

Design and Fabrication of Automatic Shot Peening Machine

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ABSTRACT:Shot peening has been used to improve the fatigue properties of a variety of metals. Shot peening is a mechanical surface treatment that introduces a roughened surface, a compressive surface layer, and increased dislocation density near the surface and also shot peening is a cold working process in which the surface of a part is bombarded with small spherical media called shot. Each piece of shot striking the metal acts as a tiny peening hammer, imparting a small indentation or dimple on the surface. In order for the dimple to be created, the surface layer of the metal must yield in tension below the surface; the compressed grains try to restore the surface to its original shape, producing a hemisphere of cold-worked metal highly stressed in compression. Overlapping Dimples develop a uniform layer of residual compressive stress and increase the fatigue strength of the material.

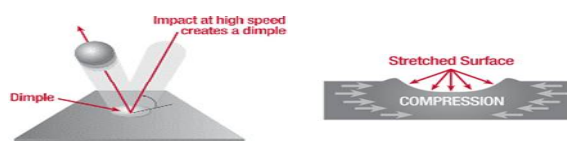
I. INTRODUCTION

Shot peening is a well-established cold working process, widely used in automotive and aircraft industries. The technique involves the impingement of a stream of spherical shots, directed at the metal surface at high velocity under controlled conditions. The process has useful applications in increasing fatigue strength, relieving tensile stresses that contribute to stress-corrosion cracking, forming and straightening of metal parts, and testing the adhesion of silver plates on steel. Shot peening generates plastic deformation in the exposed surface layer and induces compressive residual stresses in that layer. Such an effect depends on the variables of the process, i.e. shot size, nozzle pressure, impingement angle, shot flow rate and nozzle distance from the specimen surface. Those variables are integrated in the form of Almen intensity.

II. EXPERIMENTAL PROCEDURE

SHOT PEENING

Shot peening is a kind of surface cold working technology in which the surface of a part is bombarded with small spherical media called shot. Each piece of shot striking the material acts as a tiny hammer, imparting to the surface a small indentation or dimple as shown in fig.



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So this can provide fatigue life improvement by projecting of small particles. Since many components are subjected to fatigue failure due continuous loading and repeated work cycles, the components should be made without fatigue failures. For that shot peening process is preferred.

TYPES OF SHOT PEENING

There are different types of shot peening process; the types of the shot peening process are as follows,

1. Water peening
2. Air peening
3. Material peening
4. Laser peening

WATER PEENING

In water peening process, the water is passed from the nozzle towards the target material at high pressure so that the material will be peened as shown.



AIR PEENING

Air peening process, a high-pressure air is made to flow in to the target material so that the target material will be peened as shown in fig



LASER PEENING

Laser peening, or laser shock peening (LSP), is the process of hardening or peening metal using a powerful laser as shown in fig.

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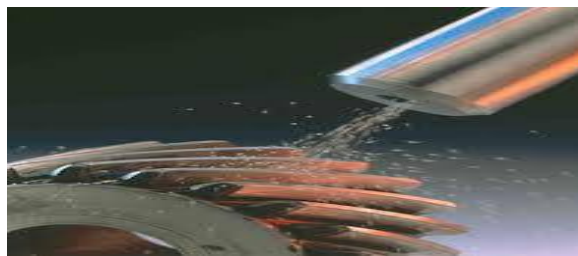


MATERIAL SHOT PEENING PROCESS

Material shot peening process, shot particles are ejected from the nozzle towards the target material at certain velocity, distance and pressure as shown in fig.

Conventional shot peening is done by two methods. Method one involves accelerating shot material with compressed air. Shot is introduced into a high velocity air stream that accelerates the shot to speeds of up to 250 ft/s.

The second method involves accelerating the shot with a wheel.



PARAMETERS SELECTION

Selection of shot peening depends upon the following parameters:

- Knowledge of the application of the component.
- Component geometry.
- Manufacturing method.
- Mechanical properties of the base material.
- Strain sensitivity of the base material environment service conditions, loads and cycles.
- Cost sensitivity.

