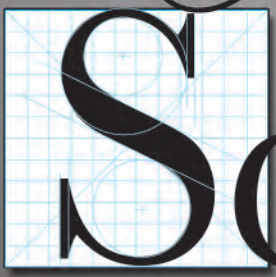

The ART and SCIENCE of Mass Finishing

By Sam Thompson

From the Finishing People…

Whether you make castings, stampings, fabrications or desire to process gemstones, Raytech has a machine to suit your application. Raytech is the world's leader in the manufacturing of small mass finishing equipment and accessories. We hold all of our equipment to the highest quality standards. In the following pages you will see Raytech's full product offering. Each machine will deburr, finish and burnish, and perform many other applications. They are task-oriented as is a file and sandpaper, or to use another term, another tool in the tool box.

Machine Selection From The Industry Leader

Raytech is the oldest and largest manufacturer of bench top mass-finishing equipment worldwide. Our vibratory line is over 25 years old and our magnetic line was introduced in 1996. No one has more machines in use or more applications experience than Raytech in vibratory or magnetic machines.

Vibratory Machines are utilized to deburr/finish irregular/ blocky shapes, since the vibrating activity works the media at blind or hidden areas passed over by the slide action of a conventional tumbler. Vibratory machines process more complex part configurations than tumblers and run cleaner with plastic media. Part size is not a problem in a vibratory machine. If the part fits in the channel and rotates, it will finish.

Magnetic Machines centrifugally finish non-ferrous parts that are small, so complex, of fine detail and have areas conventional medias won't reach that only fine small steel media shapes will reach to clean, smooth and burnish, imparting a uniform surface finish to all parts. Magnetic finishing has very short time cycles, in most cases limited to 30 minutes or less.

Oblique, Open End Machines are similar to rotary barrel tumblers. They are easy to unload and tumbling action is easily observed; however, longer cycle times are required than with rotary. Generally used for cleaning, part-on-part deburring/burnishing, drying, chemical applications and used with small or loose media/abrasives.

The Art and Science of Mass Finishing

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The Art and Science of Mass Finishing

By Sam Thompson
Metal Finishing Consultant

Samuel R. Thompson entered the deburring and surface conditioning industry in 1960 by starting a job shop; Buff, Brush and Polishing Services, providing mass finishing to the Connecticut Manufacturing market area.

In 1963 he joined Packer Machine Co., of Meriden, CT as a Field Engineer, providing feasibility and conceptual technical services nationally for automated buff, brush and polishing systems.

In 1974, Mr. Thompson became a Field Representative for Ultramatic Equipment Co., of Scottsdale, AZ, manufacturers of vibratory finishing equipment media and compounds.

Mr. Thompson was the program speaker at the Society of Manufacturing Engineers (SME) Technical Conferences, as well as numerous SME Regional Chapters. He authored several trade magazine articles and SME technical papers. Mr. Thompson was also honored nationally as a recipient of the Award of Excellence by the American Society for Abrasive Methods.

Mr. Thompson retired after 27 years with the Ultramatic Equipment Co., and acted as a consultant to Raytech Industries and other metal finishing companies. Sadly, Sam Thompson passed away on January 5, 2012, just before this book was published.

What is mass finishing?

Mass finishing is a method of surface refinement and/or burnishing (brightening) of part(s) in a mass of media (abrasive or non-abrasive).

How is this performed?

Mass finishing is performed via many methods of tumbling, vibrating, centrifugal disc or magnetic slurry. Some examples are:

Raytech Model 1000 Oblique Tumbler

1. *Tumbling* in a rotating container. Tumbling is a slide action process whereas the mass (parts and media) slides down a slope created via the container's rotation. The mass slide occurs when gravity overcomes a portion of the mass (15-20% more or less) sending it gently sliding down the incline. Over loading or under loading is not advised as both methods lengthen cycle times or damage the parts. The optimal loading is 60% of the container volume, which provides the longest slide resulting in smoother finishes and faster cycle times. Washers, coins, stones and other flat or solid objects are ideal candidates for tumbling when surface or edge finishing is important. Tumbling is not recommended for boxy, drilled or cast recesses; those areas will not finish. (See vibrator, centrifugal disc or magnetic.)

2. *Centrifugal disc* is a stationary round outer wall with a high-speed rotation bottom independent of the outer containment wall creating a tornadic motion to the mass around the outer wall.

3. *Vibrating* is the most popular method where energy is induced via rotating eccentric weights vibrating the container having a processing channel containing the “mass” parts and media.

