Introduction To Mass Finishing

Mass finishing is the general description for vibrating or flowing an abrasive media around usually a number of non-fixtured parts, moving randomly within the mass of the abrasive media.

Various types of equipment generate energy that is transferred thru the media to the part being processed. The transfer of energy and randomly moving parts automates the finishing process, with part loading and unloading to be addressed.

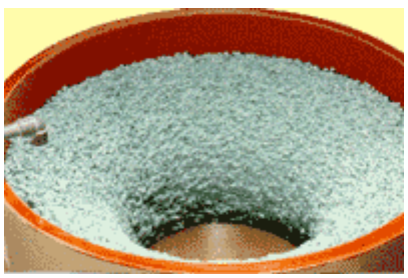
There are a number of variables that affect mass finishing which includes:

- The equipment
- Media
- Soap compounds
- The process

The effects mass finishing has on parts include:

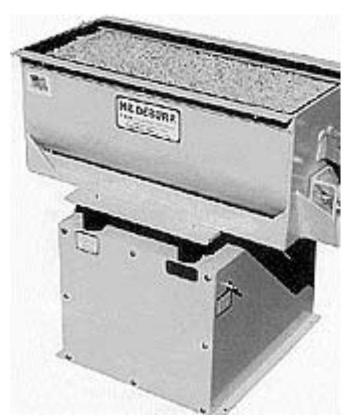
- Deburring
- Refining RMS finishes
- Burnishing (Brighting)
- Improving strength
- Pre plate
- Pre paint adhesion
- Improving oil retention on surfaces
- Cleaning

Mass finishing processes are repeatable and one of the least expensive ways to automate finishes on parts.



Tech Tips:
Mass Finishing
Machine Types

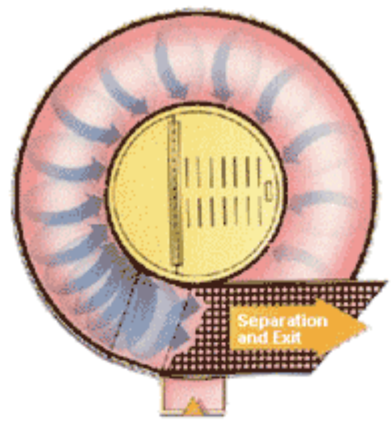
TUB VIBRATORY MACHINES



The tub vibratory machine is a horizontal urethane lined container with a u-shaped bottom and an open top. It can be manufactured with a variety of channel diameters and lengths making it an excellent choice for long or large parts. The tub can also be divided to run large parts preventing them from touching one another. The tub, built with extended lengths, lends itself to straight-line automation of vibrated parts.

The tub vibratory machine generates quite a bit more energy than rotating barrels and a minor amount of energy faster than bowl vibratory machines. The system is commonly powered or vibrated by a shaft with an eccentric attached to the tub. The shaft is rotated by a v belt, sheave and motor drive. The eccentric weights can be added or subtracted and adjusted around the shaft to increase or decrease vibration. There is another uncommon tub vibratory drive system that is driven with magnets. The tub vibratory machines were developed in the mid 1920s and were a welcome improvement over the rotating barrels that were in production prior to the tubs inception.

BOWL VIBRATORY MACHINE



The bowl vibratory machine is a horizontal urethane lined donut shaped container with an open top and vertical eccentrics shaft drive built thru the center column. The media mass rotates around the center column in a rolling forward feed motion. The machine can be built with a variety of channels and overall diameters; it is now being built with multiple channels feeding parts from one channel to another, allowing a variety of processes and drying with one machine.

The bowl vibratory machine tends to be a better finishing machine than the tub; it does a better job of keeping parts relatively orientated to minimize damage than a tub. The bowl can also be divided for large parts.

The most significant advantage of a bowl over a tub is that ramps, gates and screens can be added to the bowl allowing self unload of the parts away from the media and out of the machine.

The self-unload and improved finishing process of the bowl makes it a more popular choice over the tub.

The bowl vibratory machines were developed in the 1950s with self-unloading versions being patented in the 60s. The bowl vibratory machines were again a welcomed improvement over the tub and barrel systems previous to it.

CENTRIFUGAL DISC

The centrifugal disc is a stationary urethane lined bowl with a rotating bottom urethane lined disc that accelerates the media outward to the sidewall which then decelerates and moves inward to the center of the disc for reacceleration. This change in acceleration and deceleration of the media creates a flowing action over the part, generating energy up to 15 times faster than vibratory with the increased energy. The disc machine will deburr mall tough parts and achieve very low RMS finishes on parts for pre plate or pre electro polished finishes.

