Ultrasonic Peening Technology

MPI , Switzerland

Field of Business :
The life extension of welded structures and components.

INTRODUCTION

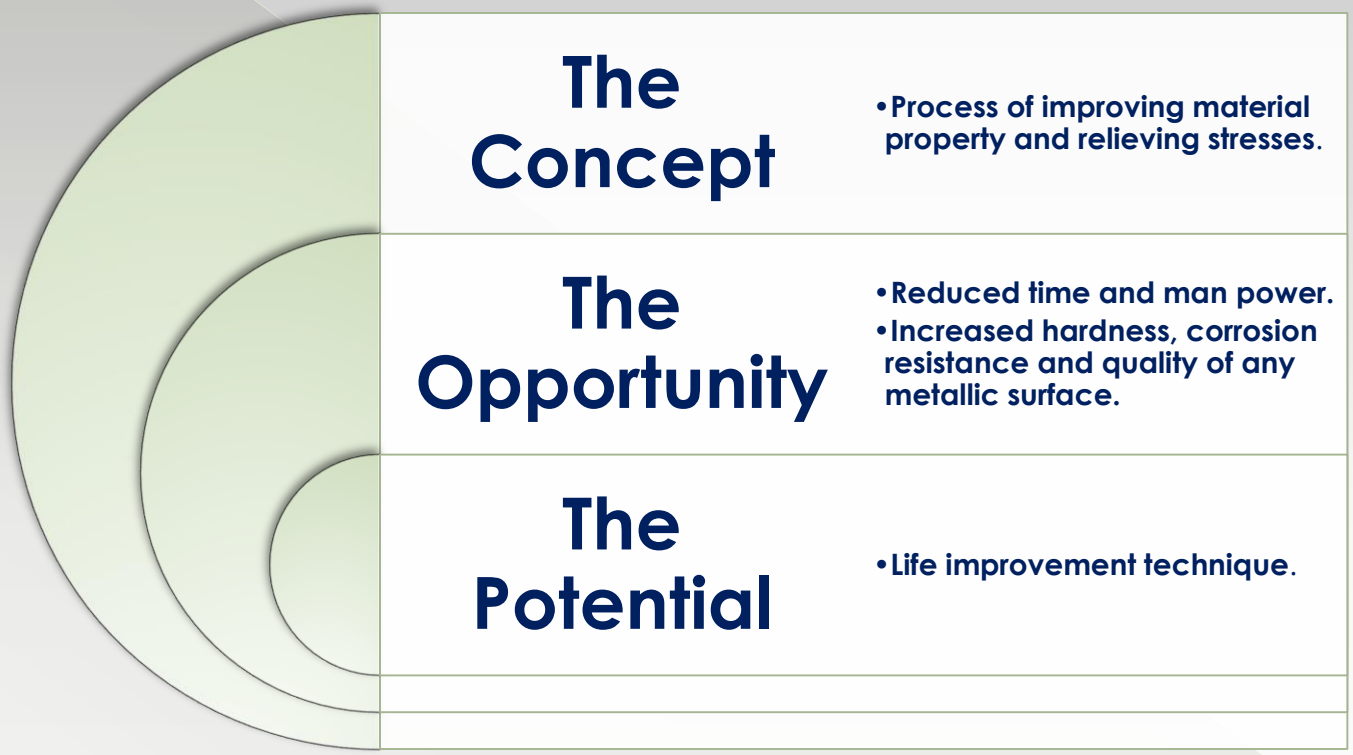
Many structural weldments – Ships , Offshore platforms , cranes , bridges , big reservoirs , big metallic constructions and machinery , antennas , and other structures are subject to the action of ***large number of cyclic loads during service***. The development of ***fatigue fractures*** amounts to ***approximately 30%*** of the total premature failures in these structures.

The fatigue limit of butt welds in different strength classes of steel established by the criterion of fatigue crack initiation is reduced to 32% to 46% of the fatigue limit of corresponding parent metal with a rolled surface . Similarly , the fatigue limit of lap joints with longitudinal fillet welds under cyclic stress conditions constitutes only 20% to 40 % of the fatigue limit of the corresponding parent metal .

