



ROLLER BURNISHING TOOLS

1. THE PRINCIPLE OF ROLLER BURNISHING PROCESS

Roller Burnishing is a cold working process which produces a fine surface finish by the planetary rotation of hardened rolls over a bored or turned metal surface. Roller Burnishing involves cold working the surface of the workplace to improve surface structure.

In the burnishing process, the pressure generated by the rolls exceeds the yield point of the softer piece part surface at the point of contact, resulting a small plastic deformation of the surface structure of the piece part.

Since all machined surfaces consist of a series of peaks

and valleys of irregular height and spacing, the plastic deformation created by roller burnishing is a displacement of the material in the peaks which cold flows under pressure into the valleys. The result is a mirror-like finish with a tough, work hardened, wear and corrosion resistant surface.

The roller burnishing pressure required depends on number of factors like ductility and tensile strength of the material, surface roughness before and after roller burnishing and diameter and shape of the rolls.

2. ROLLER BURNISHING TOOLS

2.1 Construction and working Principles :

Roller Burnishing tools incorporate a planetary system of hardened, tapered rolls which are evenly spaced by a retaining cage. When a tool engages the workpiece a hardened mandrel inversely to the taper of the rolls, forces them against the surface of the workpiece.

2.2 Self Feed Design :

The rolls axes are set at a slight helix angle to the axis of the mandrel and workpiece. This angular relationship causes the rolls to move in a helical path around the workpiece surface, thereby establishing a self feeding characteristic in the tool.

2.3 Non - Feed Design :

In application where a non - feeding tool is required such as in close approaches to shoulders or in full bottoming, the tool is constructed with the rolls axes parallel to the axis of the mandrel. With this construction, the tool depends on machine feed to advance along the workpiece.

2.4 Constant Diameter :

The interaction of the helix angle and the inversely tapered rolls and mandrel creates the pressure required for roller burnishing. The pressure is generated because the mandrel tends to overtake the rolls as the tool feeds along with workpiece. This tendency is restricted by a stop on the mandrel which establishes a fixed axial relationship between the rolls and mandrel. Since the rolls / mandrel relationship is constant, the tool maintains a uniform diameter during its complete pass.

2.5 Automatic Tool Release :

The inverse tapers of the rolls and a mandrel provide the tool with a self-releasing feature. When the advance of the tool into the workpiece is stopped, the rollers continue to feed in a helical path. In so going, they move forward on the mandrel to a point where its diameter is smaller, and the burnishing pressure is released. Only a small movement is required for the tool to release at which point it can be easily withdrawn from the workpiece.



3. BENEFITS OF THE ROLLER BURNISHING

3.1 Finer Finish :

Roller Burnishing imparts a high finish to any machinable metal. Surfaces that are bored, reamed or turned up to $3 \mu Ra$ or more can be finished to 0.05 to $0.2 \mu Ra$ in one pass at feed rates of 150-3000 mm per minute.

Roller Burnishing replaces grinding, honing, lapping and other expensive secondary operations; eliminates extra parts handling and additional machines.

3.2 Accurate Sizing :

Roller burnishing tool feature a built-in calibrated micrometer for adjustable size control in extremely small increments to cover the tolerance range of any part. Part size can be changed as little as 0.002 mm in one pass in a matter of seconds. You get selective fitting never before possible, without the costly investments of honing stones or expensive grinding equipments.

3.3 Improved Metallurgical Properties :

Burnishing 'cold-works' the metal of a machined part. Tool marks are rolled out. Grain structure is condensed and refined, and compacted surface is smoother, harder and longer wearing than ground or honed surfaces.

Rolling action greatly reduces surface porosity, pits and scratches which could hold reactive surfaces or contaminates. As a result the corrosion resistance of burnished surface is higher than the open surfaces produced by grinding or honing. Depending upon the type of material being burnished surface hardness can be increased by as much as 10-Rc. This increase often eliminates the need for heat treating or surface treatment as a means of improving wear resistance.

Due to plastic deformation in the roller burnishing operation, residual compressive stresses are inducted in the surface of the part. This compressive stresses greatly increase the strength properties and fatigue life of the part, because any forces on the part must overcome these residual stresses, as well as the tensile strength of the material, before fatigue conditions occur.

