Wear Behaviour of Nickel Chromium And Zinc Thin Sheets In EN8 Steel By Plating Technique

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Abstract- *Commonly electroplating is used to modify the surface of engineering materials to improve the mechanical properties such as hardness, wear and corrosion resistance to meet the functional requirements of the products in industries. Water-processing in the plating process, which improves the efficiency of the plating process, has also shown few researchers the disruption effect of decarburisation on the mechanical properties of the coating. The residual stress in large deposits is a major and limiting issue because of the existence of the playing cycle. It follows that precise control of these phenomena is essential, if a thick deposit is to be plated. To overcome this metal electro plating technique is employed with Nickel and chromium is plated on the substrate of material to improve the abrasive wear resistance. The research included an analysis of the effect of applying the combustion process on the wear properties of the resulting coating on electroplating thin sheets of chromium and nickel over ASTM EN8 steel substrata during the process. Ion implantation layer thickness ranges from nano to micrometer. Here carburization is introduced on the substrate before plating to compensate the loss of carbon during spraying due to this there will be increase in the wear resistance and increase in the efficiency of the steel, An investigation on the wear behavior before and after the coating with material Nickel,Chromium and Zinc is carried out. The surface of the treated coating is examined by Hardness, Wear and corrosion tests.*

Keywords- Electroplating, Salt Spray, Decarburization, Nickel, Chromium, Zinc

I. INTRODUCTION

1.1 SURFACE ENGINEERING

Surface technology can be defined as the branch of science dealing with methods for meeting necessary surface needs and their operating behavior for components of engineering. In different situations, in hostile environments engineering components must perform those functions fully and effectively.

One goal of surface engineering is to increase the functionality of an existing product. New coatings and processes can also create prospects for previously unlikely new products. For example, without the implementation of advanced surface engineering technics, satellites can not work and modern power plants can not function safely. Typically, an engineering component fails if the external forces or atmosphere to which it is subject can not adequately withstand its surface. The choice of a surface material with the appropriate thermal, optical, magnetic and electrical properties and sufficient resistance to wear, corrosion and degradation, is crucial to its fuctionality. Often only surface requirements will restrict technical advancement and production performance. For example, gas turbines or diesel engines' fuel efficiency and power output are restricted by their ability to stand up to high temperatures. But producing components out of a bulk material simply for its superficial properties is always wasteful, costly or non-economic-much better to use a cheaper formulated underlying material and to cover the material with the correct high-performance film. The resulting product preserves limited material resources, performs better than the original and will possibly be less costly to produce.

1.2. STEEL

Steel, an iron alloy, is also used for other materials, mostly carbon because of its high tensile strength and low expensiveness in building and other applications. Basic metal iron, depending upon its temperature, can take two crystalline forms, body-centered cubic and face-centered cubic. It is their interaction with the allotropes, primarily carbon, that provides a range of unique properties for steel and cast iron. An additional iron atom is in the middle of the cube centered on the body, and one on each of the six faces of the cube is in the middle of the face centered cube Carbon, other elements and iron inclusions serve as hardenants that prevent dislocation from moving elsewhere inside the iron crystal grids.

Steels are broadly classified into low-carbon steels (< 0,30%), medium-carbon steels (0,30% –0,60% carbon dioxide) and high-carbon steels (0.60% –1.5% carbon dioxide content). These numbers that seem small, but they reflect the fact that carbon is a tiny, light element, whereas iron is a substantially larger and heavier atom. The metallurgists are concerned with the presence, and particularly the form, of the Fe3C Carbide when looking at the composition of the complex steel. The carbon will make up 2.1% of its weight in standard steel alloys. Variating the amount of alloying materials, such as solvent or precipitated phases in the steel, slows the movement and thus influences the properties of iron that is comparatively ductile or heavy, such as the stiffness, ductility and the tensile strength of steel resultant. Steel strength is only possible compared with pure iron, to the detriment of the iron ductility that iron has an excess. Steel WCBA216 is widely used material with 0.30 percent carbon content used at high pressures and temperatures.. These materials are moderately wear-resistant but also prone to wear-assisted corrosion that eliminates the passive layer in specific regions these materials

1.3 EN8 STEEL

EN8 Steel is one of the most significant material solutions for the variety of rounds of black carbon and alloy steel, as well as our bright round carbon and alloy rounds, available here in Parkside Steel. A good tensile strength in this unalloyed medium carbon steel category, which has been ideal for general engineering applications such as stubs, ties, shafts, screws, rollers and connecting rods.

