CHAPTER 1

INTRODUCTION

1.1 Background of the study

Safety is one of the most important aspects that need to be considered in industry. Without a proper checking of equipment or even a single mistake done on processing plant or in an offshore section, the situation could lead to death and damaging structures, residential area and surroundings.

Gas explosion is not a rare incident occur in industry. It happens when a flammable gas/air mixture is ignited within a confined enclosure. The restriction of the enclosure places and the expansion of the burnt gases caused the pressure rise. The rapid release of energy, the pressure generation and high temperature flame and gas then leads to the term ‘gas explosion’ (Tomlin et al. 2015). In the year of 2014 there is a propylene leak in an underground pipeline which cause a series of explosions in Kaohsiung located at the southern Taiwanese city. This explosion results in injury of more than 300 people and 32 were killed in the incident.

Explosion can occur when these three elements involved reached the right concentration; fuels, ignition source and oxidizer. If one of these three elements were absent, fire could not exist. The severity of the explosion can be based on the flammability limit. Flammability limit is a range between the lower flammability limit (LFL) and upper flammability limit (UFL). Theoretically, to determine the limit of a safe combustion, it depends on the flammability limit or explosive limit.

Methane made up mostly in natural gas composition. It has become more important these days as it is used in various sectors including industrial purposes, electric power

generation and residential applications. There are many explosions occurs in industry which involves the explosion in a confined space.

In recent studies, there are many research has been done on methane gas explosion characteristics such as rate of pressure rise (dP/dt), maximum explosion pressure (Pmax), flame propagation and also explosion index, K_G. However, there is still lack of information on the explosion characteristics on methane/air premixed that are focusing on the lean fuel concentration towards the fuel concentration at its stoichiometric ratio.

Due to the frequent gas explosion accidents in recent years, more and more attention has been paid to the severity of natural gas explosion. In this study, the vessel shapes are also considered to determine the explosion characteristics by comparing the explosion in a 20-L spherical vessel, the explosion in a 4-inch pipe and in a 2-inch pipe.

1.2 Motivation

Methane composition made up mostly in natural gas. It has become more important these days as it is used in various sectors including industrial purposes, electric power generation and residential applications. Methane gas explosion might leads to life-threatening situation as the effect of the explosion is very dangerous to human beings and also to the environment.

In recent studies, there are so many researches on the explosion characteristics of methane/air mixture such as the rate of pressure rise (dP/dt), the maximum explosion pressure (Pmax), gas explosion index, K_G and also the flame propagation. However, to the author knowledge, there are no specific data focusing on the explosion characteristics at lean concentration towards the stoichiometric concentration.

1.3 Problem Statement

Methane-air mixture explosion is one of the most serious accidents in coal mines (Black 2009; Services 2006). (Wang et al. 2016) explained the cause of the methane-air explosion in coal mines. Methane-air mixture may be ignited by any strong sources of ignition and then create a massive explosion incident. During the explosion, the methane-air flame front facing many obstacles and these make the flame to accelerate more. From such kind of explosion incident that could happen, many researchers have conducted their study to know the explosion characteristics of methane-air mixture.

(Weiß et al. 2008) studied the experimental study of Markstein number effects on laminar flamelet velocity in turbulent premixed flames. In their study, the measured Markstein number with laminar flames can predict the influence of turbulence stretch onto the laminar burning velocity of flamelets. Besides, the Markstein number efficiency decreases to zero as the turbulence intensity increase.

(Li et al. 2015) in their research studied on the comparison between methane/air and hydrogen/air explosions characteristics in a cylindrical vessel. The parameters that was studied in their research were on the peak overpressures (Pmax) and maximum rate of pressure rise (dP/dt)max. The results of their studies show that the flame propagation of hydrogen/air explosion is higher than the methane/air explosion. However, the time to reach maximum explosion of methane/air is longer than hydrogen/air which indicates that the higher reactive hydrogen can cause massive severity while methane/air leads to lasting harm.

The researches above mainly described and discovered the explosion parameters in closed vessels. The foundation of the explosion characteristic knowledge is clear but no interest researches towards the severity of methane-air explosion in a closed vessel shapes at different equivalence ratio from lean to stoichiometry. Thus, this research will covered on the explosion characteristic of methane-air explosion at different concentration from lean to stoichiometry at different vessel shapes. The purpose is to provide strong knowledge and understanding on severity of the methane-air explosion in closed pipe.