Fundamentals of Metal Finishing

There are many parameters to be taken into consideration when utilizing mass finishing processes. These considerations include: part composition, size and shape, media type and compound chemistry, equipment type, workload (batch or continuous), finish requirement, etc. A typical mass-finishing operation has many elements, and each one must be evaluated to determine what is best for a single or series of applications as well as overall budget considerations. Mass finishing is most often used to burnish, clean, color, deburr, deflash, degrease, descale, radius, refine, dry, and offer pre-plate or pre-paint finishes of parts, amongst other various process applications.

The Cutting Edge

In addition to addressing the overall objective of the part, proper media and compound selection requires analysis of a part's composition and configuration. A part's shape can impede or restrict normal media contact during a mass-finishing operation. One must consider recessed areas and odd-shaped parts when selecting media and processing equipment. Media will need to be shaped so that there is as much surface contact as possible between media and parts. This is critical where parts have hard-to-reach areas. Media size also impacts the degree of cut or finish. Large media removes more metal because of the increased force it imposes and the amount of time it "drives" over the surface of a part. Keep in mind, however, that damage may result from impingement and denting. Careful control helps avoid this. Conversely, smaller media will produce smoother finishes, resulting from the reduced cutting action. When sizing media to an individual part, screening is also a necessary consideration, as parts must be able to separate themselves effectively from media during unload operations.

Media composition is the most difficult finishing decision because of the variables involved. The choice of abrasive type and grade is based on the work objectives, such as burnishing, light deburring, general purpose, or fast cutting. The quality of media varies from manufacturer to manufacturer and can usually best be judged by attrition rate comparisons of usage. Popular media selections are as follows:

1. **Ceramic media** compositions are virtually all abrasive, hard and are more abrasive than equivalent resin-bonded media because of the density comparison. The combination of an ultra-tough surface area and rigidity exposes a constant abrading surface and an aggressive cutting action. Available in a number of compositions, ceramic media can be used in a variety of delicate or aggressive applications, including burnishing, radiusing, polishing, rapid cut down, deflashing and deburring.
2. **Resin-bonded media** produces softer surface finishing action and provides a uniform finish. The media is best for parts requiring more restricted edge and corner radiusing. Resin-bonded media is manufactured in lower densities than ceramic media. The media smoothes parts but does not impart a high luster. Resin bonded media are very effective in pre-plate and pre-paint type applications.
3. **Steel media** offers two distinct benefits. Steel media is the most effective means to a highly burnished surface. Generally used in the diecast industry to offer highly reflective surfaces, steel media is now used in a variety of applications such as the stamping industry to provide a part free from sharp edges. Because of its density (approx 275 lbs/cu'), it is also an excellent "peening" material which offers a deburred part free of sharp edges as required in subsequent handling operations. The steel media does not contain abrasive, therefore, does not deburr (it will remove loose burrs) a part, but rather pounds (or peens) the surface of the material thereby eliminating sharp edges.
4. **Aluminum Star media** is designed to penetrate areas with corners and blind holes not reachable by other medias without the potential of lodging of other styles of medias. Initially designed specifically for flash removal in the diecast industry, the mill star is now used in a variety of light burnishing and deburring applications because of its added versatility. Added benefits of the aluminum and steel media include the elimination of heavy sludge created by the breakdown of the ceramic and plastic medias. Because of the natural abrasive qualities that cast aluminum renders, a cutting ability between a light cutting ceramic media and a non-abrasive media can be expected, offering a semi-burnished finish.
5. **Aluminum oxide and silicon carbide abrasive media.** The ideal aluminum oxide mass-finishing abrasive is dense and tough. Sintered bauxite has these attributes. Harder than steel, this ceramic media is used to color hardened steel, other ferrous metals, exotic metals, brass and aluminum. A pre-formed version enhances luster on a stainless steel and exotic non-ferrous materials. Shape and closely controlled sizing also eliminate lodging in recessed areas. Fused aluminum oxide abrasive is a dense, solid structure with fine crystal size and carefully controlled chemistry. Pre-formed aluminum oxide media is

random-shaped, free and fast-cutting media provided in graded sizes for applications from burr removal to final surface finishing.

Unlike aluminum oxide, silicon carbide does not impregnate soft ductile metals. Therefore, this media is best for parts that will be welded or braised, for bearing surfaces and parts that will be machined after deburring. It is more friable than aluminum oxide and fractures more readily in contact with work pieces under heavy loads. Diamond, cubic boron nitride and boron carbide are the only media abrasived harder and sharper than silicon carbide. Silicon carbide is especially effective with non-ferrous metals such as brass, copper and aluminum. It is preferred for finishing hard, brittle parts like cemented carbides, ceramics, granite, marble, glass, cast iron and low-tensile-strength, ductile non-ferrous materials.

Although a great amount of emphasis is generally placed on proper media selection, just as critical is the type of compound (soap) selected. There are a number of styles (i.e. powder, liquid) and types of solutions available all directly related to the end requirement of each individual part and the process and equipment it is being finished in. The main role of compounds in addition to providing a desired end result (i.e. burnishing, deburring etc.) for a part, is to keep the parts and media clean, by suspending soils and not allowing them to be redeposited. By doing so, this provides the desired part finish and at the same time, keeps media from becoming contaminated and losing its effectiveness. Compounds can also reduce corrosion and prevent tarnishing, effectively protecting parts during the entire surface finish operation.