In EN8 steel, the best uses are those which require superior characteristics than mild steel but can not fairly be justified with the additional cost of alloy steel. This steel-also named 080M40 or 080A42-has a chemically-based composition of carbon, silicon, manganese, sulfur and phosphorus.

Use Parkside Steel for 080M40 EN8 stainless steel rounds and gain from an wide diameter range-from 1/4 "to 300 mm. These processing rounds fall in line with those found elsewhere in the UK with parts which can be cut to size by us quickly, reliably and cost-effectively, whether in individual parts or thousands of lots.

EN8 is a medium carbon steel that is typically used for the manufacture of axles, axles, shafts, gears, and bolts. EN8 is very fast to program. Mild steel is the cheapest and most widely used type of steel. Soft steel, even though it rustles, is welded, very tough and very strong. The small amount of carbon range 0.16 to 0.3 percent. Mild steel is less flexible and can be flexed to prevent breakage. Carbon steel contains more carbon, which can be hardened and tempered up to 2%.

1.4 EN8 STEEL PROPERTIES

In the normalised or heat-treated order (quenched and templed with the properties "Q" or "R" in order to restrict ruling secctions until 63 mm) EN8 is normally supplied unregulated but can be provided, which is ideal for a wide number of applications. See our Comparisons selection guide. EN8 is a very common grade of medium carbon steel which can be easily machined in any condition. (This is our guide to machinability). EN8 is suitable for the manufacture of parts such as axles and shafts for general use, gears and bolts. This can usually be additionally surface-resistant to 50-55 HRC by induction and produces wear-resistant components.. Usage of EN8D (080A42) is recommended for these applications. EN8 M (212A42) EN8 in his thermal forms has strong homogenous metallurgical structures, which have clear machining characteristics and are also available in a free-formed version.Good heat treatment results on sections larger than 63mm may still be achievable, but it should be noted that a fall-off in mechanical properties would be apparent approaching the centre of the bar.It is therefore recommended that larger sizes of EN8 are supplied in the untreated condition, and that any heat treatment is carried out after initial stock removal. This should achieve better mechanical properties towards the core.

1.5 CHEMICAL COMPOSITION

Carbon	*0.36-0.44%*
Silicon	*0.10-0.40%*
Manganese	*0.60-1.00%*
Sulphur	*0.050 Max*
Phosphorus	*0.050 Max*
Chromium	-
Molybdenum	-
Nickel	-

1.6 INTRODUCTION TO CHROME PLATING

Chrome plating (less commonly chromium plating), often referred to simply as chrome, is a technique of electroplating a thin layer of chromium onto a metal object. The chromed layer can be decorative, provide corrosion resistance, ease cleaning procedures, or increase surface hardness. Sometimes, a less expensive imitator of chrome may be used for aesthetic purposes.

Chrome plating a Component involves usually such stage:

- Degreasing for removal of heavy soil
- Manual cleaning to remove any remaining traces of dirt and surface impurities
- Different pretreats depending on a substrate
- Put into the chromium plate tank where solution temperature is enabled to warm up.

Depending on the type of substratum being plated, there are several variations in this process. Various media require a number of etching solutions, including hydrochloric, hydrofluoric, and sulphuric acids. The etching of nimonic alloys is also common with Ferric chloride. Often, during electrical live, the part is in the chrome frame. The part can be made of platinized titanium or anode conforming to it. A regular hard chrome vat plate is approximately 1 mil (25 μm) an hour.

1.7 INTRODUCTION TO NICKEL PLATING

Electric nickel plating is a treatment type of alloy designed to improve metal or plastic resistance and hardness. The electroless method of plating with nickel is simpler than its counterpart. To start the placing process, an electric stream does not need to be passed through the chemical bath solution. Rather, the metal surface undergoes a sequence of purification and auto-catalytic reactions, perfected by Electro-Coatings.

II. EXPERIMENTAL DETAILS

2.1 PLATING PROCESS ON MEDIUM CARBON STEEL PLATE

Steel is usually considered to be carbon steel if no minimum alloy content is defined (such as aluminum, chromium, nickel, molybdenum, vanadium, etc.) or other elements added to achieve the alloy impact. Manganese is not more than 1,65%, and copper is no longer below 0,40% or above 0,60%, and silicon is no greater than 0,60%. The Alro contains the most commonly used mild / hot-rolled steel in sheets and tubes, ASTM A-36, carbon hot-rolling steel.Carbon levels are divided as follows:

Low carbon = 0.06% to 0.25% carbon content = .25% to 0.55% carbon content = > .55% to 1.00% Figure 2.1 Heat Treament Processcarbon content, hard stain. In the following classes, carbon grades are available: 10XX = unresulpherized CO_2 steel, with manganese maximum content of 1,00% (for example 1018, 1045 and 1050).11XX = carbon resulting steel (e.g. 1117, 1141 and 1144).12XX = carbon recovered and tests (e.g. 12L14 and 1215).

