Surface Technology White Papers

99 (1), 8-20 (January 2012)

Estimating the Total Solids Burden during the Waste Water Treatment of Vibratory Finishing Effluents

by

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ABSTRACT

This paper generically reviews the traditional metal hydroxide separation techniques used for vibratory processes with special attention paid to depth of metal removed from the parts being processed. Additionally, the effect of chelating agents in complicating the precipitation reaction as well as media attrition and its contribution to the total eventual solids burden will be reviewed. Since steel and abrasive ceramic media are the most common metal and media type that are utilized during vibratory finishing they will be the focus of this paper.

Keywords: vibratory finishing, metal hydroxide separation, wastewater treatment

Introduction

Vibratory processing is frequently used for the generic deburring or high-quality finishing of steel components to minimize and/or eliminate expensive, edge-belting or hand-polishing operations. When properly utilized, not only can belting/polishing costs be dramatically reduced but part quality can be improved, especially prior to final decorative nickel/chromium electroplating.

During generic vibratory processing operations, abrasive ceramic media is utilized to abrade surface roughness from the parts to generate a smoother, functional or more attractive microfinish. Chelating and/or sequestering agents are commonly employed chemical intermediates in assorted proprietary vibratory processing compounds. Their role is keep the abrasive media clean by coupling with hard water salts or the metal swarf previously removed from the parts being processed. Without the chelants, loose metallic debris in the vibratory bowl will rapidly glaze-over the media and shut down its ability to abrade and thereby refine.

Local waste treatment regulations require that dissolved metals be separated from the collected effluent prior to its discharge from the manufacturing plant. Frequently, but not always, this technology is automated and requires the use of assorted acids and alkalis to accomplish the reaction wherein the metals are precipitated as metal hydroxides.

When designing/sizing a waste treatment and metal hydroxide collection system, it is essential to estimate the solids burden that will be generated. This will allow the manufacturing facility to project the volume of waste treatment chemistries that will be required to complete the precipitation work and also to estimate the size of the tankage and filter press that will be required during hydroxide precipitation and separation. Once these volumes have been calculated, it is then possible to anticipate the volume of filter cake that will be produced so plausible final solids disposal options can be reviewed.

This paper will review generically the traditional metal hydroxide separation techniques used for vibratory processes with special attention paid to the depth of metal removed from the parts being processed. Additionally, the effect of chelating agents in complicating the precipitation reaction as well as media attrition and its contribution to the total eventual solids burden will be reviewed. Since steel and abrasive ceramic media are the most common metal and media type that are utilized during vibratory finishing they will be the focus of this paper.

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Understanding the solids burden

Vibratory processing is most commonly accomplished using a vibratory bowl (Fig. 1). The parts to be vibratory finished are placed into the vibratory bowl, which additionally contains an abrasive tumbling media that will be used to abrade the rough surface of the parts.[1] This media swarf becomes a source of solids to the vibratory effluent.[2]

Figure 1 - An overhead view of a traditional vibratory bowl showing the toroid-shaped processing channel.

Additionally, to prevent media glazing, a vibratory processing fluid is added to the vibratory bowl.[3] Chelants in the processing fluid dissolve metal removed from the parts. Since the dissolved metals must be separated from the waste water prior to final discharge, waste treatment chemicals must be added to break the chelation. The presence of the chelants then becomes of necessity a source of solids during waste treatment.

As the surface of the parts is abraded smooth the metals removed from the parts become a third source of solids to the waste treatment department.[3]

The final contribution of solids to the waste treatment department, comes from the waste treatment chemicals that must be utilized to break the chelation reaction and to precipitate the previously dissolved metals as insoluble hydroxides.[3]

Therefore, sources of vibratory process solids include:

- Media attrition and resultant swarf
- Processing liquid chelants
- Metal removed from the parts
- Waste treatment chemicals

Media attrition as a solids source

An amateur wood worker, who purchases sandpaper at a hardware store, will find sandpaper available in a variety of grades.[2] Likewise, the vibratory operator is faced with a variety of choices when choosing a suitable media for the finishing task to be accomplished.

