

Peening by Water

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Abstract:

Steel has been peened by high velocity water jets. Advantages over shot peening are assured complete coverage and a smooth surface. Induced stresses are less than by shot peening. Equipment is briefly described.

Keywords:

Peening, water peening, vibrating stress-relief.

Purpose:

The main purpose of this procedure is to harden the surface of low hardness steels, to improve the resistance to fatigue and to prevent stress corrosion. Applications are in steel mills for plates and structural shapes and in nuclear power plants.

Comparison with Shot Peening

A smooth reliably covered surface is the main advantage of peening by a high velocity water jet. The surface becomes so smooth that subsequent machining or grinding will not improve its smoothness. Complete coverage is certain because the water jet impacts a much larger surface than a steel ball. There is no danger of leaving any small area without impact. The cost of peening by water may also be less than the cost of peening with shot, depending on the circumstances.

The layer of compressive residual stress is not as deep as can be obtained by shot peening and the magnitude of the compressive stress is not as great.

The heat generated by conversion of the kinetic energy of the water jet is enough to produce substantial amounts of steam. The metal surface temperature at the point and instant of impact is probably different from the corresponding temperature when peening with shot.

Equipment

The water jet has a velocity of 90 to 100 m/sec. Pipes are 1-1/2 inch (nominal) extra strong made of carbon steel, welded and 100% inspected by radio graphs. Test pressure for the system is 30 at (3MPa). Two pumps of 22 kW are used with an accumulator of 10 m³ volume. A compressor of 7.5 kW provides compressed air. The water must be clean. Instruments such as pressure gages, flow meters, etc. and the safety valves must be protected against shock waves.

Provision must be made for exhausting the steam generated by peening and for protection against excessive noise.

Uniform relative motion of work pieces and nozzles is essential. Excessive exposure to the water jet can cut the metal surface.

Stress Relief

Because the stresses induced by water peening are sometimes undesirable provision is made to relieve them by microvibration, immediately after peening when the metal is still hot. Electric motors with eccentric masses are used for this purpose. The frequency of vibration is adjusted according to the resonant frequency of the work piece. This treatment lasts from 5 to 30 minutes.

Discussion

The author states: "Two stabilization mechanisms occur with increase of acting energy regardless of how it is supplied:

1. By bipole conversion moving to crystal boundaries transfer slipping to other slip surfaces and climbing the bipole forming dislocations reorient to a more stable position in the crystal lattice and along the crystal boundaries due to the small total stress level so that they are not displaced in case of external shear stress.
2. Atoms in the stress field of dislocation tend to take such positions in which the inherent stress level decreases resulting in blocking of dislocations. That effect is increased by mass of misfit atoms.

In this area carbon nitrides precipitate retaining and blocking the dislocation sources. If inserted an external periodic vibration of a certain amplitude and low frequency is applied to a structure, it propagates throughout the structure."