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High Power Ultrasonic Impact Treatment

Technology and equipment
presentation



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Technology introduction & brief description

Ultrasonic Impact Peening is a cold working process that uses high frequency and high-velocity impact of a hard metal tool tip to plastically deform a material in order to introduce beneficial compressive residual stresses.

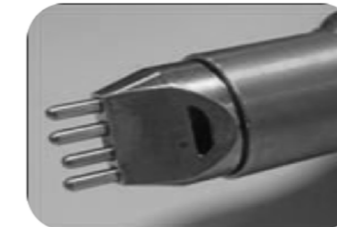
These residual compressive stresses are produced by work hardening with the intent to replace residual tensile stresses in metal surfaces and welded joints. In weld joints, one significant objective is to improve the fatigue strength of welds that may be subject to dynamic stress conditions and susceptible to stress cracking.

The ultrasonic impact peening system includes an ultrasonic generator power supply connected by a cable hose to the tool housing that contains an ultrasonic transducer assembly and the impact pin(s). The tool-housing tip holding the impact pin(s) is replaceable and can be designed in a wide range of options to allow for one or many pins in various arrangements to address many different applications. The tool housing can be optioned for hand-held operation or mounting to a robotic arm for automated applications.

Ultrasonic Impact Peening is typically a post-weld treatment that uses a high power ultrasonic hammer to treat the weld and is most commonly focused along the weld toe. The mechanism is similar to hammer peening, however ultrasonically activated peening tools offer an improved, more consistent, and faster treatment. Weld toe treatment speed is typically in the range of 30-60 cm/min (1 – 2 ft. /min).

Through the treatment of either known critical structural areas or through predetermination of stress concentrations through NDT inspection, a preventative method against fatigue failure is enabled.

MPI has developed redesigned and delivered its ultrasonic peening equipment globally for over 10 years. The MPI design team can provide custom pins and pin holders for most any application. We offer standard tool designs working at 20 kHz and 35 kHz. Other custom frequency system are available on demand.



Preventative treatment of weld sections expected to be under high stress.

Overall life extension of the structure through maintained structural integrity. Help to prevent fatigue cracks during the remaining service life of the installation.

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Ultrasonic peening treatment can:

- » Release harmful tensile residual stress
- » Decrease stress concentration in a treated weld toe zone
- » Increase repair life from months to years
- » Prevent fatigue and fracture of welded joints
- » Make grain refinement
- » Grain size reduction
- » Enhance low and high cycle fatigue and has been documented to provide increases up to ten times greater than non-treated ultrasonically peened specimens.
- » Recondition problem welds and weld repairs
- » Remove inconsistencies in metals
- » Improves weld joints for extended life

Ultrasonic Impact Treatment of the weld toe, the transition area between the weld and base metal, produces a smoothed radius that reduces the local stress concentration. The depth of the radius should be in the range of 0.5 – 0.7 mm. Due to the deformations produced in Ultrasonic Peening shallow surface cracks in welds are easily repaired. When done properly the process offers significantly improved fatigue strength.



Advantages & properties

Through the preventative technique of High Power Ultrasonic Impact Treatment, high investments in maintenance and repair will be negated.

High Power Ultrasonic Impact Treatment offers asset owners / operators a pro-active solution for fatigue related structural integrity issues. By using High Power Ultrasonic Impact Treatment, the structural integrity engineer will be able to eliminate frequent shutdowns for repairs.

When High Power Ultrasonic Impact Treatment is used in areas of stress concern, or in areas identified as having residual stresses, then fatigue and fatigue cracking can be prolonged or completely avoided. The treatment is so effective that it could extend the service life of any full penetration weld configuration by at least four times.

If, for example, High Power Ultrasonic Impact Treatment is carried out during a scheduled pipeline, tank or structure inspection it will then be a preferred way to prevent any fatigue crack developing since there is no influence on production and hard to access areas are no more limited. The treatment is relatively fast so it can be applied in addition to standard shutdown or inspection procedures.



Advantages of MPI peening tool:

- » MPI peening tool has 2 times higher, initial oscillating amplitude of ultrasonic transducer, compared to any other peening tool produced worldwide (meaning hammering, penetration impact depth can be very high and strong). It also has and stronger pulsing momentum (at least two times), than anybody else.
- » Operating regime is frequency-modulated what has advantages regarding faster and stronger stress relief (compared to competitors).
- » MPI peening tool is producing very strong pulsing or hammering (directly realizing plastic deformation), and reacts like single piston, high amplitude actuator. Peening tools from other sources react like double piston and low amplitude actuators. Single piston actuators have longer and stronger penetration of ultrasonic or mechanical pulsating energy, deeper excitation, what is better for stress relief.
- » Generator keeps frequency and power control during peening in heavy-duty conditions what is very difficult for standard ultrasonic generators.
- » Operating life: almost unlimited. Apparatus is very robust and almost indestructible, compared to competitors. Applicable in very long continuous operating regimes (it has forced air-cooling for very long and heavy-duty operations).
- » Modular design concept, with easy replaceable hammering pins, and handy for manual operations.
- » Can be applied with robotic arm.



