

CHAPTER I

INTRODUCTION

1.1 Background

Air pollution is an air with toxic chemicals or compounds in the air at certain levels that has a health risk. One of the contributors to air pollution is particulate matter (PM). The air contains a complex mixture of particles and liquid droplets called PM, which raises the risk of lung and coronary heart disease. According to World Health Organization (WHO), the safe threshold for exposure to PM_{2.5} within 24 hours is 25 micrograms/m³, while exposure to PM₁₀ is 50 micrograms/m³. Air pollution caused by particulate matter (PM) is a threatening environmental issue, and one of the PM sources is biomass burning. Biomass burning is done in most rice fields because it is the cheapest way to dispose rice straw left after harvesting. Burning of rice straw residues emits large amounts of emissions as well as toxic gases to the air but people still do not aware of the detrimental health effects of this issue. It is reported that rice straw open burning contributed majority of the total crop residue open burning (CROB) emissions in 6 Southeast Asia countries (Indonesia, Vietnam, Myanmar, Thailand, Philippines, Cambodia) with 19-97% percentage and Indonesia was the dominant contributor (33-42%) (Kim Oanh et al, 2018). In Indonesia, the research for air pollution issues especially particulate matter is currently still has so many lacks in many aspects. As a result, over the last few decades, international attention has shifted to fine particles emitted by open biomass burning (the burning of agricultural waste, rice straw, and other corps) (Akbari et al., 2021).

Indonesia is a country that has great agricultural potential. Based on Central Intelligence Agency (CIA) World Factbook, it is reported that in 2018, agricultural land takes up 31.2% of land use in Indonesia. Indonesia is the world's third largest producer of rice and one of the world's largest rice consumers. Rice production increased from 11.4 million hectares in 1995 to 13.2 million hectares in 2010 (IRRI, 2013). Therefore, Indonesia also produces a large amount of rice crop residues. In terms of crop residues subject to open burning on a dry mass basis, rice straw is found to have the most potential, with 19.3 million tonnes of rice straw per year

(Andini et al, 2016). The most economical method to remove rice straw is an open burning method (Kanokkanjana & Garivait, 2013).

Open biomass burning is known to emit a variety of toxic gaseous pollutants, as well as a number of heavy metals (Pb, Cu, Fe, Zn, and Hg etc.). These gases and metals account for roughly one-third of the particulate matter mass emitted into the air. During the 2019 dry season in Upper Northern Thailand (UNT), total emissions of metals present in the composition of PM_{2.5} emitted from all biomass types were 870 tons. Many of these are thought to have harmful effects on human health. Heavy metal emissions are known to cause local and regional pollution in the atmosphere, which can eventually contribute to climate change (Akbari, 2021).

Therefore, the urgency of this research set off from the hazardous effects to human being from open biomass burning especially rice straw burning. The emission factors of size-fractionated PMs and its heavy metals are highly necessary to determine in order to create an air pollution control for better human health. According to epidemiological and clinical studies, air pollution containing PM is linked not only to respiratory and pulmonary diseases, but also to cardiovascular diseases. Furthermore, ultrafine particles (PM_{0.1}) may penetrate the lung alveoli and enter the bloodstream, where they can directly affect health via the circulatory system. (Franck et al., 2014).

Based on literature review that has been carried out, out of 65 papers discussed about particulate matter cases in Indonesia, only few of them provide emission factors of PM (Hafidawati et al, 2017; Lestari et al, 2020) and there is no paper discussed about size-fractionated PMs in Indonesia. This can be concluded that the study of Emission Factors (EFs) in Indonesia particularly size-fractionated PMs is still limited despite its importance to model air pollution in Indonesia. Previous studies have been conducted in order to estimate the emission factors (EFs) of PMs and their metal compositions. Throughout the process, various types of combustion chambers were used to performed numerous experiments (Amaral et al., 2014; Li et al., 2016; Lusini et al., 2014; Reddington et al., 2016; Tian et al., 2015; Wiriya et al., 2016; Zhang et al., 2011). Open biomass burning simulations, on the other hand, have been carried out in closed combustion chambers with limited biomass

capacity for burning experiments, which might not have accurately represented the actual real conditions (Akbari, 2021). Therefore, the open system combustion chamber was used to simulate open burning in a way that was similar to the actual field condition. This study provides emission factors from various size-fractionated PMs with 6 range of sizes. There are Particulate Matter $> 10 \mu\text{m}$, $2.5 - 10 \mu\text{m}$, $1 - 2.5 \mu\text{m}$, $0.5 - 1 \mu\text{m}$, $0.1 - 0.5 \mu\text{m}$, and $< 0.1 \mu\text{m}$. In this study, the range of PMs is improved to provide a more practical and beneficial data so that can be used for modelling the air quality control in the future.

1.2 Objectives

This research aims to:

- 1). Calculate the emission factors (EFs) of size-fractionated PMs emitted from the burning of rice straw simulated in an open-system combustion chamber.
- 2). Calculate the emission factors (EFs) of metal elements bonded with PMs emitted from the burning of rice straw simulated in open-system combustion chamber.
- 3). Estimate the quantity of emissions of size-fractionated PMs and its metals element from open rice straw burning in Padang, West Sumatra.

1.3 Outcomes

The information provided by this research study will be beneficial to:

- 1). Estimate the pollutant emissions that comes from rice straw open burning and model the air pollution control through emission inventories.
- 2). Estimate the potential contamination to the environment and human health caused by rice straw open burning.
- 3). Metal elements analysis in size-fractionated PMs will be useful for further source apportionment database to see particulate fingerprints from rice straw burning.

1.4 Scope of Study

The scope of this research consists:

1. The research of this study focused only for rice straw burning conducted in Padang, West Sumatra, Indonesia. The burning simulation of rice straw was simulated in Air Quality Laboratory of the Environmental Engineering Department using open-system combustion chamber.
2. The parameter used in this study focused on size-fractionated PMs with 6 size range ($> 10 \mu\text{m}$, $2.5 - 10 \mu\text{m}$, $1 - 2.5 \mu\text{m}$, $0.5 - 1 \mu\text{m}$, $0.1 - 0.5 \mu\text{m}$, and $< 0.1 \mu\text{m}$) and metals bound.
3. The sample used for this study was collected from rice straw disposed from one of the rice fields in Padang, West Sumatra, Indonesia with manual cutting method.
4. The measurement of size-fractionated PMs was done in the Air Quality Laboratory of the Environmental Engineering Universitas Andalas using Nanosampler designed with filters to retain the particles. The filters weighed using 5-digits analytical balance.
5. The metal elements in size-fractionated PMs were analysed in the Water Laboratory of the Environmental Engineering Department Universitas Andalas using the Inductively Coupled Plasma-Atomic Emission Spectrometer (ICP-AES) equipment.

1.5 Bachelors Thesis Outline

The outline of this bachelor thesis consists of:

CHAPTER I

INTRODUCTION

Consists of background, objectives, outcomes, and the scope of study.

CHAPTER II

LITERATURE REVIEW

Consists of the results of literature review that has been conducted, definition of size-fractionated PMs, the impacts and sources of PM in the air, PM bounded metals, biomass burning, emission factors of size-fractionated PMs bounded metals, and open-system combustion chamber.

CHAPTER III METHODOLOGY

Consists of steps and methods used in the research.

CHAPTER IV RESULTS AND DISCUSSION

Consists of research results and discussion.

CHAPTER V CONCLUSIONS AND SUGGESTIONS

Consists of conclusions and suggestions based on the research results and discussion.