AV-40SS Vibratory Tumbler

CMF-900 Magnetic Finisher

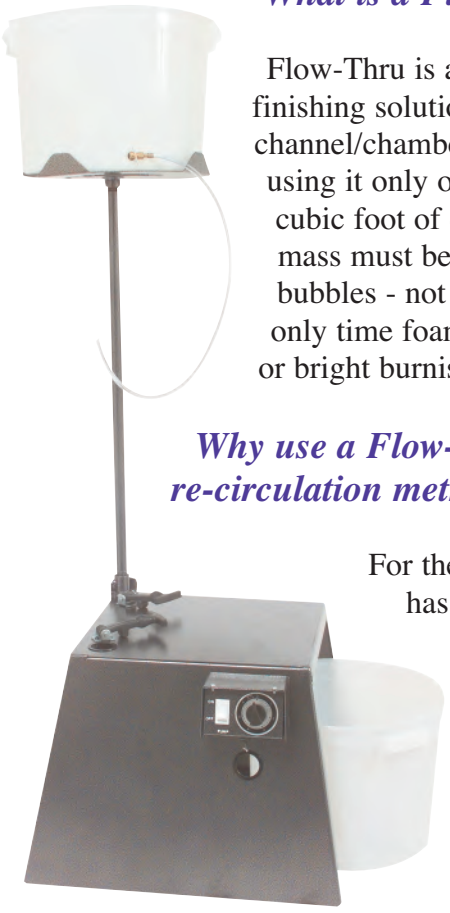
4. *Magnetic slurry* is the latest edition to the fine art of mass finishing for non ferrous parts. Its operation is unique and not fully appreciated or employed to its full potential. The processing chamber sits on a base under which a series or a single magnet is rotated. Non ferrous media of hardened stainless steel is employed. The rotation of the magnet causes a tornadic motion to the mass (parts and media), deburring or burnishing small and/or delicate parts. Very intelligent to use with jewelry, electronic parts or even small precision springs and fasteners that are too small or delicate to be completed any other way economically.

5. *Centrifugal* barrel machines are very expensive, usually dedicated to one or a family of parts such as turbine blades or parts that require the high pressure of media against the part to accomplish the required finish. The machine is of planetary design as the main frame rotates in one direction while the totally enclosed finish container rotates in the opposite direction. Mounted on the outside of the main frame usually only two containers are employed, counter balancing one another and operating at a much higher speed than a tumbling barrel. Claims are to be 10 times faster than any other method, however this method is usually employed where all others have failed. Cycles are fast and usually require dedicated labor.

My parts are filthy and encrusted with ultra fine debris when the cycle is complete, the finish is good but how do I clean them?

Your parts and media (the mass) must be kept clean during the entire cycle via a “Flow-Thru” or periodic rinsing and renewing the liquid solution.

What is a Flow-Thru Rinsing System?



Raytech FT-75 Flow-Thru System

Flow-Thru is a method of introducing the clean finishing solution (compound) into the processing channel/chamber and out through a bottom drain, using it only once at the rate of 2 gallons per cubic foot of displacement per hour +/-. The mass must be clean, having colorful and clear bubbles - not foam, as foam retains dirt. The only time foam is acceptable is when tumbling or bright burnishing.

Why use a Flow-Thru system instead of a re-circulation method?

For the same reason a washing machine has several rinses. When a re-circulation method is used, the waste solution is reused via pumping it back to the processing channel where it becomes dirtier and the removed solids are refined to even smaller liquefied solids. These solids will redeposit themselves onto the parts, media and the processing channel lining. This generally results in costing more in labor to clean the parts, media and machine post cycle.

I have a vibratory machine where the mass (parts and media) have leaner motion circling the center post but little or no rolling motion, is this good?

No, practically nothing is happening when this condition exists. The machine is either flooded or the compound mix is too rich. One, two or more conditions cause this to occur. First, the Flow-Thru is likely too heavy, flooding the channel. Check that the drain holes are clear and are sized enough to handle the Flow-Thru input or adjust the flow to 2 Gal/cu. ft. per hour, you may be using the wrong compound, foaming the mass and slowing the drain. Third, your compound concentration may be too rich, causing the mass to be cushioned by its slipperiness.

How do I know how to mix the compound concentration?

Usually 2 oz per gallon is a good place to start, however water hardness and mineral content vary over a broad spectrum throughout the US and abroad, so one recipe for everywhere is not possible. A way to solve this problem is to mix a small amount at 2 oz. per gallon as a starting point. Then wash and thoroughly rinse your hands to wash away any of the oils, natural or otherwise. Fully immerse your thumb and forefinger into the 2% compound mix and rub them vigorously together. Then, very lightly, while in the mixture, feel the interlocking of your finger print lines. If you can't feel them slip a little while interlocking, then the lubricity rate is too low and no cleaning activity will occur. At this point, you will want to increase the concentration. If the concentration is too slippery, you insulate the abrasive media from the part, slowing the process. This trial and error method may sound primitive but it works. It is a simple way to solve the problem every time. The only tools needed are a measuring cup and a very clean thumb and forefinger.

My deburring media seems to have become loaded and shiny and won't do as satisfactory of a job as it did when new.

The condition you describe has many causes. If you are introducing dirty parts to the mass, your media and processing chamber will darken and shine, indicating contamination buildup. This is not a good sign nor good for the finishing. Clean both, utilizing TSP (Tri Sodium Phosphate) available at any paint or hardware store. Introduce 1 ounce or more per cubic foot capacity and run the Flow-Thru Rinsing System with plain water, sprinkling the TSP granules in until the media and process chamber clean up, then neutralize the media by continuing to flush or using some baking soda while flushing.

How often should I change the media (wet process)?

Never! Unless the product being finished requires a shape and size specific media to prevent part damage or media lodgment. Media must run to capacity for maximum efficiency. In the case of vibratory, the process channel must run at operating capacity so keep it full and keep it clean, add media as required to keep the channel full.

How is burnishing accomplished in mass finishing?