The disc was developed in the late 60s and is being utilized today because it's easy to load and unload. Decreased process time makes it highly favorable for cellular manufacturing.

CENTRIFUGAL BARREL

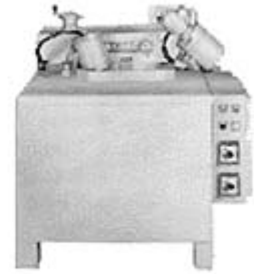
The centrifugal barrel machine has enclosed urethane-lined barrels mounted on a turret. As the turret rotates one direction the barrels are belt or gear driven to rotate to a given ratio in the opposite direction. The individual barrels are loaded with the media, parts to be processed, water and compounds. The action within the barrel is a compressive sliding action creating the maximum energy available today in mass finishing.

The process is excellent for small parts with large burrs. This system has the energy to drive small media into hard to get to areas. The system can also utilize one media to cut and brighten with one step. The bowl can also be divided for large parts.

The centrifugal barrel is also being used to brighten parts with dry medias to get as close to an as buffed finish as possible.

The centrifugal barrel machine was developed in the late 60s and is becoming more and more popular as processes are being developed. One of the disadvantages of the centrifugal barrel finishing is the load and unload of parts is a bit labor intensive.

SPINDLE MACHINES



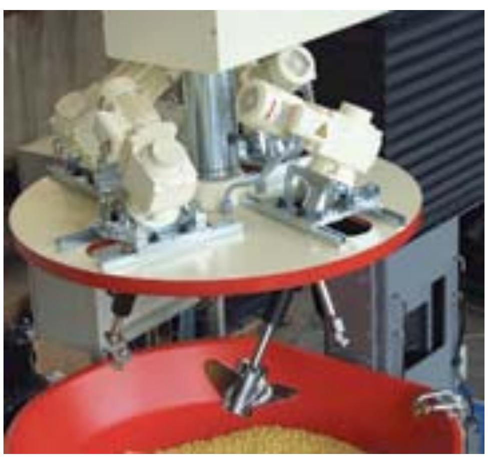
The spindle machine is a variable speed rotating bowl of random shaped or preformed media. The spinning of the bowl slings the media to the outside wall. The part is rotated by a spindle that holds it into the spinning mass. The collision of the media hitting the part as it rotates by is what creates the energy.

The individual part holding spindle can be programmed to rotate at various speeds, and can orientate the part to be worked in certain areas or dwelled to concentrate in an area. The flexibility of orientation, rotation and dwell of the spindle allows parts such as gears to be worked to achieve different radius in various areas of the gear teeth.

Spindle machines produce higher energy levels than vibratory machines. Spindles were developed in the 70s and have been popular for gear deburring. The American-built spindle machine generally uses 2 to 4 spindles per machine. Other manufacturers tend to utilize many more spindles in a given machine.

Dry process spindle machines are used to obtain an as buffed finish on large complex parts such as band instruments.

DRAG MACHINES



Drag machines are bowl machines that utilize light vibration with fixtures holding and dragging the part thru a heavy mass.

The drag machine produces more work than conventional vibratory systems resulting in reduced time cycles on complex parts.

These systems have been a recent development and are used on a variety of parts like boat propellers, and air tool handles.

BARREL FINISHING

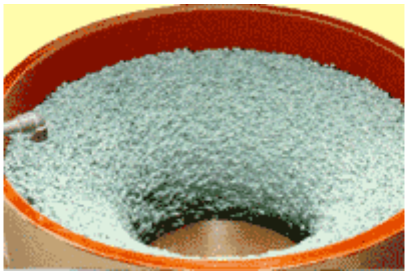
A hexagon or octagon barrel rotating horizontal will process parts slower than vibratory finishing, but produces amazing finishing results.

The barrel is rubber or urethane lined to protect parts. As the barrel rotates it lifts the media that eventually slides. The slide of the media containing the parts is the working action of the barrel. A faster RPM results in a thinner slide area, a slower RPM produces a thicker slid, 18-22 RPMS tends to be the optional slide for most applications.

The process involves water and compound, the more water and compound used the more cushioning action is achieved. Normal water levels are just above the media & parts. Media level is very important, 50% full with parts will produce the longest slide and therefore is a good starting point. Higher media levels will shorten the slide and provide more part protection.