APPLICATIONS OF SHOT PEENING PROCESS

Shot peening is used on gear parts, cams and camshafts, clutch springs, coil springs, connecting rods, crankshafts, gearwheels, leaf and suspension springs, rock drills, and turbine blades. It is also used in foundries for sand removal, decoding, descaling, and surface finishing of castings such as engine blocks and cylinder heads. Its descaling action can be used in the manufacturing of steel products such as strip, plates, sheets, wire, and bar stock.

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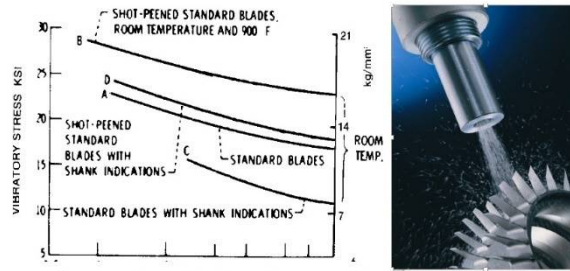


Fig. Suppression of Fatigue Damage of Inconel 713c Turbine Blades by Shot Peening

Shot peening is a crucial process in spring making. Types of springs include leaf springs, extension springs, and compression springs. The most widely used application are for engine valve springs (compression springs) due to high cyclic fatigue. In an OEM valve spring application, the mechanical design combined with some shot peening ensures longevity.

III. DESIGN AND CALCULATION

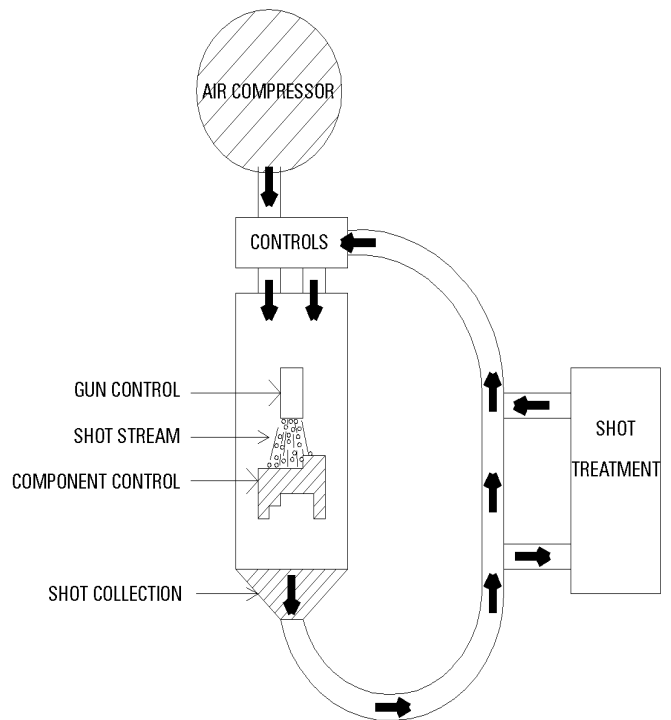
SCREW ROD

A screw rod is a mechanism that converts rotational motion to linear motion, and a torque (rotational force) to a linear force. It is one of the six classical simple machines. The most common form of screw rod as shown in fig.



GEARED DC MOTOR

A DC motor output speed will vary with load and applied voltage. The geared DC motor as shown in fig.



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SPECIMEN PREPARATION

According to the ASTM E466 standard, the fatigue test specimens were Prepared from an EN19 steel plate with a thickness 3.175 mm, length 130mm, width 12.5mm, as shown in fig.

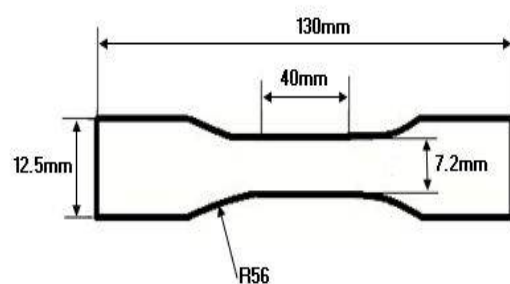
SCHEMATIC REPRESENTATION

This is simple working process of our project. Then the schematic representation as shown in fig.

