Development of Emission Factors of Nanoparticles ($PM_{0.1}$) from Solid Biomass Combustion

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INTRODUCTION

- The direct combustion of biomass fuel dominates the utilization of biomass fuels and is most important.
- However, it produces many air pollutants such as CO_2, SO_2 NO_x, particulate carbons and other pollutants. Particularly, much of ultra to nanoparticle are generated as reported elsewhere.
- Knowledge about characteristics and the control of pollutant emission is vital to biomass utilization with the minimum environmental load.
- The $PM_{0.1}$, or nanoparticle emission inventory from solid biomass burning have not been study so far in Thailand and Asian countries.
- The lack of data both of activity level and corresponding Emission Factors (EFs) would lead to large uncertainty inventory.
- Therefore, the result of EFs evaluation of solid biomass fuel will be important to develop high quality emission inventory.

METHODOLOGY

Solid biomass fuel

6 types including;
Palm Kernel
Rice Straw
Sugarcane Leave
corn stem
Bagasse
Rubber Wood

Fig 1. Para-rubber fuelwood in agroindustry, Thailand

Air Sampler as a common tool for the evaluation EFs

- Sampler: The sampler consists of four impactors stages (> 10, 2.5 - 10, 1 - 2.5, 0.5 - 1 μm) as well as an inertial filter stage (0.1 - 0.5 μm) and a backup filter (< 0.1 μm) (See Fig 2.) (Furuuchi et al., 2010)
- Filter: A quartz fibrous filters 55 mm (Pallflex 2500 QAT-UP)
- Flow rate: 40L/min.

Fig 2. $PM_{0.1}$ sampler

Combustion Experiment

- The solid biomass burned in a horizontal tube furnace with an inserted quartz column.
- Dry clean air approximately 1.6 L/min is purged into the furnace to combust the solid biomass sample.
- In order to reduce the temperature and moisture content, the exhaust was diluted with a dilutor (OD = 35 mm and L = 800 mm) include a mixing tube (L = 70 mm) by the dry clean air

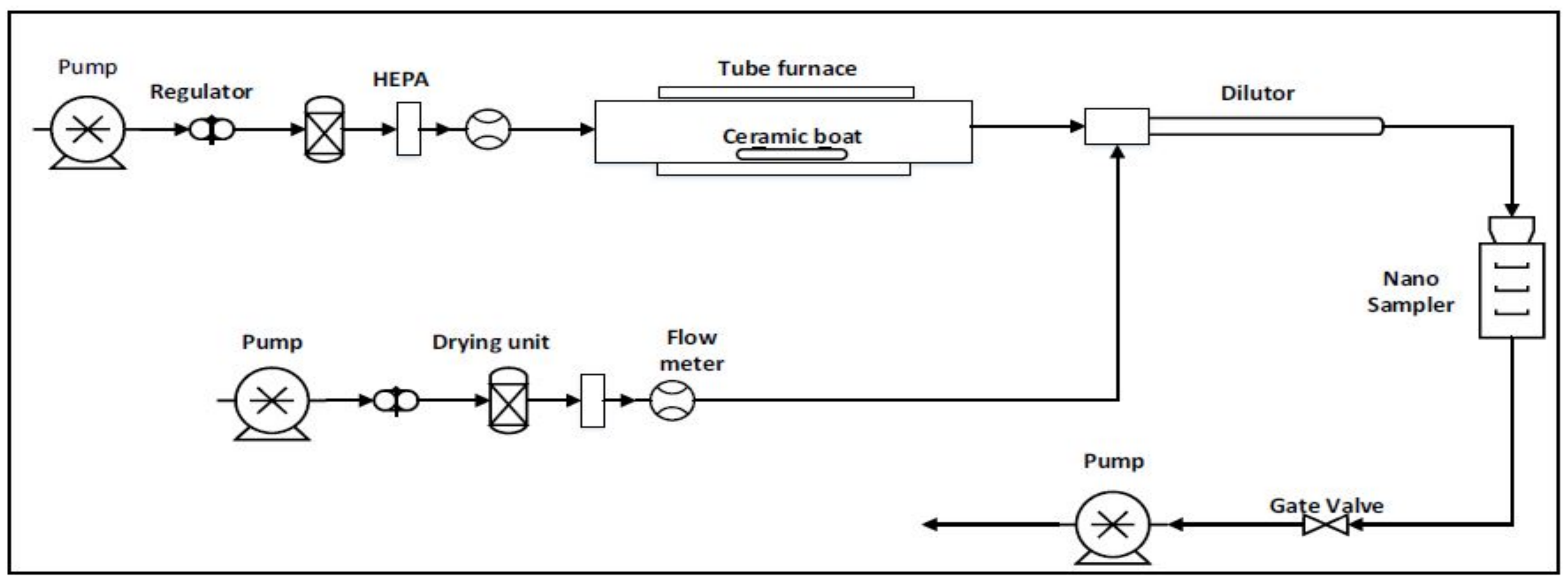

Fig 3. Schematic diagram of combustion system

Emission Factors (EFs) Calculation

Emission factors (EFs) of $PM_{0.1}$ from the burning experiment will calculate based on the flow rate of the Nano-sampler and particulate matter concentrations using Equation [1] (Kim Oanh et al., 2011).

$$[1]\quad EF = \frac{\text{Concentration } (mg*m^{-3}) * \text{Flowrate } m^3h^{-1} * \text{Sampling time (h)}}{\text{biomass burned (kg)}}$$

