SCANNING ELECTRON MICROSCOPE STUDY OF FINE AND COARSE AIRBORNE PARTICLES IN KUALA LUMPUR

Mohd. Rashid Mohd. Yusoff
Chemical Engineering Department
Universiti Teknologi Malaysia
54100 KUALA LUMPUR.

Mohd. Harun
Nuclear Energy Unit
Prime Minister's Department
Kompleks PUSPATI
43000 Bangi, SELANGOR.

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Mohd. Rashid Mohd. Yusoff,
Dept. of Chemical Engineering, Universiti Teknologi Malaysia,
54100 Kuala Lumpur.

Mohd. Harun,
Nuclear Energy Unit, Prime Minister's Department,
Kompleks PUSPATI, 43000 Bangi, Selangor.

ABSTRACT

The 24-hr average concentration of fine (acrodynamic diameter, da $\leqslant$ 2.5 um) and coarse (2.5 < da < 10 um) airborne particles collected at the UTM Air Quality Monitoring Station were studied under the scanning electron microscope (SEM).

The microphotographs of both fine and coarse particles showed that the particles have various shapes. The agglomeration of these particles on the filter surface (due to prolog sampling duration) make it difficult to resolve the particles individually. However, through approximation solutions, the fine sample was found to have higher particle count for a given area as compared to the coarse sample. Methods of improving the SEM techniques are also discussed.

INTRODUCTION

Size and chemical composition are among the most important parameters influencing the way in which airborne particles interact with the environment. Particularly, the extent in which the airborne particles penetrate the human respiratory system is governed mainly by particle size, with possible health effects resulting from the presence of toxic substances. The presence of fine particles in the air can also influence the meteorological conditions of the local atmospheric environment.

In view of this, the present paper presents a preliminary study on the optical microscopic analysis of fine and coarse airborne particulates in Kuala Lumpur.

METHODOLOGY

Sample collection.

The 24-hr average fine particulate, FP (aerodynamic diameter da $\leqslant$ 2.5 um) and coarse particulate, CP (2.5 < da < 10 um) were collected using a Sierra Anderson dichotomous sampler (model 254) operating at 1 m^3/hr. Air sampling was carried out on the roof top of a 4-storey building in the Universiti Teknologi Malaysia. The samples were collected on 37 mm diameter cellulose filters with 1.0 um pore size. Both FP and CP filters were sent to Nuclear Energy Unit for microscopic analysis.

Scanning Electron Microscopy.

The samples were examined by a scanning electron microscope, SEM (Philips 515), equipped with an energy dispersive x-ray spectrometer. A portion of the filter (approximately 4 mm^2) were cut and placed on a carbon stub before coated with gold in sputter coating unit. The particles were viewed at 29 KV and the scanning electron micrographs were taken at 2,500X, 5,000X, 10,000X and 14,000X magnifications particle size counts were made on the micrographs.

RESULTS & DISCUSSION

Figure 1 exhibits the fine and coarse airborne particles samples collected on the cellulose filter membrane. The fine filter showed relatively darker than the coarse particulate filter. This clearly indicates that the fine particles are mainly derived from high energy processes such as combustion. On the other hand, the majority of the coarse particles are derived from mechanical processes e.g. soil erosion, or wind blown aerosol and therefore appeared lighter in color. Further investigations on the chemical composition of both samples will verify this statement.

The unexposed cellulose filter examined under the SEM is shown in Figure 2. As a whole, the pore size of this filter falls within 1.0 um in diameter and almost circular in shape.

Figure 3 (a) and (b) show the micrograph of fine particles observed at 10,000X and 14,000X magnifications respectively. The particles observed were to small and the particle count was done on the micrograph of 14,000X magnification in an area of about 48 um^2. The particles were grouped as follows.

$d \leqslant 0.1$ um	:	200 particles
$0.1 < d < 0.5$	:	91 particles
$0.5 < d < 2.0$	:	8 particles

The overall particle density was 299/48 = 6.220 particles/um^2. Almost 70% (within a given size range) particles were observed to have less than 0.1 um in diameter which is well below the respirable cut-point size of 2.5 um. The fine particles count can be enhanced if shorter sampling durations were selected for the study to avoid superimpose of particles on one another on the filter membrane.