The most commonly employed mass finishing media is abrasive ceramic media (Fig. 2).[4] This media is composed of a ceramic binder and abrasive grit.[2,5,6] By altering the ratio of grit to binder, or by choosing different grit grades, the media manufacturer can alter the aggressiveness of the media.

Figure 2 - A typical ceramic abrasive media.

The ceramic binder is itself, a blend of sand, clay and feldspar.[2,3] By changing the ratio of these binder sub-components to one another, the media manufacturer can alter the kiln-firing vitrification temperature and consequently the media attrition rate (Fig. 3).

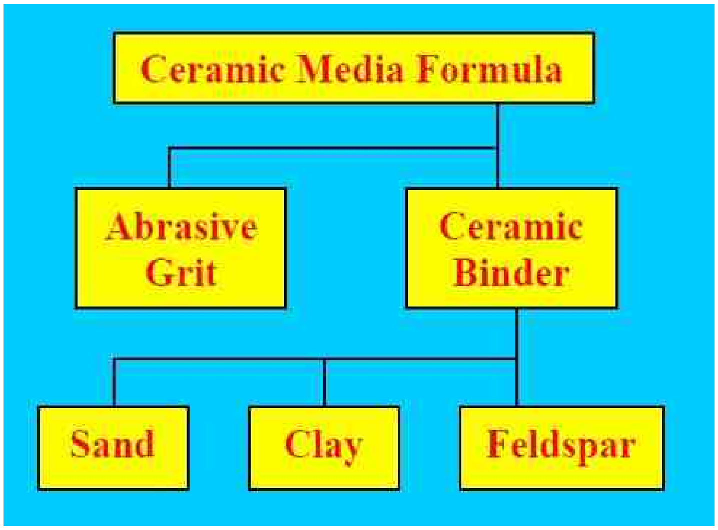

Figure 3 - The make-up of a typical abrasive ceramic media.

Media abrasiveness is usually specified by different grades, more commonly referred to as bonds (Table 1).[2,3]

By examining Table 1, it can be seen that as the ratio of abrasive content increases in the media bond; consequently too the ceramic binder content must decrease.[2,3] Since the ceramic binder is the glue that holds the media together, as its content decreases with an increase in the abrasive content, the media deterioration rate will increase. Simply stated, there is less glue present to hold the piece of media together.[2]

The rate at which media deteriorates is known as attrition rate.[2,3] Typical attrition rates for the most commonly used ceramic abrasive media are detailed in Table 2.

Table 1 - Common media bonds, binder/abrasive ratios and approximate media density values.[2,3,4,6]

Media bond number	% Porcelain binder	% Al_2O_3 abrasive	Media density[a], lb/ft^3
High density	0	100[b]	125
0	100[c]	0	90
10	92	8	88
20	85	15	85
30	75	25	82
40	65	35	80
50	55	45	78
60	40	60	75
70	25	75	72
Al_2O_3[d]	0	100	70

[a] Based upon author's experience
[b] Vitrified, 100% aluminum oxide media
[c] Pure porcelain binder, no Al_2O_3 abrasive
[d] 100% mineral Al_2O_3, non-kiln fired/non-vitrified

Table 2 - Attrition, swarf and processing time.[2,3,4,6]

Media bond number	Attrition rate[a], lb/hr	Swarf, lb/hr[b]	Lb/hr swarf in a 20 ft^3 vibratory bowl[c]
High density[d]	0.008	0.080	0.133
0	0.100	1.000	1.152
10	0.130	1.300	1.464
20	0.350	3.500	3.808
30	0.750	7.500	7.872
40	1.200	12.00	12.29
50	2.000	20.00	19.97
60	2.750	27.50	26.40
70	3.500	35.00	32.26
XA	4.000	40.00	35.84

