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MICROFINISHING – THE PROCESS OF PERFECTION

The Author – **Milind D. Kelkar**, graduate in Production Engineering from VJTI is Managing Director of Grind Master Machines Pvt. Ltd., pioneers and leaders in the field of Metal Finishing Machines. An energetic leader and innovator, who won CMTI-PMT Trust Award for Microfinishing in the year 2001 & is proud to be the World Class Supplier of Microfinishing Solutions.

PREAMBLE:
As the world is progressing forward, Designers of Auto parts are resorting to varied and stringent surface finish parameters. In a bid to meet noise and pollution norms as well as decreased warranty claims, a mundane finish like 0.4 Microns R_a which can be achieved by grinding, is suffixed by the word "**Microfinished**' to ensure 200,000 KM Warranty from the same part !!!

THE ARTICLE -

Microfinishing - The Process of Perfection for Auto Industry.

Machining has come a long way in the last one hundred years. Machine tools have become increasingly accurate, routinely achieving workpiece tolerances not even imagined fifty years ago. Finishes of critical bearing surfaces achieved by grinding, honing and polishing, while excellent processes, have been surpassed. Even lapping is no longer adequate in the manufacturing of today's more fuel-efficient automobile and truck engines. While the perfect bearing surface will never be achieved, it is possible to come very close with Microfinishing.

Process of Microfinishing with film backed abrasive was developed to achieve consistently uniform finishes faster and more efficiently than other traditional roll grinding and cylindrical finishers

For years, grinding wheels and bonded abrasive stones, abrasive sheets – even slurries have constituted the usual means for resurfacing, dimensioning and polishing rolls and cylindrical parts. These traditional methods of roll finishing are typically slow and leave room for operator error.

Fortunately, film-backed and flexible diamond abrasive offer fast, easy-to-use predictable alternatives.

Microfinishing with contact wheel (Superfinishing)

Film-backed abrasives provide predictable, consistent and repeatable performances every time for finishing operations. These film-backed abrasives enable you to quickly remove traverse marks and feed lines, eliminate chatter, follow existing geometry (including crowns) and consistently obtain sub-1 micro inch R_a (.025 microns) or finer finishes on chrome, compressed paper, nylon, chilled iron, rotogravure, epoxy and polyurethane rolls and other non-roll surfaces.

Microfinishing with non-resilient shoes

Microfinishing process that employs rigid shoes instead of a contact roller or platen to support the abrasive film. The workpiece, such as a crankshaft or camshaft, is turned and oscillated between centers as shoes introduce the abrasive to the work interface. Fresh abrasive is incrementally indexed after each part is processed, resulting in uniform stock removal and finish, part after part. Microfinishing removes the damaged or amorphous layers to improve the surface finish and roundness of the part and, in many cases, can eliminate the need for an entire grinding operation.

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Compared to conventional cloth and paper backings, film is a far more consistent substrate for the precise application of resins and micron-graded mineral. Film backings hold abrasive particles on top of the substrate, do not compress or lose particles in the backing.

Film *F weight paper* *J weight cotton cloth*

Compared to conventional cloth and paper backings, film backings provide a superior, uniform surface to coat with micron graded minerals. The uniform application of abrasive mineral with a unique resin bond creates the ability to provide a more consistent, repeatable finish.

WHEN WAS MICRO-FINISHING DEVELOPED?

In the mid 1930's, it was discovered that automobiles transported to the west coast from Detroit, had a much higher rate of wheel bearing noise, such as chatter, clicking, etc. than did the cars sold closer to Detroit. It was discovered that the bearing races (which were only ground) brinnelled during shipping due to the constant vibration of the railroad carrier.

WHAT IS MICRO-FINISHING?

Micro-Finishing is a method or process to remove the surface material of a dimensionally finished part to provide a precise fit to the mating part. An examination of the texture left on a metal surface as a result of machining operation will reveal tool marks, fragmented metal, chatter, etc. It is the micro-finishing operation that must be used to generate the final surface texture required for service life, performance and reliability of a product.

A non-microfinished surface relates to a snow covered lake. A person's weight will produce foot prints in the snow whereas, the ice will even provide support for the concentrated pressure of a person on ice skates. When a metal or steel part is machined, the surface becomes fragmented and also annealed if a heat generating grinding process is used. This type of surface will not support high bearing loads. Microfinishing is the process that removes the fragmented and annealed surface, leaving base metal for greater bearing loads.

BRINNELLED SURFACE

The weight of the vehicle and vibrations of the shipping carrier caused the stationary needle bearing to compress the non micro-finish surface, as shown in the enlarged view. The needle bearing thus rolling over the brinnelled low spots, caused an undesirable clicking noise.

The following diagrams show the effect of roughness & waviness on the performance of bearing in an engine.

The view in the centre shows the shaft supported in the bearing by a thin oil film. Loads are equally distributed if the shaft bearing journal have correct geometry and surface texture.