Burnishing covers a broad spectrum when applied to mass finishing. Are you talking a curbside finish that is nice and bright for key blanks or flawless high luster as found on jewelry? Both and all in between are accomplished via all types of mass finishing equipment, each has its application and benefits.

To burnish in mass finishing is to refine a surface until it becomes bright. This can be as simple as tumbling key blanks part on part in a tumbling barrel with some slippery foamy soap-like compound for a few hours or using a tumbling barrel employing a dry media for an overnight roll to burnish 14k charms to a buff like quality. Burnishing via mass finishing is part specific determined

by cost, quantity, the ability to hold the part for alternate mechanical finishing and/or hand finishing.

Metal media, ferrous and non ferrous, is quite popular, most especially steel and stainless steel, the heavy weight of steel actually presses and or peens the part surface from imperfect to near perfect by its sheer weight (300 lbs/cu. ft.) resulting in a near perfect surface and a bright shine. Accomplished in tumbling, vibratory, discs and magnetic equipment.

Porcelain media burnishing is usually employed to enhance a product's appearance. Employed frequently with acidic compounds to remove heat treat scale, ceramic burnishing media can weigh up to 130 lbs, but usually and more common the 90-100 lbs/cu. ft. is employed.

Dry compounds are common to tumbling and vibratory and are only used to super finish large quantity items such as plastic and metal eyeglass frames, jewelry parts and super delicate instrument pieces. Dry finishing is not quick nor to be taken casually. Usually it is the single most important step when employed in a manufacturing cycle.

In the case of plastic eyeglass fronts and temples, the cycle may involve 4-5 progressive steps, taking five to seven days to complete or a single step run overnight for electronic parts. There are many medias employed ranging from mixtures of sawdust and wood chips, nut shell particles and preformed wood shapes all mixed with preparatory creams, waxes and ultra fine rouges and abrasives specific to the product and finish requirement.

Dry finishing is by far the 5 star method of mass finishing but it may take some experimentation before you hit the best combination of pre-finish and final finish materials and cycles. When you hit on that buff-like quality, you will never regret the time spent in development, the finish you want is do-able, so don't quit.

Amplitude Adjustment for Raytech Models

To change the amplitude, unplug the electric cord and turn the machine on its side.
Remove the bottom cover with the three #8 self-tap screws.
Use a 5/16" Allen wrench to adjust the eccentric weights.
Refer to Figures 1 and 2 for adjustment. Note: The 5/16" Allen head bolt is a left-hand thread. With a 5/16" Allen wrench, loosen this bolt to change the position of the adjustable weight.
Once adjusted, secure tightly.

FIGURE 1:

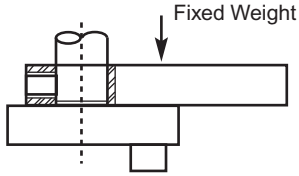


Figure 1 shows weight adjusted to minimum amplitude/aggressiveness. Adjustable weight in this position counter balances the fixed weight and reduces the amplitude/aggressiveness. (Ex. Tumbling using corncob media or any light media.)

FIGURE 2:

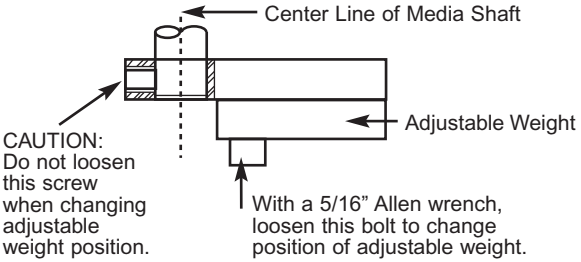
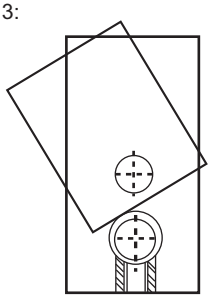


Figure 2 shows weight adjusted to maximum amplitude/aggressiveness. Adjustable weight in this position adds to the fixed weight and increases the amplitude/aggressiveness. (Ex. Tumbling using ceramic or steel shot media or any heavy media.)

FIGURE 3:



Recommended Position for Light Media

My vibratory machine vibrates at the base causing the surface area to vibrate and the unit to move.

First, verify the surface the unit is on is solid and level. If that's ok, check the vibrator feet to insure positive contact in all areas with the surface its mounted on, then check the vibrator base for level, check all the vibrator's springs for worn mounts and all the springs are present, mounted properly and are of equal length. Finally, verify that the vibrator's counter weights are not loose and are within the manufacturer's operating specs. Last, but not least, that you are not overloading parts to media ratio with too many parts, causing an uneven mass flow resulting in the container not having a smooth, even motion.

My tumbler barrel blows off foam and liquid when I open the lid mid cycle to rinse and recharge with fresh compound, the same thing happens at unloading. How do I prevent this?

This is common to tumbling cycles, they generate heat which causes expansion. Large floor mounted units can become dangerous. One solution is to relieve pressure more frequently. Another is to install a petcock to open and relieve the pressure prior to removing the cover. Also, a pressure relief valve can be installed, which when properly adjusted, will relieve pressure periodically during the cycle.

What is the best way to separate the parts from the media?

Sorting parts from media can be challenging, especially if the parts and media are of similar size.

Magnetic - if the parts are of a ferrous material, an industrial magnet can be employed.

