CHAPTER 5

CONCLUSIONS

The results of this thesis presented the control efficiency of vapor recovery unit for VOCs and HAPs at two Bulk Gasoline Termnals, the Shell of Thailand and Fuel Pipeline Transportation. The HAPs in the study were benzene, toluene, ethybenzene, m,o- xylene and MTBE. The results of control efficiency were also evaluated on the effectiveness of emissions control.

The volatile organic compounds presented in gasoline emission at both inlet (uncontrolled) and outlet (controlled) of VRU were analysed by GC/MS. The results shown huge of either identified or unidentified compounds. The unidentified compound must has average more than 20 hit compounds listed in the GC/MS's library. The exactly identification of those compounds, their standard were needed for the peak/compound confirmation. According to the budget limitation, therefore the only the major volatile hydrocarbons and the HAPs were identified.

The identified compounds that found at the inlet samples were benzene (B), toluene (T), ethylbenzene (EB), all three isomers of xylene (para, meta, ortho) (X), metyl tert-butyl ether (MTBE) and 1-butene. The results also shown that the gasoline emission at outlet of VRU similar to the inlet samples.

The average VOCs emitted at the Shell of Thailand and FPT were 0.24 mg/l and 0.11 mg/l, respectively that under the compliance limit of notice of the Science, Technology and Environmental Department, that gasoline emissions at Bulk Gasoline Terminals (less than 17 milligram of total volatile organic compounds (mg/l) per one liter per hour).

The VOCs and HAPs removal efficiencies of two units were almost the same rate which an average efficiency of 99.97% and 99.01% respectively. The control efficiency for individual HAP was insignificantly difference and has the similar trended for individual HAP removal efficiencies of two units. The order of HAPs control efficiency were ethylbenzene > MTBE > o-xylene > benzene > toluene > m-

xylene, 100%, 99.82%, 99.69%, 98.75%, 98.21% and 97.93%, respectively. These studies indicated that the carbon adsorption units tend to control HAP emission independent of the control efficiency for VOCs and also shown that HAPs control efficiency was lower than VOCs control efficiency.

The HAPs generated during gasoline loaded from both sites, FPT and Shell, was 7,452.65 Kg. MTBE was the highest of emission, it was emitted by 5,276.32 Kg. While ethylbenzene was the less emitted by 85.64 Kg. The VRU showed the results to control those HAPs more than 99% but the total HAPs after controlled still emitted 423.41 Kg in year 2002. The average VOCs generated without the vapor control equipment at Shell and FPT in year 2002 totally, were 588,000 kg and 151,298 kg respectively. The implementation of VRU could reduced the VOCs emitted to 264 kg, 27.23 kg at Shell and FPT, respectively.

The vapor recovery unit with 99.955% efficiency at the Shell has been recovered VOCs by 576.24 tons that was 6.72% of VOCs from area source or 0.27% of total VOCs in Bangkok , 212,180 tons. It was estimated that 2,732 million liters of gasoline were loaded from major oil companies 5 terminals in Bangkok in 2002 (Department of Energy Business, 2002). VOCs had been generated approximately 2,677 tons during this amount of gasoline was transferred to tank truck at gasoline terminals (calcualted using AP-42 uncontrolled VOC emission factor of 980 mg/l). At an assumption of 95% VOCs control efficiency, the lowest control efficiency for the carbon adsorption technique mentioned by Best Available Control Technology (BACT) of EPA, 2544 tons of VOCs will be controlled by approximately. This amount of removal VOCs (Stage I) is 30% of VOCs from area source or 1.2% of total VOCs in Bangkok. Even though VOCs controlled by VRU comparing to the total of VOCs in Bangkok is a very small ratio, it is atleast one third of VOCs can be controlled efficiently from area source.

The conclusion of cost effectiveness of VRU presented in Table 5.1

Table 5.1 Cost effectiveness of VRU

	Shell (Baht)	FPT (Baht)
Net annual revenue of VRU	-63.65 million Baht	-28.87 million Baht
Average cost per kg. of VOCs removed	22.657	35.711
Average revenue per kg. of VOCs removed	15.43	11.43

The cost-effectivenes getting from FPT and Shell, it could imply that quantity of gasoline loaded affects the cost per liter of gasoline transferred. The more gasoline transferred from the terminal with pass through the VRU the less cost payed to remove those emissions. At the present, only 20% of VRU capacity were used. made more cost.

However, there are other benefits that could get from emissions control at gasoline terminals by VRU i.e. it could reduce risk of helth impact to operators who work at site during gasoline loaded, and reducing air pollution, especially for ozone accumulation. Nevertheless, the health benefit from VOCs and HAPs reduction at gasoline terminals can be valued from the reduction of sickness day-off of operators who work at site. In conclusion, even though the vapor recovery system will cause the company a financial burden, it will benefit far better from both reduced chance of the gasoline loading terminal personnel to inhale the hazardous air pollutants and reduced level of air pollution, especially for ozone accumulation.