3M Purification Inc. Filtration Solutions for Hot Dip Galvanizing Processes

Introduction

The Hot Dip Galvanizing (HDG) process involves the application of a zinc film / coating to steel parts for corrosion protection. Zinc seals the underlying steel from contact with its environment. In the HDG process, a piece of steel is immersed for a set amount of time in the zinc solution in order for the metallurgical reaction between zinc and iron to reach completion.

It is necessary for the steel parts to be pre-treated with a pickling (acid) solution to ensure proper adhesion of the zinc coating on the steel parts. Proper filtration of the pickling bath solution is required to prevent the contaminants reduced in the pickling process (rust, mill scale) from building up in the system.

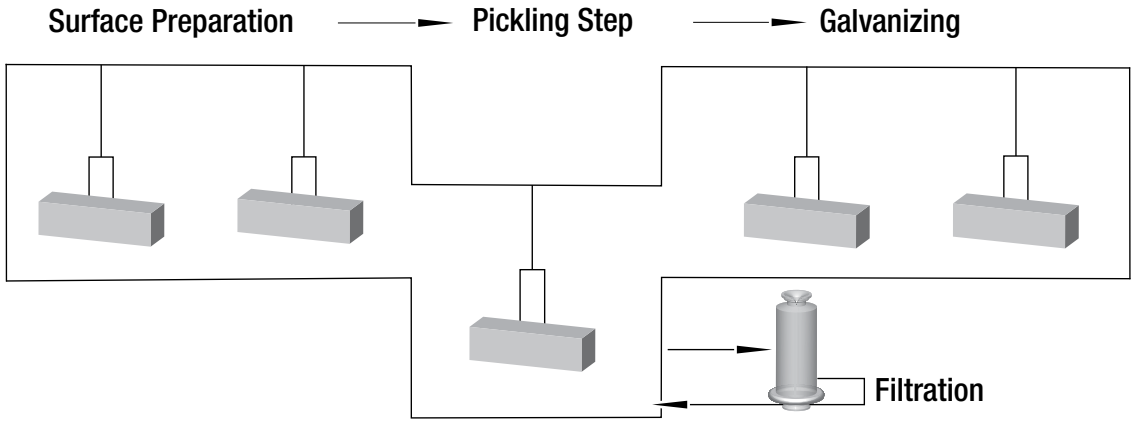
While there are several potential opportunities for filtration in the HDG process, this customer application brief is focused on the benefits of proper filtration of the pickling solution, and provides guidelines for selection of the appropriate 3M Purification Inc. filter solution.

The Process

The HDG process has existed for more than 250 years and is used on a wide range of steel products. Though the process may vary somewhat from plant to plant, the fundamental steps in the HDG process are as follows:

- Soil and grease reduction: A hot alkaline solution reduces dirt, oil, grease, and any soluble markings.
- Pickling: Dilute solutions of either hydrochloric or sulfuric acid reduce surface rust and mill scale to provide chemically clean metallic surfaces.
- Fluxing: The steel product(s) are immersed in a liquid flux (usually a zinc ammonium chloride solution) to reduce oxides and to prevent oxidation prior to dipping into the zinc bath. In a “dry” galvanizing process, the products(s) are dipped in a separate liquid flux bath, reduced, allowed to dry, and then galvanized. In a “wet” galvanizing process, the flux floats on top of the molten zinc solution and the product(s) pass through the flux immediately prior to galvanizing.
- Galvanizing: The steel product(s) are immersed in a bath of molten zinc (at temperatures between 815-850 F). During galvanizing, the zinc metallurgically bonds to the steel, creating a series of highly abrasion-resistant zinc-iron alloy layers.
- Finishing/Inspection: After the steel product(s) are withdrawn from the galvanizing bath, the excess zinc is reduced - usually by draining and/or vibrating. The galvanized product(s) are then air-cooled or quenched in liquid. The final steps in the HDG process consist of coating thickness measurements and surface condition inspections.

A schematic of a typical galvanizing process is below in Figure 1.



The Problem

As described above, proper pickling of the steel parts is critical to ensuring proper adhesion of the zinc coating on the steel parts. To maintain proper control of the pickling process, target acid and metal (iron) concentrations are maintained.

If the iron levels in the pickling bath solution rise above acceptable levels, it is often necessary to dump the acid bath, incurring the following costs:

- Waste treatment associated with disposal of acid solution
- Fresh acid for pickling bath replenishment

To extend the useful life of the pickling bath solution, it is common to use a side-stream cartridge or bag filtration system for reduction of the contaminants (rust, mill scale). Typically, the filtration system is designed to allow for system turnover every two hours. For example, a 6000 gallon pickling bath solution would have a side-stream filtration system sized for 50 gpm. ln some systems, a chemical additive is used to help precipitate soluble iron from the acid solution to enhance F in the filtration system.

