APPLIED WASTE MANAGEMENT TECHNOLOGY: IN–HOUSE RECOVERY OF METALLIC ZINC FROM CONTINUOUS GALVANIZING DROSSES

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ABSTRACT

Waste management studies in the continuous galvanizing industry suggest that every galvanizing company knows the market price for zinc, but it can be debated that few know the true value of the top drosses they generate during production. Data collected in recent years indicates that recoverable metallic zinc from continuous galvanizing drosses can be as high as 90% of the weight of material collected. Dramatic increases in the price of zinc during the time of the study have made it increasingly important to control every aspect of waste. Typically, the only option for dross recycling has been to sell it to traders willing to pay up to 75% of LME zinc rate. Continuous galvanizers now have an opportunity to improve their position by processing their drosses on-site to yield technically and commercially acceptable zinc for re-introduction into their process baths. This paper will describe in detail the constituent procedures for in-house dross processing and will give reference examples of actual savings at industrial galvanizing facilities.

Keywords: Waste Management, Top Dross, Zinc Recovery, Continuous Galvanizing

INTRODUCTION

Minimization of processing wastes is imperative for any manufacturing operation, but it is especially important in the steel industry where small variations in scrap may have a tremendous impact on profitability. The largest source of zinc waste for galvanizing plants is zinc drosses and residues from the molten galvanizing bath. Dross forms as a result of intermetallic reactions with the iron in the bath that has been introduced by the steel sheet being coated. In a continuous galvanizing line (CGL), the zinc bath possesses a specified amount of aluminum (0.12-0.3wt%Al) to generate the desired coating structure. Looking at the zinc-rich corner of the Zn-Fe-Al phase diagram [Figure 1], the Fe solubility and subsequent dross compounds can be observed for each of the galvanizing regimes.

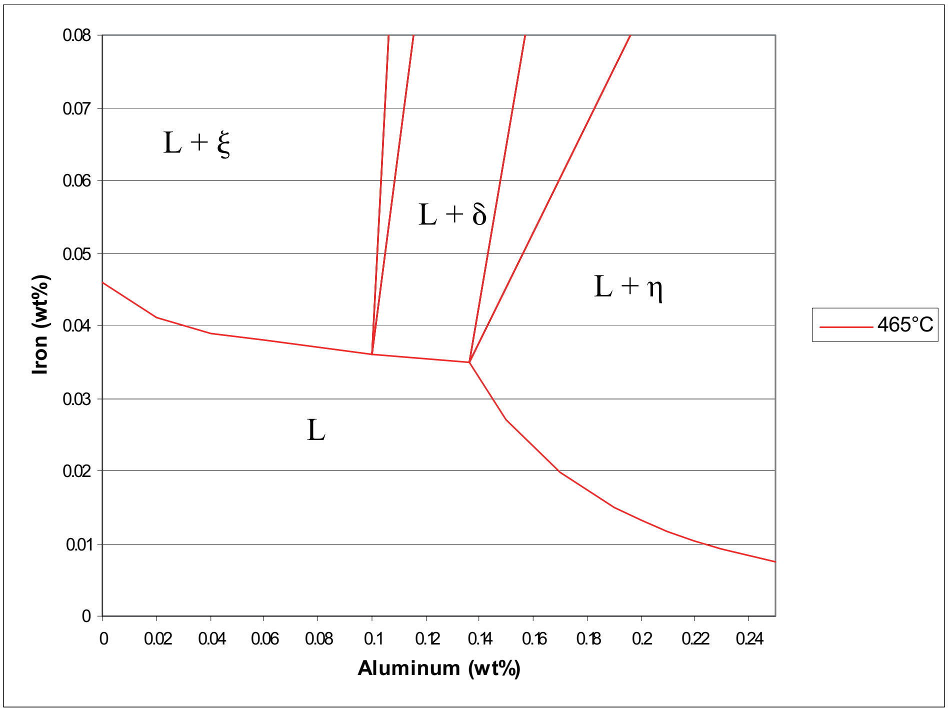

Figure 1 Zinc-Rich Corner of Zn-Fe-Al Ternary Phase Diagram at 465°C[1)]

In a continuous galvanizing pot, floating “top” dross consists primarily of Fe_2Al_5 (η) while the dross on the bottom of the pot is $FeZn_{10}$ (δ)[1,2]. Typically, a substantially greater amount of top dross is formed relative to bottom dross. However, during standard cleaning procedures to remove the accumulation of top dross, a tremendous amount of “clean” metallic zinc is also extracted from the galvanizing pot and may contain up to 95% usable zinc[3]. In 2003, DuBois[4] noted that CGL drosses contain minimal amounts of oxide particles (<1%) and the percentage of zinc entrained in the removed dross volume is proportional to the operator skimming practices. Hence, when these drosses are discarded and sold to recycling or metal trading companies, a phenomenal amount of “good” zinc is also being lost with the waste material.