3.4 No Additional Machine Investment :

Roller burnishing tool can be used on most of the machine already installed in the shop, like screw machines, turret lathes, engine lathes, drill presses or the most sophisticated N/C machines. In most cases roller burnishing operation can be integrated with the automatic cycle or indexing sequence, eliminating time-consuming, costly secondary operations. Burnishing tools operate at standard speeds and feeds found in the most conventional shop machines.

3.5 Long Tool Life :

Thousands of parts can be finished with little or no burnishing tool wear. In many cases rolls and mandrels will hold size through 5 to 25 thousand operations. Even with a very small size tool, several thousands parts can normally be run before replacement parts are required.

3.6 No Operator Skill Required :

Set-up of roller burnishing tool takes less than a minute, using the built-in micrometer adjustment.

Unskilled operators can produce close tolerance work with consistent part-to-part uniformity through an entire production run.

3.7 Low Torque and Power Requirements :

Power requirements for burnishing is very low due to the small amount of torque generated. Work-holding problems are therefore considerably simplified when designing fixtures and machine set-ups to be employed in surface finishing with this type tool.

3.8 Maximum Parts Interchangeability :

Interchangeable parts of roller burnishing tools keep inventory low. Tools are grouped in standard series, each covering a specified size range. Since most parts in a series are standard, each tool is easily converted to other sizes within its range. Only the cage, mandrel and rolls are changed. This convertibility feature can save up to 50% of the cost of a new tool each new size needed.



4. STOCK ALLOWANCE - SURFACE FINISH CHART

STOCK ALLOWANCE

When machining a surface prior to Roller Burnishing, stock must be allowed for metal displacement. The amount of stock allowance varies with job conditions, material properties, wall thickness of the part, nature of the machined surface and the quality of the surface finish desired.

The accompanying table shows typical stock allowances for burnishing. However, because of the number of variables involved, these figures should

be considered only approximate. An exact allowance can best be determined by roller burnishing an actual workpiece to the desired finish and measuring the amount of stock displaced.

Remember, you should displace only the amount of stock necessary for producing the desired surface finish. Excessive roller burnishing not only accelerate tool wear but also can produce flaking of

STOCK ALLOWANCES - SURFACE FINISH CHART

WORKPIECE SIZE RANGE mm		INTERNAL SURFACE				EXTERNAL SURFACE			
		STOCK ALLOWANCE mm	SURFACE FINISH μ Ra (Rt)		STOCK ALLOWANCE mm	SURFACE FINISH μ Ra (Rt)			
			MACHINED	ROLLER BURNISHED		MACHINED	ROLLER BURNISHED		
High Ductility Material	3 - 12	0.010 0.017	2.0 (8) 3.1 (12)	0.2 (1) 0.2 (1)	0.010 0.015	2.0 (8) 2.5 (10)	0.2 (1) 0.2 (1)		
	12 - 25	0.017 0.040	1.5 (6) 3.1 (12)	0.2 (1) 0.2 (1)	0.012 0.025	2.0 (8) 4.5 (18)	0.2 (1) 0.2 (1)		
	25 - 50	0.025 0.050	1.5 (6) 3.1 (12)	0.2 (1) 0.2 (1)	0.017 0.025	2.5 (10) 4.5 (18)	0.2 (1) 0.2 (1)		
	50 - 165	0.040 0.075	1.5 (6) 5.0 (12)	0.2 (1) 0.2 (1)	0.025 0.050	3.1 (12) 10.1 (40)	0.2 (1) 0.2 (1)		
Low Ductility Material	3 - 12	0.010 0.017	2.0 (8) 2.5 (10)	0.4 (2) 0.4 (2)	0.008 0.012	1.5 (6) 2.3 (9)	0.4 (2) 0.4 (2)		
	12 - 25	0.017 0.025	2.2 (9) 3.1 (12)	0.4 (2) 0.4 (2)	0.012 0.018	2.5 (10) 3.5 (14)	0.4 (2) 0.4 (2)		
	25 - 50	0.025 0.040	3.1 (12) 4.5 (18)	0.4 (2) 0.4 (2)	0.012 0.025	2.5 (10) 4.5 (18)	0.4 (2) 0.4 (2)		
	50 - 165	0.040 0.050	3.0 (12) 5.0 (20)	0.4 (2) 0.4 (3)	0.020 0.035	3.1 (12) 5.0 (20)	0.4 (2) 0.4 (2)		

The chart is guideline only, derived from experiments. Under your own conditions the results may be slightly different. The chart indicate that, in the 25-50 mm range, a hole machined in a high ductile material to 3.1 m Ra and 0.050 mm smaller than the burnishing tool size, will be burnished to 0.2 m Ra. If the hole is finished to 1.5 m Ra, before burnishing, 0.025 mm of stock need be left for burnishing to 0.2 m Ra.

