ART OF ROLLER BURNISHING

Chip free finishing & cold working

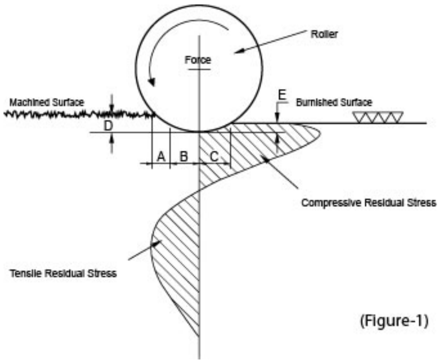
Surface operations by "Cold Working" are applied in order to:

* Improve the surface finish,
* Improve the fatigue life,
* Improve the size control.

The basic idea of the methods is plastic deformation of material by applying a relatively small force so that a hardened layer on the surface exists. Roller Burnishing, Shot Peening, LPB (Low Plasticity Burnishing) are such methods.

If relatively small force is applied using a highly polished roller, which has the translation and rotation actions it will follow a path through the metal surface. This case is called Roller Burnishing operation.
The production of ROBUTO® - Roller Burnishing Tool, in Turkey was started in 1985 for inner and external diameters. According to the theoretical basis, today different applications are developed and studied by YAMATO. Special designs are made for the Industry.

ROLLER BURNISHING
The principle of Roller Burnishing is transferring the force applied on a roller to the surface in a certain path. During the rotation action the contact area is so small that hertz type pressure occurs on material surface (like roller bearings). This provides low energy and rolling force requirement. Roller Burnishing a metal surface is only possible with specially designed rollers and mandrel - roller combinations.



(Figure-1)

Figure-1 presents a pattern diagram of roller burnishing process for a spherical roller. The first contact to the machined surface occurs in Section (A). In section (B) the yield point of the surface is exceeded and plastic deformation takes place. Pressurized depth can be seen here as (D). After the material has been subjected to the maximum compressive strain, in section (C) it begins to elastically relieve (E) through the finishing zone finally leaving with a smooth surface and a compressive residual stress of significant peak value.
The stresses formed on the material during the compression decrease towards the centre. These stresses reach approximately 1 mm. below the surface increasing surface hardness as a result.
ROBUTO® tools comprise a mandrel and rollers placed in a slotted cage. This design provides sizing with high dimensional accuracy.

Effects of Roller Burnishing Operation

* Surface roughness value of 0.05-0.10 µm. (Ra) - (ISO N2, N3)

* 0.01 mm or better tolerances

* 30% - 70% increase in Brinell hardness on surface.

* Up to 300 % increase in resistance to fatigue failure

* Eliminating the factors of stress corrosion cracking

* Increase in corrosion resistance

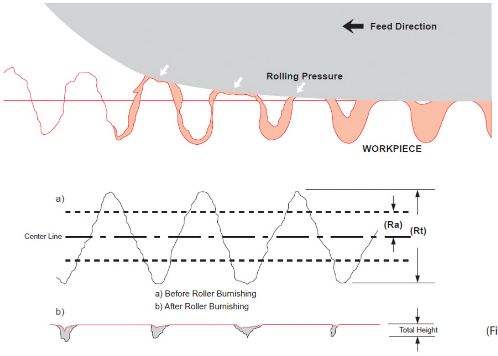
* Elimination of tool marks, pits, scratches and porosities

* Reduced friction up to 35 %

* Reduced noise level is achieved

Chip free Finishing & Cold Working

Roller Burnishing operation is a chip free finishing method. By the rolling pressure applied to the workpiece surface, the microscopic peaks flow into the valleys in the surface profile. (Figure-3)



(Figure-3)

Roller burnishing process cold - works metal surfaces to produce a uniform, dense, low micro surface finish. The fact that ROBUTO® does not remove metal - thus does not produce chips - enables the tool to offer a variety of advantages, most of which are not obtainable with other finishing processes such as reaming, boring, and grinding.

The chip free finishing process, roller burnishing cold - works metal under relatively small forces. These forces slightly exceed the yield strength of the material causing a plastic deformation of its surface material. Because the plastic deformation occurs under the recrystallization temperature this process is called cold working.

Advantages

Increase in Resistance to Fatigue Failure

Because fatigue failure damages are instantaneous and cause major harm, preventions are necessary. Metals can get cracked even if the forces applied are very small when compared to the yield point. Experience has shown that notches, sharp changes of section and other forms of stress raisers are dangerous to metals in applications involving dynamic forces.

Roller burnishing has an effect of smoothing the profiles of sharp surface imperfections like notches and tool marks. Another and more important point is that the operation of roller burnishing reduces the harmful effects of dynamic forces by forming compressive residual stresses at the surface of workpiece material. After roller burnishing, at a given depth below the surface, the material is elastically deformed and tries to spring back. This gives rise to compressive stresses at the surface and tensile stresses in the elastically deformed zone. This in turn increases the resistance of the material to fatigue failure, because any external forces must first overcome these residual stresses.

These two major effects of roller burnishing (eliminating the surface imperfections and forming compressive residual stresses) improve the resistance to fatigue failure up to 300%.

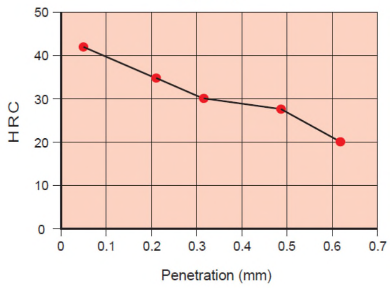
Work - Hardening

Roller burnishing compacts and compresses the workpiece metal where it is contacted by the tool. Subsequently, the grain structure is changed and the part becomes strain hardened. Through this granular dislocation and deformation, the grain size is decreased and the boundary volume is increased in the cold worked area.

Because we are dealing with surface hardness, hardness increase cannot be measured by means of Rockwell or Brinell testing. Instead, a method known as Tukon testing is used. Knoop value is obtained from the measurements of Tukon testing. The Knoop Hardness value can be converted to Brinell or Rockwell hardness values.

The Knoop hardness measurement shows a clear hardness increase at the surface, with hardness gradually decreasing to the original value at greater distances from the surface. In Figure-5 the relation of surface hardness and penetration of the hardness (distance from surface) is shown.

(Figure-5)



Corrosion and Porosities

Workpieces that are roller burnished have high resistance to corrosion. Eliminating the pits, scratches and porosities, which could collect reactive substances and contaminants, provides high corrosion resistance.

A workpiece has the risk of cracking when it is under the effect of both reactive substances and tensile residual stresses. Cracking that occurs due to the interaction between static tensile stresses in the metal and a corrosive medium is called stress corrosion cracking. During roller burnishing, these tensile stresses are eliminated when the material is compressed, because compressive residual stresses are formed at the surface of the workpiece.

Roller burnishing successfully removes these factors causing stress corrosion cracking.