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MEDIA

Introduction

This report has been prepared to remove some of the mystery associated with the media; "stones" or "chips" used in vibratory and barrel finishing. Included are the functions and characteristics of media, the types and shapes of media available, and selection of the best grade for a given task.

Functions

The primary functions of media are as follows:

1. Cut. Media, who cuts, can remove burrs and smooth surfaces. Cutting grades of a media may be considered abrasive metering devices, releasing a given amount and size of abrasive per unit time. As a carrier of abrasive grain, the large media pieces effectively increases the impact force of the abrasive on the metal part to be cut, thereby improving the efficiency of the abrasive. Cutting media develop dull matte surfaces.

2. Luster. Some grades of media are designed to promote luster on the surface of metal parts. These products are generally non-abrasive or have a very low degree of abrasiveness. They deburr by peening, rather than actually removing luster, making the part bright and shiny or developing a very matte, dull surface characterized by a completely random scratch pattern, or anything in between.

3. Parts Separation. A very important function of media is to separate parts during the deburring, cutting, surface improving or burnishing operations. The media: parts volume ratio is normally used to control the amount of part-on-part contact, which will occur in a vibratory or barrel finishing operation. At low ratios, considerable part-on-part contact occurs, while at higher ratios part-on-part contact is limited.

4. Scrub Surfaces. Media has the unique ability of scrubbing surfaces and physically assisting compounds in their cleaning function. Both abrasive and non-abrasive media are effective in providing this action. They are effective on organic soils, as well as on scale and other inorganic residues.

Media Characteristics

Any media has certain characteristics, which make it unique in its capabilities. These characteristics are discussed below.

1. Cut-rate or Surface Roughness Reduction per Unit Time. This characteristic refers to the ability of media to remove metal by its action of scraping the part's surface and taking off high spots, gradually smoothing the surface. Figure 1 is a graphical presentation of surface roughness versus time. The solid line is the cut rate and is a characteristic of any media. The steeper this slope, the faster cutting is the media.

2. Minimum Surface Roughness Capability. Under a given set of conditions, media is characterized by its ability to develop a minimum surface roughness measured in RMS. Of AA units. This minimum, shown in Figure 1., is highly dependent on a number of variables discussed below. Normally fast-cutting media will give higher minimums and slow-cutting media will give lower minimums.

3. Media Wear Rate. Attrition rate of any media is generally a function of its ability to remove metal. However, little media wear occurs when it abrades a metal part, but primarily when media abrades against it. His is necessary in vibratory and barrel finishing because it helps keep the media clean and free cutting. It is then capable of performing the cutting or deburring function for which it was selected. Generally speaking, faster-cutting media have higher wear rates.

4. Media Hardness.

The inherent hardness of various media types, for example ceramic versus resin-bonded, is a characteristic that frequently allows one grade of media to be selected over another for a given application. High-hardness media types like the ceramic cannot be used where its hardness would cause detrimental indentations in soft metals. For this reason, high-quality surface finishing on soft metals is normally done with resin-bonded media, which has lower hardness.

5. Available Shapes and Sizes. While not a physical characteristic of media, its available shapes and sizes are critical in certain applications because of access, lodging, separation, or for other reasons. If a given type of media is not available in the optimum shape or size, it may not be selected for that application.

6. Sensitivity to Compounds. Certain media types show sensitivity to certain compounds regarding cut rate and minimum surface roughness capabilities. Burnishing compounds on certain types of media severely reduced the rate of cut and at the same time reduces surface roughness minimum too much lower levels. In addition, some of these media types will give a bright, lustrous appearance on metal surfaces when the proper compound has been selected. Some ceramic media types, for example, have been designed as "cut and color" media, where only a change in compound type alters their performance. They will cut while a deburring compounds used, and then "color" or develop luster during the burnishing process.

7. Soil Generation. In general, fast-cutting media wears at a much greater rate than slow-cutting media does. In addition, soils generated by the media itself can be troublesome in subsequent finishing if cleaning during finishing is not adequate. Some grades of fused aluminum oxide develop tremendous amounts of a dark, smutty soil, which is capable of depositing on metal surfaces. Plastic media can show this effect if the wrong compound is used. Steel and porcelain ceramic media give the cleanest systems.