Time cycles range from 1 to 24 hours, 1 for burnishing, 2 for deburring and longer cycles when deburring and burnishing in on operation.

The load and unload of barrels is labor intensive; therefore vibratory finishing has replaced many barrel applications. Internal areas of parts are not finished well with barrel processes, but when it comes to keeping flat parts from sticking together or super luster finishes without part damage, barrels have always been an excellent choice.



Mass Finishing Tech Tips: Media Types

OVERVIEW

Vibratory or mass finishing media transmits the energy from the machine to the work piece. It carries the compound for cleaning or brightening and it suspends and protects the parts.

The weight and size of the media has a lot to do with the amount of work it is capable of doing. Heavier and larger media cut faster and do more work because of the heavier hammer effect. The larger medias also create more voids within the mass allowing a more aggressive action. A smaller media will create a tighter mass capable of holding more fluid, and with less voids within the mass it will work to protect the part.

The shape of the media allows it to get into an area to get something done or stay out of an area so it will not lodge. A round or cylindrical shape will finish better because of single point contact with the part, like a ball pean hammer effect. A flat shape, such as a triangle, has a wide surface to rub over an edge allowing quicker deburring.

Media hardness has a lot to do with the finish depending on the type of material and hardness of the part. This and other factors will be discussed under media selection.

MEDIA TYPE	COLOR	APPROX. WT./CU.FT.	CUTTING ABILITY	SURFACE FINISH	MEDIA HARDNESS	GENERAL COMMENTS
CERAMIC						All ceramics are cleaner running and in general, less expensive to operate than Plastic Medias. They give a scratchy Matte. Finish Best RMS Finish in vibratory is app. 12.
High Density	Brown	120 lbs.	Fastest	Dull Rough Matte Finish	60-65 Brinell	
Super Fast	Grey	70-90 lbs.	Very Fast	Scratchy Matte Finish	60-65 Brinell	
Fast Cut	Grey	70-90 lbs.	Fast	Scratchy Matte Finish	60-65 Brinell	
Medium Cut	Grey	70-90 lbs.	Medium Fast	Matte Finish	60-65 Brinell	
Light Weight	White	40 lbs.	Very Fast	Matte Finish	50 Brinell	
Polish	White	70-90 lbs.	Very Little	Bright Reflect	70-90 Brinell	
PLASTICS Synthetic: Plastic						*Very clean running media. *All medias are biodegradable. *All synthetics are capable of a preplate finish depending on metal type. *This media will cut a burr when a ceramic media will roll it over.
Fast	Pink	45 lbs.	Fastest of Synthetics	Good (Matte)	0 on Brinell	
Medium	Tangerine	45 lbs.		Good (Matte)	0 on Brinell	
Preplate	Light Green	45 lbs.		Bright Matte	0 on Brinell	
SP	Tan	45 lbs.	Slowest	Bright Polish	0 on Brinell	
POLYESTER: Plastic						*The media hardness is 45 Brinell. *Longer wearing than the synthetic medias.
High Density	Grey	55 lbs.	Fastest of Polyester	Good(Dull Matte)	42-45 Brinell	
Fast&Medium	Green/Red	55 lbs.		Very Good(Dull)	42-45 Brinell	
Preplate	Light Green	55 lbs.	Slowest	Dull Matte	42-45 Brinell	

CERAMIC MEDIA

This media is identified by its bonding agent, which is ceramic. The cutting abrasive bonded by the ceramic is most commonly aluminum oxide between 80 to 220 grit size. Silicon carbide grit is also used in ceramic media.

Ceramic media is a very popular choice in finishing processes because of its long lasting and clean running characteristics. There are different grades of cut within the ceramic media family:

*** Polish**

*** Super Fast Cut**

*** Medium Cut**

*** High Density Fast Cut**

*** Fast Cut**

*** Light Weight (low density)**

Below are the factors affecting media cutting performance:

<u>Abrasive Size And Percentage</u> - Polish medias have no abrasives where faster cut medias have courser grits and more of it.

<u>Bonding Agent Strength</u> - Faster cutting medias are bonded softer allowing the bond to wear away exposing new abrasives which increases cut rates. Polish medias are very hard.

<u>The Ceramic Itself</u> - Different clays will assist cut and affect weights of medias. Heavier and larger media will cut faster.