[a] Based upon author's experience and measurements
[b] Assumes 1,000 lb. media in vibratory bowl at $t = 0$
[c] 20 ft^3 vibratory bowl with 16 ft^3 usable volume and 12.8 ft^3 media
[d] High-density, vitrified, aluminum oxide media

A simple technique for calculating media sludge generation

Let us assume for illustrative purposes that the vibratory finishing department has a 20 ft^3 vibratory bowl with 16 ft^3 of usable capacity. Additionally, let us assume that the operator loads the machine at an 80% media to 20% parts ratio.[6]

It is now possible to calculate the volumetric displacement of the media and parts as follows:

- Media = (16 ft^3)(0.8 usage) = 12.8 ft^3 media
- Parts = (16 ft^3)(0.2 usage) = 3.2 ft^3 parts

Now let us make the following additional assumptions for this example:

- The media is a 20-bond abrasive ceramic
- The processing time is two hours

Using the data found in Tables 1 and 2, it is possible to determine the actual weight of media consumed and therefore the weight of media sludge generated for the two-hour processing cycle as follows:

- From Table 1, 20-bond media has a weight density of 85 lb./ft^3
- From Table 2, 20-bond media has an attrition rate of 0.35%/hr.

A two-hour processing cycle will generate the following weight of media sludge:

$$(12.8 \text{ ft}^3)(85 \text{ lb./ft}^3)(2 \text{ hr})(0.0035/\text{hr}) = 7.62 \text{ lb.}$$

During the processing cycle the media becomes a source of abrasive swarf that is utilized to mechanically abrade the parts to a smooth finish.[6] In this example, 8.27 lb. of abrasive swarf is generated in the two hours of vibratory bowl processing time and becomes a solids contributor to the vibe bowl effluent and the waste treatment system.

Vibratory finishing chemistries as a solids source

During vibratory processing, vibratory soaps also known as burnishing compounds are added to the vibe bowl.[6] Typically sold as liquid concentrates, these soaps are diluted with city water then pumped into the vibratory bowl using a chemical feed system. Chelants and sequestrants in these chemistries couple with the iron abraded from the steel parts. By coupling with this iron, the processing chemistries maintain the cleanliness of the processing media and prevent the iron from glazing-over the media (Fig. 4).[3,6]

Figure 4 - Three pieces of high-density glazed media in the foreground compared to three pieces of clean media to the rear.

During subsequent waste treatment operations, the chelated metals coupled by the vibe processing liquids must be liberated and precipitated as insoluble hydroxides.[3] Typically, this is accomplished by the addition of a substitutional cationic source that has a greater affinity for the chelant than the previously dissolved heavy metal. Once the chelants have been co-reacted during the waste treatment process, they become contributory to the final solids loading that will be generated during the final precipitation step.

Depth of metal removal as a solids contributor

The purpose of the vibratory processing operation is of course to refine the surface of the parts loaded into the machine and/or to generate appropriate edge deburring properly. To complete this task, metal must be abraded from the surface of the parts being processed. The metal, coupled by the chelants, must be precipitated as an insoluble hydroxide and therefore contributes to the solids loading.[6] It is possible to calculate the contribution of this metal as solids sent to the waste treatment department, as long as the depth of steel removed and the total surface area of steel loaded into the bowl is known. The following paragraphs highlight an illustrative example.

Consider first a one-cubic foot block of steel (Fig. 5), which weighs 489.54 lb.[4,6]

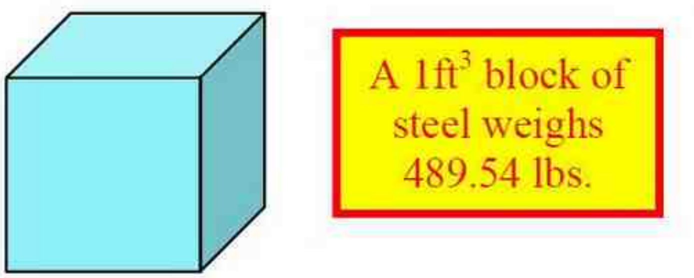

Figure 5 - A representation of a one-cubic foot block of steel.

