATION	ELEMENTS (% by weight)													
	Al	Ca	Cl	Cu	Fe	K	Mg	Na	Si	S	Ti	C	O	Zr
LOCATION 1														
Sample 1	15.7					4.0			21.8			8.0	50.5	
Sample 2	1.1				55.5							4.5	38.9	
Sample 3	10.1					1.4		3.5	25.6			4.8	54.6	
LOCATION 2														
Sample 1	10				17.4	8.5	3.1		16.8			5.5	38.8	
Sample 2	8.6				1.7			1.0	11.2			42.4	35.1	
Sample 3	0.5	9.1	1.4		6.7		1.5	2.4	2.8	3.1		43.7	28.9	
LOCATION 3														
Sample 1	16.4				6.4				16.8			14	46.4	
Sample 2				10.7	46.1				1.6	3.7	2.8		30.2	
Sample 3	13				3.0	4.8		0.7	16.7			17	44.6	
LOCATION 4														
Sample 1	8.7				11.4	4.0	5.2		18			3.5	49.2	
Sample 2	9.9					13.6			36.3			14.9	30.2	
Sample 3	16.2				1.7				18.5			15	44.6	
LOCATION 5														
Sample 1		36.4					0.6		1.5	2.8		9.8	49	
Sample 2	2.6				45.8		0.8		4.8			10	36.2	
Sample 3	9.0					13.3			33.3			7.2	37.2	
LOCATION 6														
Sample 1	1.1	1.7							12.7			11.4	35	38.2
Sample 2	0.9							0.3	36.5			3.9	51.9	
Sample 3	4.3	0.7						0.5	11.4	2.0		43.9	37.2	

LOCATION 7														
Sample 1	16.9					6.3			21.6			4.2	51.0	
Sample 2									31.3			25.7	43.0	
Sample 3	9.9					12.3		1.0	33.4				43.3	
LOCATION 8														
Sample 1	9.3	1.1				1.3			16.7			20.4	51.1	
Sample 2	9.8				26		3.5		11.1			5.8	43.8	
Sample 3	1.0								39.2			7.6	52.2	
LOCATION 9														
Sample 1					14.8				2.3	8.7	34.5	4.9	34.8	
Sample 2			1.2		50.2							7.8	40.9	
Sample 3	8.4				16.6	6.0	2.8	0.7	16.9			8.1	40.7	
LOCATION 10														
Sample 1	10.2				23.2		2.4	0.7	11.2			9.3	43	
Sample 2	1.6								37.4			9.5	51.7	
Sample 3	1.1				53.2				1.6			8.7	35.4	

Table 2 Elements Present in the PM collected in Nibong Tebal.

	ELEMENTS (% by weight)												
LOCATION	**Al**	**Ca**	**Cl**	**Fe**	**K**	**Mg**	**Na**	**Si**	**S**	**C**	**O**	**P**	**N**
LOCATION 1													
Sample 1	8.1	12.3						10.2		17.0	52.5		
Sample 2	94.5									4.0	1.5		
Sample 3	17.7				7.8			23			57.8		
LOCATION 2													
Sample 1	2.9			51			1.3	4.1		9.0	31.7		
Sample 2	10.5							22.8		17.1	49.6		
Sample 3	15.8				5.8			18.3		3.8	56.3		
LOCATION 3													
Sample 1	1.0							42.1		7.3	49.5		
Sample 2	15.3				6.9			19.4		4.7	53.6		
Sample 3	12.3			3.7			1.0	11.0		20.1	57.9		
LOCATION 4													
Sample 1								37.5		3.0	59.5		
Sample 2	9.2			8.0	2.3			17.9		4.2	54.5		
Sample 3								36.9		4.7	58.4		
LOCATION 5													
Sample 1	15.3				5.7			18.8		1.6	57.9		
Sample 2								39.7			60.3		
Sample 3	16.1				6.8			20.3			56.8		

LOCATION 6													
Sample 1	4.9							29.1		29.5	36.5		
Sample 2	10.5				5.6		1.0	19.4		15.5	47.5		
Sample 3	10.0	2.8					4.8	22.2		12.9	47.3		
LOCATION 7													
Sample 1	16.3			6.6				17.0		13.9	46.2		
Sample 2	8.6						6.7	27.9		12.9	43.9		
Sample 3	13.3			4.9	2.2			15.2		11.8	52.6		
LOCATION 8													
Sample 1	13.5						0.8	15.4		14.1	55.7		
Sample 2	12.4				1.0		0.7	15.0		20.2	50.7		
Sample 3	13.5			0.2				14.0		21.5	50.8		
LOCATION 9													
Sample 1	14.6			1.3				16.3		14.3	53.4		
Sample 2		2.1			4.3	6.3	3.8			27.9	31.5	9.8	14.4
Sample 3				70						5.5	24.5		
LOCATION 10													
Sample 1	1.8			8.2				27.1		10.6	52.3		
Sample 2	7.6			2.1	1.4		1.3	12.5	/	37.8	33.9		
Sample 3	7.8				9.9		25.7			5.3	51.3		

Out of 60 collected samples, only seven of them contain S element. This data support that the sampled APM mostly came from the earth crust mineral because research by Gong and Beaglehole (2000) found sulfur is usually found on the particles emitted by the diesel engine.

Due to the abundant of Si and O element in the sampled PM, it is belived that these APM are silicate minerals originated from the earth crust. Those particles could be olivine (Mg,Fe)2SiO4 , Augite (Mg,Fe)SiO3 , Hornblende Ca2 (Fe,Mg) 5Si8O22(OH)2, Biotite K(Mg,Fe) 3AlSi3O10(OH)2, Muskovite KAl2(AlSi3O10) (OH)2, orthoclase KAlSi3O8, Plagioclase (Ca,Na)AlSi3O8 and quartz SiO2.

Earth crust material could present into the ambient atmosphere by the action of wind which blown on the earth surface. The wind could be result from the natural phenomena or turbulence created by vehicles which moving on the road. Asphalt road pavement as an example Contains Quatz (SiO2), Calcite (CaCO3), asphalt and Iron Oxide (FeO). Mean while concrete pavement is mixed of limestone aggregate (CaCO3), Iron Oxide (FeO) and cement.

CONCLUSION

Elemental components of collected APM in Parit Buntar and Nibong Tebal show that earth crust mineral are the most contributor of APM in the ambient air in urban areas. Al, Si and O are the most elements present in each samples. Earth crust mineral happen to be in the ambient air when wind is blowing on the loose soil surface and transport them to other places. Turbulence created by the vehicles movement also plays role in resuspended the APM. It is suggested that in the future, more studies on elemental as well as physical properties of APM should be carried out in Malaysia in order to enhance the knowledge on airborne particulate matters.

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