Chapter 7
Optimizing Shot Peening Machines for Compact Components

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ABSTRACT

Optimizing shot peening is a cold-working process employed to generate a compressive residual stress layer and modify the mechanical properties of metals. It involves impacting a surface with a shot with sufficient force to induce plastic deformation. Peening a surface spread it plastically, leading to alterations in its mechanical properties. Its primary application is to prevent the propagation of microcracks from the surface. Such cracks do not propagate in a material that is under compressive stress. Optimizing shot peening can induce such stress on the surface. In this process, shots are accelerated using centrifugal force generated by a rotating impeller, which directs the shots to impact the surface to be peened. Media choices include spherical cast steel shots, ceramic beads, or conditioned cut wire. Peening necessitates well-graded shots with consistent hardness, diameter, and shape, and a mechanism for removing optimized shot fragments throughout

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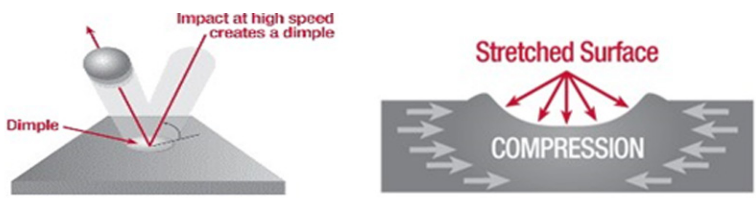
the process is desirable.

INTRODUCTION

The shot peening process significantly influences the microstructure and mechanical properties of metals. Shot peening refines the surface grains into nanocrystals, leading to increased surface hardness, tensile strength, and enhanced corrosion resistance (Pan.H.,2023). It is a process of cold working a part to enhance its resistance to metal fatigue and certain forms of stress corrosion. It entails bombarding the surface of the desired part with metallic (usually steel), glass, or ceramic beads with sufficient force to create dents on the surface (P.S.G College, 2011). As depicted in Figure 1 (Kirk, David., 2009 and Haverty, Donncha and Brendan Kennedy, 2009), optimizing shot peening induces plastic deformations on the surface of the peened part. This process alleviates surface tensile stresses that may have been introduced during part machining. More importantly, it introduces beneficial compressive residual stress, thereby fortifying the surface of the part. Additionally, shot peening is occasionally employed to manipulate or modify the shape of thin parts.

Figure 1. Principle of shot peening



Compressive residual stress refers to any stress remaining in a material after the source of the stress has been removed. It occurs when the shot creates dimples in the surface by displacing the material sideways. This compression is generated by the transfer of kinetic energy from a moving mass (shot particle) into the material's surface, capable of undergoing plastic deformation. Atoms just below the surface resist this displacement, leading to compressive lateral stress aimed at restoring the surface to its original state. This stress contributes to surface hardening and prevents crack formation and propagation.

The depth and magnitude of the compressive residual stress layer depend on various factors, including shot type, intensity, coverage, and part hardness. The depth of the compressive layer can vary, from 0.05 mm for light peening applica-