Figure 4 (a) - (d) show the micrographs of the coarse particles viewed at different magnification levels. The coarse particles sample were relatively easy to observe even at lower magnifications. As a comparison, the particle counts were made as follows.

magnification 10,000X

micrograph area	:	108 um^2
$d \leqslant 0.1$ um	:	48 particles
$0.1 < d < 0.5$ um	:	107 particles

The particle density for this filter was 1.435 particles/um^2. As expected, the coarse sample filter has lower particle count for lower size particles as compared to the fine sample. In addition, this finding supports the manufacturer claims that the fine particles (d_a < 2.5 um) would also be collected onto the coarse filter compartment during normal operating condition.

Future Consideration.

This study is preliminarily aims as a fact-finding on the application of SEM for future pollution studies. It seems that this technique can serve an important tool in resolving pollution source impacts through the identification of particles concerned.

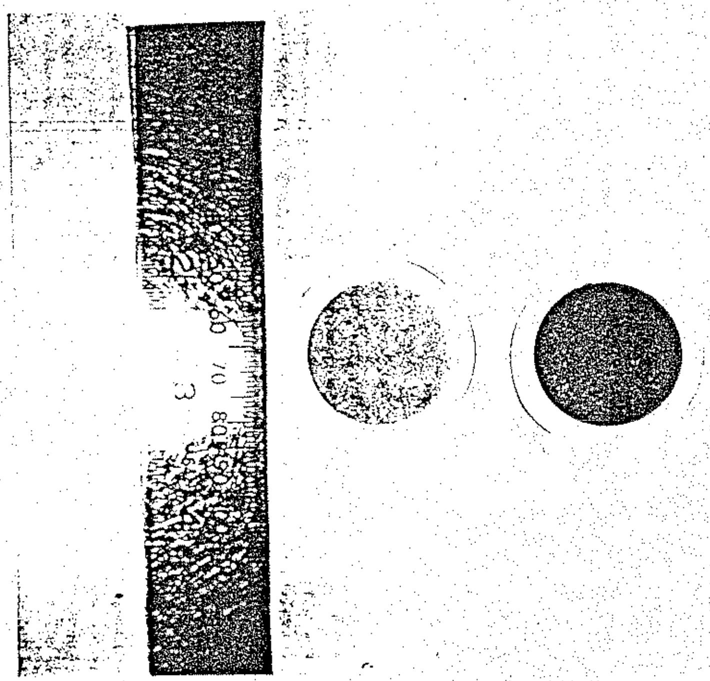
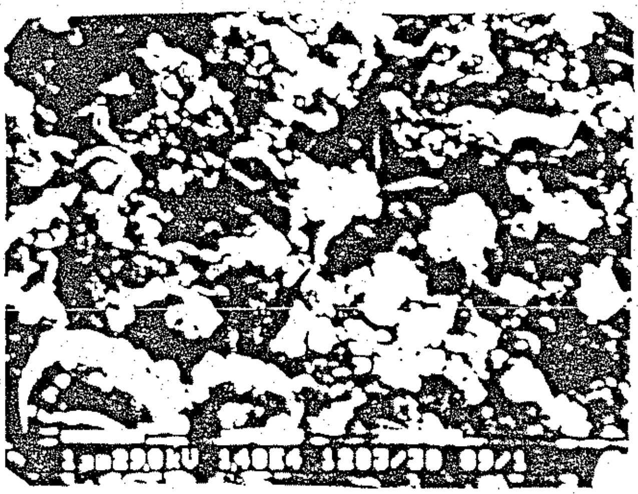