2.2 HEAT TREATMENT

Effect on material structure and grain of heat treatment method. In order to enhance mechanical properties such as tensile and yield strength, heat can be used for the most carbon steels and carbon alloy steels. The heat treatment basically improves the micro-structure of the steel.

2.3 HARDENING

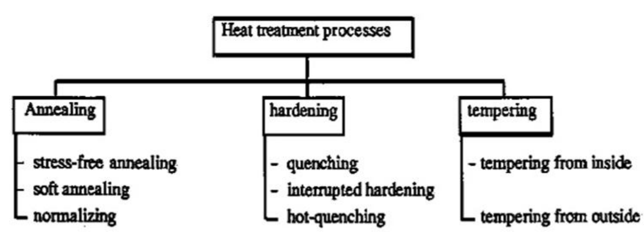
A ferrous metal is usually hardened to a certain temperature by heating a metal and then cooling it rapidly by dipping the hot metal into an oil, water or brine quenching medium. In order to harden them, most stones must be quickly cooled. The hardening process increases the hardness, strength and fragility of metal.

2.4 TEMPERING

Steel is usually harder than necessary and, after hardening, too brittle for practical use. During rapid metal cooling, severe internal stresses are created. Steel is tempered to reduce internal tension and its fragility after hardening. Tempering involves heating the metal to a given temperature and then allowing the metal to cool down. During tempering the cooling rate normally has little impact on the metal structure. The metal is therefore usually allowed to cool down in still air. Normally, the temperature used for tempering is much lower than the temperature used for hardening.

2.5 ANNEALING

Steel is typically more difficult than required and too brittle for use after hardening. Extreme internal stresses are generated during fast metal cooling. Steel is tempered after hardening to reduce internal stress and fragility. Tempering means that the metal is heated to a certain temperature and then the metal is cooled. When the cooling rate is tempered, the metal structure usually has little effect. Therefore, the metal will normally refresh in still air. The temperature used to cool is typically much lower than that used to harden.



2.6 NORMALIZING

In the process of machining, forging, or welding, iron metals are refined to relieve internal stresses. Standard steels are tougher than annealed stones and heavier. In a standardized state steel is much harder than in any other setting. Parts that are subject to impact and parts which require maximum durability and resistance are generally standardized against external stresses. Until hardening, normalization is desirable for the desired hardness such that the hardening process is carried out correctly. Low carbon steel generally does not need standardization but does not have any damaging impact if these steels are standardized.

2.7 CASE HARDENING

Case hardening is a good heat treatment for parts that need a wear-resistant coating, a hard core, for example, gears, cams, belts, etc. Carburelling and nitriding are the most common case hardening methods. A low-carbon (either straight carbon or low carbon steel) steel is heated to a defined temperature during the case-hardening process in the presence of a material (solid, liquid, or gas) which decomposes the surface of a steel and stores more carbon. After that, the outer surface or case becomes difficult when the component is cooled quickly, making it soft, but still strong, inside the piece.

2.8 ANNEALING

It is possible to anneal most nonferrous metals. The rinding cycle consists of the metal radiator, soaking and cooling at the room temperature at a particular temperature. The cooling process and temperature differ by metal form. Reinforcement is also carried out during numerous cold operations as a result of the cold processing of several nonferrous metals. Annealing is also used to eliminate the effects of heat treatment solutions to improve machining or working performance.

2.9 SOLUTION HEAT TREATMENT

Many non-ferrous alloys are able to increase their tensile strength by taking the materials in the alloy to a solid solution and then regulating the rate of return to a modified mehanal mixture. The process is known as heat treatment solution. When an alloy is heated to a certain temperature, it is easily "quenched" or cooled that traps the solid solution content obtained during the heating process. The method differs greatly according to the metal from this point onwards. A phase of aging or precipitation hardening will occur if the materials in the alloy do not return to original shape after a period of time.

2.10 ELECTRO PLATING PROCESS

The electroplating is an art of electrolysis which is used to deposit superior or more noble metal on a base metal.For example, metals like iron are electroplated to protect against corrosion with nickel or chromium deposits. Frames and sections of machines are mostly chromium-plated to protect against corrosion thus giving them a good look.

