UTILIZING PUMPS TO CONTINUOUSLY REMOVE DROSS FROM INSIDE THE INLET SNOUT.

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INTRODUCTION

What are the zinc pot operational problems most frequently experienced on continuous hot dip GA or GI line? Based on a recent informal survey of North America, and some European facilities, conducted by Metaullics Systems Co. L.P, a manufacturer of submerged roll bearings and dross removal components, they include “Flaking Contamination”, “Zinc Dust”, Top Dross contamination, Transition issues, Roll build-up, Roll lock-up/Skidding, Vibration/Flutter, and inadequate Sink Roll Bearing Life. *The first five operating issues have resulted in a number of companies investing in mechanical means to continuously remove debris and dross from within the inlet snout.*

With the installation of these devices, the subject companies have seen, or expect to see, a reduction in the effect of flaking and zinc dross on the sheet surface, shortening of the period of time required to transition from GA to GI, and a slowing down of dross build-up on the sink roll. Overall, an increased quality level of the surface coating has been achieved by a number of manufactures involved with supplying hot dip galvanized sheet.

Currently, the preferred technologies for removing the dross from inside the snout are specially designed pumps. The two types of pumps discussed in this writing are the MetJet® Jet transfer pump and the D13-SD centrifugal pump, fitted with special alloyed wearing parts.

We will first discuss the results of the aforementioned survey, with a short description of each issue addressed in the survey. Secondly, we will discuss the construction and features of both the patented Jet pump and the MSA centrifugal pump, and finally compare the two.

SUMMARY OF INDUSTRY SURVEY

The data contained within the survey, taken during the period of March-July 2001, has been compiled from 34 different facilities located in the USA, Mexico, Canada, Finland, and The UK. This encompasses 58 lines using a variety of processes including galvanizing, galvanneal, and galvalume. Though it is understood that each process has its own unique set of operational priorities within the zinc bath, for simplicity purposes they will we viewed as one group when reviewing the survey results. This is easily justified as long as it is understood that all of the issues discussed, with the exception of "transition", do apply to each of the process but in different magnitudes. Which issue represents the most concern for a particular facility, is dependent on the plants standard operating procedures, and a number of other variables, many of them outside of the zinc pot itself.

The sheet produced within the subject facilities can be used in the fabrication of a variety of finished products. These range from automotive components to building and construction components. Generally speaking, they can be broken down into the following groups:

Finished Products Included In Survey
Automotive Exposed/Painted
Automotive Unexposed
Construction Painted
Construction Exposed
Construction Unexposed

Based on discussions with the subject facilities, it seems that the first three listed product categories have higher surface quality standards, normally resulting in more attention being paid to technologies capable of improving the surface appearance. However, all companies surveyed showed an interest in the technologies directed at increasing the campaign life of a normal run.

The major issues within the zinc pot, as indicated by the survey, include Flaking, zinc dust, top dross (general), transition issues, roll build-up, skidding, vibration/flutter, and low sink roll bearing life.

- **Flaking-** Iron oxide builds up in the furnace during a shutdown, leading to large particle "flakes" and refractory dropping into the snout during start-up.
- **Zinc Dust-** Vaporizing of molten zinc bath during a shutdown. Sits on bath surface, adhering to inside of snout.
- **Top Dross General-** The impression that dross sitting on the surface in the inlet snout has the tendency to adhere to the sheet surface affecting coating quality.
- **Transition Issue-** Lines that produce both galvanize and galvanneal coated sheet, will experience a period of time where bottom dross "becomes" top dross.

- **Roll "Build Up"-** When the bath dross or top dross adheres to the sink roll, causing a thick layer to form on outside edge and fills in roll grooves.
- **Skidding-** Caused on sheet finish when correcting or stabilizer roll does not turn freely. Roll lock up.
- **Vibration/Flutter-** Can occur at start-up until bearings set. Can occur during normal operation with bearing wear. Has direct affect on the ability to control film thickness.
- **Low Sink Roll Bearing Life.**

Typical Inlet Snout

Keep in mind that these issues are not the only common problems experienced on a hot dip galvanizing line. They are only those that were most commonly found in the zinc pot. *The results of the subject survey can be found in the table below. The chart below the table ranks the "dross related" issues more specifically to the coating type.*

If your line is experiencing any of the first five of the eight most common operational issues listed, then installing continuous snout dross removal pumps is something you should consider. If flaking or zinc dust occurs, then the pumps can remove it on a continuous basis, not allowing them to affect sheet quality. In theory, part of the dross contributing to roll build-up is coming directly from underneath the snout, particular if your annealing furnace is not sealed tightly. Removing the dross from under the snout, and away from the strip face as it enters the bath, should result in a noticeable improvement in surface quality and also help reduce roll build-up.