The manufacturing process determines the shapes ceramic medias are available in. The ceramic and abrasive are mixed wet or green and then extruded thru dyes. This limits the shapes available which are equal sides. As the media is extruded it is cut for thickness and then baked in a continuous or batch klin to dry and harden. The ceramic cone and ball are a couple exceptions to the extruded equal side shapes.

Ceramic is a good all around media and is one of the first choices to make for all metals. The 45 to 65 rockwell hardness of ceramic can sometimes damage softer metal, testing prior to processing is always advised.

PLASTIC MEDIA

Plastic media is known by its bonding agent. The two primary bonding agents of plastic are:

- ***Polyester***

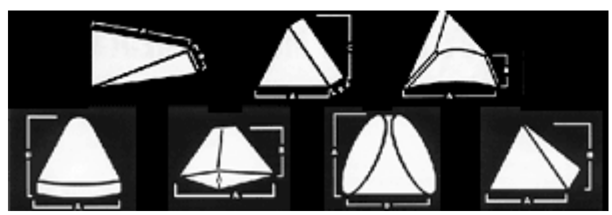
  Polyester is the original formulation of plastic media. It is produced from an oil derivative, therefore, non-biodegradable. The polyester breakdown is a white chalky sediment that's difficult to clean off of parts.

- ***Synthetic***

  Synthetic plastic is a recent development and runs cleaner than polyester. Synthetic is softer and lighter than polyester achieving superior finishes. Synthetic is also biodegradable.

The cutting element in plastic medias is usually quartz. The cutting element is limited to a given percentage because the manufacturer's process starts with a liquid and like adding sugar to water and mixing it, if too much sugar is added it will drop out. After the quartz is added a catalyst is added to harden the mix that's poured in a mold. The molds provide a variety of interesting shapes: cones, pyramid, tetrahedron and wedges.

Plastic medias are processed in a variety of different cuts:



- Fine Cut (Pre Plate)
- Medium Cut
- Fast Cut
- Extra Fast Cut (High Density Zirconium, 100 LBS Cu. Ft.)

Plastic medias in most cases do not cut as fast as ceramic but do give lower R.M.S. finishes and eliminates the nicking or damaging of edges on softer metals.

Below are a number of advantages of plastic media:

- Light weight and soft bonding agents allow it to wear a burr off with out rolling the burr onto the part. Once a burr is rolled it's very difficult to remove.
- Certain plastic shapes, particularly a wedge, will sharpen as it wears allowing points to get into inside radious of parts. In large mass finishing systems with large parts, hard medias compressed between the machines sidewall and the rotating part can gouge and damage the part. Softer plastic medias eliminate this type of damage.
- Low RMS finishes.

In summary plastic media has many advantages. Your parts should be run in a lab prior to media selection to determine its future success.

RANDOM MEDIAS

Random medias are comprised of a variety of natural shapes and types of materials, one of the oldest recorded applications of random media used in mass finishing were by the Romans. They gathered certain types of rock, put them in pouches attached to their belts and polished their uniform ornaments as they marched.

Today, some popular random medias are microcrystalline aluminum oxide, silicon carbide and sintered ceramic. These medias are tough, chemically inert, economical, non-toxic and uniformally sized.

Random medias can cause more lodging problems than the more commonly used preformed medias.

DRY PROCESS MEDIA

The most common dry process media are wood pegs, corncobs and walnut shells. They are produced in a variety of shapes and sizes.

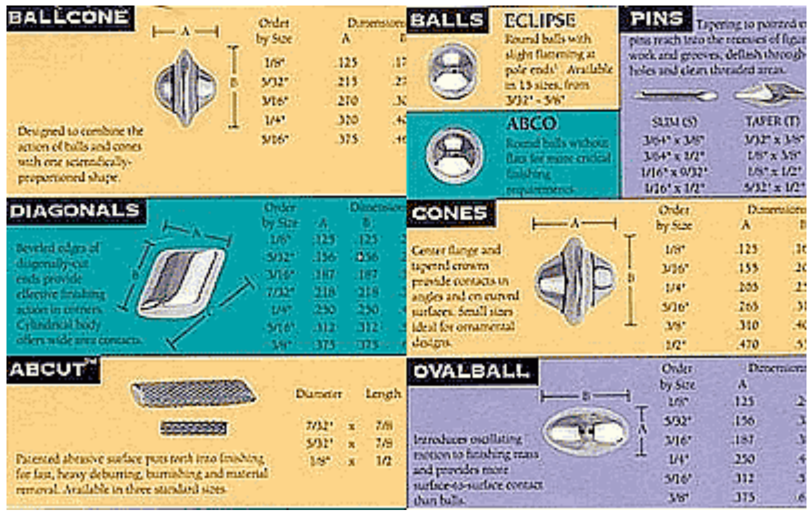
The dry process medias are most often impregnated with dry polishing powders or creams. The dry polishing powders are chrome rouge, iron oxide or calcide aluminum that are normally impregnated by the media manufacture. The polishing cream also contains polishing powder combined with other elements that are added to the dry process media by the user and recharged between part batches.

