The History of Shot Peening

Shot peening is not a new process. People have long known that pre-stressing or work-hardening metal could create harder and more durable materials. The process of shot peening has long been used to strengthen armor, armor plating, and the surface of machine tools. The process was first used in Europe during the 19th century to strengthen steel weapons and armor. In the 20th century, shot peening was used extensively in the aerospace industry to strengthen components such as turbine blades and engine parts.

Shot peening is a process in which small, high-velocity metal or plastic shot is directed at the surface of a metal component. This shot causes the metal surface to compress, creating a layer of metal that is harder and more durable than the original material. The process is used to improve the fatigue life and strength of metal components, as well as to decrease the wear and tear of metal surfaces.

Shot Peening Benefits

• Enhances fatigue strength
• Improves ultimate strength
• Prevents cracking due to stress
• Prevents hydrogen embrittlement
• Prevents corrosion
• Improves fatigue
• Prevents peening
• Can increase yield by more than 50%
• Can increase yield by 50% to 100%
• Can increase yield by 100% to 1000%
• Can prevent the use of the same tools by reducing brittleness
• Can increase fatigue strength by 50%
• Can increase drive pinion life up to 400%
• Can increase crankshaft life 100% to 1000%
• Can prevent corrosion
• Can prevent hydrogen embrittlement
• Improves ultimate strength
• Enhances fatigue strength

Controlling the Process

Media

Media control involves using high quality shot that is miscibly ground and of uniform size and shape. The diameter of the shot should be the same throughout the media. If the shot diameter is not uniform, each individual shot will have a significantly different impact on the material. This exposes the material surface to varying impact energies that create non-uniformities. These non-uniform layers will create inconsistent fatigue results.

Intensity

Intensity control involves changing the media size and shot velocity to control the energy of the shot stream. Using large media and increasing the velocity of the shot stream will increase the intensity of the shot peening process. To determine what intensity has been achieved, Almen strips are mounted to Almen blocks and the shot peening process is performed. The Almen strips are then measured to determine the intensity of the shot peening process. By measuring the height of the arc, the intensity can be accurately calculated. This process is done before the actual peening process to ensure that the peening process is correct.

Coverage

Coverage is the measure of the original surface area that has been saturated by shot peening. Shot peening coverage is usually determined by using standard test pieces that are coated with a known amount of shot peening media. The saturation point is defined as the point where the shot peening media has covered 100% of the surface area. A surface that does not have 100% coverage is likely to develop fatigue cracks in the un-peened surface areas.

References:

Peenable Materials

• High Strength Steels
• Carbonized Steels
• Cast iron
• Aluminum Alloys
• Titanium
• Magnesium

Powder Metallurgy

• Powder Metallurgy

Applications

• Powder Metallurgy
• Aluminum Alloys
• Titanium

Shot Media

• Steel spheres
• Ceramic balls
• Glass beads
• Ceramic beads

How It Works

Shot peening is a useful working process that imparts a small indentation on the surface of a part by impacting small spheres (shot) onto the material surface. (Figure 1) This process creates the same effect that hammering does by causing outer surface to yield in tension. The material directly beneath this indented area is subjected to high compressive forces from the indentation and tries to restore the outer surface to its original shape. By overlapping the surface indentations, a uniform compressive layer is achieved at the surface of the material. The compressive layer squashes the grain boundaries of the material to prevent the grain boundaries from changing. The material yield is significantly reduced by flattening the indentations.

Figure 1 Figure 2

Laser-shot Peening

Laser-shot peening is a process in which the surface of a material is exposed to a laser beam. The laser beam produces a high-intensity, high-temperature plasma that is directed at the material surface. This plasma causes the material to expand, creating a layer of material that is harder and more durable than the original material. The process is used to improve the fatigue life and strength of metal components, as well as to decrease the wear and tear of metal surfaces.

Dual Peening

Dual peening further enhances the fatigue performance from a single after peening operation by re-peening the same surface a second time with smaller shot and lower intensity. (Figure 3) This process creates the same effect that hammering does by causing outer surface to yield in tension. The material directly beneath this indented area is subjected to high compressive forces from the indentation and tries to restore the outer surface to its original shape. By overlapping the surface indentations, a uniform compressive layer is achieved at the surface of the material.

Figure 3

Methods of Shot Peening

Conventional (Mechanical) Shot Peening

Conventional shot peening is done by two methods. Method 1 involves accelerating shot materials with compressed air. The process is introduced into a high velocity air stream and then accelerated into a high velocity air stream. The shot gets dropped off the rotating wheel. (Figure 4) Powder Metallurgy

Figure 5

Figure 6

• Glass beads
• Ceramic beads
• Steel spheres

• Powder Metallurgy
• Aluminum Alloys
• Titanium

Laser-shot peening utilizes a high-energy laser beam to vaporize the surface of the material. The high-energy laser beam causes the material to expand, creating a layer of material that is harder and more durable than the original material. The process is used to improve the fatigue life and strength of metal components, as well as to decrease the wear and tear of metal surfaces.

Figure 7

Can be used to curve metal or straighten shafts without creating tensile stress in a Peen forming process

Increases lubricity by creating small pores in which lubricants can accumulate

Can increase drive pinion life up to 400%

Can increase crankshaft life 100% to 1000%

Prevents corrosion

Prevents hydrogen embrittlement

Improves ultimate strength

Enhances fatigue strength

References:

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