WORK HOLDER

The permanent magnet work holder produces strong attractive force. It can be used for various machining application and which is effective for positioning of work piece.

Comparison work piece setup in a vice, setting work on the magnetic work holder is done more effective. Then the magnetic work holder as shown in fig.



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SHOT PEENING GUN

SBG-03S (Sand Blasting Gun) is used. Then the shot peening gun as shown in fig.



Code no	SBG - 03S
Fluid nozzle orifice dia(mm)	4
Minimum required pressure (kg/sq.cm)	4
Air consumption of rated pressure (letter/min)	211
Weight of gun with pipe(gms)	534

Table: Technical Data

RECIPROCATING AIR COMPRESSOR

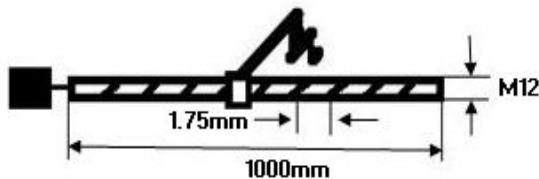
Compressors are work absorbing devices which are used for increasing pressure of fluid at the expense or work done on fluid. The simple air compressor as shown in fig.

decrease. When its temperature reaches to 25°C, the following readings were note down. Temperature at compressor inlet outlet temperature, Expansion valve inlet and outlet. Final Energy meter reading

Again, the same procedure was repeated and note downed the required valves when evaporator water temperature is 20°C, 15°C.



Calculation



INERTIA (J):

$$J_L = J_A + (J_L / N^2) + (w/g(1/2\pi p)^2)$$

Where

J_A = motor inertia

J_L / N^2 = Gear inertia

$w/g(1/2\pi p)^2$ = lead screw inertia

$$\begin{aligned} J_L &= 0.0052 + (0.0052 / (6)^2) + (800/9.81(1/2\pi \times 1.75)^2) \\ &= 0.0052 + 1.4e^{-4} + 631.77 \\ &= 631.78 \text{ grams} \end{aligned}$$

TORQUE:

$$\begin{aligned} \text{Torque pay load} &= \text{mass of the gun} + \text{inertia load} \\ &= 6 + 631.78 \\ &= 6.7 \text{ Kg} \end{aligned}$$

$$\begin{aligned} \text{Peak load} &= 1:3 \text{ times of the pay load} \\ &= 20.1 \text{ Kg} \end{aligned}$$

S.NO	DESCRIPTION	PARAMETER
1.	Dc geared motor	60 Rpm
2.	Arduino u.n.o	1
3.	Relay board	6 relay
4.	Battery	12 Volt
5.	Push Button Switch	3
6.	Adaptor	12v
7.	Connecting props	As required

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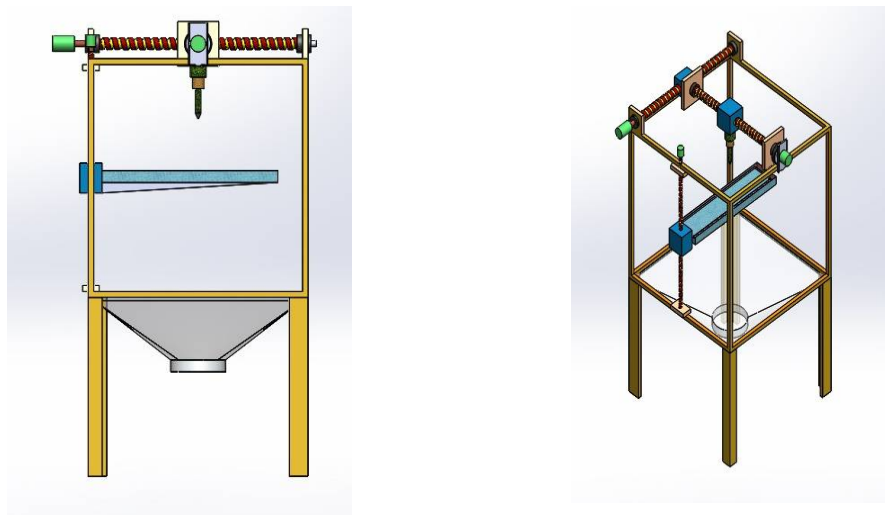
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S.NO	DESCRIPTION	PARAMETER
1.	Screw rod (3 No's)	(18*600) (18*600) (18*800) in "mm"
2.	Steel shot	1 Kg (Diameter=1.5mm)
3.	Outer frame volume	700mm*700mm*900 mm
4.	Compressor	8 bar
5.	Shot peening gun	Diameter=4mm
6.	Sheet metal	3000 mm
7.	Bearing	18mm