If this block of steel could be segmented into 12 uniform slabs, each slab would be one inch thick and would weigh 1/12th of the original 489.54 lb. or 40.80 lb. (Fig. 6).[6]

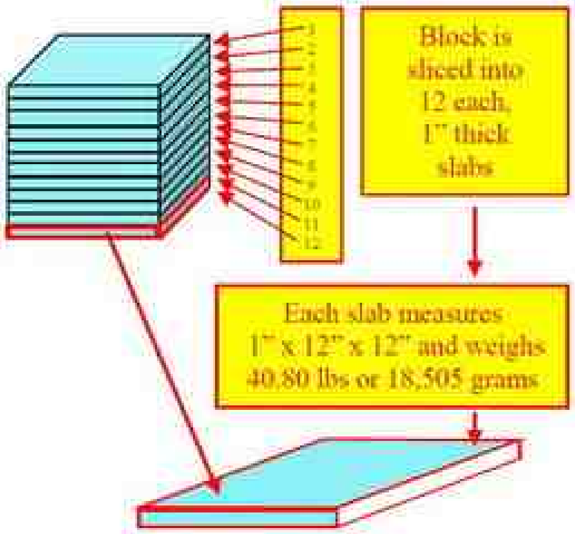

Figure 6 - A representation of a one-cubic foot block of steel that has been segmented into 12 individual one-inch thick slabs.

During traditional vibratory finishing however, metal removal occurs in thousandths of an inch depths. Knowing this, it is possible to additionally extrapolate the weight of steel that will be removed. If each 1 × 12 × 12-in. slab were now micro-sliced into one thousand individual sliver-thin slices, then each slice would weigh 1/1000 of 40.80 lb. or 0.0408 lb. (Fig. 7).[6]

Knowing this data, it is now possible to calculate the weight of steel that is removed from the parts during the vibratory processing cycle. Let us assume that a lot of steel parts with a total surface area of 50 ft^2 is loaded into a vibratory bowl. The parts are processed to remove a depth of 0.0005 in. of steel. The solids loading of steel can be calculated as follows:

$$(50\ \text{ft}^2)(0.0408\ \text{lb./ft}^2/0.001'') \div 2 = 1.02\ \text{lb.}$$

To make these calculations easier, Table 3 is a quick reference guide for the weight in lb. of steel solids removed from assorted surface areas of steel for assorted depths of metal removal.[6]

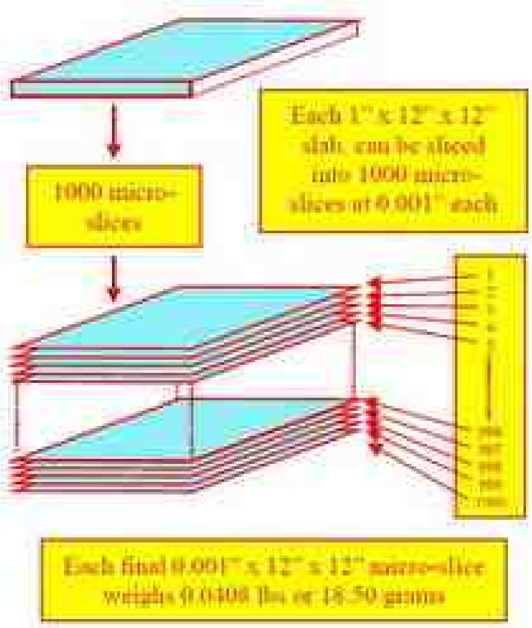

Figure 7 - A 1 × 12 × 12-in. slab that has been micro-sliced into 1,000 individual slices which have final dimensions of 0.001 × 12 × 12 in.