Roughness on a bearing journal breakes up the supporting oil film and allows the surface to contact each other and cause pre-mature wear. Waviness in roundness geometry is referred to as Chatter or lobing and it is another factor which increases the bearing loads. Combination of roughness and waviness geometry are most detrimental to bearing life.

Automotive companies are now demanding crankshafts and camshafts with bearing surface Ra's that are within a 0.05um (2mu) to 0.2um (8 mu) range. The leading company that has spent more than a half-century developing the metal removal process needed to produce more reliable and more fuel-efficient engines is IMPCO Machine Tools in Lansing, Michigan (USA).

It is not easy to achieve such surface finishes. However, before working with microfinishing, it is important to understand the surfaces and geometries of bearing journals.

Surface measurement, Ra

Roughness average (Ra) surface measurement are nearly always shown on engineering drawings where surface finish is specified, but it is not the only surface measurement that indicates a good bearing surface.

R_a can be misleading. Both the surfaces shown in sketch below have same Ra value, but surface with flat areas separated by deep grades makes a better bearing surface with good oil retention.

Bearing ratio, Tp

Bearing ratio Tp is extremely important since it illustrates the amount of bearing area one can expect from a surface. When normal beak-in occurs on bearing surfaces, highest peaks will be worn away in a short period of time leaving a longer supporting surface slice level at depth which should be specifieded for Tp measurement.

Surface Comparisons

Now, newer more fuel-efficient smaller engines produce higher bearing loads than engines produced a decade ago. Engine test studies have shown that some bearing surfaces with slight cross hatch finish specifications help engines maintain maximum hydrodynamic oil film on journals, but oil seal surfaces generally do not require cross hatch finishing. A cross hatch finish on an oil seal may cause a vane-type pumping action to pump oil past the seal. An oil seal with a straight- line finish is much more effective.

Geometry profile

Grinding operations of crankshaft main bearings and connecting rod journals, camshaft lobes and bearing and transmission shafts will produce bearing journals with many different types of errors, including errors in roundness, waviness, chatter, taper, barrel, hourglass, etc. Even though a bearing journal has optimum surface finish, the hydrodynamic oil film cannot be maintained if any of these conditions exist.

Controlling bearing surface finish and geometry

Microfinishing removes what is best described as unstable surface material from a dimensionally finished part. This amorphous (non-crystalline) material layer exists on every ground or turned part. That is not a problem with previous machining operations, but simply an undeniable physical fact. Left on bearing journals, this layer can, at best, cause poor performance and, at worst, bearing failure.

Roughness, waviness and form are a factor in all surfaces. Most surfaces will show the combination of these 3 forms. They are never isolated.

Each of these characteristics are measured by different methods as shown below.

Microfinishing – Closing in on Perfection

Microfinishing is the process that enables manufacturers to accurately remove the amorphous material layer and thus to control surface finish, bearing ratio, geometry, and even size of bearing journals. It is used by manufacturers of auto parts to assure efficient, troublefree, long-term performance.

Microfinishing process uses a noncompressive, coated abrasive film backed by patented, precision-shaped non-resilient tooling for full, consistent part-to-abrasive contact through the finishing cycle. The film is automatically indexed after each cycle to present fresh abrasive to each workpiece and thereby help to achieve consistent finish specifications.

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The benefits of include:

- Reduced warranty costs
- More uniform oil clearances
- No component break-in required
- Lower friction, allowing high performance
- Higher component efficiencies
- Removal of ferrite nodules (caps) in nodular iron parts.
- Optional: generate oil hole radius.

To accommodate varying production requirements, process parameters--including shoe pressure, oscillation frequency, stroke, part rotational speed, cycle duration, and amount of abrasive tape index--are fully adjustable for optimum performance and productivity.

Now, many automobile engines use nodular iron crankshafts, which include ferrite caps protruding above the material surface. Other finishing processes do not adequately remove the ferrite caps, presenting a serious component durability problem. Microfinishing effectively removes the very hard ferrite nodules protruding above the bearing surface on iron bearing journals. It is a capability that engine manufacturers worldwide require. Although the ferrite caps or nodules may be no more than 0.0005-in. (0.020 mm) above the bearing surface, they can cause bearing failure, resulting in expensive warranty claims.

New Modular microfinishing system NANOFINISH GBQ600Cr CNC Series and NF600Cr CNC designed by Grind Master, has more flexibility and quick change tooling to tool up different varieties of crankshaft , camshafts & transmission components. It is designed for easy manual loading as well as automated gantry style part loading system. These models have a unique Nano Finish Control System which is designed by Grind Master to make the machines most user friendly. This system also generates MIS data which can be accessed and used.

These models have easy access for tooling from front of the machine, simple film loading & trouble free film disposal. The unique space saving film management system saves the valuable operator time & also ensures complete safety.

The Nano finish series by Grind Master is a benchmark for production machine tool reliability & automakers worldwide find this essential in the production of long life, high performance engines, both gas & diesel with minimal warranty costs.

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