Premature Crankshaft Bearing Wear and Journal Finish
This article is an overview of the history of crankshaft journal surface finishing and how it has evolved into today’s higher standards and the processes and equipment that support this evolving process and will focus on the Micro-polishing process. The importance of crankshaft journal surface finish is much more than a visual appearance check!

One area of the engine that has seen much refinement in modern day engine design has been the crankshaft. Not so long ago, as engines became smaller, shorter and more compact, the width of the crankshaft mains and rod journals was reduced. By doing so, the OE’s soon realized that by having narrow journals, there was not enough bearing support area. In some cases, this created premature engine bearing wear and eventual engine failures.

Short of engine redesign, their solution became improving the journal geometry and surface finish of the crankshaft. To accomplish this condition the grinding and Micro-polishing process had to improve and become more precise and consistent.

Within the Micro-polishing process (Micro-polishing is a metal removal process) there are several methods.

• Abrasive film in the form of belts and rolls are most commonly used.
• OE’s use a method that incorporates an abrasive (typically aluminum oxide) that is attached to a Mylar film.

The manufacturing process of this product is closely monitored for grit size which is measured in Micron.

There are (2) measurements for abrasives –
• Mesh – How many particles in a square inch.
  (Example – 320 mesh = 320 particles in one square inch)
• Micron – Actual size of the particle.
  (Example – 15 Micron = the size or the particle - 15 Micron = .0006 inch, 30 Micron = .0012 inch.)

Before the Mylar film type abrasives, cloth or paper were used as a backing.

Unfortunately, cloth and paper compress, which limited the ability to maintain or correct journal geometry such as roundness, flatness, lobing.

With the use of the Mylar abrasive film, backed by a hard material, the Micro-polishing process is able to maintain or improve the grinding process geometry characteristics and provide a consistent surface finish.
OE’s in some cases use two and three step Micro-polishing process’s starting with a large size particle (grit) and then stepping down in grit size to achieve the surface specification needed.

OE’s have an advantage over engine rebuilders because they manufacture crankshafts in large lot runs, but as engine rebuilders, most often only have single or small lot runs.

To accommodate the smaller production volumes and many different varieties of crankshafts - some shops use the power belt Micro-polishing process. This process is good on improving the surface finish, however, it has limited control over geometry characteristics or consistency for the process.

Machines that use the OE’s type Micro-polishing process were developed to accommodate the rebuilder and performance Micro-polishing needs.

The machines are designed to be flexible, quick change over to various crankshaft journal widths, diameters, strokes, maintains or improves geometry, reduces operator involvement and provides a constant Micro-polishing process.

This equipment can also consistently Micro-polish the fillet radius in tangential filleted crankshafts (eliminating the line at the point of tangent). A special abrasive film with serrated or scalp edges is used and it allows the abrasive film to go into and up the tangential radius without breaking.

Undercut fillet radius crankshafts generally are deep rolled burnished. This strengthens this area and should not be polished or damaged in any way. Polishing or damaging this area will cause stress risers. The abrasive film spans over the undercut fillet with the equipment mentioned above and eliminates oil hole washout. Abrasive film cost per crankshaft average 20 to 30 cents for the above-mentioned equipment.

Today, in addition to measuring the surface finish, many other measurements are made.

Two of the basic measurements are surface finish “Ra” and bearing ratio “Tp”.

- Basic definition of surface finish “Ra” — Average surface roughness using measurements of the peaks and valleys from the grinding process.
- Basic definition of bearing ratio “Tp” is the ratio (expressed as a percentage) of the length of the bearing surface at any specified depth in the evaluation area. Bearing ratio results are available for profile data (Tp) and surface area (Stp).

There are numerous other measurements such as Rz, Rpk, Rvk, etc.

Micro-polishing has been available to the engine builder for some time now; more shops are using it as time goes on as they become aware of its benefits. Many production engine builders and crankshaft suppliers have been using Micro-polishing for years.

Premature bearing wear on crankshafts may be created by a number of conditions, below is a list to consider.