Table 3 - Weight of steel solids generated from set surface area of steel and at set depths of removal.[6]

Steel Area, ft^2	Solids in lb., if 0.0001" removed	Solids in lb., if 0.0002" removed	Solids in lb., if 0.0005" removed
1	0.00408	0.00816	0.02040
5	0.02040	0.04080	0.10200
10	0.04080	0.08160	0.20400
20	0.08160	0.16320	0.40800
25	0.10200	0.20400	0.51000
50	0.20400	0.40800	1.02000
100	0.40800	0.81600	2.04000
125	0.51000	1.02000	2.55000

Waste treatment chemistries as sources of solids

The following is a list of the most commonly employed chemicals used during traditional metal hydroxide precipitation waste treatment operations:[6]

- Sulfuric acid, H_2SO_4
- Calcium chloride, $CaCl_2$
- Sodium hydroxide, NaOH
- Lime, $Ca(OH)_2$

These chemistries are typically employed as they are the most inexpensive materials available in bulk, which can be utilized for pH neutralization and hydroxide precipitation.

During chemical reactions with the chelated metals, these chemicals are used to liberate the chelated cationic metals. This additionally results in the fact that the former non-needed cationic or anionic portion of the waste treatment chemical itself becomes a useless component in the reaction and an additional solids loading burden. This additional solids burden contributes to the total eventual solids loading based upon each molecule's gravimetric factor.[4,6]

To better understand the beneficial portion of each molecule versus its pure gravimetric equivalent weight in solids burden, each of the chemicals is reviewed below. But first, a discussion on gravimetric equivalency follows.

Gravimetric equivalency and its relevance to waste treatment

Let us assume you have one pound of iron phosphate that is dissolved in water and you desire to precipitate the iron out of solution. The actual weight of the total iron phosphate molecule consists of the weight of the cationic (+ charged) iron ion plus the weight of the anionic (- charged) phosphate ion. The iron, which is the target for precipitation, is therefore just a small percentage of the total molecule's weight.

Using the Periodic Chart of the Elements, it is possible to calculate the gram atomic weight (GAW) of the iron phosphate molecule from which the weight percent of iron can then be determined:

1. Iron phosphate has the molecular structure of $FePO_4$. It contains one iron atom, one phosphor~~o~~us atom and four oxygen atoms.
2. One atom of Fe = 55.85 g × 1 = 55.85 g
3. One atom of P = 30.97 g × 1 = 30.97 g
4. One atom of O = 16.00 g × 4 = $\underline{64.00\text{ g}}$
5. One GAW $FePO_4$ = Total = 147.82 g
6. Percentage of iron in iron phosphate is:
   (55.85)(100) ÷ 147.82 = 37.78% iron
7. Therefore, one pound of $FePO_4$ contains:
   a. 0.3778 lb. Fe^{+3} (iron cation)
   b. 0.6222 lb. PO_4^{-3} (phosphate anion)

Understanding the solids burden this represents, we now realize that when the waste treatment operator adds sufficient waste treatment chemicals to precipitate the 0.3778 lb. of iron, the 0.6222 lb. of phosphate will additionally become part of the precipitated solids weight. This ratio of the difference caused by the need to balance the molecular charges is known as gravimetric equivalency and for heavy metal-containing molecules, it can add considerable additional solids weight to the waste treatment burden.

Sulfuric acid, H_2SO_4

Sulfuric acid is typically used to lower pH in the final effluent and to acid hydrolyze the chelated metals, thereby liberating them for precipitation reactivity.[6] The density of the typically used 66º Bé sulfuric acid is 1.84, which yields a per gallon weight of 15.35 lb. Of this 15.35 lb./gal, only the free hydrogen cation is beneficial in reducing pH. As such, only 0.31 lb. of the 15.35 lb. of sulfuric acid is beneficial and 15.04 lb. of the sulfuric acid is the complementary anionic sulfate solids burden.

Calcium chloride, $CaCl_2$

Calcium chloride is typically used to offer cationic calcium as a preferential precipitant to the cleaved chelant molecules following an initial acid hydrolysis.[4,6] Calcium chloride, is typically purchased in flake form at a concentration of 77%. The final contribution of the beneficial calcium cation per pound of 77% calcium chloride flake is 0.28 lb. The balance of the weight, 0.72 lb. is complementary anionic chloride solids burden.