It has been common for HDG operations to use either conventional string-wound filter cartridges or nominally rated bags in the pickling bath side-stream filtration systems. While these products have relatively low unit costs, issues associated with the use of string-wound and/or bag filters include:

- Compressible nature (string-wound filters): The non-rigid structure of string-wound filters can result in the filters compressing as contaminants are loaded on the filters. This in turn can result in bypass and/or unloading of the contaminants.
- Relatively low contaminant holding capacity (nominal bags): Resulting in more frequent filter change-outs

The Solution

To improve the performance of side-stream filtration of pickling bath solutions, 3M Purification offers the below filtration solutions:

3M™ DF Series Filtration System (for systems with bag filter housings)

The 3M™ DF series filtration system is an improved alternative to the use of conventional nominally rated liquid filter bag systems. Compared to conventional bag filters, 3M DF series filter elements offer the following features:

- Greater than 60% more filter surface area - for increased contaminant capture capacity
- Graded-porosity structure - for cost effective capture of contaminants of wide ranging sizes and shapes
- Innovative new geometry of both filter element and basket for 100% support of the filter media - eliminating the potential for element/bag rupture and subsequent downstream contamination

The unique design of the 3M DF series filter system can provide for up to 2 - 5 times more service life and 2- 3 times more contaminant capture capacity than conventional bag filters translating into reduced change-out requirements.

Figure 4. - Grooved Structure

3M DF series elements are available in polypropylene materials which are compatible with pickling bath solutions. 3M DF series filter elements come in Size #1 and #2 configurations which can handle up to 75 and 150 gpm of process fluid flow respectively and in a wide range of grades (1 – 200 μ). Using specially designed baskets, 3M DF series elements can be retrofitted into most major manufacturer's bag housings.

Features and benefits of the 3M™ DF series filter system are summarized below. For more information on the 3M DF series filter system, request 3M Purification Literature Piece LITCDUOF1.

Features	Benefits
Unique filter design combining a graded-porosity media with 62% more filter surface area	Longer Service Life - up to 5 times or more that of conventional felt filter bags
	Reduces Filter Usage - minimizes labor, disposal costs, and operator exposure
	Increases Productivity - less down time for filter change-out
100% downstream support of the filter element	Reduces filter rupture, contaminant bypass and unloading
	Allows operation to higher differential pressures before filter change-out
Superior flow characteristics	Maximizes utilization of filter surface area and maintains low operating pressure drop
	Reduces flow per unit area (flux) for improved downstream quality

Micro-Klean™ RT Series Filter Cartridges (for systems with cartridge filter housings)

Micro-Klean™ RT series filter cartridges represent an excellent choice for those systems employing cartridge filtration system. Micro-Klean RT series cartridges, utilizing a patent pending unique extrusion bonded manufacturing process, offer the following advantages over conventional string-wound filter cartridges:

- Grooved filter surfaces - for increased contaminant capture and subsequent filter life
- Rigid construction - preventing by-pass and unloading of captured contaminants and subsequent pickling bath contamination

The materials of construction (polypropylene) make Micro-Klean RT series cartridges compatible with pickling bath solutions. Micro-Klean RT series filter cartridges come in a wide range of grades (1 – 75 µ), sizes (10" – 40") and configurations (double open end, single open end…) and can be used in most major manufacturer's cartridge filter housings.

Features and benefits of the Micro-Klean RT series cartridges are summarized in the following table. For more information on Micro-Klean RT series filter cartridges request 3M Purification Literature LITCPOLYKLN.

Figure 3: Micro-Klean™ RT Series Filter Cartridges

Features	Benefits
Grooved filter construction with extended surface area	Longer Service Life - up to 10 times or more that of competitive melt blown filters
	Reduces Filter Usage - minimizes labor, disposal costs, and operator exposure
	Increases Productivity - less down time for filter change-out
Rigid depth filter construction	Reduces filter unloading, contaminant bypass and unloading at high differential pressures
	Consistent contaminant reduction efficiencies throughout filter life

Conclusion

In the Hot Dip Galvanizing (HDG) process, it is necessary for the steel parts to be pre-treated with a pickling (acid) solution to ensure proper adhesion of the zinc coating on the steel parts. Side-stream filtration of the pickling bath solution is frequently employed to prevent the contaminants reduced in the pickling process (rust, mill scale) from building up in the system.

Depending on the type of installed side stream filter system (cartridge or bag), the use of 3M™ DF series filter elements or Micro-Klean™ RT series filter cartridges represent excellent choices and can result in the following process improvements and/or cost savings.

- Longer pickling bath life - resulting in reduced waste treatment associated with disposal of spent pickling acid solution and reduced fresh acid requirements
- Longer filter life - resulting in less costs associated with filter change-outs.

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