8. Chipping and Fracture Sensitivity. As vibratory finishing machinery gets larger and more automatic, handling systems for media are involved and media can drop considerable distances. When media drops on other media, it can chip or fracture if it is highly vitrified ceramic without sufficient toughness. Fragments of fractured media can cause excessive lodging problems, and the shape change of the media due to fracture will promote lodging problems and cause abnormal war of the media.

9. Bulk Density. This characteristic of media is often overlooked in mass finishing but is important as the media wears from its original size and shape and a full media size distribution is developed. Bulk densities can increase by 20 to 25 percent during this process, and have sometimes caused users of media to become alarmed at their consumption rates. This consolidation of media due to its increase in bulk density must be differentiated from media wear. Higher bulk density media types impart greater pressures on work pieces. For example, hardened steel burnishing media at 300 pounds per cubic foot imparts tremendous forces on metal parts and is capable of peening surfaces very rapidly, while non-abrasive ceramic media at 100 pounds per cubic foot or less will require a much greater time to accomplish the same results.

10. Shape Retention. Certain media in vibratory finishing systems show excellent retention of their shape cutting edges throughout their life. In general, slower-cutting products are better in this respect than faster-cutting materials. When access to slots or small areas is required of the media, shape retention can be critical to success. A rotary barrel had the ability to develop edge radii more efficiently than vibratory equipment. Therefore, media in a rotary barrel will tend to become round and lose its shape much more readily than will occur in vibratory equipment.

11. Noise. Large, hard media is very loud in any size vibratory equipment. OSHA laws govern allowable noise exposure levels, sometimes limiting the size of media selected.

12. Cost. Normally the cost of media is a prime concern to may users, as it should be. But product cost in dollars per pound can be misleading without good media attrition rates and productivity of parts-per-unit time through a given size machine. Expensive media, such as high-density hardened steel media is "very expensive" in dollars per cubic foot, but because its attrition rate is essentially zero, its cost per part produced is extremely low.

Cost analysis, therefore, should never be attempted without good media wear rates and until after productivity or cycle times have been establishes.

Media Families

Abrasive-containing media types come in families. The family may have two, three, or many members, having equivalent binder systems. Resin-bonded media, of course, would have a plastic binder, while vitrified ceramic media has abrasives particles bonded with a porcelain type of ceramic matrix. Figure 2 indicates three media types in a family. It is noted that the fast-cutting media has a very steep slope and can reduce surface roughness very quickly with relatively short finishing times. It is also noted that the minimum surface roughness capability of this product type is relatively high. The so-called preplate or slow-cutting member of the family has a shallower slope of surface roughness versus time, but has the capability of developing very low surface-roughness values. Intermediate materials fall in between these two extremes. In addition, fast-cutting media generally has a much higher wear rate, and the slow-cutting grades have much longer life or slower attrition rate. Fast-cutting media normally is comprised of more, courser abrasive grains, while slow-cutting grades generally have less of much finer and/or softer abrasive particles.

Variables Affecting Media Characteristics

The primary reason manufacturers have not published good, hard data concerning cut rates and minimum surface-roughness capabilities is because of the tremendous influence of capabilities, which affect these characteristics. Manufacturers of media and equipment are cognizant of the importance of these variables and their influence on cut rate, wear rate, and minimum surface-roughness capabilities. These are discussed below:

1. Part Material. The material to be cut or finishes has certain hardness and toughness parameters, which make it easy or more difficult for given media to cut. If it is a tough, stringy metal which is difficult to machine, it can also be difficult to finish and to deburr. If it is a relatively soft metal, it will be much easier to cut, but will also be much easier to impinge if hard media is used. Certain types of media cannot cut hardened steel because the abrasives contained in these products are not sufficiently hard to scratch the hardened steel surfaces.

