CHAPTER ONE

INTRODUCTION

In a typical electric arc furnace (EAF) steelmaking operation, the high temperatures and turbulence developed results in the vaporisation of 1 to 2 % of the charge. These vapours subsequently react with oxygen and condense on available sites, quite often on particles mechanically carried out of the bath, and report to the baghouse.

About 650,000 tons/year of EAF dust are generated in the United States (Zunkel and Schmitt, 1995), containing between 100,000 to 160,000 tons/year of zinc and 200,000 to 260,000 tons/year of iron. In addition, these dusts contain lead, cadmium, chromium, nickel, and halides in significant amounts.

In August 1988, EAF dust was classified by the Environmental Protection Agency (EPA) of the United States as a hazardous waste and designated K061 because it fails the EPA's Toxicity Characteristic Leaching Procedure (TCLP) test for lead, cadmium, and chromium. Until recently, EAF dust was manage by disposal in a secure landfill, treated to render it nonhazardous. However, a recent ruling by EPA, to be discussed in more detail later, now allows for the dust to be stabilised and disposed of in landfills if it meets the TCLP test requirements.

The alternatives presently available to steelmakers to manage EAF dust include :

1) shipping to and offsite processor,
2) process onsite themselves or via a contractor, or
3) stabilise/glassify and dispose or sell the product.

These alternatives are becoming increasingly restrictive and expensive because of the limited number of domestic offsite processors, limited success of emerging technologies.

The stabilised and dispose option may become increasingly available but the legal viability of this option is not yet fully clarified.

In Thailand, about 60,000 tons/year of EAF dust are generated. The Thai Department of Mineral Resources has classified EAF dust and reported that the range of composition of EAF dust is 1-30% zinc, 20-60% iron, 0.01-0.5% cadmium and trace elements of chromium(VI), aluminium, and copper. All of these dusts are sent to landfill. The majority of the dust is from carbon steel producers with a lesser amount coming from stainless steelmakers.

Treatment of EAF dust creates several important opportunities. First, significant and valuable quantities of already mined and concentrated zinc and iron can be recovered and returned to the economic cycle. This latter point is particularly important because Thailand is a significant importer of zinc and iron. Second, a hazardous waste can be rendered innocuous and its products safely re-enter the environmental cycle.

A number of major issues face steelmakers as they contemplate their future options for management of EAF dust. Tipping fees are continuing to rise and the number of available processors remains quite limited. New technologies, both hydrometallurgical and pyrometallurgical, continue to emerge, all claiming to be the answer to the steelmaking problems. However, many of these processes continue to fall short of expectations, technically, economically, and environmentally.

The process for treating EAF dust from carbon steelmaking can be classified into either pyrometallurgical or hydrometallurgical methods which produce either zinc oxide or metallic zinc. There are numerous technologies available for the pyrometallurgical treatment of EAF dust. High temperature processes for the recovery of zinc such as, Waelz kilns and Plasma reactor offer attractive benefits, including the potential for recovering iron values; however, most are still in the development stage and some are not successful due to technical and economic reasons.

The dust used in this study were generated at Smorgon Steel Works, Laverton North, Victoria, Australia. This steel company produces about 650,000 tons/year of steel product from EAF. All of the feed charge are carbon and stainless steel scrap. Approximately 10,000 tonne of EAF dust is generated per annum at Smorgon Steel Works. The EAF dust collected from the filters in baghouse is collected in the adjoining pelletiser. The pelletiser simply consists of a roating drum into which town water is added to bind the dust into small pellets. There are no other additives, such as a binder that is included with the water (Wycherley and Costabile, 1998). Presently, all dust is sold to the Waste Treatment Company. The EAF dust from this steelwork contains zinc and iron as the major elements.

The aim of the present study was to examine the technical feasibility of recovering zinc and iron from EAF dusts. The overall objective was to produce metallic zinc, recover the iron as iron oxide, and reduce hazardous elements.

The recovery of zinc as a metallic zinc is more usable because zinc oxide product has to be processed to obtain metallic zinc. The returning iron oxide to the ironmaking or steelmaking process would enable steel production to be increased without increasing the load. The benefits of such a treatment process would include :

1) recovery zinc as the metallic zinc,
2) increased steel production,
3) utilisation of a waste product,
4) possible economic saving by avoiding the cost of dumping, and
5) elimination of a potential environmental hazard ; via, the dump site or reduce hazardous element by processing.

To achieve this aim, Chapter 2 gives a review of the literature of the EAF dust characterisation and the methods of treatment in both pyrometallurgical and hydrometallurgical processes as well as the detailed analysis of the iron-reduction distillation process. Chapter 3 lists the objectives of this project. Chapter 4, the thermodynamic considerations of the EAF dust treatment are explained. Chapter 5 describes the experimental methods of the iron-reduction distillation process. The results of the experiments are given in Chapter 6. These results are discussed and the kinetic model of the reduction of zinc oxide by metallic iron are given in Chapter 7. Chapter 8 concludes the outcomes of this study. Finally, the recommendations for future works are also given in Chapter 9.