4 times
extended life of construction

30-60 cm/min
treatment speed

3,5 kg
manual tool's weight

46%
reduction of fatigue limit

System specification and requirements



The power supply equipment is the heart of the UP system which produces high efficiency active power in wide-band sonic and ultrasonic vibrations. The peening tool is enabled to produce proprietary "single-piston" peening action, and every other peening tool known from other sources (from competitors) is based on double-piston action. In essence, by utilizing the proprietary peening action, a much deeper metal penetration (up to factor 2) is achieved.

Ultrasonic generator:

- » Output voltage 600-1200 V
- » Main supply voltage 230V 50/60 Hz
- » Operational frequency range 17.5 - 21 KHz

(already factory adjusted).

- » Dimensions - 260 x 85 x 370 mm
- » Weight - 4 kg

Hand tool:

- » Length - 420 mm
- » Weight approx. - 3.5 kg
- » Includes single pin working head, two or three pins in line working head and multi-striker
- » Combined air and electrical inlet allow use of single hose line to power and air supply station.



- » Sliding outer housing with spring shock absorber to reduce vibration for reduced operator fatigue.
- » Non-Corrosive materials

Cases and examples of implementation

Many structural weldments are subject to the action of large number of cyclic loads during service. The development of fatigue fractures amounts to approximately 30% of the total premature failures in these structures.

High Power Ultrasonic Impact Treatment is a valuable technique for the improvement of fatigue life through the cold working of weld toe and weld face. This technique improves the fatigue strength of any full penetration weld configuration well over four times.

It is normally targeted at areas of structural integrity concern. Therefore, the fatigue life extension of these specific welds will result in an overall life extension of the structure through maintained structural integrity. This treatment can be used to avoid / prevent fatigue cracks in high stressed weld connections in all types of metal structures either civil, industrial, onshore or offshore, such as:

- » Wind Turbine Towers
- » Transport Pipelines
- » Bridges
- » Ship & Floating Vessels
- » Platform Support Structure
- » Civil Structures
- » Aerospace Drive Shaft and Critical Parts
- » Storage Tanks
- » Pressure Vessels
- » High Speed Rail Components

Ultrasonic peening is recommended as a preventative treatment of weld sections expected to be under high stress.



Cases

Floating Storage and Offloading (FSO & FPSO) Vessels

The problem

Weld joints on offshore rigs are subject to constant stress and strain due to rough sea conditions. The same is true for Floating Storage and Offloading (FSO) vessels that are additionally subjected to the stresses of the cyclical loading, especially in fatigue prone areas. As the rig and vessel welds approach the end of their known fatigue life our clients are faced with the challenge of repairing and maintaining failing weld joints. Normal repairs to these high stress joints are often temporary and not sufficient for long term operation.

Wind Turbine Towers

The problem

Both land based and offshore wind turbine towers are subject to cyclical loading caused by gusting winds and rotor vibrations. Floating offshore towers are additional subject to sea waves. These conditions create high stress conditions for tower structure welds that require special consideration and solutions to enhance weld joint fatigue strength.



The solution

By using our Ultrasonic Peening technology to dress repaired welds and also treat undamaged welds in high stress areas our clients can reset the fatigue life and add up to fifteen years of additional service life. The fatigue life extension of those specific welds will offer a general life extension of the offshore structure or vessel. This type of treatment is currently used to avoid or prevent fatigue cracks in high stressed weld connections in offshore structures.



The solution

While some conventional solutions offer a bit of added fatigue strength none offer the proven and superior results achieved by Ultrasonic Impact Peening. UIP offers rapid and efficient weld toe reshaping that seals surface cracks, makes metal grain refinement, improves residual stress and gives significant fatigue strength improvement.



Railway Structures

The problem

Railway structures, as with all welded structures, are designed with a limited life span that is highly dependent on the fatigue strength of welds that are subject to dynamic stress conditions. In many cases that life span may be significantly reduced because the original structure designs were based on short sighted requirements that underestimated the number of train rail cars used and the frequency of use. Due to normal aging and the added stresses compounded by the added train weight and frequency of use many railway structures have prematurely reached or are approaching their end of life.

MPI design team can adapt our technology to your robotic application and design tips to your requirements. We can offer custom tip shapes, modify the impact force, and provide a range of multi-pin tips.



The solution

A railway structure may be inspected for cracking and treated by UIP while under live load conditions. Identified critical weld areas may be treated with UIP as a preventative measure to reset and make life extension of the welds. UIP offers significant cost savings over other conventional solutions by eliminating the cost of added materials and providing a rapid treatment solution. It will significantly improve the performance of welds and extend the fatigue life.





Thank you
for the business



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