Sodium hydroxide, NaOH

Sodium hydroxide is typically utilized to raise the pH of the final effluent and form the insoluble metal hydroxides. The density of the typically used 50% sodium hydroxide is 1.66, which yields a per gallon weight of 13.84 lb.[6] Of this 13.84 lb./gal, only the free hydroxide anion is beneficial in raising pH. As such, only 0.31 lb. of the 2.94 lb. of sodium hydroxide is beneficial and 3.98 lb. of the sodium hydroxide is the complementary cationic sodium solids burden.[4,6] The remaining 6.92 lb. is the water portion of the chemical's 50% starting concentration.

Lime, $Ca(OH)_2$

Typically sold as a dry powder, lime is usually dissolved in water to achieve a 1.0 lb./gal solution that is then pumped into the waste treatment tank. Lime is typically used to raise the pH value of the final waste treatment water prior to plant discharge. Each pound of lime powder yields 0.52 lb. of calcium cation and 0.48 lb. of hydroxide anion.[4,6] Unlike the other chemistries, both the cationic calcium portion of the lime and the anionic hydroxide portion of the lime can be beneficial, depending upon which stage the lime is added during waste treatment. If lime is used rather than calcium chloride to contribute free calcium cation following an acid hydrolysis step, the calcium cation is an active participant in the waste treatment reaction. If lime is utilized only as a final pH adjustment material, then unfortunately, the lime cation becomes a solids burden only.

Hypothetical waste treatment solids calculation

In this example we will calculate the solids loading burden on the waste treatment department as well as the volume of filter press cake that will be generated for disposal. Let us assume that we have a vibratory finishing process that has been set-up and is running with the following performance characteristics:

1. A 20-ft^3 vibratory bowl is used that has 16 ft^3 of usable capacity.
2. The loading ratio of parts to media is 20% parts to 80% media.
3. The media that is being used is a 20-bond media.
4. The vibratory finishing department processes the parts for two hours.
5. The area of steel parts in the bowl is 50 ft^2.
6. Processing removes 0.0005 in. of steel.
7. The waste treatment procedure at the facility treating the vibratory finishing effluent proceeds as follows:
   a. Lower pH to 2.0 to cleave the heavy metals from the chelants.
   b. Add calcium chloride to couple with the liberated chelants.
   c. Raise the pH to 7.0 with sodium hydroxide.
   d. Add anionic polyelectrolyte to flocculate generated hydroxides.
   e. Elevate the pH to 10 with lime to maximize hydroxide precipitation.

Solids from media attrition

Using information in Tables 1 and 2 and as calculated earlier in this paper, the solids attributable to two hours of processing with a 20 bond media are 7.62 lb.

Solids as metal removed from the parts

Knowing we have 50 ft^2 of steel surface area and have removed a depth of 0.0005 in. of steel, we can use Table 3 to determine that this generates 1.02 lb. of iron solids.

Solids attributable to waste treatment: acid hydrolysis with sulfuric acid

This step separates the iron from the vibratory processing liquid chelants. For each pound of iron placed into solution initially, 1.07 lb. of sulfuric acid will be required to separate the iron from the chelants.

Solids attributable to waste treatment: chelant coupling with calcium cation

This step adds calcium to couple preferentially with the chelants when the pH is raised, thereby allowing the iron to precipitate as a hydroxide. For each pound of iron placed into solution initially, 1.80 lb. of $CaCl_2$ will be required for chelant coupling.

Solids attributable to waste treatment: intermediate pH elevation to 7.0

This step minimizes lime solid bulk by raising the pH to an intermediate 7.0 with sodium hydroxide. For each pound of iron placed into solution initially, 1.94 lb. of sodium hydroxide will be required.

Solids attributable to waste treatment: polyelectrolyte addition

Typically polyelectrolyte will be added at this point to flocculate the accumulating hydroxides into large, gravity-favoring lumps.[6] This increases precipitation efficiency and adds negligible solids weight (Fig. 8).

