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FUNDAMENTALS OF MASS FINISHING

This report is designed to acquaint the reader with the purpose and scope of mass finishing. It is hoped that it will assist in better understanding the field of vibratory and barrel finishing.

THIS REPORT COVERS THE FOLLOWING SUBJECTS:

Purposes:

- Deburr
- Improve Surfaces
- Brighten
- Clean
- Inhibit
- Dry
- Transfer

Elements Of Mass Finishing:

- Parts
- Equipment
- Media
- Compound and Water
- Other Process Variables

Purposes:

It should be noted from the discussion to follow that many of these purposes are accomplished in a single operation, which further improves the economics of a properly designed system.

DEBURR

Deburring can vary from the removal or preening down of very fine feather burrs to the removal of large burrs. The process depends on the hardness or toughness of the base metal, the shape and size of the burr, media accessibility to the burr, and the requirements of the parts themselves. The equipment type, media type, and size are all-important factors in the deburring process.

IMPROVE SURFACES

Reducing the roughness of surfaces is also a well documented capability of vibratory and barrel finishing. Rough surfaces can be made smoother by the use of the appropriate media and compound. If the original surfaces are uniform in their roughness, very predictable cycles can be developed to bring these down to required tolerances. In this respect, the mass finishing process is an excellent quality control tool. Surface finishes as low as 5 micro-inches or below can be developed on metal parts.

BRIGHTEN

Surfaces can be brightened or made more reflective by the use of proper compounds in conjunction with the right media. Hardened steel media will bring out the maximum luster and reflectivity of the surface. Non-abrasive, long-wearing ceramic perform media, certain grades of fused aluminum oxide and natural stone can also be used for the brightening of metal surfaces, depending on the hardness of metal involved. These are selected depending on luster requirements.

Matte surfaces can be developed by more abrasive media. These non-reflective surfaces are characterized by random scratch patterns, which are generally not aesthetically pleasing, but provide excellent adhesion for paint or electroplating or for retention of lubricant films.

CLEAN

Well-designed mass finishing systems are able to develop clean parts while performing other operations as well. The process of cleaning is highly dependent on the compound type and the solution. In severe applications where aggressive abrasive media is used, parts should be rinsed after deburring. The best cleaning often occurs when steel burnishing media, which in itself does not produce soil, is used for deburring, cleaning and brightening of metal parts. Cleaning, therefore, is more economical, faster and more effective than by other means.

INHIBIT

Vibratory finishing is capable of developing extremely active metal surfaces which, unless properly inhibited, can be sensitive to corrosion. This effect is most easily noted if plain water is used in the vibratory process with ferrous metal parts. This problem is easily overcome by the proper selection of compound for use in the vibrator and, when

necessary, use of an auxiliary rinse-inhibit station on the screen deck. Both ferrous and non-ferrous metals should be properly inhibited, depending on their ultimate requirements. Inhibition must begin during the finishing process. Once started during processing, corrosion cannot be easily stopped.

DRY

Because vibratory and barrel finishing is a wet process, it is frequently desired to dry these parts. Drying systems most commonly utilized include the spin dryer, wherein parts are put into perforated baskets and spun at high speeds to throw off water. Heat can be applied to speed up drying, but the limitation of this system is that it is strictly a batch operation and cannot be easily automated.

More automatic equipment is also available. The vibratory dryer, utilizing heated cob meal, offers continuous drying in cycles from 1 to over 4 minutes with automatic parts and media separation. Tunnel-type vibratory or endless belt dryers with external heating sources are other continuous types. Heated dip tanks with drag-out conveyors allow parts to flash dry.

The type of drying system recommended, again will be determined by the requirements of the parts themselves, whether cob meal will lodge in any holes or recesses, whether cup-shaped areas would retain too much water on a belt-type dryer, and whether wiping of the surfaces is desired to effect further cleaning.

TRANSFER

While not normally associated with mass finishing, the transfer of parts can be accomplished automatically, or by whatever means are desired, both into and from the finishing operation. This may be in tote baskets, by conveyor belts, or hopper feeders, depending on the requirements of the parts. Automatic transfer of parts can be made between vibratory equipment as well. For example, a vibratory deburring machine can feed a vibratory burnisher and it can feed a vibratory dryer.