Dry medias are used in most mass finishing machines, including: vibratory, rotating barrels, centrifugal barrels, centrifugal disc and spindle machines.

The most common applications of dry finishing media is surface brightening (an as buffed finish) on final finish refinement. The dry media process can be a one step process, however, it's usually the last step of a two-step finishing process. Cleaning (especially with the creams) may also be required.

STEEL MEDIA

Steel media is a cold headed, heat treated, ground and finished carbon or stainless steel shape. It is highly finished. Steel media is used in vibratory or barrel mass finishing to burnish, clean, improve compressive strength, dull edges, smooth finishes and reduces porosity on plated parts.



Steel media can last 10 years, runs very clean and eliminates lodging of media in parts. The media is available in a variety shapes and sizes.

The weight is approximately 300 lbs per cu ft. Specially built heavy duty machines are usually required to run steel because of it's weight.

Process times are relatively short and waste treatment is simplified because of non-sediment waste stream.

SOAP COMPOUND

Soap compounds are critical and in many cases have more importance in obtaining processes and finishes in mass finishing than the media itself.

Soap compounds accomplish many things:

- Lubricates the mass resulting in extended media life.
- Cushions the part eliminating part damage.
- Suspends the dirt, oils and media residues and flushes them from the system keeping the parts and media clean.
- Inhibits rust or corrosion of parts in the finishing process. Extended shelf life inhibiting should be done as a post dip or spray with water-soluble inhibitors.
- Burnishing (Brighting)
- Descaling
- Accelerates media cut

Soap compounds are identified in the following categories though many compounds will do multiple functions:

- Deburring compounds (General Purpose)
- Burnishing compounds (Brighting)
- Rust inhibitors (Post operation sprays or dips)
- Chemical accelerations (Metal oxidizes)
- Descalers

Soap should be mixed with water and then flowed thru the system. The soap and water in many cases can pass straight to sewer and now more commonly recirculated back thru the system after being filtered.

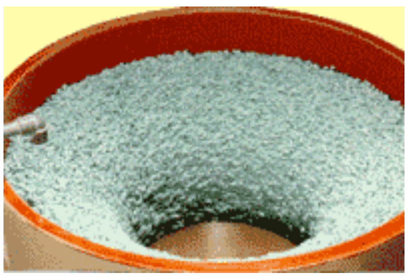
The general soap concentration and water flows are 1 to 2 oz of soap per gallon of water and 1 to 2 gallons of water per cubic ft per hour.

A good starting point for the following processes are as follows:
Ceramic Media - 1 oz of soap per gallon of water and 1 gallon of water per cubic foot per hour

Plastic Media - 1 oz of soap per gallon of water and 1 1/2 gallons of water per cubic foot per hour

Dense Media - 1 oz of soap per gallon of water **(small shapes)** and 1/2 gallon of water per cubic foot

You will need to increase these minimums as parts get dirtier or oilier.



Mass Finishing Tech Tips: Work Load

The workload or amount of parts that can be processed in a given batch will largely determine the finishing cost of the part.

Factors that affect the workload are:

- Part size and configuration
- Part weight
- Alloy of material part is make of
- Media to be used

General comments about workload:

- Larger parts and or sharp cornered parts can be more susceptible to part on part damage.
- Heavy parts may require larger media to support and suspend the part within the mass.
- Smaller media (a dense mass) provides more protection, therefore allowing more parts to be run without damage.
- Parts that require very fine finish refinements or bright finishes cannot be loaded as heavy as a deburring application.

The workload is determined by volume and is expressed by media to part ratio.