NOTE : Surface finish can be achieved upto 0.05 m Ra by selecting Preburnishing Parameters.

High ductility Materials have more than 18 % elongation and less than Rc 25. They include: Annealed Steel, Aluminium, Brass Bronze, Malleable Iron.

Low Ductility Materials have less than 18% elongation & a Max. hardness of Rc 40. They include: Gray C.I., Modular Iron, Heat Treated Steels, Mg. Alloys, Hard Cu Alloys.

5.1 FEEDS

The thru style tool (IH series) is self-feeding, that is the tool feeds itself into or onto the work. It will feed itself independently of machine feed or any external power. All that is required is rotation. The tool should be allowed to feed at its natural rate without being forced or retarded. On machine equipped with automatic feeds, the machine feed should be slightly more (10-20 %) than the natural feed rate of the tool so there will be no possibility of retarding the tool, thereby causing it to release prematurely. In applications on automatic machines where the feed rate of the tool exceeds that

Full bottoming style tools (IB series) are supplied with non-feed cages and must be machine feed. With this non-feed design, minimum clearance are required to obtain the closest approach to bottom. Feed rate from 30 to 100% as charted for thru style tools are generally satisfactory for all bottoming applications. The exact feed rate of the tool is therefore governed by the specific machine set-up. If under some circumstances, the feed and speeds shown on subsequent pages are not suitable for the application, a high helix angle cage may help. This fast feed tool is

5.2 SPEEDS

The tool is designed for conventional right hand rotation, and either the tool or the workpiece can be rotated. Rotational speed is not critical, but higher

than recommended speeds will reduce tool life. If long-length tools, or tools with extension drive are used, speed should be reduced to prevent excessive whip.

SPEED AND FEED RATE CHART

Burnishing Diameter	INTERNAL		EXTERNAL	
	* Speed	** Feed (mm / rev)	* Speed	** Feed (mm / rev)
5	1500	0.1	1000	0.15
12	1000	0.3	700	0.3
40	600	1.3	400	1.0
65	300	1.5	250	1.8
95	250	1.8	200	2.7
165	200	3.4	—	—

* Speeds may be increased or decreased by 50% to suit special requirements.

** Feed may be increased by 30% to suit special requirements.

Since the rotation speed of the tool is not critical to performance, high surface speed will produce the same burnishing result as low speed; therefore rapid production cycles for the burnishing operation yield the most economical piece / part cost when compared with other types of finishing operations.

5.3 MACHINE CONSIDERATIONS

The tool must be properly aligned with the part in the machine to facilitate the engagement of the tool with the work. A slight misalignment (max. 0.15mm) does not produce any adverse effect on the tool or surface finish produced in the workpiece. However, excessive misalignment in a rigid setup between tool and workpiece will cause bending stress in the tool, resulting in fatigue failure of the mandrel tip. Proper alignment is more important when the tool is rotating because tool whip is more likely than part whip.

The tool should be rigidly mounted on the drive shank to prevent any axial movement during the release cycle. This is particularly important for large, heavy tools when operated in a vertical position. A keeper key or binding screw also eliminates any possibility of tool accidentally coming out of the spindle.

In using the tool on multiple spindle automatics, it is best to mount the tool in a top position to minimize chip contamination from the other cutting operations.

5.4 LUBRICATION

A filter (max. 50mm) in the lube system is recommended to prevent entering of chips and grit into the tool. The tool requires lubrication but cooling only in case of long workpiece as hydraulic cylinders.

Therefore, any light lubricating oil or a rich, soluble oil mixture is recommended. Lubricant should be fed to the tool in a steady ample volume to provide flushing and cleaning action.