Separating Screens - Either manual or powered can be configured to allow either the parts or media to pass through. Remember

excessive motion can damage parts as they are no longer separated and cushioned by the media nor lubricated by compound.

Hand Picking - This may sound tedious and labor intensive, but sometimes it is the only way to economically solve the problem ~ call it quality control with each piece being hand inspected.

Large machines having a round bowl/doughnut configuration can be fitted with a device to internally separate within the processing channel. Unless the machine has dedicated use to a family of similar sized parts, it would be best to separate externally, where a better separation method can be employed as well as accountability of all parts.

An Inclined Ramp will work if the parts are round and the media is blocky, or vice versa.

External power driven separators are handy, inexpensive and extremely versatile. Fitted with any variety of screen openings of varying shapes and/or sizes, lots of mass is separated in a short time. They are also handy to classify media by size.

How do I prevent media from lodging in my parts?

Media lodgment the #1 hazard of mass finishing. Even classifying media every time a process is completed can still result in lodgment since the media is constantly wearing away during the process.

One way to prevent lodging is to employ foam rubber pieces. If you have a dead-end or thru-hole, stuff some in the hole (no, it won't fall out). If you want the hole edges finished, recess the foam; if you want the edges not to be finished, keep the foam slightly protruding from the hole. It may sound silly, but it works every time. This method is better than any costly custom urethane plugs.

For external areas, purchase a melting pot and material used to protect drills and milling cutter edges and coat the areas you don't want finished. These two methods are tried and true. They have been utilized for 30 years or more on millions and millions of parts.

One point to note: keep the parts submersed in a container of mixed compound, never letting them dry after removing them from the machine. If they dry, you have a cleaning nightmare on your hands. The liquefied swarf is so "re-refined" that it becomes a liquefied solid that, if allowed to dry, becomes parent to the part. Keep your parts wet until they go to your cleaning station, be it manual hand wash or automatic. Do not let them dry until inspected after the final cleaning.

Another trick is to use plastic wire ties. They can be inserted through a part and loosely fastened to insure movement enough to finish completely.

My parts take too long to clean up, the machine oils and coolant seems to coagulate in the corner holes, etc. How do I overcome this problem?

Clean all parts prior to finishing. What seems like an extra step is actually part of the mass finishing process. Clean parts finish faster and more uniformly. Dirty parts load the media, preventing it from achieving consistent quality and uniform time cycles. Evidence of this is a dirty processing channel, having a scum-like dirt ring just above the mass line.

My vibratory machine is quite noisy in what formerly was a quiet workplace, other than locating it to a remote area, what can I do to quiet it down?

Stop the noise by isolating the machine in plain sight. Build a simple frame around the machine fitted with foam rubber baffles, then rig a lid of similar construction over the processing chamber, hinged or hanging from a pulley or totally enclose it. Bear in mind the heat build-up from the motor, as you may want to add a fan. The more baffles you create, the better.

Why are tumbling compounds different from vibratory compounds? Why can't I use one for both?

Tumbling is a closed cycle process. While mid-cycle cleaning, rinsing and compound replenishment may take place; it still is a closed cycle operation, while vibratory cycles most always operate with the flow principle. Vibratory processes employing the flow thru principle rely on friction and energy developed in the processing channel to create the toroidal flow of the mass. High foaming compounds necessary to the positive displacement method of tumbling would impede that activity, smothering the motion. Foam holds air and consists of liquid, holding dirt and won't flow out at the required volume. This develops a slippery cushioning effect necessary for tumbling, but bad for vibrators. Many tumbling operations have multi-stage processes where more than one compound is employed while vibratory processes usually use only one.

Tumbling compounds are complex materials and can be tailored to specific operations, creating effects such as acid etching, pickling, oxidizing, deburring, and bright burnishing - be it part on part or with media.

What is the difference between open-end tumbling barrel shapes? How do I know which one to use?

Two shapes are most common and are found in sizes from large floor mounted units to small tabletop machines. Oblique shapes consist of several trapezoidal panels fabricated to form a processing chamber larger at the bottom, tapering to the open-end top. Bottle shaped units feature a round potbelly-like processing chamber with a narrow neck to access the process chamber. These units are usually employed for use with media; the small neck is an aid for foam control. The bottle bottom processes similar to a tumbling barrel, while allowing access for inspection while in process. The open-end oblique is frequently employed as a dryer using untreated corncob particles as the absorbent.

More commonly employed as a part on part finisher, chemical treatment for acid descaling after heat treat, even unique operations such as antiquing, using shoe pegs to slough off the high spots after painting or oxidizing to achieve the desired effect.

With all the shapes and grits on the market, how do I know which to choose?

Comparing media to hard tooling is appropriate; however, hard tooling when not in use, can be tucked away or stored on a shelf, hardly the case with 1,000 lbs of ceramic media that requires a minimum of 10 cu. ft of storage area.

Compounding the problem is the time honored situation of media lodgment in the parts, requiring unspecified time, labor and area for removal. Extreme situations often render the part useless.

A manufacturing procedure of this nature is in sharp contrast to today's other modern manufacturing operations; automatically producing high quality parts with deliberate repeatability, often with tolerances to the tenth.

Until recently the only solution has been to maintain an inventory of a variety of media shapes and sizes matched to the parts. The alternative is to hand finish each part individually. This results in no two parts alike, a situation hardly in keeping with today's hi-tech standards.