2. Contour of the Part Surface. Under a microscope, a study of the contour of the surface of the part to be finishes can be revealing. If it is a surface that can be cut with an abrasive belt, a series of sharp parallel hills and valleys will characterize that surface. It is; therefore, relatively easy to knock the peaks off these hills, but much more metal must be removed in order to remove the last traces of the valleys. If a multiple belting operation has occurred, tramp scratches imparted by the coarse belt which have not been removed by the fine belt, often require excessively long vibratory finishing time, merely because the second belting operation was not complete. Steel castings, forging, stampings, die-cast parts etc., all have their own unique surface contour as a result of the manufacture of that parts, condition of the die from which it was made, and other treatments of the parts prior to surface finishing.

   Figure 3 shows the effect of vibratory finishing cycle time on the initial surface roughness of the part. Good surfaces need only short finishing cycles, while poor initial surfaces require much longer cycles. The economic differences between short and long cycles are important.

3. Machinery Settings. Speed and amplitude of vibratory and barrel equipment have direct Influence on the rate of metal removal and also influence minimum surface-roughness capabilities and media depreciation rates. Higher speeds and higher amplitudes give increased metal removal rates, increased media depreciation rates, and increased minimum surface-roughness values.

4. Machinery Type. As indicated above, machinery with less speed and/or amplitude produce slower cutting action, and in general, better surface finishes with a given media. The rotary barrel is a low-energy machine for mass finishing and, therefor, has the advantage or disadvantage of slower cutting speeds for a given type of media with greatly reduced media depreciation rates and superior surface finishes. The tub-type vibrator, in general, runs at higher speeds than the round vibratory machine and, therefore, has the ability to remove metal at the greatest, but with a sacrifice in media war rate. The rotary barrel therefore is most efficient on media usage per pound of metal removed from the

surface of parts. The round vibratory machines are intermediate, and the tube-type vibratory equipment is least efficient.

5. Media Size and Shape. With a given type of media, larger sizes increase metal removal rates and deburring rates and give longer life prior to classification before lodging occurs. Larger ceramic media has a higher wear rate than small media of the same composition while, on the other hand, larger resin-bonded media has lower depreciation rate than smaller shapes of the same bond. The larger the surface area to volume ratio of a particular shape of media, the higher its wear rate. Or, the more spherical, the lower it's wear rate for a given size. Cylinders and cones are generally better in depreciation rate than equivalent triangles, for example.

   Shape of media can also influence surface roughness. The more spherical the media, the less impact or impingement defects will be developed on a metal surface. Cones or cylinders, therefore, can give slightly improved surface finishes as compared to triangular-shapes media.

6. Media-to-Parts Ratio. Slight variations in the ratio of media to parts by volume have little effect on media characteristics. Large variation do, ratio of 0:1 indicates no media and all parts. A ratio of 1:1 indicates equivalent volumes of media and parts. At this condition, especially if the parts are heavy, the bulk density of the media-parts mass is extremely high and high wear rates of media occur. Accompanying this, higher metal removal rates are also attained. The expense of this condition, however, is that because of extensive part-to-part contact, poorer surface finish result. At high media-to-parts ratios, 6:1 or above, part-on-part contact is minimized except for very irregularly shapes parts.

7. Compound Type and Flow Rate. Deburring compounds are designed to keep media clean and free cutting, as well as to clean metal surfaces and thereby promote rapid cutting of metal per unit time. Burnishing compounds are designed to cushion the mass, to develop luster on metal parts and, because of their frequent characteristic of high lubricity, will reduce cut rates. Some burnishing compounds have the ability to reduce the abrasiveness of one piece of media against another and thereby allow the media to "glaze." Glazed media will not cut, but it can burnish well. Proper compound selection, therefore, can change the physical characteristics of the media used very considerably. In addition, cleaning of organic and/or inorganic soils as mentioned below is a function of compound type and the optimum flow rate of that compound through the vibratory or barrel chamber. Dirty media cannot produce clean parts.

8. Water Flow rate and Drainage Rate. It has been known for years that high water compound levels in rotary barrels are used for burnishing, thereby decreasing the force with which one piece of media hits another and hits the parts contained. This same effect is true in vibratory equipment. If water is not permitted to drain from the machine, a sluggish action occurs, because vibratory equipment induces vibratory energy only at the walls of the chamber and requires contact from media particle to media particle to the wall in order to impart this energy into the parts. This action is readily dampened down by excessive water content in the vibratory chamber due to a lack of drainage, excessive water flow or excessively high foam of the compound. Optimum flow in vibratory equipment is normally 1-1/2 to 2 gallons of water-compound solution per cubic foot machine capacity per hour of operation. These values are increased with excessive

cutting media who is generates tremendous amounts of soil and reduced when non-cutting media is used.