2.11 ELECTROPLATING PROCESS STEPS

The material to be electroplated in an electroplating phase is formed into a salt solution of the coating metal with a cathode (i. e. linked to the negative DC source terminal).The current flowing through the electrolyte starts when the DC supply is applied to the two electrodes. The metal ions are going to and deposited in the paper. The demand for voltage is typically only low in the range of 1-16 volts.

Figure 2.12 EN 8 steel machined sample

Figure 2.13 EN 8 steel

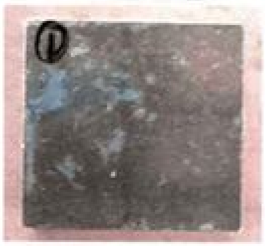


Figure 2.14 Plated samples (a) Nickel

Figure 2.15 Plated samples Chromium

Figure 2.16 Plated samples Zinc

III. PROBLEM IDENTIFICATION

3.1 PROBLEM DEFINITION

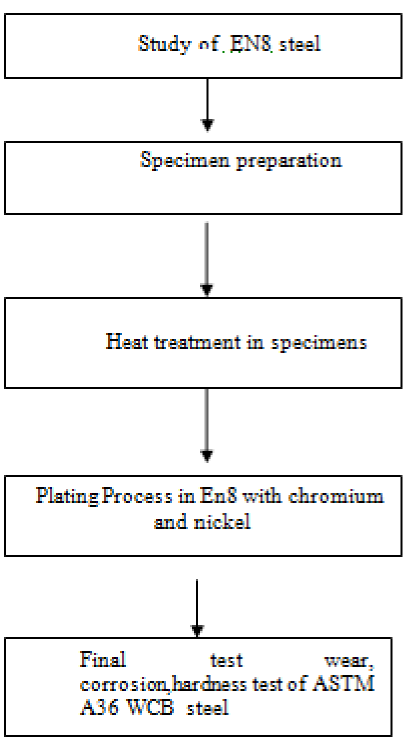
The EN8 steel is commonly employed in medium carbon steel in heavy industrial applications such as valves and tube connections. However, corrosion material loss reduces the material's performance and lifespan. This resistance to wear and efficiency in low carbon steel were not successful.

3.2 PROBLEM STATEMENT:

Steel plates with chromium and nickel thickness of 0.2 mm are used to enhance adhesivity and hardness.

To harden the material when plated in steel so that corrosion rate is reduced and wear resistance improved.

IV. METHODOLOGY



V. RESULTS AND DISCUSSIONS

5.1 CORROSION TEST

The salt spray test is a standardized, common method for testing the materials and surface coating resistance to corrosion. The materials to be tested are usually metallized (even though stones, ceramics and polymers may be tested) and finished with a surface layer designed to ensure the underlying metal is protected from corrosion. Salt spray test is an accelerated corrosion test, resulting in a corrosive assault on coated materials, in order to assess the suitability of the coating for use as a protective finish (mostly comparatively). In a fixed time frame, the presence of a corrosion substance (rust or other oxides) is evaluated. Test time is based on the corrosion resistance of the coating; in general, the longer the test period until corrosion / rust occurs, the more the corrosion resistant the coating is. One of the longest-standing corrosion tests is the salt spray test. The first widely recognised standard for salt spray Fig 5.1 Nickel Test Samplewas ASTM B117, first published in 1939. ISO9227, JIS Z 2371 and ASTM G85 are other relevant standards.