ULTRASONIC PEENING TREATMENT PROCESS

- It is a fatigue life improvement technique of welded structures by application of ultrasonic and mechanical impulses at the high stress locations in the weld. As a result of ultrasonic and mechanical impulses the welded metal is modified at the atomic- and/ or metallurgical- level.
- It introduces compressive residual stresses (up to 900Mpa at and near the surface), increases hardness, corrosion resistance and improve the quality of the surface.
- It increases hardness by 10% and improved surface quality by 50%.
- Reduces stress concentration associated with weld local geometry.
- Creates plastic deformation strain hardening in a surface layer (up to 0.7 mm in depth).
- It improves the fatigue life of the structure by approximately a factor of 10. This improvement is mainly because of reduction of tensile stresses, introduction of compressive stresses, increase in hardness and improvement of surface quality.
- Ultrasonic peening treatment can be applied to a wide range of metals including steel, cast-iron, aluminum, inconel, titanium, stainless steel and bronze.
- For cylindrical parts the UP treatment is also available due to possibility of rotation of the component. Hence UP device designed for robotic use can easily be adopted to lathes and milling machines.
- It is the most efficient and easy to apply technique on the welded structures.

Ultrasonic Peening(UP) Summary



Principle

High Power Ultrasonics

They involve power levels of hundreds to thousands of watts, and ultrasonic systems operating in frequency ranges from 15 kHz to 100 kHz.

Typical amplitudes range from about 10 to 40 microns.

Such ultrasonic system operating at 20 kHz creates a cyclic acceleration of around 50,000 g (g=9.8 m/s2).

These high power Ultrasonics are very advantageous in ultrasonic peening of metals and welded elements. For the metal treatment special high strength material strikers are made of different shapes.

Peening is the combined effects of high frequency impacts (more than 20 kHz) by the special strikers and the simultaneous exposure to ultrasonic oscillations of the treated material ,producing unique beneficial effects in metals and welded components.

ULTRASONC GENERATOR

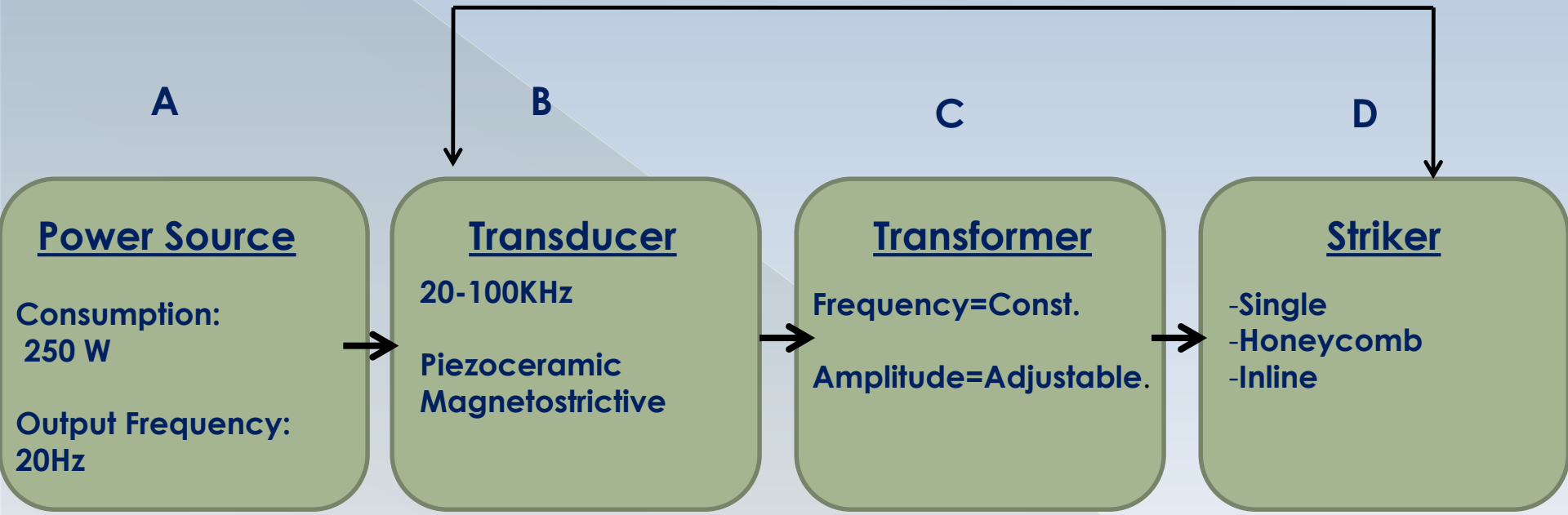
ULTRASONIC PEENING TOOL

A

B

C

D



Single and multi-strikers working heads.

