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$_{10}$, 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.

RESULTS AND DISCUSSION

- 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 have a mass that fell within a range of < 100 nm.

METHODOLOGY

Solid biomass fuel
- 6 types including; Palm Kernel, Rice Straw, Sugarcane Leaf, Corn stem, Bagasse, Rubber Wood

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.

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

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).

\[
[1] \text{EF} = \frac{\text{Concentration (mg/m}^3\text{)} \times \text{Flow rate (m}^3\text{h}^{-1}\text{)} \times \text{Sampling time (h)}}{\text{biomass burned (kg)}}
\]

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

<table>
<thead>
<tr>
<th>Biomass type</th>
<th>Excess air (L/min)$^*$</th>
<th>Heating rate (°C/min)$^*$</th>
<th>Maximum temperature(°C)</th>
<th>PM$_{0.1}$ Emission Factors (g/kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Palm Kernel</td>
<td>0.25</td>
<td>5</td>
<td>575</td>
<td>0.17</td>
</tr>
<tr>
<td>Rice Straw</td>
<td>0.15</td>
<td>5</td>
<td>575</td>
<td>0.11</td>
</tr>
<tr>
<td>Sugarcane leave</td>
<td>0.15</td>
<td>5</td>
<td>575</td>
<td>0.11</td>
</tr>
<tr>
<td>Corn stem</td>
<td>0.10</td>
<td>5</td>
<td>575</td>
<td>0.14</td>
</tr>
<tr>
<td>Bagasse</td>
<td>0.14</td>
<td>5</td>
<td>575</td>
<td>0.22</td>
</tr>
<tr>
<td>Rubber wood</td>
<td>0.13</td>
<td>5</td>
<td>575</td>
<td>0.15</td>
</tr>
</tbody>
</table>

*excess 130% air

- The Emission Factors (EFs) values for six types of solid biomass burning in the laboratory experiment range from 0.11 to 0.23 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


Fig 1. Para-rubber fuelwood in agroindustry, Thailand
Fig 2. PM$_{0.1}$ sampler
Fig 3. Schematic diagram of combustion system
Fig 4. Size Distribution of Solid Biomass Combustion

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