Traditionally, successful mass finishing operations involve products that are configured so that media lodging is not a problem or precautions are taken (plugging) to prevent the problem from occurring.

New media shapes

Recently two new shapes of media have had a rush of popularity, which appears by far to be the most flexible or perhaps universal designs yet developed. One is derived from the cylinder shape but

cut so the ends join at the bottom forming a V shape; thus its name, V-cut Cylinder (VCC). The other is the 60 degree polyhedron which is an elongated triangle having 60 degree end cuts creating an elongated piece that finishes like a triangle, yet has the mobility of a cylinder. A unique factor with these shapes is the popularity with job shops. The aggressive competitiveness among job shops promotes the constant search for better ways to solve challenging problems on a daily basis without the involved procedures found in large organizations. Perhaps, the true value of a product's versatility can be determined by studying its application in an area of unlimited scope, such as the job shop.

Currently the shapes are performing unquestionably well in products ranging from jewelry to critical aircraft parts. Comparison has revealed that they finish faster and more completely than cylinders and cones; as quickly as triangles and other flat-sided shapes, but without their common lodging characteristics.

This is not to say they cannot lodge, only that the uniqueness of the shapes drastically reduce this potential over other shapes, allowing products never before considered to now be mass finished.

These new shapes are included in the category of spheres, cylinders and cones, which are highly mobile. Triangulated or thin, flat shapes lay up and key together, restricting mass motion. Media mobility is critical to the vibratory process, since vibratory motion is developed from kinetic energy rather than positive displacement (tumbling).

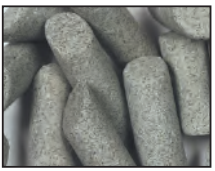
The mobility factor is what keeps the parts and media in harmonious motion. Without the uniformity of motion, the parts and media get out of step, increasing the potential for part-to-part contact. To counter this situation in the past, the media supplier would usually specify a more forgiving shape or where a triangle was necessary, the surfaces would be more angled and equally squared rather than of a thin, flat shape, thereby lessening the potential of restricting the mass activity.

The author's opinion is that these shapes provide more versatility than others categorizing them as utility or universal. This lessens the confusion encountered when storing a variety of shapes. The

Common Types of Media

Ceramic Media

Triangles
5/16" x 7/8"



Angle Cut Cylinders
3/8" x 7/8"

3/8"
Polyhedrons

Ceramilite Media

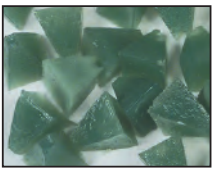
5/8" V Cut
Cylinders

Angle Cut Cylinders
5/16" x 3/4"

Plastic Media

1/4" Brown
Pyramids

1/4" White
Pyramids



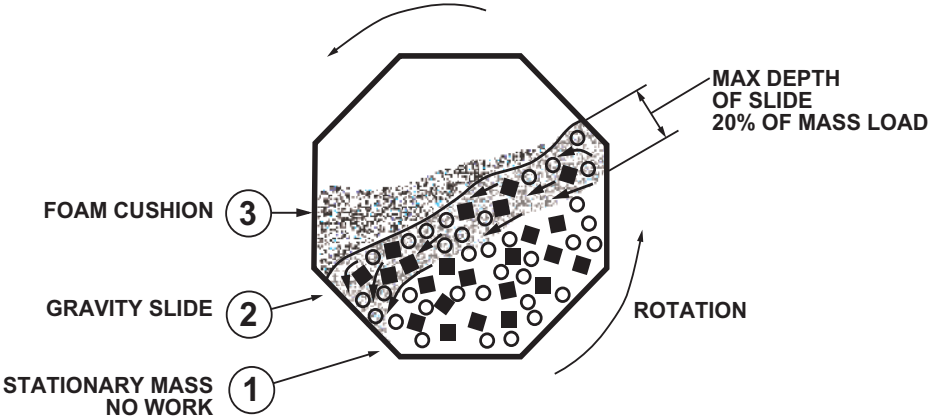
1/4" Green
Pyramids

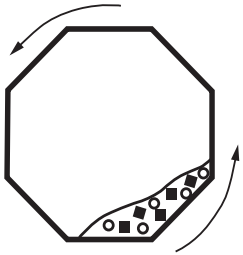
1/2" V Cut
Cylinders

5/8" XF Cones

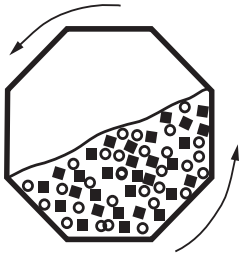
BARREL TUMBLING

PARTS RATIO - 4 MEDIA TO 1 PARTS BY VOLUME.
USE AS A STARTING POINT
CHANGE UP/DOWN TO ACHEIVE DESIRED RESULTS.