9. Part Surface Contaminates. Inorganic contamination of the surface of metal parts, such as heat-treated scales or other oxides is often harder than the base metal to be cut. If this is the case, metal removal rates can be "affected" until this surface contamination has been removed. By the same token, the presence of excessive amounts or organic materials, such as oils, greases, and other lubricants used in the manufacture, machining, or heat-until these organic soils have been removed from the surface.

10. Configuration of Parts. Parts that tend to interlock hang up in the finishing chamber, or which may tend to "nest" can cause variations in metal removal rates and minimum surface finishes.

11. Parts Handling Systems. The handling of parts both before and after vibratory or barrel finishing can be critical to surface finish. For example, zinc die-casting handled like forging and allowed cascading against one another can have defects pounded into the surfaces which must be removed during vibratory finishing. The result of these poor handling systems is excessively long cycle times in vibratory or barrel finishing, as well as very poor economics.

Types of Media

A great variety of media is currently available on the market to provide a tremendous range of capability in cutting, deburring, smoothing surfaces, and developing luster, scrubbing, and parts separation for a whole host of materials, including metals, ceramics, plastics, wood, painted, plated, and materials with other finishes on them. These types will be discussed below in an approximate order of their popularity and uses today.

1. Preformed Ceramic Media. Mixing clay-like materials and water with abrasives manufacture ceramic media, forming this mud into shapes, drying these shapes, and firing them at high temperatures to vitrify the binder. Many of these binders are porcelain like in nature. Variabilities in these products occur both with the type of binder used, firing temperatures, the amount, size and type of abrasive grains they contain, and their uniformity of firing. This type of product today is general work horse of mass finishing systems and is that type of media generally selected because of its availability in a variety of desirable shapes and sizes, its low cost and low media wear rate. The following is a brief list of the many types available.

   a. Porcelain. Porcelain media with no included abrasives is wearing, can develop extremely good surface finishes, and has very little cut. It is used primarily for light deburring and for brightening metal surfaces. The same media is available with very finely divided aluminum oxide which imparts no cut in it but which improves the rate of the body. This resistance, especially in the presence of abrasive compound commonly employed in barrel finishing.

   b. Light-cutting ceramic media. Is available for use primarily in the rapid, light deburring of steel and die-cast parts. It is long, wearing and extremely efficient to use.

   c. Fast-cutting media. Is available in a wide range of abrasiveness and media depreciation rates. Extremely fast cutting materials are used primarily when a limitation in cycle time is a requirement on parts. Their excessive wear generally makes them less efficient than the slower cutting grades available. Intermediate to fast cutting grades are used where large amount of metal must be removed in relatively short cycles. These grades are characterized by poor shape retention, high media depreciation rates, and higher soil generation.

Preformed ceramic media is available as angle cut or straight cut triangles, angle cut or straight cut cylinders, diamonds, stars, arrowheads, spheres, and cones. Probably 80 percent of the use of preformed ceramic media involves the popular angle cut cylinders and angle cut triangles.

2. Preformed Resin-bonded Media. Plastic or resin-bonded media utilizes a wider range of abrasive types and sizes than preformed ceramics. The most popular grades are those using quartz as an abrasive. These are used for pre-plated finish on zinc die-casting, cutting steel parts prior to plating, deburring materials when ceramic media would either impinge the surface of would roll over the burrs because of its weight and hardness, thereby making the oxide, silicon carbide and

other abrasives are also used. Usually low cost polyester resins are employed as the binder and the various shapes are cast. Resin bonded media can develop excellent pre-plate finishes on any metal surface. Their most popular shapes are cones and triangles. Pyramids, stars, tetrahedral and other shapes are also available.