RESULTS AND DISCUSSION

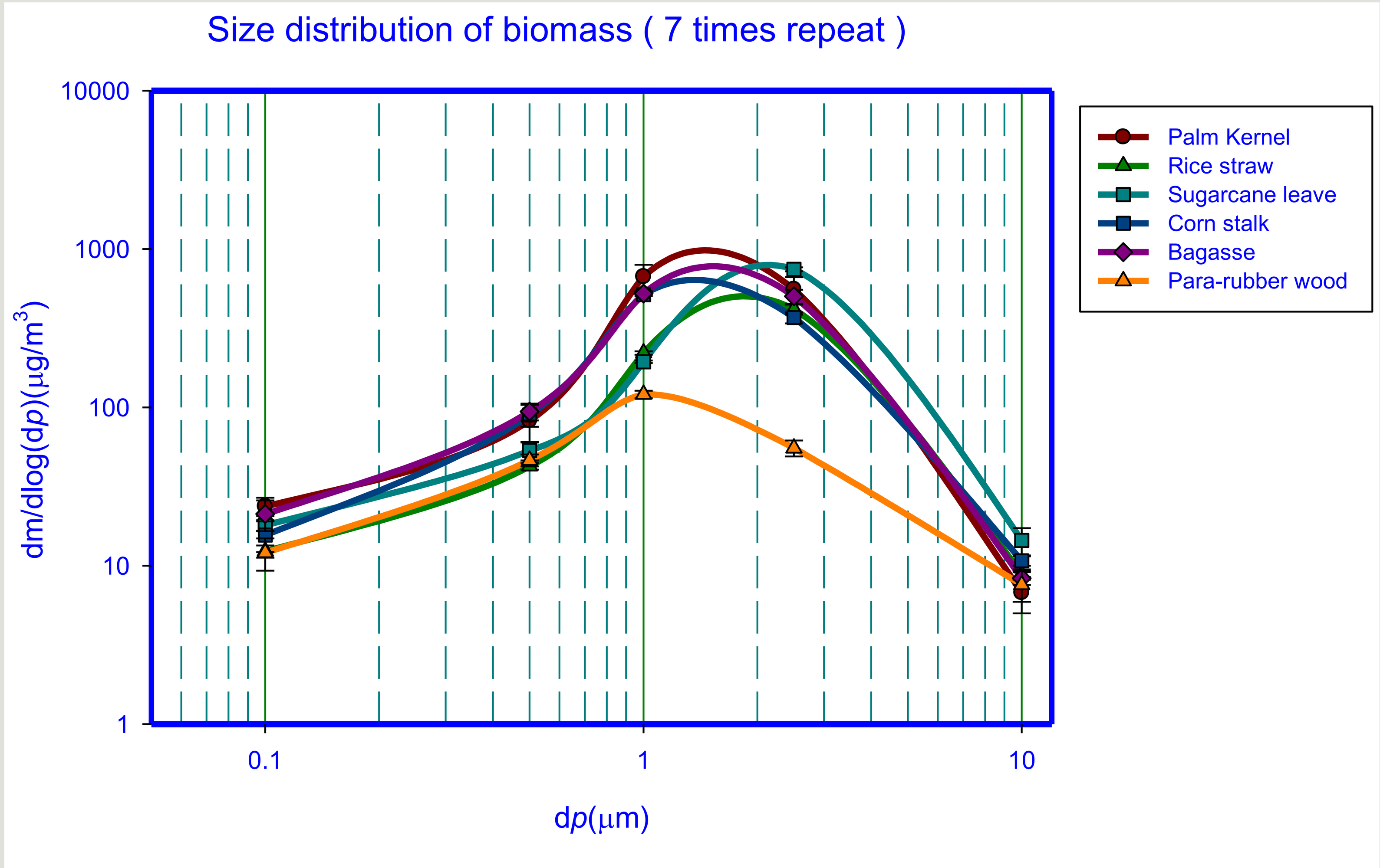

Fig 4. Size Distribution of Solid Biomass Combustion

- The size distributions of the smoke particles indicates a single-mode behavior.
- They contained major particles in an accumulation mode (0.1 μm < particle size < 2.5 μm)
- The results display that the combustion of solid biomass emits a large fraction of fine particles.
- Around 20% of the six types of the smoke particles has a mass that fell within a range of < 100 nm.

Table 1. Measured $PM_{0.1}$ Emission Factors (g.kg^{-1}) for Solid Biomass

Biomass type	Excess air (Lmin^{-1}) *	Heating rate (°Cmin^{-1})	Maximum temperature(°C)	$PM_{0.1}$ Emission Factors (g/kg)
Palm Kernel	0.25	5	575	0.17
Rice Straw	0.16	5	575	0.11
Sugarcane leave	0.15	5	575	0.11
Corn stem	0.16	5	575	0.14
Bagasse	0.14	5	575	0.22
Rubber wood	0.13	5	575	0.15

*excess 130% air

- The Emission Factors (EFs) values for six types of solid biomass burning in the laboratory experiment range from 0.11 to 0.22 g/kg.
- The highest EFs come from Bagasse (0.22 g/kg), the minimum EFs derive from rice straw and sugarcane leave (0.11 g/kg).
- The EFs are important for the development of strategies for pollution control and decrease the biomass burning.
- EFs of $PM_{0.1}$ will be discussed in detail based also on other chemicals.

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References

[1] Furuuchi, M., Eryu, K., Nagura, M., Hata, M., Kato, T., Tajima, N., et al., (2010). Development and performance evaluation of air sampler with inertial filter for nanoparticle sampling. *Aerosol Air Qual. Res*, *10*, 185-192.

[2] Kim Oanh, N. T., Ly, B. T., Tipayarom, D., Manandhar, B. R., Prapat, P., Simpson, C. D., & Liu, L. J. S. (2011). Characterization of particulate matter emission from open burning of rice straw. *Atmospheric Environment*, *45*(2), 493-502.

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