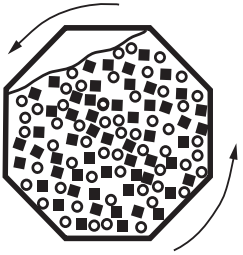




20 - 30° FILL VOLUME
PART ON PART
TUMBLE, NO SLIDE



50 - 60° FILL VOLUME
LONGEST SLIDE
FASTEST FINISH



70 - 80° FILL VOLUME
SHORT SLIDE
SLOW FINISH
BURNISH OF DELICATE
PART LOADING

COMPOUND REQUIREMENTS

1. **THICK - DURABLE**
2. **HEAVY FOAM - CUSHION FOR SOIL RETENTION**
3. **HIGH LUBRICITY - TO MAINTAIN A GOOD DEPTH OF SLIDE**
4. **SPEED, VARIABLE FROM 50 TO 200 S.F.M.**
   SLOWER SPEED - BURNISHING HIGHER SPEED - DEBURRING

Coordinating the elements

Shape by itself will never solve all the problems encountered with mass finishing. Other factors of importance include matching media size and abrasiveness to the task at hand. A small media size having a coarse abrasive grain will produce a finer finish than a larger one containing the same abrasive.

The smaller media, having less contact area, produces a close pattern, resulting in a finer finish. If a small media is in use performing a deburring operation it is logical to employ a fast cutting abrasive blend, improving the overall efficiency to the process time and production value.

Liquid compound concentration for vibratory systems

Often ignored is the compound concentration and viscosity that may cause excessive lubricity (slipperiness). Excessive lubricity can play havoc with process time. If a compound is highly concentrated or slippery to the touch it may need additional thinning or change. Excessive slipperiness or viscosity becomes a barrier, preventing the media from complete contact with the work piece, thereby decreasing its efficiency.

A simple test is to vigorously rub two fingers together under the compound dispensing inlet to remove any oils (natural or manufacturing). Then, while still under the flow, very lightly rub. If you can feel your fingerprint lines interlocking, the lubricity concentration is correct and not impeding the media's abrading efficiency.

The machine drains should be clear, allowing an unrestricted flow. Flooding the mass dampens the activity. In contrast, insufficient flow causes a dirty condition, contaminating the parts and also insulating the media from performing properly.

Simply put, the entire operation should look good and clean with a smooth, uniform mass motion.

Vibratory Media Versatility
Processing Characteristics by Shape

Media Shape	Lodging Potential Low High	Mobility	Surface Contact Area	Media Shape Retention	Surface Refinement	Process Time 1 Long - 5 Short	Versatility
Sphere		5 B	1	5	5	1	17
V-Cut Cylinder		4	5	5	5	5	24
Cylinder		4 C	2	4	5	3	18
60° Polyhedron		5 A	5	5	5	5	25
Cone		5	2	5	5	3	20
Pyramid		3	5	2 D	4	4	18
Elliptical		4	3	4	5	3	19
Triangle		3 A	5	4	4	5 E	21
Diamond		3 A	4	4	4	4 E	19
Tetrahedron		2	4	2	4	4	16
Star Shapes		2 A	3	3	4	4	16

Numerical scoring: 1 = Low, 5 = High. Efficiency is not rated by a high accumulated total.
The total score is an indication of the media's all around versatility.

A. The mobility factor is best in moderate sizes and when more evenly dimensioned ($\frac{3}{8}$" x $\frac{5}{16}$"). Poor when thin and broad ($\frac{3}{8}$" x $1\frac{1}{4}$").

B. Small sizes absorb energy, dampening mass activity. The lack of any flat surfaces further impedes the transmission of energy development, limiting the use of spherical media.

C. Mobility is restricted when width to length ratio exceeds 2 to 3.5.

D. Loses edge and becomes a tapered elliptical shape.

E. Thin flat shapes finish faster than those more evenly dimensioned.

Horizontal barrel media is somewhat more complex. Since you cannot see what is going on inside the barrel, you must envision what is happening.

The compound requirements for tumbling processes are quite different from vibratory processes: the foam is thick and foamy to cushion the bottom of the mass slide, as well as slippery to enhance the mass slide, which is usually 20% of the total mass load and the fluid level is filled to just above the mass (parts and media) level when positioned horizontally. A starting point for parts loading is usually 4 parts by volume of media to 1 of work.

Media selection for tumbling is wide open depending upon type of work and finish requirement. Were you to be finishing washers, then a cylinder shape or a thin angle cut triangle would compliment the slide requirement since tumbling is primarily an edge finishing process. On the other hand, rugged sand castings can be finished just as well with a blocky media such as a large star.

Finishing small parts is a common use for tumbling since the media is small also and the entire mass must be dumped (evacuated) for rinsing and separation in 99% of all tumbling processes.

Fixture tumbling employs small equilateral shaped media. Fixturing a part or parts is usually accomplished by attaching a fixture to hold a specific part/parts to the removable door of the tumbler thus holding the part stationary while the media cascades through/around the part/parts as the barrel rotates.

Plastic, ceramic, wood, nutshell and metal: how do I choose? How do I know what and when to use them? Do I need everything? Do I need special machines?

First, decide what it is you want to accomplish. Next, determine what materials are involved. Finally, consider planning previous manufacturing operations to compliment the finishing.

If you want to deburr, radius and blend, then have you preplanned

your operations to leave as small and uniform burr as possible? Mass finishing is not a final machining operation, swagged metal edges caused by excessive depth of cut and/or fast cutter feed, chatter, etc. just won't work.