Areas of Concern	Number of Sites	% of Sites
Flaking	8	23%
Zinc dust	5	15%
Top Dross-General	11	32%
Transition	5	15%
Roll Build-up	13	38%
Roll Lock-up/Skidding	10	29%
Vibration/Flutter	4	12%
Sink Roll Bearing Life	30	88%

Summary of Survey Results.

Typical Dross Affected Issues On Hot Dip CGL Line

Galvanize-850 Deg F	Galvanneal-850 deg F	Galvalume-1200 Deg F
.14% to .22% Al content Aluminum rich "Top Dross"	.12% to .14% Al content Iron rich "Bottom Dross"	45% to 55% Al content "Both Types of Dross"
1. FLAKING 2. TOP DROSS-GENERAL 3. ZINC DUST 4. ROLL BUILD-UP	1. TRANSITION 2. FLAKING 3. ZINC DUST	1. FLAKING 2. ROLL BUILD-UP 3. Zinc Dust

Chart indicating Dross Related issues per Process.

Next, we will discuss the proven pump technologies currently available for continuous snout dross removal.

<u>Considerations when Evaluating Continuous Snout Dross Removal Pumps.</u>

Simply speaking, a snout dross removal pump is a cost effective, simple means to continuously remove dross from under the snout and transfer that dross to a specific area within the zinc pot where it can be easily removed. Any pump chosen for this duty must meet the following minimum criteria:

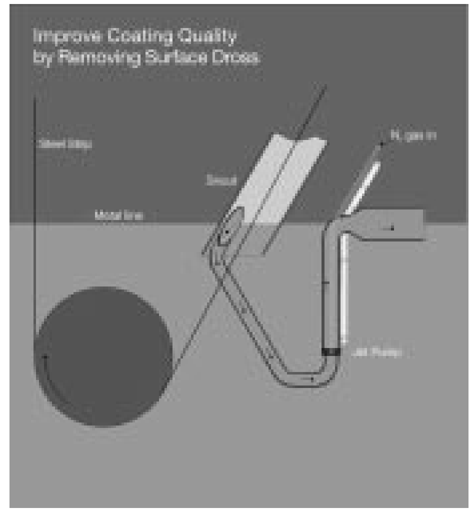
1. Have materials of construction conducive to a molten zinc/aluminum environment.
2. Be capable of pumping solids up to ¼" inch diameter.
3. Be able to operate trouble free for extended periods.
4. Be relatively lightweight and have a small envelope mounting size.
5. Must be economically justifiable to install and operate.

All of the above considerations are self-evident with the possible exception of the requirement to pump at least up to ¼" diameter solids. Keep in mind that you may want to use the pump to be able to pump out flaking debris and under certain circumstances pieces of the annealing furnace refractory, from inside of the snout. It is not uncommon for these articles to achieve at least a size of ½" diameter.

It is extremely important that the pump be very robust and reliable. Remember that the pump will be installed in and over an 850 degree F. molten metal bath. Not exactly the best place to be performing pump maintenance. Also, there is a temperature gradient issue to consider. The high temperature difference experienced within the pump during installation can cause high thermal stresses. It is usually an advantage to choose a pump that is capable of handling these high thermal stresses without the need for an extended “heat-up” period.

There are two pump designs that currently meet the above listed criteria and have been installed as snout dross removal pumps. They are the Metaullics© MetJet® jet pump and the Metaullics D13-SD centrifugal pump.

Metaullics Patented MetJet® Jet Pump



The Metaullics patented MetJet® jet pump uses compressed nitrogen forced through specifically sized orifices to generate a vacuum effect, effectively pumping the top dross and surface suspended dross from under the inlet snout to a specific surface point within the zinc pot.

Two pumps are normally mounted in the snout, continuously removing dross from the front corners. This is done to take advantage of the strip action as it enters the bath, which forces the dross to the snout corners. *Removing this dross continuously does not allow the dross to coagulate and build up to the point where it will start adhering to the sheet surface.*

MetJet® patented Jet pump.

The MetJet pump is capable of easily handling up to 2” diameter solids, which is an advantage over the centrifugal design under certain conditions.

The pump construction is summarized as follows:

- 316L ss Housing
- 3” Diameter Suction Pipe.
- 4” Diameter Outlet Pipe
- 12”x8” Discharge.
- 316L ss Jet Housing, w/MSA2020 Inserts.
- Flanged Jet Assembly.
- 3/4” Diameter Nitrogen Inlet Pipe. 316L ss.
- Approximate Wt: 260lbs

This pump can easily pump up to 2,750 lb/hr of molten zinc/aluminum, using a maximum nitrogen flow rate of 25 scfm. *The other features of the MetJet Jet pump are*

- *Simple Pump Operation and Control*
- *Low nitrogen usage.*
- *Variable flow rate.*
- *No moving parts.*
- *Smooth inlet and outlet flow.*
- *Easily pumps 2" diameter solids.*
- *Lightweight, approximately 260 lbs.*
- *Easy mounting.*
- *Small envelope size.*

The other proven pump design to consider for this application is the centrifugal D13-SD.