3. Steel. Casehardened, stress-relieved steel preformed shapes are available in a variety of sizes and configurations. Balls, balls with flat spots, oval balls (footballs), diagonally cut wire similar to angle cut cylinders, ballcones and cones (both of which are different than the standard concept of cones) and pins are the most commonly used. Steel media weighs approximately 300 pounds per cubic foot and is expensive for initial installation but, because it has a zero depreciation rate and because of its extreme cleanliness, steel media is being more widely used for light deburring applications and for cleaning. Compounds are available which keep steel burnishing media clean bright for year's sot that it can rapidly and quickly clean, brighten, and deburr metal, plastic or ceramic parts.

4. Synthetic Random-shaped Media. The most popular synthetic random media is fused aluminum oxide, which is available in a number of grades. The more loosely bound, fast cut and high depreciation rates characterize coarse-grained materials. Because of the dark color of fused aluminum oxide, the soil generated by this material is excessive in many applications. Fine-grained fused aluminum oxide is generally employed for burnishing and in this respect is unexcelled in many application with the possible exception of steel. Where some light cutting is required, fine-grained aluminum oxide can develop a better luster on stainless steels and other hard surfaces than can be achieved with steel burnishing media.

5. Natural Random-shaped Media. River rock, granite, quartz, limestone, emery, and other naturally occurring abrasive materials are being used in vibratory efficient in vibratory equipment because of their high depreciation rates. Their use in barrel burnishing and barrel finishing is well documented and, when lodging is not a problem, the cost savings by use of natural media are excellent.

6. Cobmeal, Walnut-shell, Flour, and Related Materials. Are used for drying applications because of the natural ability of these products to absorb water from metal surfaces. These products can also be blended with abrasives and used for fine-polishing applications in vibratory, barrel, or spindle finishing equipment.

7. <u>Other</u>. Shoe pegs, leather, carpet tacks, and almost any solid materials conceivable have been used at one time or another in barrel and vibratory finishing for certain applications.

Multiple Media Cycles

Applications often require normal removal of large amount of metal from surfaces. In this respect, the effect of multiple media cycles should be considered. Figure 4 shows the surface roughness versus time slopes for single, two and three cycle systems. When rough stampings, for example, must be cut to remove all surfaces distortions and pre-plated finish of the highest quality is required, as would be the case with musical instruments, keys, jewelry, cigarette lighter parts and so forth, two media cycles may be easily justified because of the saving in equipment capacity required to perform the task. A reduction in overall cycle time requires less installed vibratory or barrel finishing capacity to perform the same production rates. Reduced space and capital investment often offsets the increased cot of faster-cutting media types.

Another popular multiple media operation is "cut and color." This involves cutting in plastic or ceramic media followed by coloring or burnishing in steel, fused aluminum oxide or non-abrasive ceramics. Drying in cobmeal following finishing in another media is also a second or third media step.

Media Selection

The discussion above has generally indicated how media is selected. With an understanding of the requirements for parts regarding deburring, surface finishing, and cleaning, a general media type would be mentally selected. Lodging characteristics, available shapes of media, time-cycle limitations, surface-finish requirements not specified but known because of subsequent painting, plating, or other applications, the effects of contamination on the metal parts and other considerations are generally made prior to selecting a media. Most manufacturers of vibratory and barrel finishing equipment and supplies would process parts in one or more types of media to facilitate selection by the customer. The aesthetic differences in surface appearance as a result of the media, as well as an individual's personal desires play an important part in media selections. Normally, a media is available which will do the job required at an economical cost.

Summary and Conclusion

No discussion of media can ever be complete until the reader sees his part processed in more than one type. Only in this way can a direct comparison be legitimately made on his parts. Most equipment and media manufacturers are familiar with this phenomenon and, therefore, perform this educational exercise for the serious potential customer. After seeing parts processed in different types of media for various lengths of time, deburring requirements, and surface finish requirements, and other will allow him to select time cycle satisfactorily in each type of media. Aesthetic judgments on surface appearance can be considered and good cost calculation can be made prior to a firm commitment on the part of the potential user of a given media type. The tremendous variety of available shapes and compositions today often makes this particular area of selection an extremely confusing one to novice and to many who have worked din this area for years. It is really not that complicated