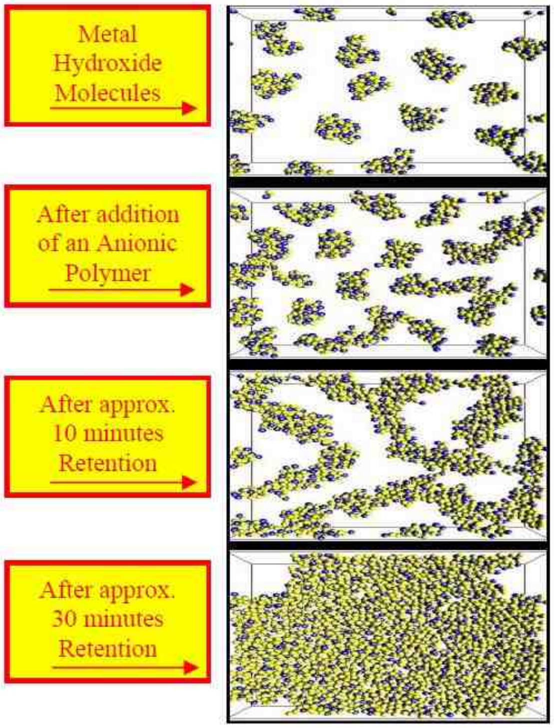

Figure 8 - Schematic illustration of flocculation action.

Solids attributable to waste treatment: final pH elevation to 10.0

Raising the pH to the final desired value of 10.0 can now be completed by adding the lime to the pH 7.0 liquid. For each pound of iron placed into solution initially, 2.40 lb. of lime will be required for this final pH adjustment.[6]

Summation of total solids generated for one pound of steel removed

Removing one pound of steel in a two-hour cycle with 20-bond media and waste treating the vibratory finishing solids generates 15.85 lb. of solids, calculated as follows:

Steel solids =	1.02 lb.
Media solids =	7.62 lb.
Sulfuric acid =	1.07 lb.
Calcium chloride =	1.80 lb.
Sodium hydroxide =	1.94 lb.
Lime =	2.40 lb.
Total Solids =	15.85 lb.

The effect of waste treatment solids on filter cake generation

The procedure typically used to separate waste treatment solids from the final liquid to be discharged is by the use of a filter press (Fig. 9).[6]

Figure 9 - A typical filter press for solids separation during waste water treatment.

Although a considerable volume of water is squeezed from the solids during the filter press operation, the resultant filter cake is not 100% dry. Typically, a filter cake at 35% by weight as solids is produced (Fig. 10). This of course means that the balance of the weight of the filter cake - 65% - is water.[6]

Figure 10 - The typical appearance of a 35 wt% solids filter cake generated in a filter press.

Typically, the generated filter cake has an average density of 80 lb./ft^3.[6] Therefore the final weight and volume of waste treatment solids for final disposal will grow correspondingly as follows:

- Final filter cake solids weight for each pound of steel removed
  (15.85 lb.)(100) ÷ 35 = 45.29 lb. moist cake
- Final filter cake solids volume for each pound of steel removed
  45.29 lb. moist cake ÷ 80 lb./ft^3 = 0.57 ft^3

As can be seen from the previous calculations, one pound of steel (iron) that is initially dissolved into solution during vibratory processing can result in a substantial volume of final solids.[6]

The example illustrated in this paper doesn't necessarily apply just to vibratory finishing. Iron in any waste water will require similar waste treatment, precipitation and separation techniques. Therefore the factors present in this paper can be used for other waste treatment calculations.

Table 4 details the expected filter cake solids weight and filter cake volume generated for the data presented in Table 3.