Table: Electrical parts Requirements

SOLID WORKS DESIGN



IV.SHOT PEENING SPECIFICATION

PARAMETER SELECTION

The choice of shot peening parameters is dependent on a variety of conditions:

- knowledge of the application of the component
- component geometry
- manufacturing method
- mechanical properties of the base material
- strain sensitivity of the base material
- environment

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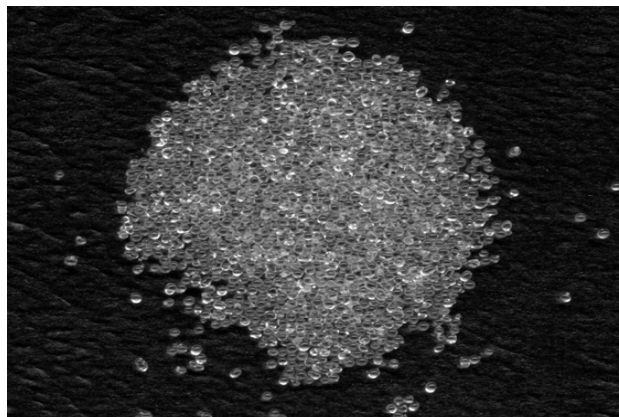
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- service conditions, loads and cycles
 - cost sensitivity
- All the above must be considered when deciding on parameter selection and, equally important, maintained throughout the life of the product in a repeatable and consistent manner.
- Following process controls are used and critical to maintaining process integrity:
- Media
 - Intensity
 - Coverage
 - Equipment & Process Integrity

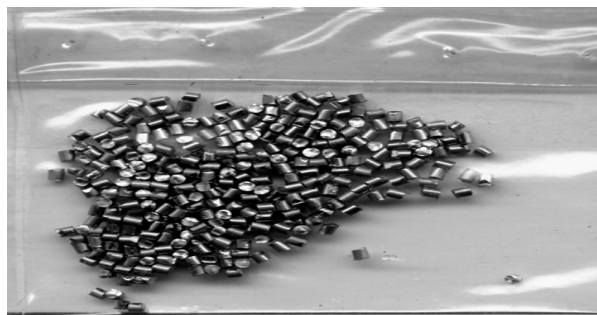
MEDIA: SHOT SHAPE AND SIZE GLASS AND CERAMIC BEADS

Typically used for light peening applications. Glass bead sizes are usually specified by the letters AGB followed by a number that represents the mean diameter in microns divided by 10. Thus AGB-30 is on average 300 microns in diameter.



CUT WIRE SHOT

Often preferred over steel shot due to the fact that it lasts longer, generates less dust, and has a greater uniformity in size. It is made by taking wire of the desired type and cutting it in lengths that are approximately equal to the wire diameter.



SHOT SIZE AND SHAPE

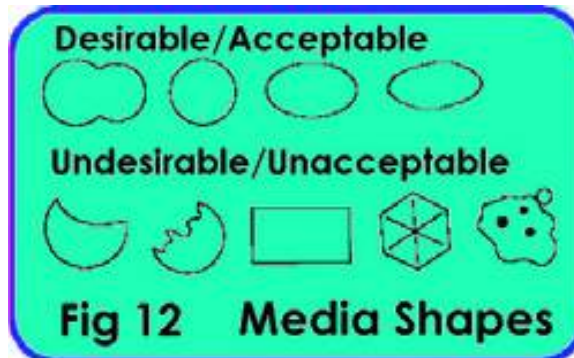
Shot size and shape refrigerant results in improvement in the thermos physical properties and heat transfer characteristics of the refrigeration system.