- Improper mating part materials
- Crankshaft bearing surface finish
- Crankshaft bearing geometry
- Improper clearances
- Improper maintenance
- Improper preparation before assembly into engine block
- Oil Contamination

Although any of these factors may be the underlying cause of bearing failure, our understanding (from customer interviews) is that the three leading causes are:

1. Improper preparation prior to installation
2. Improper or no controlled Micro-polishing of bearing surfaces and thrust walls
3. Improper engine maintenance

Failure to properly Micro-polish the journals may leave the crankshaft with a rough surface, and tapered, or wavy bearings. Failure to Micro-polish may also leave the journals with out of round surfaces and wash out of the oil holes that may also contribute to rapid bearing wear.

The proper controlled Micro-polishing process will help correct any or all of the following conditions that may contribute to premature bearing failure. The controlled Micro-polishing process will also eliminate ferrite caps found in nodular iron crankshafts. This is another common cause of premature bearing failure.

Geometry

Improper bearing geometry conditions such as concave, convex, taper, out of round, and combinations of these conditions will create conditions that prevent the journal from mating evenly with the mating bearing.
The controlled Micro-polishing process will provide a bearing surface that will run smoother and last longer than a crankshaft that has not been Micro-polished. The crankshaft will have better efficiency, durability and performance. Crankshaft thrust walls that are Micro-polished can help prevent premature thrust bearing failure in certain engines that have experienced that condition.

This process can be applied to all load bearing surfaces including camshaft lobes and camshaft main bearing journal diameters. Balance shafts, rocker shafts and idler shafts will also benefit when Micro-polished.

**OTHER SURFACE IMPROVEMENT TECHNOLOGY**

Surface improvement technology, as it is applied to metal removal, has grown substantially in the past few years. Tighter tolerances, new work-piece materials, and new and improved abrasives are a large part of the developments.

The following is a list of various surface finishing descriptions.

- **Polishing** is the use of abrasives to create a smoother surface with little, if any, geometry improvements (seal areas, low-loading bearing areas).
- **Lapping** is the process of folding the work-piece material. It incorporates a loose abrasive for very fine surface finish and small amounts of stock removal. (Generally, used on flat applications.)
- **Honing** is generally associated with inside diameter surface finishing. It uses abrasives to improve surface finish and geometry characteristics such as roundness, taper, and sizing. (High wear areas and applications needing close tolerances.)
- **Superfinishing** generally incorporates vitrified abrasive products such as diamond and CBN. It applies a light pressure with a high reciprocating action to achieve improved surface finish and geometry characteristics (outside diameter applications with high load areas and tight tolerances).
- **Micro-polishing / Micro-finishing** has grown significantly in the past few years. Generally associated with abrasive film as the media, it has replaced most polishing applications where high loads and tight tolerances are required and in OE facilities
- **Burnishing** – this process commonly uses rollers with high pressure to compress the material resulting in a smoother surface.

Other surface finishing methods such as brushing and buffing improve the work-piece appearance and sometimes are incorporated with other processes to enhance results. These processes have deviations within their category which allow varying process results.

**CHOOSING THE PROPER PROCESS**

In most cases, the process can be selected by an experienced person. However, it is becoming more common in areas of reliability, efficiency, and performance that a certain amount of development is incorporated into the discussion. To properly define process and machine...
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BY KEN BARTON

CHOOSING THE PROPER PROCESS
This outline will serve as a checklist for various aspects of the Micro-polishing selection process.

Incoming work-piece condition
- Material
- Hardness
- Previous process (grinding, hard turning)
- Undercut fillets
- Tangential fillets
- Surface finish

Outgoing work-piece conditions
- Surface finish
- Geometry (roundness, flatness, etc.)
- Size

Production rate per hour
- Manned or un-manned equipment
- Machine type
- Abrasive media
- Tooling
- Coolant
- Tool cost

Gauging and Measurement
- Process monitoring

The incoming work-piece condition varied in surface roughness. Abrasive stone superfinishing requires a rough incoming surface to dress the stone. Without this condition, the stone loads up and becomes dull. Abrasive film, on the other hand, indexes new abrasive each cycle which allows a more forgiving incoming surface requirement. If damaged by oil holes or other part characteristics, the abrasive again is indexed and new abrasive is in place for the next incoming part. Work-piece geometry such as concave or convex surfaces can wear a stone’s contact surface improperly. Abrasive tape, with a hard backup and new abrasive media indexed in place each cycle eliminates this problem.

AERA would like to thank Ken Barton of QPAC for his contribution to this article. For more information, feel free to contact Ken at (517) 881-1981, email QPACC@aol.com or visit www.micropolishing.com.

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