CHAPTER

5

ASSESSING AGRO-WASTE DUST EXPLOSIONS FOR RENEWABLE SAFETY

Noor Alazim Noordin and Rafiziana Md Kasmani

5.1 INTRODUCTION

Concerns over global warming together with the cost of fossil fuels are leading to the wide scale adoption of solid biomass as a renewable source of energy. Malaysia is an agricultural country which has multiple crops produced each year due to the favourable climate. The major crops include rice, palm oil, pineapple and sugarcanes. The use of biomass in pulverized form gives the most efficient combustion with the least excess air for low carbon dioxide (CO_2) emissions. These crops produce large quantities of residues and disposal of these residues requires land and has a cost. However, it is known that agricultural products are combustible and usual in a form of fine dust or pulverized biomass for the end products. Thus, any form of ignition sources (spark, flames, or warm materials) is sufficient to trigger a fire and worst, a dust explosion as some processing involving the agricultural dust could form dangerous cloud of dusts and this condition increases the risk of explosion. There is very little information on the combustion properties of pulverized biomass, particularly for agricultural waste (Saeed et al., 2015). It will be similar properties on the agricultural wastes, which inappropriate

handling and storage may result in fires and explosions, possibly causing injuries to employees, loss of lives and also considerable economic loss together with environmental damage as reported by Casal (2018).

In pulverized biomass combustion, flame propogation is driven by the transfer of heat which mainly through conduction and radiation i.e. from the combustion zone into the turbulent region containing the unburned biomass–air mixture. As the biomass particles approach this high-temperature zone, they begin to decompose thermally. Agricultural biomass typically releases up to 80% of its mass as volatile components when subjected to temperatures around 300°C, a characteristic behavior observed in the current study (Sattar et al., 2012). In contrast to biomass, coal typically emits only around 30% of its mass as volatile matter, which is often assumed to consist mainly of hydrocarbons. However, the current analysis of biomass reveals that its significantly higher volatile release during heating cannot be attributed solely to hydrocarbons. Instead, the evolved gases are likely a combination of carbon monoxide (CO), hydrogen (H_2), and smaller fractions of hydrocarbons.

Additionally, under the intense thermal conditions near a flame front, it is plausible that a greater portion of the biomass structure undergoes thermal decomposition, resulting in increased volatile production. Sattar et al. (2012) have found no evidence for char to remain after biomass dust explosions in the ISO 1 m^3 explosion vessel and this indicates that all the biomass is converted into volatile products during the rapid heating in flame front. Determining explosibility of the agricultural waste particularly related to the stored materials ignite or to explosion consequences, is of crucial important to determine the direct or indirect causes influencing these processes for the processing industries. Moreover, there are fundamental safety problems for which there is a lack of data on the minimum ignition energy, the explosibility indices, and peak pressures. This study aims to examine the explosion characteristics of two different agricultural wastes, namely pineapple peels (PP) and rice husk on their overpressure, rate of pressure rises or magnitude of severity in the influence of mixing ratios between the dusts and ignition energy.

5.2 DUST EXPLOSION

Dust explosion is a phenomenon where the fire is caused by the dispersion of dust in the air, this phenomenon will produce fire with high pressure to produce air explosion. This can happen or be done in the presence of a closed atmosphere and flammable dust particles scattered in the air followed by the presence of propagators such as embers from cigarette butts, electric sparks and friction causing high temperatures. This dust explosion incident is actually not a foreign thing to hear in the manufacturing and processing industry as there have been 200 dust explosion or fire in United State alone in 2019 (Blair, 2007). Although this is heard due to dust being the cause of the explosion, the record of deaths caused by the explosion is not small.

Although, a dust explosion sounds easy to happen but in reality, it requires some conditions to do it. According to Ebadat (2010), this phenomenon requires six conditions that must be met, namely as follows:

(1) Minimum ignition energy
(2) Size of particle
(3) Minimum explosible concentration
(4) Minimum ignition temperature
(5) Oxidant concentration
(6) Limiting oxygen concentration

This is a general example of the conditions that need to be met to get a dust blast. If one of these conditions is not met it is possible that the phenomenon of dust explosion does not occur and turns into another phenomenon.

5.3 PHYSICAL CHARACTERISTIC OF PINEAPPLE PEEL

Ananas comosus, commonly known as pineapple, is a perennial herbaceous plant, as depicted in Figure 5.1. A perennial herb typically has a short life cycle, where the plant produces flower buds that develop into fruit. PP are rough, spiked, and thick, with a fibrous texture and a color that ranges from