ELEMENTS OF MASS FINISHING

The parts to be finished, the equipment used, the media, compound, and water and other process variables constitute the elements of mass finishing. A discussion of these elements individually will help clarify the relationships between them.

PARTS

The part requirements dictate everything else in the mass finishing process. The requirements for burr removal, surface improvement, luster, cleanliness and the volume of parts involved will dictate the type of system best suited to handle them.

The uniformity of the parts is critical to the uniformity of process cycle time. For example, parts that are produced on a brand new die will have minimal burrs or flash,

while parts produced on the same die after many thousands have been made will have heavier burrs or more flash.

Die-casting dies, where heat checking can occur, are notorious for this progressive deterioration. Sharpness of stamping dies will have a significant effect on the amount of burr on the part. This gradual deterioration or change in the part will often cause problems in the vibratory finishing of these parts, unless this phenomenon is understood by all concerned.

For this very reason, the vibratory and barrel finishing processes are outstanding quality control tools. If a standard cycle has been set up and burrs have not been completely removed, it is time to perform maintenance on the tools.

At very high media to parts ratios, parts have little contact with each other and are well separated by the media particles. At very low ratios or when media is not used, severe part-on-part contact is encountered and damage can be caused by parts striking each other which can nullify the benefits of the finishing process. The process of parts loading is also critical. A tote pan of parts dumped in one spot in the vibrator can damage them beyond recovery.

EQUIPMENT

The rotary barrel, the tub-type vibrator, the vibratory "round" machine and other variations of these equipment types are available for processing parts. Most of this equipment has variations in speed or amplitude or weight settings, which will cause a change in the speed or efficiency of the operation. Less understood are the effects of drains in vibratory equipment and their importance in allowing the compound-water solution to be removed from the chamber efficiently so that contaminated liquid is not retained in the machine. These same drains may be used also to remove fine media particles and metal filings from the chamber, thereby helping to prevent lodging of these small particles in the parts.

The type of equipment should be determined after the requirements for the parts and volumes of parts to be processed are known. For example, if a very heavy radius is required on parts that are flat and which would tend to stick together, the rotary barrel may be a more desirable machine for this purpose. If high volumes of parts are required, a vibrator would be preferred in order to speed up the process and to effect separation from the media mass very quickly. A continuous process may also be in order. Amplitude, speed, or weight settings are also adjusted depending on the requirements of the parts.

Whenever parts are mixed with a media, they must be separated from it later. A critical step in vibratory finishing involves this separation. Parts configurations, media shape and size, screen deck design and media-parts flow rate across the screen deck are critical to success. Wire mesh or polyurethane screens are standard. Tie rod screens, inverse separation, steps to turn over parts, and magnetic separators are available to speed up this important operation.

MEDIA

Media used in vibratory and barrel finishing processes are primarily pre-formed ceramic cylinders or triangles, pre-formed plastic or resin bonded media in triangles or cone shapes, hardened steel in a variety of configurations, random-shaped, fused aluminum oxide, random-shaped natural stone, etc. The primary functions of media are to keep parts separated, and to provide the abrasives to perform a cutting operation on burrs or surfaces, or to perform a brightening or cleaning action on the surfaces.

Proper media selection depends on the requirements for the parts. Faster cutting media has coarser abrasive particles, which provide the faster cut. They develop a rougher surface texture. Finer grades of media have particles of a smaller size, which produce finer surface finishes. Some media have no abrasive, and will develop luster on the surface.

The more abrasive the media, the more expensive it is to operate per hour. Less abrasive media require longer times to perform a given deburring job. The shape and size of media is usually selected to be as large as possible without lodging in any holes, slots, or tapered areas in the parts, and small enough to allow good separation from parts.

Steel media, used with good compounds, will not wear away. Losses that do occur are from carry-out with parts. It is heavy, 300 pounds/cubic foot, and the most expensive. It is clean, peens down light burrs quickly, brightens metal surfaces, is manufactured to very close dimensional tolerances and because it doesn't change dimensions, is excellent in difficult situations.

Ceramic-bonded abrasive and non-abrasive media weigh about 100 pounds/cubic foot. They are normally longer wearing than equivalent cutting plastic media. They are used for a great bulk of general purpose deburring and cutting applications. Ceramics are much harder and can damage softer metals. Their hardness, rigidity and density can also bend over burrs causing much longer cycles on some parts.

