CHAPTER 1 INTRODUCTION

1.1 Overview

The term of heavy metal includes of metal and metalloids. This group consists of biologically essential and non-essential. Cadmium is one of non-essential metals that are known as toxic element (Nriagu, 1988). Significant problem associated with cadmium is phytotoxic and zootoxic. Cadmium toxicity affects human health, which can cause serious damage to organs (mainly kidney and liver) by eating cadmium contaminate in food (Roberts et al., 1994). Cadmium enters the environmental pathways through the industrial wastes such as metal plating, cadmium-nickel batteries and mining pigment (Adriano, 2001; Cordero et al., 2004), and the agriculture such as phosphate (P) fertilisers. P fertiliser can be reached the food chains and it is considered to be main source of cadmium. High cadmium concentration accumulation in pasture soil passes through phosphorous fertiliser that can be observed in many countries such as New Zealand and Australia (Roberts et al., 1994). Phosphate rocks (PRs) is known as a major source of cadmium. PRs are the main raw materials used for the manufacturing of phosphate fertilisers. The cadmium content levels in all PR samples ranged from 0.15 to 507 mg/kg (Swe Swe and Okazaki, 2012). The uses of P fertiliser may increase the level of soil P, in a meanwhile bring Cd contamination to soil. The methods which have been used to remove heavy metals ions are chemical precipitation (Matlock et al., 2002), ion-exchange (Feng et al., 2000) and electrodialysis (Mohammadi et al., 2005). All these processes have various disadvantages such as specific condition, high capital investment and operating cost, incomplete removal, low selectivity, high energy consumption and generation of residual sludge (Celaya et al., 2000). Adsorption is a well-established technique for heavy metal removal. At present, the biosorption is potential alternative to existing method for heavy metals removal (Wang and Chen, 2006; Wang and Chen, 2009). The advantages of biosorption include low cost, highly availability, possible reuse, high adsorption capacity and flexible operation.

The biosoil is one of alternatives that uses as effective biosorbent to adsorb phosphorous and cadmium. The alkaline stabilised soil or biosoil is employed to reduce the leaching of P and Cd into soil. As the alkaline stabilised soil contains highly content of organic matter (OM) and alkaline materials, which are able to retard P and Cd by adsorption and stabilisation, respectively. The biosoil or organo-soil is made through alkaline

stabilisation process by mixing between biosolids, which is derived from biological treatment wastewaters and alkaline materials such as fly ash and quick lime (Logan and Burnham, 1995). The use of activated sludge biomass as adsorbent also offers a potential alternative to existing methods for heavy metal removal (Aksu et al., 2000). The cell walls of activated sludge biomass, essentially consisting of various organic compounds such as chitin, lipids, amino acids and other cellular components offer many functional groups, which can bind metal ions such as carboxylate, hydroxyl, sulphate, phosphate and amino groups. The alkaline stabilisation process can minimise the pathogen and odour. Moreover, the biosoil that used in agricultural can be divided into two categories: class A and class B biosolids. The pathogen in class A biosolids must be completely killed but the class B biosolids may contain a reduced level of pathogens. The biosoil has many advantages such as used to landfill cover material, land remediation, use or as topsoil blend in agricultural (USEPA, 2007).

Moreover, the mobilisation of metals in soil can be reduced through chemical and biological immobilisation using a range of soil amendments such as lime, phosphate fertilisers and stabilised alkaline biosolid compost (Adriano et al., 1982; Basta et al., 2001; Bolan et al., 2003a; Boland et al., 2003b). The mechanisms have been referred to the effect of inorganic (phosphate compounds) and organic (biosolids) amendments on the restoration of metals in soil, which are enhanced metal adsorption (Adriano., 2001), precipitation of metals bonded phosphates, carbonates or hydroxides (Basta et al., 2001) and formation of insoluble metal-organic complexes in the presence of organic amendments (Naidu et al., 1996; Senesi,1992). This research aims to examine the optimum ratio between sewage sludge and alkaline material, maximise cadmium and phosphorous adsorptive capacity, highly stabilised and storage cadmium and influences of phosphorus on cadmium sorption onto biosoil. The concepts in demonstration study in the microscopic scale.

1.2 Objectives

This research aims to produce the biosoil via the alkaline stabilisation process. The biosoil is demonstrated to either adsorb cadmium (Cd) and phosphorous (P). Furthermore, this research examines the influence of phosphorous towards adsorption of cadmium onto biosoil. The objectives of the research are:

1. To estimate the suitable ratio between alkaline materials to sewage sludge.
2. To examine the characteristics of alkaline stabilised biosoil and the cadmium and phosphorus sorption capability.
3. To evaluate the mechanism between cadmium and phosphorus and biosoil during and after sorption process.
4. To examine the mechanism of phosphorus on cadmium sorption ability onto biosoil

1.3 Scopes

To be completely achieved all objectives, the scope of thesis is established as follows.