The Finish Line

Mass finishing regulates the degree of surface profile on a part. It is measured in terms of the average micro-inch distance from the surface's peaks to its valleys. The degree of surface texture is expressed as RMS (root mean square) or Ra (roughness average) of these surface variations. A higher micro-finish translates into a rougher surface and, conversely, a lower number equates to a smoother surface.

Burnishing a part's surface involves smoothing the surface peaks into the valleys, producing a highly reflective finish. The operation uses non-abrasive media, such as sintered bauxite or metal media and a viscous lubricating compound (most likely with an acidic base). Certain general concepts about burnishing include: 1) Dense (i.e. - steel) media is preferred; 2) Smaller sized media offer higher luster;

3) Media previously broken in and free of sharp edges or corners is required; and 4) Acidic (usually citric) based compounds generally offer the brightest surface possible as well.

Coloring is another phase of finishing that shows the degree of light reflectivity or light distortion of a part's surface. The operation exposes the ultimate color potential, polish or brightness of a part's surface.

Deburring and Deflashing removes undesirable protrusions and sharp edges generated from previous manufacturing operations such as grinding or diecast operations. There are generally three types of deburring operations in mass finishing:

1. **Light deburring**, which removes small brittle burrs produced from grinding operations or flash resulting from diecasting or other molding operations. When utilizing a long wearing ceramic or plastic media, these appendages are broken free from the part and the exposed edges are smoothened. Steel media is also an excellent means to provide a light flash removal as well as provide a part free from sharp edges for subsequent handling ops.
2. **Heavy burr removal** or heavy cleaning uses a fast-cutting media to remove large, thick burrs caused by sawing, milling, drilling, turning and other similar operations.
3. **Radiusing** rounds sharp edges or corners using a variety of medias ranging in composition dependent upon the requirement of the individual part.

Degreasing and Descaling are a function of both media type and probably more critically a function of the correct compound (soap) selection. Compounds are selected for a variety of reason including their ability to handle specific soil types, to provide inhibiting qualities, specific de-scaling or de-rusting capabilities as well as for a ferrous or non-ferrous process application.

A Means to an End

Choosing the proper parts processing equipment is the final step in a successful implementation of a finishing process. With a wide variety of choices of mass-finishing equipment available, virtually any part can be accomplished in this type of equipment.

Mass finishing equipment can be divided into four major categories: 1) Barrel Tumblers; 2) Vibratory finishers; 3) High Energy Centrifugal Finishers; and 4) Drag

Finishing machines. The size and operating intensity are major considerations when selecting media.

Tumbling Barrels are the oldest and simplest form of mass finishing and are seldom used in manufacturing environments. These units impart the least amount of action and typically produce longer cycle times than any of the other styles of equipment. Most effective in a part on part, or part on media environment, the barrels are manually loaded with parts (and media) at which time water and compound is added. These units (mostly horizontal in design, octagonal in shape) provide a sliding type action. As the barrel rotates, the parts and media rotate along the outside diameter of the wall. At the transition point (or top of the roll), the force of gravity exceeds the centrifugal force exerted on the parts and thus the mass begins to slide down to the base of the barrel. This action is repeated continuously while the barrel is rotating.

Vibratory Finishers are the most common style of mass finishing equipment available. These units consist of the more popular circular bowl style units as well as tub style finisher. Circular vibratory bowls are popular where frequent media changes are not required. Processes can be very simple or can be designed to be fully automated where little or no operator interference is necessary.

Centrifugal Disc and Centrifugal Barrels are the higher energy form of mass finishing. Generally, 10-20 times faster than standard vibratory finishing, these units provide faster throughput in processes where it is required.

Drag Finishing is a very unique process in that parts are fixtured and "dragged" through a stationary bed of media at a high rate of speed. These parts are generally have many contours and are difficult to finish in manual operations and are adverse to part on part contact.

Although there are many factors to consider in mass finishing, these factors can generally be broken down into four major areas: Equipment, Media, Compound and Workload. In every instance, it is the part, which dictates the process, or determines if there even is a viable mass finishing solution.

FOUR FACTORS TO CONSIDER IN MASS FINISHING

1) TYPES OF EQUIPMENT
   - A. Barrel Tumbling
   - B. Vibratory Finishing
   - C. High Energy Centrifugal
   - D. Drag Finishing

2) MEDIA
   - A. Ceramic
   - B. Resin bonded (Plastic)
   - C. Steel
   - D. Aluminum
   - E. Aluminum Oxide or Silicon Carbide

3) COMPOUNDS
   - A. Type
   - B. Concentration

4) WORKLOAD
   - A. Ratio - Volume (i.e. - parts to media)
   - B. Finish requirements
   - C. Type of Material (i.e. - stainless, mild steel, brass, aluminum, plastic)
   - D. Part Configuration
   - E. Continuous or Batch

Please feel free to contact us and let us help you determine if mass finishing is the proper solution for your parts requirements.

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