Single

Single

Inline

Honeycomb

The Ultrasonic Peening Device

The Ultrasonic Peening device (total weight - 5 Kg) includes,

1. The hand tool (with a piezoelectric transducer) is easy to use. It has a number of different working heads designed for several industrial applications. The weight of the hand tool is 2.2 kg.

2.The Ultrasonic Generator has a power consumption of 250 W and an output frequency of 20 Hz. The weight of the

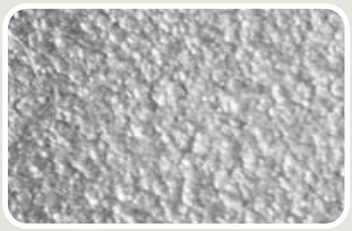
generator is 2.3 kg.

Comparison of post weld treatment

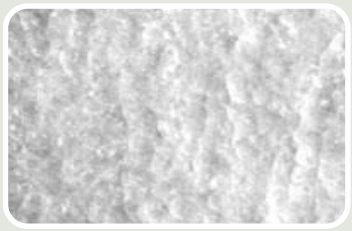
Ultrasonic Peening is an advanced technology that modifies the physical and metallurgical properties of the treated component. While some fatigue life improvement techniques relies on the change of the geometrical shape of the weld toe (grinding, TIG dressing, etc), others relies on the introduction of compressive residual stresses (hammer peening, spot heating, etc).The Ultrasonic Peening treatment achieves simultaneously the improvement of weld toe geometry and the deep introduction of beneficial compressive residual stresses, during the same work operation

TECHNIQUE / RESULT	GRINDING	SHOT PEENING	HAMMER/ NEEDLE PEENING	THERMAL STRESS RELIEF	TIG DRESSING (GTAW)	ULTRASONIC PEENING
Increase Fatigue Resistance.	*	*	*	*	*	*
Increase Corrosion Resistance.		*				*
Decrease Residual Deformation.			*	*		*
Decrease Residual Weld Stress.				*		*

Surface Treatment



Original surface of spring steel "as received" condition. Magnification 8x.



Surface of spring steel after treatment with the UP technique with "treatment A" conditions. Magnification 8x.

Surface of spring steel after treatment with the UP technique with "treatment B" conditions. Magnification 8x.

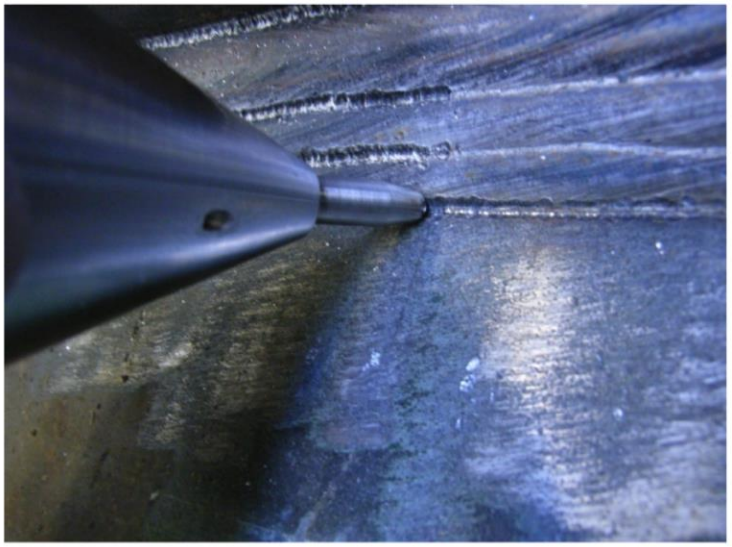
Surface Roughness Measurement Results:

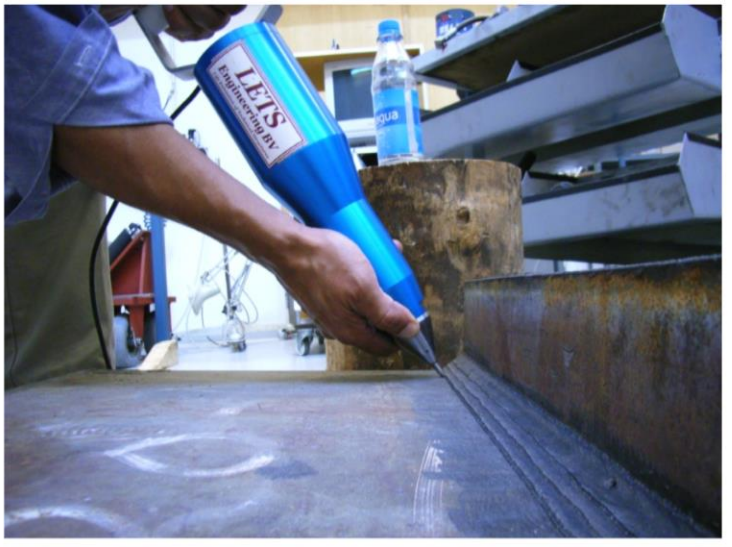
Surface roughness of material measured "as received" condition	Surface roughness of material measured after UP treatment for shorter time	Surface roughness of material measured after UP treatment for longer time
6.6 ± 2.1 Ra(μ)	4.4 ± 0.4 Ra(μ)	2.9 ± 0.3 Ra(μ)

Comparison Of UP Process VS PWHT

Ultrasonic Peening Process	Post Welded HeatTreatment (PWHT)
1. Reduction of tensile residual stresses. Introduction of compressive stresses.	1. Reduction of tensile residual stresses. Introduction of compressive stresses.
2. Improves breetle facture resistance of welded joints.	2. Improves brittle facture resistance of welded joints.
3. Improves the toughness of weld metal and heat affected zone.	3. Improves the toughness of weld metal and heat affected zone.
4. Useful for weld thickness up to 12 mm. For 40 mm thick weld the treatment could be applied after every weld pass.	4. Useful for highly stressed nodal welds greater than 40 mm thick and other welds greater than 50 mm thick.
5. Easy to apply due to the fact that UP equipment is small and/ or versatile even for places of difficult access.	5. Difficult to apply on welded structures.
6. Shorter time required for treatment, less energy used during treatment.	6. Longer time required for treatment, more energy used during treatment.
7. Treatment can be applied locally or partially.	7. Difficult to apply locally or partially.

Ultrasonic Peening Process	Post Welded Heat Treatment (PWHT)
8. Environment friendly due to saving of energy, no using of gas or other combustible.	8. Not Eco friendly because if emission of gases.
9. The equipment is cheaper.	9. The equipment is expensive.
10. It increases hardness by 10% and improved surface quality by 50%.	
11. UP treated services show reduced rate of near micro pitting fatigue process. This reduction of micro pitting is the main cause for the improved fatigue surface resistance	

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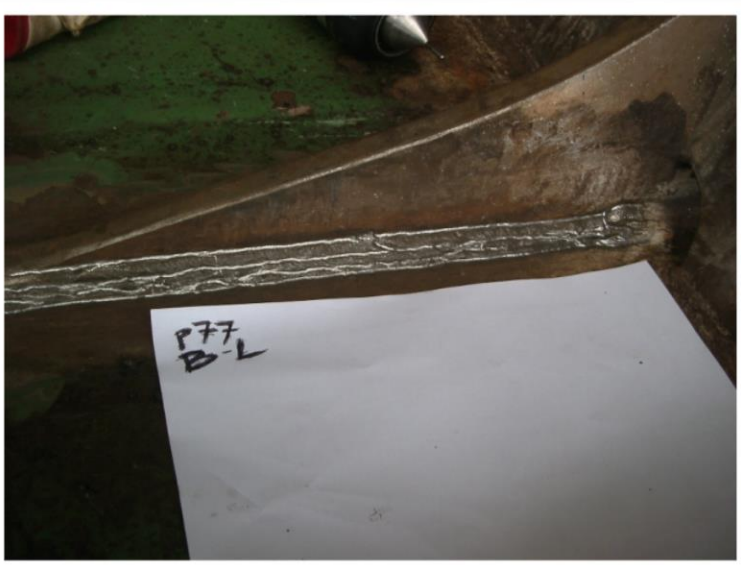
Engineering Pty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