1. The sludge samples were collected from Sittinan (St) Co. Ltd., Pathumthani, Thailand.
2. The commercial grade of quick lime (CaO) is employed. A fly ash is also obtained from Sitthinan Co. Ltd, which is residue of biomass burning boiler were used as the alkaline materials.
3. The cadmium synthesis wastewater was prepared $Cd(NO_3)_2.4H_2O$.
4. The adsorption capacities of biosoil samples were evaluated by the batch test.
6. The stability of restoration of cadmium in biosoil was examined using the sequential extraction process.
7. The functional groups of biopolymer and biosorbed cadmium and phosphorous can be examined through FTIR spectroscopy.
8. The interaction between biosorped phosphorus and cadmium can be analysed by XRD technique.

1.4 Expected research outcomes

This research can access the possibility of biosoil in term of agronomic utilisation. The expected outcomes are:

1. The suitable ratio between alkaline material and sewage sludge for producing biosoil,
2. The mechanism between P and biosoils, and
3. The stability of sorbed Cd onto biosoil.

1.5 Chapter organisation

This thesis was separated into five chapters, the statement of problem was overviewed in Chapter 1. The literatures were reviewed in order to set up the research hypothesis as given in Chapter 2 Literature Review. Chapter 3 Experimental Setup provided the details of experimental design that has materials and testing methods used for determinations, these were the tool to prove the established hypothesis. Chapter 4 Results and Discussions contained the analytical data and findings of the experiments. The conclusion of this research was presented in Chapter 5 Conclusions. Schematic diagram for research framework is illustrated in Figure 1.1

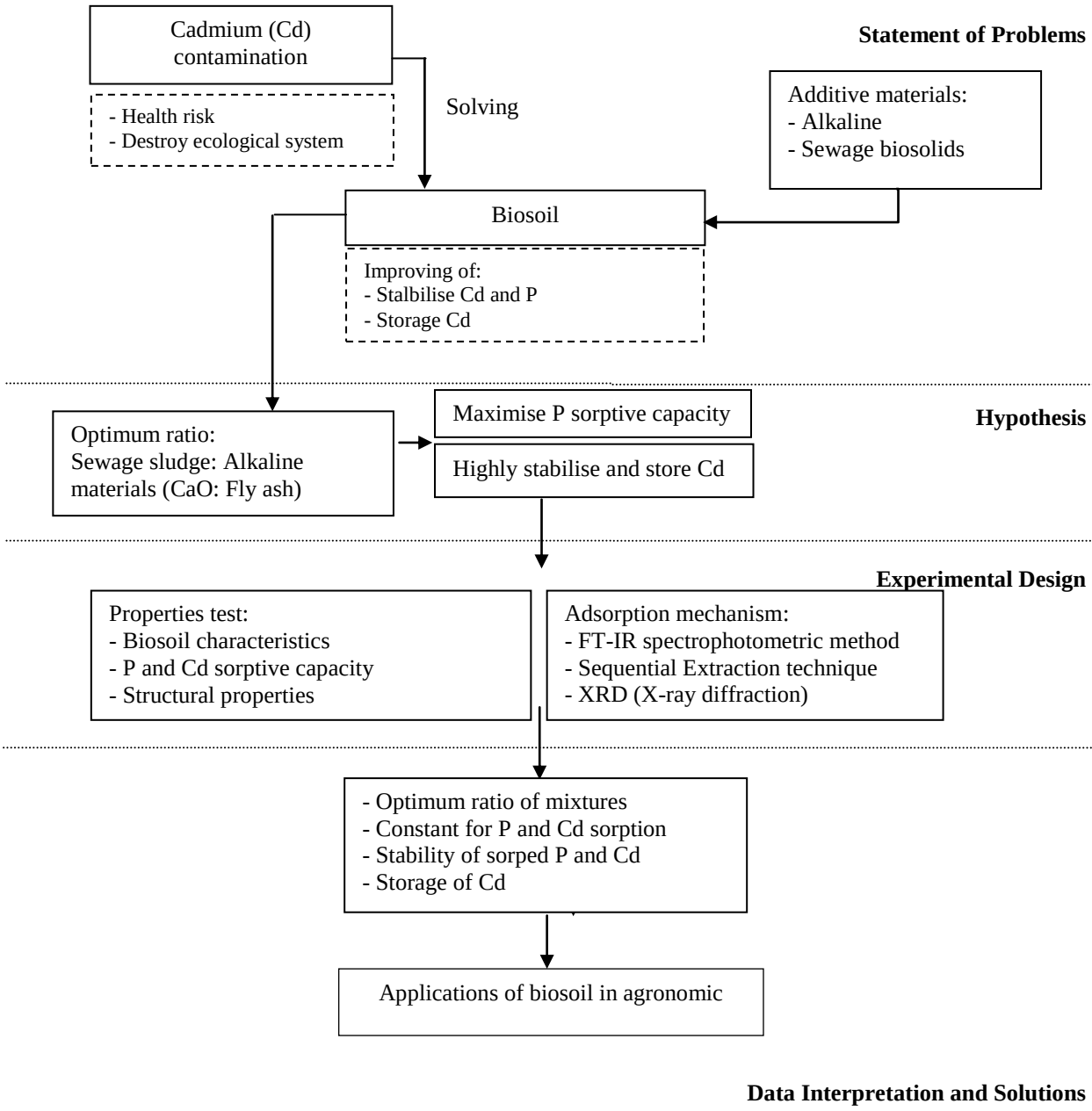

Figure 1.1 Schematic diagram for research framework