Obviously most galvanizing and metal coating companies are knowledgeable about the daily market price for primary zinc and alloying compounds used in the galvanizing process. Similarly, they also possess a detailed understanding of all major operational costs and plant productivity values. However, limited awareness exists that business profitability can be enhanced by realizing the true value of the top drosses and zinc process wastes generated during their galvanizing production process.

Options available to enhance zinc waste reduction have been limited both in scope and in the magnitude of return on investment. Improved drossing procedures and general housekeeping (including automated robots) have had a minor impact on reducing zinc content in discarded dross. Additionally, small increases in the LME percentage payment from traders for purchased drosses and waste have slightly eased the pain of rising zinc costs. Nevertheless, zinc prices are having a greater impact on the production costs of hot-dip galvanized (HDG) steel. “Zinc is now reported to account for 25% to 30% of the cost of HDG steel, as compared to around 5% before the price of zinc headed skywards[5].” Hence, steel companies must now start to consider alternative technologies for minimizing their zinc consumption such as tighter coating weight control and recycling of metallic zinc waste materials.

IN-HOUSE RECOVERY OF ZINC FROM DROSSES AND WASTE

Two major factors exist which make in-house recovery of metallic zinc from discarded drosses attractive: (1) the rising price of virgin zinc and (2) the availability of a simple, effective, low cost zinc recovery processing system.

In early 2006, the price of primary zinc and zinc alloys used in galvanizing and coating processes rose above US$3000/tonne and has remained above that level ever since (Figure 2). Market conditions indicate that zinc prices will continue to trade at high levels for the anticipated future[6-10].

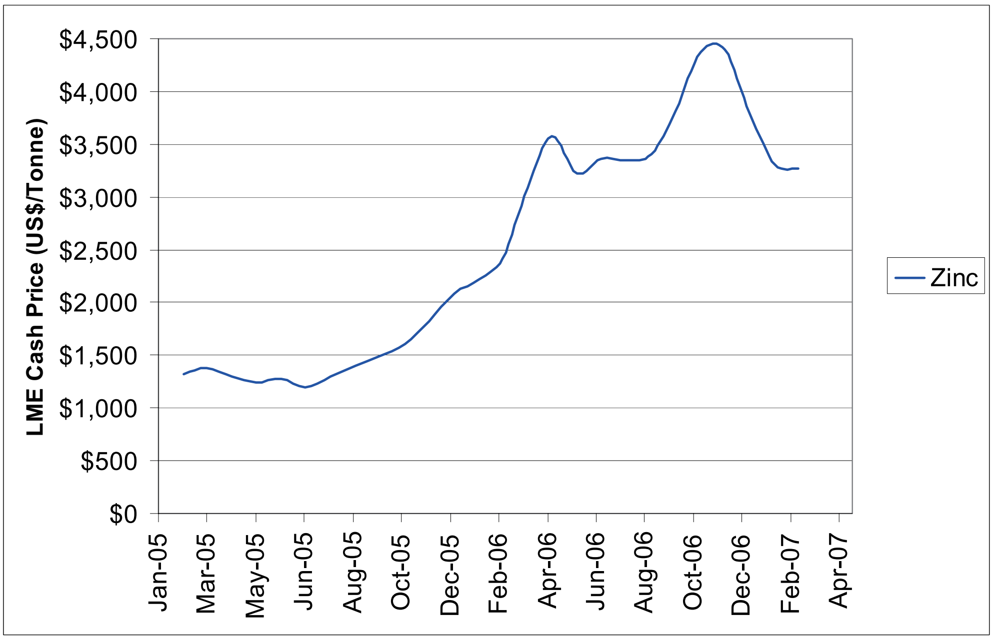

Figure 2 LME Cash Price for Primary Zinc Ingot[11,12]

Thus, the need for galvanizing operations to minimize the quantity of discarded functional zinc is becoming more economically important. Analogously, this need has been satisfied in the general hot dip (batch) galvanizing industry through the use of in-house recovery of zinc from drosses and waste. Implementation of these recycling procedures may now be applied to continuous coating and galvanizing operations to enhance zinc retention.

