CHAPTER I

INTRODUCTION

1.1 General

Fly ash is generated from a coal-fired power plant during the combustion process. In Thailand, fly ash has been generated 8,000 tons per day or more than 3 million tons per year. These are from 35,000 tons per day or 18.9 million tons of lignite per year mostly from Mae-Moh and Kra-Bee power plants. Only a small percentage of fly ash is recycled and the remaining ends up in large ponds or landfill sites.

Currently fly ash is mostly used as a supplementary cementing material in concrete. Fly ash, which used to be an industrial waste produced of more than 3 million tons per year, now has worth. It can reduce the cost of concrete production and minimize landfill area. It has been found to improve the quality of concrete and reduce its environmental impact. The replacement of cement with fly ash can decrease the amount of released carbon dioxide by 1.6-1.8 million tons per year. This helps to abatement the greenhouse effect problem as well. Furthermore fly ash utilization can reduce the amount of limestone, subsoil, and gypsum used in cement production. Thus, a lot of energy is saved from stone grinding and dust burning.

The utilization of fly ash in the cement process from 2000-2003 is shown below:

- In 2000, the amount of fly ash utilization was 1.2 million tons
- In 2001, the amount of fly ash utilization was 1.3 million tons
- In 2002, the amount of fly ash utilization was 1.2 million tons
- In 2003, the amount of fly ash utilization was 0.26 million tons (3 months)

The use of fly ash as an aggregate is estimated at about 3.96 million tons per year. The total cost that has been saved is about 9927 million baht (Energy policy and planning office, 2003). In the past four years, fly ash concrete has been used in large construction projects such as in the fire resistant walls at the Ratchaburee power plant, foundation of the BTS sky train, and foundation of the Phraram 8 Bridge, etc.

Most of fly ash generated in Thailand is Class F fly ash from the Mae-Moh power plant. The amounts of iron, silica, calcium, and sulfur in feed materials are adjusted by the addition some minerals into the feed materials to prevent acid rain and to protect the boiler from the slag. As a result, the composition of this fly ash is more stable.

In the discuss above, it can be seen that fly ash is a promising alternative for cement replacement in concrete. However, a previous study found that fly ashes from different coal sources have various physical and chemical properties. In Thailand, lignite coal has been under national reserve, and can only be used in limited amounts. Therefore, coal has been imported from other countries to compensate for the country's deficit. The changing of the coal type has varied the properties of fly ash on the market. It can lead to undesirable concrete properties as little research has been done on these fly ashes, unlike Mae Moh fly ash. This is a continuing impediment to the utilization of coal fly ash in concrete in Thailand. Thus, our research is aimed at studying the effects of different compositions on fly ash reactivity as a basis for classifying fly ash.

ASTM-618 (ASTM C 618, 1997) classifies fly ash into only two types, class F and class C by the summation of SiO_2, Fe_2O_3, and Al_2O_3. The summation of SiO_2, Fe_2O_3, and Al_2O_3 should be higher than 50% for Class C fly ash and 70 % for Class F fly ash. The maximum percentage for SO_3 is 5% and 1.5 % for Na_2O and K_2O as they can reduce the corrosion resistance of concrete. However, a standard for CaO content is not included in this criterion. There are some fly ashes that do not fall into these criteria.

Another factor that bars the utilization of fly ash in concrete is the failure of the current ash classification system to correlate effectively with material performance. The current fly ash classification (ASTM C 618) does not provide an accurate measure of expected performance. A classification based on fly ash reactivity would serve as a better predictor of performance in concrete. Rather than chemical composition, the mineralogical characteristics should be used to assess the reactivity of the fly ash. A reactivity approach assesses the quantity of reactive components and the rate to which they enter into a hydration reaction (Dewey, 1996).

To understand more about the factors governing fly ash reactivity, the effect of composition on the leaching rate was investigated. The synthetic fly ash was prepared to sample the regions of the fly ash glass composition space. This is because it is difficult to obtain fly ash with a specific composition as fly ash composition varies within one batch. A modified Single Pass Flow Through leaching test was used to measure reactivity of this fly ash as a function of time. The results might be used as primary criteria to assess the reactivity of real fly ash from different sources.

1.2 Objectives

The main objective of this study was to determine the relation between fly ash composition and its reactivity.

1. To determine the effect of NBO/T, alkali, and alkaline earth content on the dissolution rate of fly ash.
2. To investigate the effect of CaO/Na_2O+K_2O content on the dissolution rate or reactivity of fly ash.
3. To study the effect of pH on the dissolution of fly ash.

1.3 Scope of study

1. Synthetic ash was prepared from mixes of oxides with a fixed $SiO_2/Al_2O_3/Fe_2O_3$ ratio of 5:2.5:1. The ratio of CaO/Na_2O+K_2O were 1:3, 1:1, 3:1 for class F and 1:3, 1:1, 3:1, 1:10, and 10:1 for Class C.
2. The SPFT test was operated at different pH levels, 11.5, 12, and 12.5, to investigate the leaching rate of synthetic fly ash.
3. The leaching characteristic of each synthetic ash was examined.
4. The effects of NBO/T, Al/Si, and alkaline content on fly ash reactivity were investigated.
5. The effects of CaO/Na_2O+K_2O content and pH on the leaching rate of fly ash were investigated.