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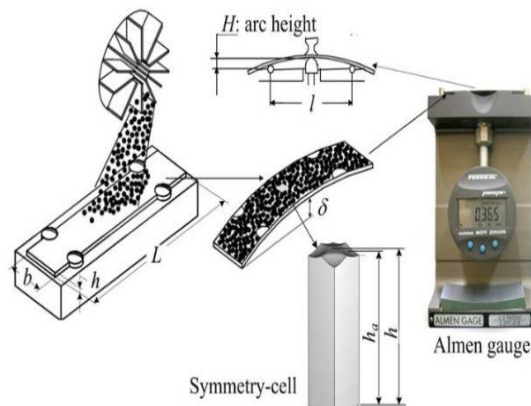
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INTENSITY MEASUREMENT

The strips should be mounted in the same position and orientation relative to the shot nozzle as the piece to be peened.

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APPLICATION OF SHOT PEENING (after some manufacturing process)

- Processes like Grinding, Electro Discharge machining (EDM), Plating, Electro-Chemical Machining (ECM), Anodizing, Plasma, Decarburization

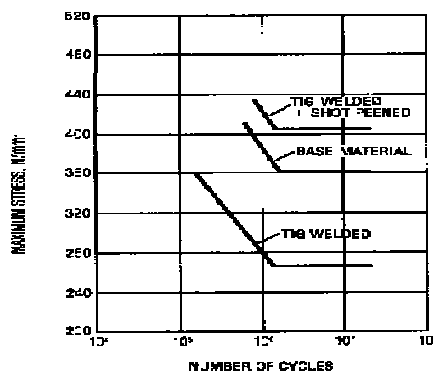
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Heat generated by the welding process often will produce tensile stresses approaching the yield strength of the material. These harmful self-stresses in the heat-affected zone (HAZ) contribute to poor fatigue characteristics of element



S.

V. BENEFITS AND LIMITATIONS

BENEFITS OF SHOT PEENING

- Enhances fatigue strength
- Improves ultimate strength
- Prevents cracking due to wear
- Prevents hydrogen embrittlement
- Prevents corrosion
- Prevents galling
- Prevents fretting
- Can increase gear life more than 500%
- Can increase drive pinion life up to 400%
- Can increase spring life 400% to 1200%
- Can increase crankshaft life 100% to 1000%
- Can permit the use of very hard steels by reducing brittleness
- Possible to increase the fatigue strength of damaged parts extending the wear
- Increases lubricity by creating small pores in which lubricants can accumulate
- Substitution of lighter materials can be possible without sacrificing strength and durability
- Leaves a uniformly textured, finished surface ready for immediate use or paint and coatings
- Can be used to curve metal or straighten shafts without creating tensile stress in a Peen forming process

VI. CONCLUSION

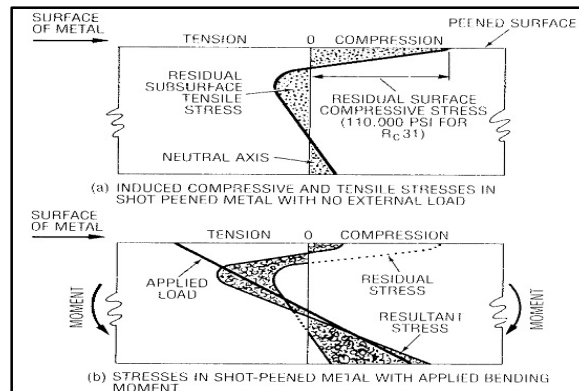
Shot peening is an operation which is used largely in the manufacture of mechanical parts. It should not be confused with sand blasting used in cleaning or descaling parts. Shot-peening is in fact a true machining operation which helps increase fatigue and stress corrosion resistance by creating beneficial residual surface stresses. The main advantage of this particular surface treatment is that it increases considerably the fatigue life of mechanical parts subjected to dynamic stresses. It has many uses in industry, particularly in the manufacture of parts as different as helical springs, rockers, welded joints, aircraft parts, transmission shafts, torsion bars, etc.

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