CHAPTER 1

INTRODUCTION

1.1 Background

Gasoline vapor is categorized into volatile organic compounds that consist of various hazardous air pollutants especially aromatic group such as Benzene, Toluene and Xylene. These vapors are considered toxic at high concentrations with major effects on nervous and metabolic system, and can be cancer-causing. Once released this volatile organic compound or hydrocarbon vapors can also react with oxides of nitrogen from tailpipe emissions and in the presence of sunlight can cause photochemical oxidants such as ozone, which can reduce lung capacity, irritate eyes, damage respiratory system and aggravate asthma. (U.S.EPA, 2001)

Gasoline transport from fuel depots to gasoline stations and refueling to cars are major causes of hydrocarbons in the air. It was found that consumption of gasoline in the year 2000 in Thailand is about 6,761 million liters. That could produce large amount of gasoline vapor in the atmosphere (Automotive Emission Organization, Pollution Control Department [PCD], June 2001) of the Bangkok metropolitan area where the consumption of gasoline station is about 2 billion liters per year and the emission of 5,560 tons per year.(National Energy Policy Office, 1995). A study by Wongwises (1995) 21,000 ton of gasoline by approximately found that evaporated annually in Thailand from petroleum storage and transfer operations. The report stated that the largest source of emissions was the evaporative loss from gasoline distribution which included loading gasoline to storage tanks (21%), the transfer from storage tanks to tank trucks (28%), the transfer from tank trucks to underground storage tanks at the service stations (24%) and the refueling loss (22%).

It is not only gasoline vapor which directly affects the amount of ozone in the atmosphere, but also benzene, a hazardous air pollutant found in gasoline vapor and a known carcinogen. The WHO announced that it was a hazardous pollutant with no safe level. Thus, the control of gasoline vapor control should be as low as possible to avoid this risk. The result of ozone measurement in ambient air in Bangkok in the

year 1996-2000 shows an increasing trend particularly in 2000, when it was found that the highest ozone concentration was 203 ppb., where the standard is 100 ppb. In the Bangkok area, there are 45 days a year that ozone concentration is over the standard and need control system. . (Automotive Emission Organization, PCD, June 2001)

There are increasing concerns worldwide about the environmental and health effects of volatile organic compounds (VOCs) emissions, which have led to legislation in a number of countries. The control of emissions from gasoline distribution and marketing has also been addressed in many countries including Thailand. In the final report of "Vapor Emission from Gasoline Transport, Storage and Refueling in Bangkok" done by Air&Waste Technology Co.,Ltd and submitted to National Energy Policy Office in 1995, they recommended that the Energy policy Office should impose regulations on vapor emission stage I, to control vapor emissions generated during gasoline loading to underground storage tanks in all municipal areas nation wide. In addition, the stage II to control vapor emissions during refueling should be imposed for Bangkok Metropolitan Region in the first phase and expanded to all municipalities in 5 years.

To accommodate the gasoline emission problem during transfer, law has been enacted to control gasoline vapor at gasoline terminals, oil tank trucks and gasoline station in Bangkok Metropolitan Regions. This notice has been promulgated since July 1, 2001. From this law, the concerned business must install these type of gasoline vapor control equipment:

- At gasoline terminal, vapor recovery unit should be installed and also change refuel system from top loading to bottom loading.
- Gasoline tank truck and gasoline station, gasoline vapor collecting equipment should be installed. At the retail site the vapors displaced during the filling of the underground storage tank can be fed back into the tanker compartment in place of the off-loaded gasoline. The vapor can then be transported back to the terminal for processing.

The Petroleum Institute of Thailand studied the increasing cost of gasoline as affected by this law. They found the total investment will be around 831 million Baht

by 10 gasoline companies and 35 million baht per year for operation cost. That will increase the cost of gasoline in the Bangkok Metropolitan Region by approximately 4.7 satang per liter. (Memorandum of Petroleum Institute of Thailand,2000)

Although the control of emissions from gasoline distribution and marketing has been addressed in many countries, especially developed countries, it is new for Thailand to implement and there is also no information on the efficiency of vapor recovery units being used. The vapor recovery units are an example of western technology which is applied in countries with different conditions, i.e. climate and composition of gasoline. Thailand also has no regulations that specifically regulate hazardous air pollutants at gasoline terminals. Since the law has been promulgated, there have been no follow up studies on either the VRU efficiency or cost-effectiveness. In this thesis research the efficiency of vapor recovery units will be described both for total volatile organic compound and major hazardous air pollutants. Also cost-effectiveness of the control systems will be discussed.

1.2 Objectives of the study

- To identify the volatile organic compound and hazardous air pollutants at bulk gasoline terminals where the vapor recovery unit is installed.
- To evaluate the control efficiency of vapor recovery unit that can control total volatile organic compound and hazardous air pollutants (Benzene, Toluene, Ethylbenzene and Xylenes or BTEX and Methyl tert-butyl ether (MTBE)).
- To study the cost-effectiveness of vapor recovery systems and discuss the results for country policy on VOCs/hazardous VOCs emissions at bulk gasoline terminals.
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1.3 Scope of the Study

The Hazardous Air Pollutants (HAPs) in this study focused on hazardous air pollutant which could be found in gasoline vapor: Benzene, Toluene, Ethyl Benzene, total Xylene, Methyl tert-butyl butyl ether or MTBE and total volatile organic compounds (total VOCs). In addition, compounds present in gasoline vapor, both inlet

and outlet of vapor recovery unit, will be analyzed. Then cost effectiveness of the mentioned unit will be discussed.

Due to a few limitations of sampling procedures, i.e. control temperature of gasoline vapor to be used in study and the limitation of selected gasoline loading plans. The limitations are the operation is performed at night on Monday to Friday, while daytime operations are on Saturday and Sunday. Thus in this study an average temperature at day and at night will be observed only.

The experiment must be carried out at 2 bulk gasoline terminals, The Shell Company of Thailand Limited and The Fuel Pipeline Transportation Limited.

The vapor recovery unit to be used in this research is a carbon vacuum adsorption vapor recovery type (CVA).