Materials matter: the material characteristics and machining problems directly relate to finish ability, cycle times and media selection. One might think the harder the metal, the harder, more dense or abrasive the media should be. Back to what you want to accomplish - example: for aircraft or surgical type materials, ceramic media might be your first choice, however you are now working with two hard materials and that creates a “glance-off” characteristic where the two materials do not have enough contact time (on time) together. On time is important and the only way to accomplish this with ceramic media is by using a very small size with coarse abrasive.

A better way would be to use a plastic media having a shape and size that compliments the task at hand, the plastic media being softer and lighter will finish faster and more uniform and achieve a smoother finish. 2-4 RMS surfaces are common to hard materials that enter the machine having 16 RMS surfaces. This surface refinement, while smooth, is not a shiny one. Reflective quality does not automatically mean smooth, only that it is shiny.

Plastic medias are also used quite commonly for pre-plate finishes where the bright nickel applies the reflective (shiny) appearance. Dry media performs many different operations from simple part drying with ground corn cob to single or multi step deburring and final aesthetics of bright finishing copper, steel, silver, gold and any number of other metals, plastics and wood (wooden and plastic knife handles as an example). Dry media finishing processes are somewhat proprietary and the methods and materials for specific applications are developed jointly between the material manufacturers, blenders, additive manufacturers, and vendors. Dry finishing is truly under-sold and can benefit more users than are currently benefiting from it.

So media selection is like any other tool selection. If you are truly lost then your vendor or the media manufacturer can assist you if you supply them with a “before” sample and a description of the finish requirement, how many and how often (hourly, daily, etc). The frequency and volume are important as is the size and type of equipment you intend to use.

Ceramic media has an excellent deburring quality. It is extruded into a broad variety of wire cut shapes and sizes, providing the broadest range of shapes, sizes and abrasive qualities from fast cut to burnishing (no abrasive). Weights range from 90 to 110 lbs per cubic foot.

Plastic media is cast while a broad number of shapes are available. The shapes are limited by only what can be cast (example: no spheres or cylinders). Plastic media more commonly uses softer abrasives producing high quality surface refinement. Its lighter weight of 45 to 55 lbs per cubic foot lends itself to more precision work, lighter, more delicate parts and pre-plate finishing.

Metal media, having many sizes and shapes made of carbon and magnetic stainless steel is the workhorse for smoothing sharp edges and bright burnishing. Its heavy weight of 300 to 350 lbs per cubic foot make it ideal for light peening a burnish and smoothing edges of parts requiring curb appeal.

Dry materials offer many options for finishing but are employed where a near buff-like finish is required. On smaller parts such as 14k necklace catches, parts so small they cannot be held, it's the only finish. Electronic contactors and precision springs are big benefactors.

Dry finishing of plastics in many applications is the only solution such as plastic eyeglasses, clear desk ornaments (paper weights), key fobs and the like.
Composite parts need finishing also and you can look forward to more and more applications.

Metal media is employed over a broad spectrum in mass finishing; however, it is not a media for general use. Many metals utilized usually are steel, aluminum, cast iron and brass. The last three are part specific and custom cast either by or for the user, usually in the form of jacks.

Steel media employs stainless and carbon materials. Previously, the popular type was the carbon/ferrous material usually due to cost. However, as industries' manufacturing methods and processes became more precise, rust contamination could not be tolerated and today more and more stainless materials are used.

Steel media has many sizes and shapes and is employed to snap flash off injection-molded parts, and to burnish gold, silver and platinum ring mounts and prongs to a quality and luster to accept precious stones.

Incorporating dry processing on a big scale, dry processing is an age-old method reborn.

Steel media is the heavyweight of media, weighing in at about +/- 350 lbs per cubic foot. The weight aids in closing casting porosity and smoothing out tool marks and sharp edges. When parts are pre-cleaned and run in a process with a burnishing compound, this process can and will provide the final bright curbside finish you are looking for.

Metal media is utilized in all types of mass finishing equipment. Due to its heavy weight, you should check with the equipment manufacturer for the adjustments necessary to compensate for the extra weight. If you are going to utilize carbon steel media, you will need a good rust inhibitor to hold the media over night or for long-term storage.

What do I need to know about spent compound disposal (wet and dry)?

Getting rid of liquid compound depends on what it contains on a whole. The liquid concentrate is okay 99% of the time, however some applications such as heat-treat or rust descaling materials having Ph values of high acid or alkaline. Contact the manufacturer for instruction. Some manufacturers will take away the waste.

Other liquids are rather benign, they look really dirty and they are, but are harmless and no more polluting than washing dirty hands after shop work.

The swarf content in vibratory processes varies from media bond and size. Media bonds of plastic wear much faster and finer than ceramic bonds and their solids liquefy much easier, thus they are more difficult to settle out the foam retention. This may cause concern and may need to be flocked out; fabric softener applied via a trigger spray bottle is a good way to start.

Settling systems vary in size and usually have 2 or more stages. The first stage catches heavy sinkable solids, after stages retain the liquid, allowing longer settling times and can be as simple as 5 gallon pails running into one another or elaborate settling flocking and filter press systems. Liquid compound flow is small but constant. Take the example of a 3 cubic foot machine running at 2 GPH per cu. Ft per hour 2 x 3 = 6 x 8 hours run time = 48 gal waste per day, not really a big deal, especially if you run to a drain.

