

## CHAPTER V

### CONCLUSIONS AND RECOMMENDATIONS

#### 5.1 Conclusions

The objective of this study is to develop a prototype of the crushing unit to manage used fluorescent lamps and remove mercury contained in these lamps. In this study, the characteristics of the used lamps before and after crushing were examined. Release of mercury in vapor and other forms from crushed fluorescent bulbs, including the amount of mercury in the lamp residue was investigated. To control the amount of mercury vapor emitted from the crushed lamps, chemical spraying into the crushing unit was experimented. Eventually, the stabilization/solidification of the lamp residue sprayed by chemical was studied. The results of these experiments could be summarized as follows;

- The fluorescent lamp crushing unit constructed in this study was a small single unit with the capacity of 230 liters. This unit could crush about 4-6 4-ft decapped lamps per minute and contain about 1,300-1,400 crushed lamps.

- The masses of the fluorescent lamps from different manufacturers or even from the same manufacturers or the same brand varied. After being crushed, the volume of the fluorescent lamp decreased by 77.3-79.8 percent.

- After the used fluorescent lamp was broken, mercury; vapor phase, leached from the lamp residue and total mercury in lamp residue was investigated. The results were concluded as follows;

- 1) The average value of mercury vapor concentration from a broken lamp was  $4.64 \text{ mg/m}^3$  or  $1.07 \text{ mg}$  based on the drum volume. This concentration was about 93 times higher than the allowable concentration of mercury vapor in the workplace.

2) The amounts of mercury in a lamp varied considerably even within the same model and manufacturer. Total mercury concentrations were in the range of 13.9-47.0  $\mu\text{g}$  of Hg/g of lamp residue with the mean value of  $26.7 \pm 10.3 \mu\text{g/g}$ . The average value of mercury per lamp was  $5.1 \pm 2.0 \text{ mg}$ .

3) The concentrations of mercury leached from lamp residue samples were quite low, compared with the reported values in the previous studies. The concentrations of mercury ranged from 18 to 78  $\mu\text{g/l}$  with the mean value of 41  $\mu\text{g/l}$ . These concentrations were also less than the limit of leachable substance standard ( $\text{Hg} \geq 0.2 \text{ mg/l}$ ).

- Both sodium sulfide solution and water spraying could reduce the amounts of mercury vapor released from broken lamps with an efficiency of 97.3 and 71.3 percent, respectively. However, the concentrations of remaining mercury vapor in the crushing unit still exceeded the allowable concentration of mercury vapor in the workplace.

- The concentrations of leached mercury from solidified wastes were less than the limit of leachable substance standard for mercury. The mercury concentrations from leached wastes ranged from 0.014 to 0.099 mg/l.

## 5.2 Recommendations

- The chemical spraying system should be developed to increase the efficiency of mercury reduction and its consistent operation. Other chemicals should be tried in further studies, including more amounts of sodium sulfide.

- The direct reading instruments should be considered to measure the mercury vapor. The concentration of mercury vapor in the experimental area should also be detected to investigate the leakage of mercury vapor in further studies.

- Other binders which are available in local areas such as rice husk ash should be considered in order to reduce cost of waste treatment.

**Operating instruction of the fluorescent lamp crushing unit**

1. Remove the aluminum caps of used lamps before crushing.
2. Check and tie the clamps of the crushing unit to prevent the leakage of mercury vapor before turn on the crushing unit.
3. Turn on the crushing unit.
4. Insert a decapped lamp into the crushing unit once a time via chute.
5. Cap the chute immediately after put a whole lamp in the crushing unit.
6. Wait until a whole lamp is crushed; insert the next tube in the chute.
7. Spray sodium sulfide to reduce the amount of mercury vapor, after crushing 3-5 used lamps.
8. Move the drum-top mounted crusher to another container, when the container is full with the lamp residue.
9. Cover the full container by plastic sheet and wait for treatment or recycling.