CHEMICAL ASSESSMENT AND SOURCE IDENTIFICATION OF FINE AND COARSE PARTICULATE MATTER IN KUALA TERENGGANU, MALAYSIA

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Abstract of thesis presented to the Senate of Universiti Malaysia Terengganu in fulfillment of the requirement of the degree of Master of Science

CHEMICAL ASSESSMENT AND SOURCE IDENTIFICATION OF FINE AND COARSE PARTICULATE MATTER IN KUALA TERENGGANU, MALAYSIA

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Samples of fine and coarse fraction of atmospheric particulate matter were collected in Kuala Terengganu from August 2006 to December 2007. A total of one hundred and sixty fine and coarse particulate samples were collected. The samples were collected using a Gent stacked filter sampler in two size fractions of < 2.5 μm (fine) and 2.5 to 10 μm (coarse). Samples were analyzed for elemental concentrations using Inductive Couple Plasma – Mass Spectrometry (ICP-MS) and Inductive Couple Plasma – Optical Emission Spectrometry (ICP-OES). Water-soluble ionic species was determined using Ion Chromatography. Results showed that the mean concentration of coarse particle (CP), fine particle (FP) and PM_{10}, define as sum of coarse and fine particles (PM_{10} = CP + FP), were 10.41 ± 5.41 (± standard deviation), 14.31 ± 6.54 and 24.72 ± 11.63 μgm^{-3}, respectively. In general, the average concentration of PM_{10} and FP were lower compared to the Malaysian Ambient Air Quality Guidelines (24-hr average of 150 μgm^{-3}) and National Ambient Air Quality Standard (24-h average of 65 μgm^{-3}), respectively. The highest particulate concentration was observed in October 2006. HYSPLIT backward trajectories air mass model showed that the particulate matter could be attributed to the

transboundary haze pollution. In addition, a second high particulate concentration was observed during dry southwest monsoon (April to August 2007) where a relatively dry weather condition and widespread open burning activities was carried out during this period. In contrast, particulate concentration was observed to be at minimum during the wet monsoon (October to December 2007) which corresponded to high rainfall and maximum windspeed with no major report of haze occurrence during the period. On the average, measured chemical species in this study accounted ca. 74% of the CP and 32% of the FP, respectively. Na^+, SO_4^{2-}, Cl^-, NO_3^-, Al, Ca, Fe, K and Na were mainly in CP and occupied ca. 52% of the CP mass, while SO_4^{2-}, NH_4^+, K^+, Al, Ca, K and Na were mainly in FP and occupied ca. 28% of the FP mass. The data sets were then analyzed using Principle Component Analysis (PCA) to identify the possible sources of these fine and coarse particles based on their chemical species. For both fractions, soil, marine aerosol and vehicle exhaust were identified as main sources. In addition, contribution from secondary aerosol, traffic (non-exhaust) and biomass burning were also identified. Furthermore, crustal enrichment factors (EF_{crust}) were calculated and the results were consistent with PCA analysis. The EF_{crust} values for Zn, Cd, Ni, Cr, Pb and Cu were enriched in both CP and FP which reveal these elements were related to anthropogenic sources. In contrast, the EF_{crust} values for Ca, Fe, K, Mg, Na, Mn and Co in both fractions were within the range associated with crustal origin. However, even though within the range, these elements were slightly enriched in the FP relative to the CP suggesting possible association with input of non-localized crustal origin. It is hypothesized that the enrichment of crustal element in FP could be associated with long-range transport from their sources.

Abstrak tesis yang dikemukakan kepada Senat Universiti Malaysia Terengganu sebagai memenuhi keperluan untuk ijazah Sarjana Sains

