Corrosive environments are known to cause the most damaging influence on the integrity and performance of many structural parts and components. Service failures under the influences of aggressive environments are generically termed as Environment induced failures (EIF). EIF continues to be the main source of service failures in modern high technology systems such as chemical and petrochemical plants, oil drilling rigs, pipelines, aircrafts, ships, power industries, reactors etc. Some of the specific mechanisms of EIF include hydrogen embrittlement, season cracking, liquid metal embrittlement, delayed failures, stress corrosion cracking (SCC), corrosion fatigue etc.

Among the various forms of EIF, SCC has received most attention because there is an ever increasing trend for more efficient utilization of materials by operating at higher stress level. However, from the industry point of view it is of significance to find a solution to the problem of EIF, rather than to achieve a thorough understanding of the problem. Nevertheless, an effective solution always lies with the complete understanding of the cracking process.

All corrosion related problems invariably begin at the outer surface where the hostile environments such as aqueous solution, gas or solid pollutants come in contact with the metal piece. At the interfacial regions between the metal surface and the environments various chemical, electrochemical reactions take place.
On the other hand, shot peening is primarily a surface treatment process which changes the surface conditions by a number of ways. Two major surface characteristics which are greatly affected by shot peening method are, namely residual stresses and the work hardening characteristics.

The present communication aims to focus on the current state of knowledge on the control of EIF by shot peening technology. No elaborate discussion will be made either on SCC or shot peening method. Only some results will be discussed to demonstrate the beneficial effects of shot peening in controlling the corrosion related failure problems. The discussion will be centered around the SCC, CF and intergranular fracture of stainless steel in chloride mediums.

**Austenitic stainless steel**

Two grades (AISI 304 and 316) of austenitic stainless were made into U-bend specimens with 0.25 mm thick plate and the SCC test was conducted in boiling 42 percent magnesium chloride solution. The samples were solution treated before tests. Time to initiate the crack under SCC and the time for complete fracture were monitored in both peened and unpeened conditions.

In unpeened U-bend samples the average time to cause initiation and complete fracture of the samples were around 30 minute and 120 minutes respectively. The nature of intergranular cracking (IGC) was investigated in both kinds of samples. In a large component, the region under peening showed no sign of IGC, while unpeened region exhibited attack and severe cracking at the grain boundaries. In this study, the effectiveness of shot peening method is observed for a wide range of shot peening conditions.

The other steels selected for discussion are

2) Welded stainless steel
3) Ferritic - Austenitic stainless steel
GENERALIZATION OF SHOT PEENING APPLICATIONS

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ABSTRACT

The knowledge is useless if it is intact in research labs and kept closed in books and journals. Every special thing, if it is useful for mankind should be made general. The Shot Peening is very useful process and treatment, it is beneficial in aviation and auto industry for cost reduction and material saving, it should be used very extensively and the knowhow must be made general to give it a wide acceptance and publicity.

Although most engineering designers are familiar with the term, many companies who employs shot peening keep its secrets shrouded in mystery. This makes it very difficult for designers to obtain sound, reliable and useful information upon which to base decisions on possible applications.

An interesting incident in USA shows how the shot peening can be generalized and publicized. A sport person purchased an ellsworth hand builds bike in the USA - and noticed that the company promoted that, its aluminium frame has been Shotpeened. He then purchased some handlebars, also shotpeened, and the pedal crank is shotpeened too. He was curious to know what is shotpeening and why it is so important to be featured in product details.

The company highlighted the very effect of shot peening that, parts are shot peened for increased fatigue life.

APPLICATIONS OF SHOT PEENING:

1. Aviation industry
2. Automotive industry  
3. Agricultural implements industry  
4. Nuclear field

Worldwide the Aviation Industry is booming.

A class room training is required to teach general peening knowhow, as also requested by boeing U.S.A.

- A training for auditors and inspectors.
- Application in the field of nuclear plants.
- Computer aided process planning and controlling.
- Online documentation and analysis of all significant peening parameters including shot velocity.
- Consultancy and customized solution for specific production requirements.