A thermo-mechanical device has been developed[13-15] which by means of its construction, operational capability and processing procedural specification, allows free zinc or its alloys present in industrial wastes and drosses to be separated and collected for re-use in the original coating process. In this patented processing equipment designed to apply the technology of separation, a mixture of materials of different but similar melting points is subjected to indirect heat while being tumbled and stirred. Melting starts and is encouraged by the continuous tumbling action under the sustained application of heat until a point is reached where liquid metal and dross segregate due to a density differential. The liquid metal collects at the base of the process barrel and can be tapped into an ingot mould (Figure 4). The dross, which floats on top of the metal during processing can be either discarded per typical dross procedures or retained in-situ and further processed to form a residue valued by zinc chemical producers.

Figure 3 Dross Processing Furnace (patented)[14]

Figure 4 Pouring Recovered Zinc from Galvanizing Dross[15]

With regards to recovered zinc quality, Table 1 provides an outline of the ICP (Inductively Coupled Plasma) analysis of a representative processing run. Approximately 556kgs. (1223 lbs.) of top dross from a continuous galvanizing pot were heated for 4.5 hours with over 524kgs. (1153 lbs.) metallic zinc extracted, resulting in a metal recovery in excess of 93%. Furthermore, the zinc purity of the recovered metal was >99.6wt% Zn and was analogous to the chemistry of the production galvanizing bath. Previous research[16] has indicated that controlled usage of secondary recycled zinc ingot in galvanizing operations can provide a functional enhancement to primary zinc supply. Moreover, the zinc-depleted residual material from the recovery process was still viable for sale at a reasonable rate due to the Zn content entrapped in the intermetallic dross.

Table 1 Identification of Zinc Chemistry for Input and Output Products from Processing Dross

	Dross Analysis	Recovered Metallic Zinc	Residual Mat'l
Zn:	98.2	99.6	85.12
Fe:	0.135	0.049	1.673
Al:	0.606	0.324	4.885
O:	0.0073	<0.001	8.31

Meanwhile, metallic zinc recoveries recorded are wide and varied and associated values attributed to them are subject to different accounting procedures and metal prices which move daily. However, two examples indicate what probable improved returns can be expected from a 500 t/year dross generating facility which currently sells its dross to a trader. Table 2 illustrates the extra returns possible when a trader pays 70% of LME for zinc and Table 3 illustrates the possible extra returns when the trader pays 75% LME for zinc.

Table 2 Possible returns when a trader pays 70% of LME for zinc

Dross:	500t/year.
Trader Value:	70% LME of Zinc
Recovery Value (90%)	450 tonnes
Trader Returns. (Equivalent Value).	350 tonnes
Premium Metal Purchase (After Payment of LME Premium)	335 tonnes
Balance.	115 tonnes.

Table 3 Possible returns when a trader pays 75% of LME for zinc

Dross:	500t/year.
Trader Value:	75% LME of Zinc
Recovery Value (90%)	450 tonnes
Trader Returns. (Equivalent Value).	375 tonnes
Premium Metal Purchase (After Payment of LME Premium)	360 tonnes
Balance.	90 tonnes.

CONCLUSIONS

- Rising primary zinc prices have reached historic levels and are greatly impacting the raw material costs of galvanized steel production.

- The quantity of metallic zinc contained within the waste materials of galvanizing facilities is extremely high and drosses which are discarded from a molten zinc pot may exceed 90%.

- Implementation of defined in-house procedures by galvanizing operations could help extract higher fractions of valuable zinc from their process wastes.

- The application of a zinc recycling system, designed to allow the recovery of technically acceptable and commercially attractive zinc from drosses and wastes, can provide a source for enhancing zinc inventories.

- Waste management technology applied in-house is a highly attractive option to satisfy environment legislation while offering opportunities to make significant commercial returns.

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