Plastic media are lighter weight, from 55 to 75 pounds/cubic foot, can cut off burrs without preening them flat, and can develop outstanding low micro-inch finishes.

Random-shaped fused aluminum oxide is used like ceramic media, but where lodging is not critical. Natural stones are used less in vibratory equipment than in rotary barrels because of high depreciation and lodging problems.

COMPOUND AND WATER

Compounds are either dry or liquid and are used for rotary barrel or vibratory finishing systems. Many types of compounds are available which provide cleaning, corrosion inhibition, lubricity, cutting, and/or mass control. The proper compound selection provides economy of operation and, in many cases will dictate the success or failure of the entire installation. The amount of compound or water to be used should keep the media mass and parts clean and, provide or whatever requirements have been specified. Use of too little or too much compound will often adversely affect the cycle time and/or the ability of the media to perform the job required.

THE FOLLOWING CATEGORIES OF COMPOUNDS ARE NORMALLY AVAILABLE

DEBURRING NON-FERROUS METALS

Metals such as zinc, aluminum, brass, other copper alloys and magnesium require compounds that develop light metal colors, that will keep media clean, that will defoam plastic media, and that will produce exceptional cleaning of dye lubricants, machining or shop oils. Soil suspension is also a requirement for many of these applications to prevent residues from depositing on the metal parts.

DEBURRING AND BURNISHING FERROUS METALS

Ferrous metals require compounds that have excellent rust inhibiting properties to prevent corrosion both of the ferrous metal parts themselves, as well as steel burnishing media. Some of these compounds have the ability to provide light rust removal and provide outstanding corrosion inhibiting.

BURNISHING NON-FERROUS METALS WITH STEEL MEDIA

Developing luster on non-ferrous metals is as important commercially as for ferrous metals. Compounds for application in this area require the ability to prevent corrosion of the metal being processed, as well as the steel media. As with any burnishing compound, the amount of foam, lubricity, cleaning and brightness on the specific metal is critical to its success. Bleaching or oxide removal on the metal surface can occur with proper burnishing compounds.

CLEANERS

There is a need for water-based compounds to clean metal surfaces quickly and efficiently. Vapor degreasers and solvent degreasing systems are becoming more difficult due to current safety requirements. Water-based cleaners are, therefore, available for the purpose of removing a tremendous variety of inorganic soils and organic soils. Some cleaners are developed specifically for use with steel burnishing media, while some are better suited for use with ceramic or plastic media. Media must be clean to get clean parts!

INHIBITORS

As would be expected with any wet process, corrosion inhibiting is important in the design of good compounds. A wide variety of commercial corrosion inhibitors are available. Most of these produce an oily film on metal parts and in turn require removal before plating, painting, or other finishing operations. Water-based inhibitors, which do not produce oily surfaces and are easily removed by water, are available for ferrous metals or for non-ferrous metals. Some can be welded on or painted over without removal.

ABRASIVE CUTTING COMPOUNDS

These dry, powdered products are used primarily in rotary barrel applications, where the use of abrasive materials speeds up the rate of metal removal on parts. Various abrasive types, particle sizes, and blends are used.

DERUSTING AND NEUTRALIZING COMPOUNDS

Highly alkaline compounds are available for light scale removal on ferrous metals and also for the protection of steel burnishing media for extended periods of time. These products can neutralize acidic scale-removing compounds when required.

MISCELLANEOUS

Other products are available for more specialized requirements. These include products to prevent excessive dust formation in vibratory cob meal drying equipment, specialized inhibitor systems, compounds specifically formulated to meet requirements for toxicity (for example, on toys), as rust inhibitors combined with rinse aids to sheet off water from parts, to speed up drying, acidic decaling products, foam-control compounds, control of excessive water hardness, etc.

OTHER PROCESS VARIABLES

These include the solution system, noise abatement covers to meet industrial and federal standards, parts loading devices to simplify and/or automate the handling of parts into the vibratory equipment, rinse stations to provide fresh water rinsing, rust inhibiting or rinse-aid materials on parts as they leave the vibratory equipment, drying equipment for automatic or semi-automatic handling of parts, multiple-machine systems to reduce parts handling, etc. These devices are customer designed for each particular installation. They can be complex, but extremely economical.