The most exotic application of shot peening is peen forming. This causes the metal sheet to develop a spherical curvature, convex on the peened side. By exercising rigid controls in this process, panels that cover the wings of most of the layer aircraft can be peened to exacting aerodynamics curves.

**SHOT PEENING FOR THE (MOST DEMANDING) AUTOMOTIVE INDUSTRY**

The requirements of the automotive industry are different compared to the ones coming from the aviation industry.

Shot peening has long been a solution to many problems, and has been successful on parts as large as pressure vessels and for assemblies measuring upto 4.25 m diameter.

At the other end of the scale are some of the most difficult parts to peen such as leaf springs and diagpharagms only 1.5 mm thick and also the springs used in computer hardware.
IT IS ESTIMATED THAT AVERAGE CAR WOULD WEIGHT ABOUT 130 KGS MORE WITHOUT PEENING

Since fuel consumption of cars is of increasing importance to sell cars and other vehicles, the automotive industry is trying to use all means to design lighter cars.

Shot peening is definitely one of the few technical solution which allows in increase of the fatigue life without adding weights. Depending on the application an increase of the fatigue life of upto 50 times have been reported.

THE VARIETY OF ITEMS THAT RECEIVE SHOTPEENING IS IMPRESSIVE

- Gears of all sizes and types
- Shafts
- Bearing surface
- Steam and gas turbine parts
- Aircraft undercarriage parts
- Helicopter prop drives and blades
- Compressors and high performance engine parts
- Pistons
- Crank shafts
- Valves and Blocks
- Springs of all types
- Tooth wheels shafts and transmission parts.

Practically every part on the compressor end of the jet engine, hot turbine end are peened, not only when new, but each time the engine is overhauled.

- improvements in fatigue strength by as much as 50% have been experiences with tractor engines crank shafts.
- conventional forged steel crankshafts can be replaced by less expensive nodular iron castings by shot peening the critical fillet radii of bearing journals.
in general, all high performance parts made of metal can certainly benefit from the effect of shot peening.

The internal peening of an engine shafts is a demanding application.

**SOME OTHER BENEFITS OF SHOT PEENING**

Some investigations have shown an increase of 100% in the fatigue life by virtue of shotpeening. (But only moderate increase in hardness).

Shot peening has another distinct advantage that is not only does it induce a residual compressive stress. But also increases the integrity of the surface by removing some imperfections.

Apart from the increase in fatigue strength, the U.T.S and elastic limit also increase.

**STRESS CORROSION CRACKING**

- Stress corrosion cracking is a problem in many industries.
- This has been peculiar to the aircraft designer
- Shot Peening is more effective than special coatings for protection against stress corrosion cracking. Because by virtue of shotpeening a compressive stress layer produces, the cold working of the component surface makes the atom on the surface more chemically active thus partially alleviating corrosion problems.

Also the cold working closes many of the micro-cracks and stops intercrystalline corrosion.

The entire process can be made very general by making very simple, easy to use and cheap type peening machine for general peening, as has already manufactured and developed by Dr. M.C.Sharma in his MACT Lab. This machine is being used by many researchers and
students. Induction symphonic type peening machine is considered to be more appropriate for peening agricultural machines parts particularly at lower intensities with related parameters. Since agricultural implements are generally failed due to fatigue, wear, impact and corrosion and therefore demand greater attention to the structural design aspects for durability and ensuring adequate fatigue life.

In India where the economy is agriculture based, and because of the social reason the implements have to be very effective and durable. Shot Peening as a manufacturing tool has been found to be very useful, alternate. For improving surface properties of metal parts and enhancing service life of components and parts.

REFERENCES

- Research papers of Prof. IIDA, Meiji University, Higashimita Tama, Kawasaki, Japan.
- Research papers of Dr.M.C.Sharma, Mechanical Engineering, MACT, Bhopal about the induction symphonic type machine : ICSP - 1 and ICSP & BC - 1.
- Various issues of "The Shot Peener" an International newsletter for shot penning industry - by "Electronics incorporated" Mishawaka U.S.A.
- Various issues of "MFN" - By Metal Finishing News : Zurich, Switzerland.
- Ron John of Vacu - Blast Ltd.