Figure 1 : Fine (darker) and Coarse Airborne Particles Samples

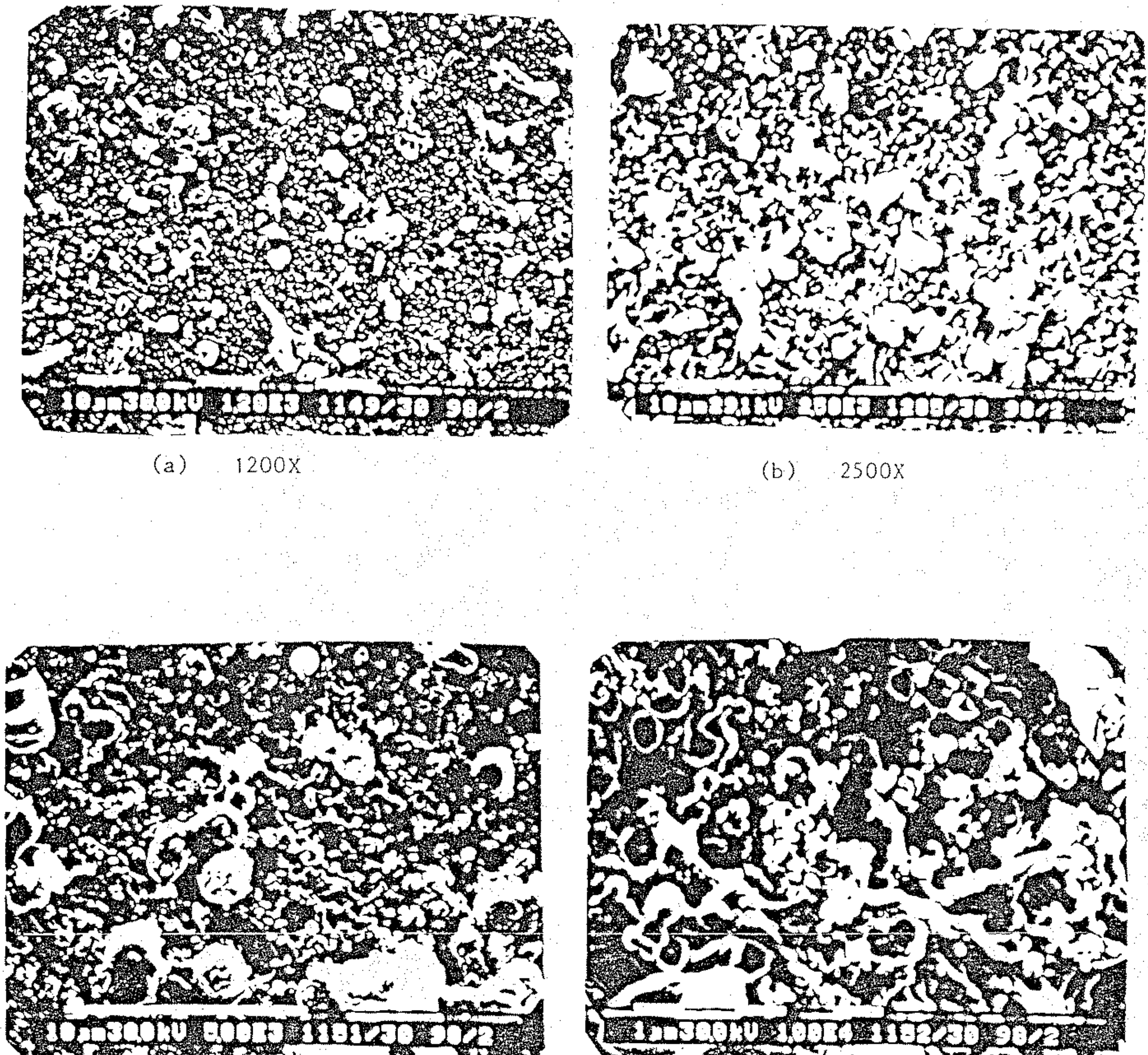
Figure 2 : Unexposed Cellulose
Filter 10,000X



(a) 10,000X

(b) 14,000X

Figure 3 : Airborne Fine Particle Micrographs



(a) 1200X

(b) 2500X

(c) 5000X

(d) 10000X

Figure 4 : Airborne Coarse Particle Micrographs