

## CHAPTER V

### CONCLUSIONS



#### 5.1 Conclusions

- The appropriate burning conditions in laboratory were 1450°C with 90 minute. By this condition, the clinker characteristic between real clinker and synthesis clinker were similar.
- Heavy metals strongly affect on the value of free lime content. As original value of free lime content of clinker without any heavy metal was 1.21%, the value of free lime content in addition of chromium 2 wt.% was increased as equal to 4.005%. Nickel and zinc exhibited the decreasing of the value of free lime content as equal to 0.64% and 0.365%, respectively for the initial concentration of nickel and zinc as 2 wt.%.
- From the study of leaching behavior of chromium from cement, the findings could be summarized as follows:
  1. Chromium was likely to be leached easily from cement due to the new compound of chromium identified as  $K_2CrO_4$  which was chromium with valance +6 which is readily soluble.
  2. From the studied pH, chromium was effectively leached at pH range 4-10 in which the highest for leachability of chromium was obtained at pH 8.
  3. As the raw material was doped with concentration of chromium more than 0.1 wt.%, the leachate from TCLP and NFMI exceeded the allowable value of U.S. EPA and Notification of Ministry of Industry No.6 B.E. 2540, respectively. Thus, the obtained cement that come from addition of chromium with concentration higher or equal to 0.1 wt.% in the raw material could not be used as a product.

- From the study of leaching behavior of nickel from cement, the findings could be summarized as follow:
  1. Nickel was unlikely to be leached from cement due to the new compound of nickel identified as  $\text{MgNiO}_2$  was a hydrated form which could not have reacted with water.
  2. From the studied pH range, nickel was effectively leached at pH 4.
  3. As the raw material was doped with concentration of nickel upto 2 wt.%, the leachate from TCLP and NFMI did not exceed the allowable value of U.S. EPA. Thus, the obtained cement that come from addition of nickel with concentration lower or equal to 2 wt.% in raw material could be used as a product.
  
- From the study of leaching behavior of zinc from cement, the findings could be summarized as follow:
  1. Zinc was likely to be leached easily from the cement.
  2. From the studied pH range, zinc was effectively leached at pH 4.
  3. As the raw material was doped with concentration of zinc upto 2 wt.%, the leachate from TCLP and NFMI did not exceed the allowable value of U.S. EPA. Therefore, the obtained cement that come from addition of zinc with concentration lower or equal to 2 wt.% in raw material could be used as a product.

## **5.2 Recommendations**

- The leaching behavior of raw material doped with mixed heavy metals should be further studied. The mixture of various heavy metals with raw material may provide the different effect from raw material doped with single metal.
  
- The raw material doped with other metals such as vanadium, lead, and mercury should be further studied due to the different metals may provide the different leaching behavior.

- The forming of new compound of heavy metals in the phase of clinker should be deeply studied because it will provide more understanding in leaching behavior of each metal.