In the case of precious metals, reclaim can be evaporated using most any heat source (casting furnace or burnout furnace). Other metals such as zinc and lead are heavy metals; therefore samples of the waste stream should be checked by local authorities. Filtering is an option; however explore all options carefully.

Dry media disposal is not unlike wet compound disposal. What is the metal type and content? Lead, zinc, etc. is hazardous waste

and should be treated accordingly. Gold and other precious metals go for reclaim. When used for waxing, paint, highlight and the like, it makes a good floor-sweeping compound.

My vibratory machine floods and foams, how do I prevent this?

In the case of a closed loop recirculating system, first check that the drain and the hose leading from it aren't blocked or restricted. If they are clear, slow the in flow. When small media is in use, there are more and smaller pocket spaces between the media holding solution thus causing foam.

In the case of a flow through machine where the compound in solution is flowing in as a clean fresh solution and out through a drain (not being recirculated), check the drain to ensure it's flowing freely. Measure by time and flow volume that the out flow is the same as the input.

Foaming may be caused by too high a solution flow, by the wrong compound or the concentration of compound in solution being too rich (see small media closed loop above)

I find blind holes, crevices and inside corners have a film left after finishing that is difficult to remove. What can I do to make this condition go away?

First, run a clean process in the case of a plastic media pre-plate, deburring or surface refinement with plastic media. The media is light, soft and generally employs a less aggressive soft abrasive. All this sets the stage for much finer particulate debris or swarf from the part and media, which is difficult for the compound in solution to handle. Due to the media's softness, the debris is generated quickly. Getting rid of it is a problem and may require the drains to be opened more to accept more of the clean compound in solution in flow.

Ceramic media can also leave stubborn to remove deposits not unlike plastic media. In both cases you must run a clean process. Whatever process you use, when complete should include a thorough rinse using some of the compound in solution to do this. It is a good idea to never let the parts dry prior to inspecting them, this way they are easier to clean. Cleaning the residue with a toothbrush and WD40 can sometimes be a big help.

I am confused about foam, isn't this an asset to cleaning?

Yes and no. Think of it in terms of closed and open. Closed systems are tumbling, magnetic and centrifugal barrel. Closed systems require the use of durable, foaming, slippery compounds, usually in the dry powder form (magnetic is the exception) for ease of dispensing and handling. Open systems are vibratory and centrifugal disc, open-end barrels, oblique and bottle. The latter two fall into the specialty category. They are open but their processing capabilities are so vast and varied. This discussion will not include them except to say to use a foaming tumbling compound with them for deburring and burnishing operations is appropriate.

Vibratory and centrifugal disc operations depend on a flow through of liquid compound in solution blended for their unique operating characteristics of flushing away contaminants (swarf generated from parts and media), as quickly as they are created. Also, disc machines depend on the liquid to prevent premature wear on the precision gap between the disc and the outer wall; a foaming condition in a disc machine can impede the liquid flow resulting in costly repairs and down time.

Vibratory units utilize flow through for the same cleaning features as above. Foam is only acceptable in certain vibratory burnishing operations to cushion against possible scratching or part impingement. The acceptable foam will be evidenced by a small collar of foam around the center post in bowl machines or on the front wall of tub type vibrators. Foam of this nature is an indicator or having

the correct lubricity (slipperiness) to the mass. Remember: foam retains dirt and ultra fine particles that can result in a lesser finish in a vibrator. (see “how do I mix compound concentration” pg. 8)

My parts finish well, however if left for any length of time they start to rust. What precautions do you advise?

After completing the final post process cleaning and inspection, immerse the parts in a heavy concentration of 10-15% alkaline processing compound solution. This should hold them from rusting. (Don't allow the parts to nest or touch together holding moisture or they may spot. Dry them first.) For long-term storage, use a good rust inhibitor.

Cast iron parts should be totally immersed for up to an hour to allow the rinse water caught in the parts porosity to leach out and the compound and/or rust inhibitor to soak in, otherwise days, even weeks later, rust will appear. High relative humidity can spoil a lot of work also. The longer you dry the parts, the better. Some method of dry heated storage is also recommended. Cast iron is tricky. Sand-cast zinc and aluminum will leach also, so soak them well to prevent them from staining.

How do I choose a compound?

Selection of a compound may seem confusing, however some simple rules and common sense prevail. Acidic compounds help brighten most metals but will require rust prevention attention when used with metal media and ferrous parts. To remove heat treat scale, some acid compounds are not good cleaners, so pre washing of parts is always advised. Neutralizing the media and cleaning the processing channel from time to time is also advised, especially when the channel walls begin to darken and become shiny.

Alkaline compounds are the most widely used. They have a good cleaning qualities but tend to foam when they get out of hand in vibrators. Alkaline compounds have some natural rust inhibiting

qualities while others are formulated with added inhibitors. Your vendor usually guides your selection and those recommendations may fit your application perfectly. Most vendors are prepared to assist in your selection. Some maintain an experimental area at their facility that can work out the problem for you. Water hardness, pH and mineral content vary widely from place to place and since water is the vehicle that carries the compound, that is where the problem lies 98% of the time.

Compounds can be adjusted or reformulated and tailored to these extreme conditions. More common is that your situation has been encountered before and there is a material in place to fix the situation. You will never solve any problem unless you do the legwork. Your task should include a water analysis from the water company or well contractor. Usually that's all you need and your vendor will do the rest.

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