PENILAIAN KIMIA DAN PENGENALPASTIAN SUMBER ZARAHAN HALUS AND KASAR DALAM PARTIKULAT DI KUALA TERENGGANU, MALAYSIA

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2012

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Sampel zarahan halus dan kasar telah dikumpulkan di Kuala Terengganu dari bulan Ogos 2006 sehingga Disember 2007. Sejumlah satu ratus enam puluh sampel zarahan halus dan kasar telah dikumpulkan. Sampel dikumpulkan menggunakan pensampelan penapis 'Gent Stacked' dalam dua pecahan saiz iaitu <2.5 μm (halus) dan 2.5-10 μm (kasar). Kepekatan elemen sampel dianalisa menggunakan Aruhan Gandingan Plasma – Spektrometri Jisim (ICP-MS) dan Aruhan Gandingan Plasma – Spektrometri Pemancaran Optik (ICP-OES). Spesies ionik yang larut air ditentukan menggunakan Kromatografi Ion. Hasil kajian menunjukkan bahawa purata kepekatan partikel kasar (CP), partikel halus (FP) dan PM_{10}, ditakrifkan sebagai jumlah partikel kasar dan halus (PM_{10}=CP+FP) masing-masing adalah 10.41±5.41 (± sisihan piawai), 14.31 ± 6.54 dan 24.72 ± 11.63 μgm^{-3}. Umumnya, purata kepekatan PM_{10} dan FP masing-masing adalah lebih rendah jika dibandingkan dengan Panduan Persekitaran Kualiti Udara Malaysia (purata 150 μgm^{-3} untuk 24-jam) dan Piawai Kualiti Udara Persekitaran Kebangsaan (purata 65 μgm^{-3} untuk 24-jam). Kepekatan partikulat yang tertinggi diperhatikan dalam bulan Oktober 2006. Model trakjektori kebelakang jisim udara HYSPLIT menunjukkan partikulat disebabkan oleh

pencemaran jerebu lintas sempadan. Di samping itu, kepekatan partikulat yang kedua tertinggi diperhatikan semasa musim kering monsun barat daya (April-Ogos 2007) iaitu ketika keadaan cuaca yang relatifnya kering dan meluasnya aktiviti pembakaran terbuka yang dilakukan semasa tempoh ini. Sebaliknya, kepekatan partikulat adalah dalam keadaan minimum semasa musim tengkujuh (Oktober-Disember 2007) iaitu dengan taburan hujan yang tinggi dan had laju angin yang maksimum tanpa adanya kejadian jerebu ketika tempoh tersebut. Secara puratanya, spesies kimia yang diukur dalam kajian ini terdiri daripada 74% dan 32% masing-masing untuk CP dan FP. Na^+, SO_4^{2-}, Cl^-, NO_3^-, Al, Ca, Fe, K dan Na merupakan kandungan utama dalam CP dan menyumbang 52% daripada jisim CP, manakala SO_4^{2-}, NH_4^+, K^+, Al, Ca, K dan Na merupakan kandungan utama dalam FP dan menyumbang 28% daripada jisim FP. Data set yang ada kemudiannya dianalisa menggunakan Analisis Komponen Utama (PCA) untuk mengenalpasti sumber yang berkemungkinan untuk partikel kasar dan halus berdasarkan spesies kimianya. Untuk kedua-dua pecahan, tanah, aerosol marin dan asap kenderaan telah dikenalpasti sebagai sumber utama. Sebagai tambahan, sumbangan dari aerosol sekunder, trafik (bukan asap) dan pembakaran biojisim juga turut dikenalpasti. Di samping itu, faktor perkayaan kerak (EF_{kerak}) juga telah dikira dan hasilnya adalah konsisten dengan analisis PCA. Nilai EF_{kerak} untuk Zn, Cd, Ni, Cr, Pb dan Cu adalah kaya dalam kedua-dua CP dan FP yang mendedahkan elemen-elemen ini boleh dikaitkan dengan sumber antropogenik. Sebaliknya, nilai EF_{kerak} Ca, Fe, K, Mg, Na, Mn dan Co dalam kedua-dua pecahan adalah dalam julat yang berasal dari kerak bumi. Namun begitu, walaupun dalam julat tersebut, elemen-elemen ini menunjukkan sedikit perkayaan dalam FP relatif kepada CP yang mencadangkan terdapat kemungkinan pertambahan dengan input yang berasal daripada kerak bukan terpencil. Adalah dihipotesiskan bahawa

perkayaan elemen kerak dalam CP mungkin berkaitan dengan pengangkutan jarak jauh dari sumbernya.