Media to part ratio guidelines are as follows:

- Part on part processing using no media

0:1

- Very small stamping, forging, castings

1:1

- Very small machined parts

2:1

- Minimum amount required for self unloading machines

3:1

- Average part

4:1

- Softer non ferrous metals

5:1

- Very fine finishes and bright burnished parts

7:1

- Very delicate part

10:1

- Parts that cannot touch one another compartmentized

Using media to parts ratio to calculate parts per cubic foot:
Once you've estimated the media to part ratio one can calculate the parts per cubic foot by multiplying part L" x W" x H" x media to part ratio (on ratio 4:1 use 5) % 1728 = parts per cubic foot.

Calculation of machine size required:
Example: use the following parameters

- If you've estimated 12 parts per cubic foot
- One hour total cycle (50 Min. process, 10 Min. unload)
- Daily production 1000 parts 1 shift, on 7 one-hour cycles. Divide 1000 by 7 = 143 parts per cycle
- Machine size required 143 divided by 12 (Parts per cu. ft.) it will require a 12 cu. ft. machine to process the 1000 parts per day.

WORK LOAD COST CALCULATION

Calculation of media attrition (wear out) rate and media weights:

Media	Attrition Rate	Weight
Ceramic med cut	.005	80 LBS cu. ft.
Ceramic fast cut	.01	80 LBS cu. ft.
Polyester plastic	.0125	50 LBS cu. ft.
Synthetic plastic	.015	45 LBS cu. ft.

Cost calculation:

Once you've determined the:

• Machine size • Process time cycle • Parts per cycle • Media and its attrition rate

Use the following finishing cost justification formula:

Cost per part:

Example:

- 12 cu. ft. vibratory
- 50 minute cycle time
- 10 minute unload ($10.00 labor rate)
- Medium cut ceramic .005 attrition rate,80 LBS cu.ft.)
- 143 Parts per cycle
- 1 oz of soap per gallon of water, 1 gallon of water per cu. ft. 5 cents per oz for soap compound

Finishing Cost Justification:

Compound used per hour 12 oz. x $.005 per oz.......... $ .60

Media Cost per load:

960 LBS per load x $.80 per lb. x .005% attrition...... $3.84

(80 lbs cu. ft. x 12 cu. ft. = 960 lbs)

Total consumables..... **$4.44**

Total Cost per load:

Total hourly rate $4.44 x .83 hours per load.......... $3.69

(50 min. is .83% of hour)

Direct labor rate (+fringes) $10.00 per hours x .16

hours per load....................................... $1.60

Total................................... **$5.29**

Total cost per part:

Cost per load $5.29 = $.074 per piece.

piece per load 143

The part above costs less than 7.5 cents per part to process.

DEBURRING

Deburring is one of the most common applications of mass finishing. Below is general information on deburring applications:

- External burrs are easier removed than internal burrs.
- Burrs can be created too large to remove.
- Small parts with large burrs can be difficult requiring longer time cycles or higher energy machines.
- Burrs can be rolled by heavier medias therefore requiring lightweight medias to cut them instead of rolling them. Once a burr is rolled and flatted to the part it becomes impossible to remove by mass finishing.
- Stainless burrs will work harden themselves off the part instead of being worn off like other types of metals.
- Larger media, faster cutting and heavier media will remove larger burrs.
- Increased time cycles will assist in removing larger burrs.

SURFACE FINISHING

Surface finishing in mass finishing refers to refining or smoothing a surface to lower the RMS finish. Pre plate finishes are often referred to in the industry as surface refinement.

Various medias will affect surfaces in different ways. Medias that are sharp cornered or harder than the work pieces can nick and damage parts.

Ceramic medias may do an excellent job of bringing an RMS from 64 to 16 but a secondary plastic media cycle may be required to bring the surface from 16 to 6. High-energy systems that flow media and or special medias will be required to bring surfaces in the 2 to 3 RMS range.

Time cycles can become extended in surface refinement ranging between 2 to 6 hours in vibratory or one hour in high-energy systems.

BURNISHING

Burnishing in mass finishing is to brighten a work piece surface producing a luster finish.

Burnishing medias are primarily steel media, ceramic porcelain or dry medias. The process cycle times are usually one hour or less.

A bright surface will amplify scratches, nicks or imperfections; therefore, in many cases require a cut and smooth cycle prior to the burnishing cycle. The cut and smooth cycle can be fairly long, one to three hours in vibratory and is commonly done with a plastic media.

A subsequent drying cycle may be required to eliminate water spotting caused by the minerals in the water.