<u>Metaullics D13-SD Centrifugal Pump</u>

The D13-SD has a long history as a transfer and circulating pump, first utilized in the zinc die casting industry. Approximately four years ago, the transfer design was modified with a "u-shape" inlet pipe assembly, a side discharge, and fitted into a galvanizing line as a snout dross removal pump. The original pump was supplied in all 316ss construction and performed its duties very well. The only issue was the short life of the 316ss wear components.

In 1997 Metaullics developed and patented a family of superalloys, called MSA materials, specifically alloyed to operate in molten zinc/aluminum alloys. These new alloys were incorporated into the wearing components (casing, impeller, and shaft) of a number of installed D13 pumps approximately 2 years ago. ***The new MSA components consistently outperformed the identical 316L ss components by a factor of 10:1 relative to operational life.***

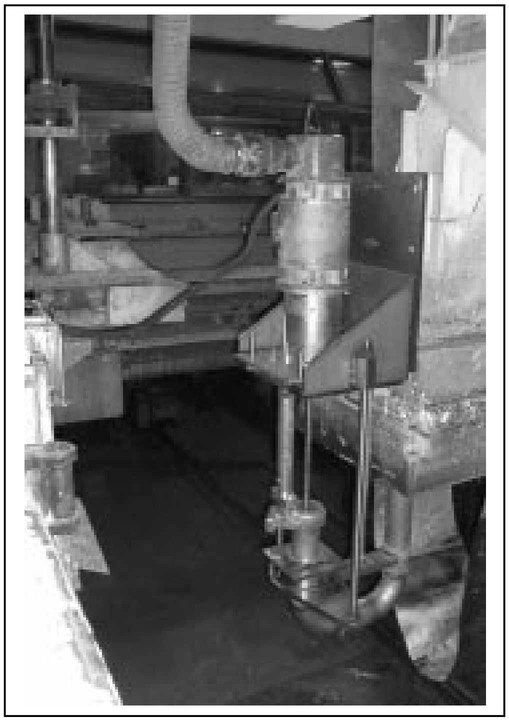
The family of MSA's materials has certain material properties that make them ideally suited for use in molten zinc/aluminum alloys. They exhibit low solubility in zinc/aluminum solutions. The high carbide structures within the material lower aluminum diffusion rates. The non-wetting surface is extremely hard. And finally, they all have high thermal dimensional stability resulting in excellent thermal shock resistance. In simple and general terms, MSA's achieve their material properties from the following:

1. The formation of strong covalent bonded molecules, promoted to generate a microstructure rich in hard and steady carbides. Moreover, maximizing the formation of carbides by proper selection of the carbon ratio to carbide forming elements.

2. The promotion of a thick and complex inter-metallic region.

3. By choosing alloying elements that narrow the gamma iron region.

These are the reasons the MSA2000 wear components in the D13-SD pump are capable of outperforming the 316L SS so significantly.



D13-SD Snout Dross Removal Pump

The D13-SD is normally fitted into the front corners of the snout, using a custom fabricated mounting bracket. An air or electric motor, depending on the preference of the user drives the pumps. The pump pulls the dross from under the snout and discharges it directly into the zinc bath, approximately 24" below the surface. This differs from the Jet pump in that the Jet pump discharges the dross on the surface of the bath. The D13-SD is capable of pumping up to ½" diameter solids.

The standard construction of the D13-SD pump is:

- Cast Iron Mounting Plate.
- MSA2000 shaft, Impeller, and Casing
- 316l SS riser Assembly.
- 1 1/2" submerged discharge.
- 2 ½" Inlet
- Approx. weight with air motor is 280 lbs.

The D13-SD has many of the same features of the Jet pump. The major difference in the pumps is their ability to handle solids. The Jet pump can handle up to a 2" diameter solid, where the D13 is limited to ½". Also, the Jet pump seems to more forgiving relative to the bath height fluctuations. Comparison of the two technologies can be found on the following page.

CONCLUSIONS

The installation of a pump to continuously remove dross from inside of the snout and prevents the accumulation of the top dross which can lead to surface contamination and additional roll build-up. In addition, a pump can help eliminate the effects of flaking and zinc dust on surface quality. Finally, operating a pump during the transition period to transfer the dross to a specific part of the zinc pot, away from the entering strip, will keep the inlet snout clean from dross build-up.

MetJet	Feature	D13-SD
1300 Kg/min	**Maximum Realistic Flow Rate**	1000 Kg/min
60 Days	**Time Between rebuilds**	140 Days
Lower	**Mounting Envelope size**	Higher
Up to 2”	**Maximum Solids Size**	Up to 1/4”
Lower	**Typical Rebuilding Cost**	Higher
Good	**Intermittent Operation**	Better
Higher	**Energy Costs**	Lower