Table 4 - Data for the depth of steel removed, the weight of metal hydroxide generated, the weight of filter cake generated and the final volume of filter cake generated.[6]

Steel depth	Final solids	Area, ft^2 1	Area, ft^2 5	Area, ft^2 10
0.0001 in.	Lb. solids	0.03	0.16	0.33
	Lb. cake	0.09	0.46	0.94
	Ft^3 cake	0.001	0.006	0.012
0.0002 in.	Lb. solids	0.07	0.33	0.66
	Lb. cake	0.19	0.94	1.89
	Ft^3 cake	0.002	0.012	0.024
0.0004 in.	Lb. solids	0.13	0.67	1.32
	Lb. cake	0.38	1.91	3.77
	Ft^3 cake	0.004	0.024	0.047
0.0005 in.	Lb. solids	0.17	0.82	1.65
	Lb. cake	0.43	2.34	4.71
	Ft^3 cake	0.005	0.290	0.059
0.0006 in.	Lb. solids	0.20	0.98	1.98
	Lb. cake	0.57	2.80	5.66
	Ft^3 cake	0.007	0.035	0.071
0.0008 in.	Lb. solids	0.26	1.34	2.64
	Lb. cake	0.76	3.83	7.54
	Ft^3 cake	0.010	0.048	0.094
0.0010 in.	Lb. solids	0.33	1.64	3.30
	Lb. cake	0.86	4.69	9.43
	Ft^3 cake	0.011	0.059	0.118

As an example, assume 0.0005 in. of steel has been removed from 10 ft^2 of steel parts. Moving across Row 5 for 0.0005 in. removed to Column 5 for 10 ft^2 of steel area, you will:

- generate 1.65 lb. of hydroxide solids which when filter pressed,
- yield 4.71 lb. of moist filter cake solids, that
- occupy 0.059 ft^3 of volume.

Conclusions

Solids generated during waste treatment operations on vibratory finishing effluents come from a number of sources, including:

- Media swarf for media attrition
- Metal removed from the parts
- Hydroxides created during the waste treatment precipitation step
- Gravimetric additional weights from the contaminants and the added waste treatment chemistries that are non-reactive ingredients present in the original molecules

Using media of a lower bond number results in less media solids to waste treatment because lower bond media has a higher concentration of ceramic binder.

Metal removed from the parts is frequently chelated by the vibratory processing liquids to prevent media glazing. These chelants must be deactivated during waste treatment by the intentional addition of calcium. Using a non-chelated burnish compound can eliminate this step thereby reducing solids loading.

Metal hydroxides created during the subsequent treatment operation are typically removed from the waste stream using a filter press. However, filter presses cannot achieve 100% dry cake and usually generate material that, at best, is 35% by weight solids and 65% by weight water.

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About the author

William P. Nebiolo received a B.A. degree from The University of Connecticut in 1976 and an M.S. degree from Long Island University in 1978. He began work in 1978 at the Union Hardware Div. of Brunswick Sporting Goods as a waste treatment operator and a plating lab technician. After tours of duty at Eyelet Specialty Co. in Wallingford, CT, Nutmeg Chemical in New Haven, CT and The Stanley Works Corporate Laboratory in New Britain, CT, he accepted a position at REM Chemicals, Inc. in Southington, CT as a sales engineer in 1989. He has been with REM ever since and currently serves REM's Midwestern Sales Territory and is REM's Product Manager .

He joined the AESF as a member of the Waterbury Branch of AESF and has served as the 1984-85 Branch President and as Branch Secretary from 1991 until the branch's assimilation into the Connecticut Branch in 2004. He has served as the Connecticut Branch Secretary since its creation. He represented the Connecticut Branch as a Delegate and recently accepted the position of Connecticut Branch Vice-Treasurer. He chaired the merger committee that resulted in the merger of the Waterbury, Bridgeport and Hartford Branches into the Connecticut Branch.

He has published more than a dozen papers through a number of professional organizations and with a number of technical journals including *Plating & Surface Finishing*. Since 1996, he has been one of the Mass Finishing Technical Training Program instructors for SME and has taught vibratory finishing at more than two dozen seminars across the United States. He prepared one of the training manuals that has been used for years with the SME training course.