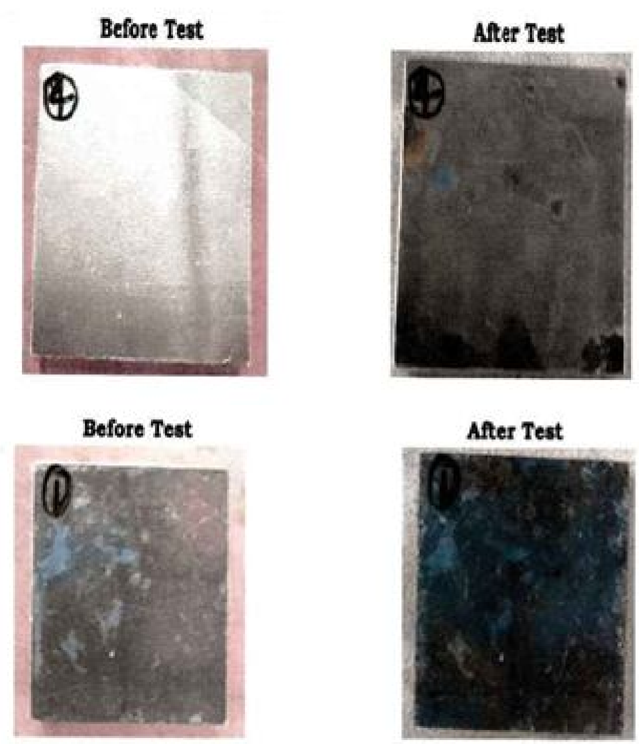


Figure 5.1 Chromium sample

5.2 CORROSION TEST PARAMETERS

The salt spray system has been used for 24 hours with the correct conditions for corrosion monitoring. Red and white spots have been noticed through observation. Red rust is visible in the chromium sample. It is clear. No defects are found in the sample of nickel.

5.3 ROCKWELL HARDNESS TEST

The Rockwell is a hardness measure based on the hardness of a material's indentation. The Rockwell check, which tests the depth of penetration of the indenter under large loads (major loads) as compared with the penetration produced through the preload (lower load). The resulting number is a dimensional number, indicated by the following Rockwell scale as HRA, HRB, HRC and so on. Durity of indentation correlates with tensile strength when metals are examined. The Rockwell hardness of a material is determined by applying a small load, followed by a large load. The minor load establishes the zero position. The major load is applied, then removed while still maintaining the minor load. The depth of penetration from the zero datum is measured from a dial, on which a harder material gives a higher number. That is, the penetration depth and hardness are inversely proportional. The chief advantage of Rockwell hardness is its ability to display hardness values directly, thus obviating tedious calculations involved in other hardness measurement techniques. Hardness is a characteristic of a material, not a fundamental physical property. It is defined as the resistance to indentation, and it is determined by measuring the permanent depth of the indentation. Simply put, the less indentation the more difficult the material is to apply a defined force (load) and a given indenter.

5.4 ROCKWELL HARDNESS TEST

Load on indenter (kg): 100 kg
Diameter of indenter(mm): 2.5mm

Table 6.2 Rockwell Test observed values

OBSERVED HARDNESS VALUES						*AVERAGE VALUES*
EN8 STEEL	*68.1*	*68.2*	*62.5*	*65.5*	*67.1*	*66.28*
NICKEL	*82.1*	*83.2*	*84.5*	*83.2*	*82.9*	*83.18*
CHROMIUM	*78.3*	*77.9*	*80.1*	*79.9*	*78.9*	*79.02*
ZINC	*77.1*	*75.2*	*82.1*	*78.2*	*78.1*	*78.14*

5.5 WEAR EXAMINATION

Material Specification

Dimension = 50mm x 30mm
Length = 50mm
PIN-ON-DISC TEST

The pin was placed on the opposite side of a turning disc with a square wear pattern of 12 to12 mm (ES31 Steel Disk). A dead weight loading mechanism loaded the pin against the disks. The wear test was performed for all specimens with standard 50N load and a velocity of 150 rpm. In similar conditions as described above, wear tests have been performed for a total sliding distance of approximately 3000 m. The samples had a length of 50 mm. For tribological characterisation pin-on-disk testing method was employed.Therefore, the pin surface has initially been made smooth, so that it supports the whole cross-section called first stage charging. This has been achieved by using emery paper (80 grams) on the surfaces of the pin sample floor before checking the technique Run-in-wear in the next stage/ second stage. In this point, the friction and wear curves escape initial turbulent time.

Figure 5.5 Pin On Disc Setup

The current test called constant / state wear is the final phase / third level. This stage is the complex rivalry between the processes of transmission of material (transfer of material from pin to disk and the creation and removal of wear debris).

Table 5.1.1 Specifications of Pin & Disc Tribometer

Specifications of pin on disc Tribometer	*MAKE: Ducom Ltd, Bangalore.*
Pin Size	*3 to 12 mm diagonal*
Disc Size	*165 mm dia. X 8 mm thick*
Wear Track Diameter (Mean)	*10 mm to 160 mm*
Sliding Speed Range	*0.26 m/sec. to 10 m/sec.*
Disc Rotation Speed	*100-2000 RPM*
Normal Load	*200 N Maximum*
Friction Force	*0-200 N, digital readout, recorder output*
Wear Measurement Range	*4 mm, digital readout, and recorder output*
Power	*230 V, 15A, 1 Phase, 50 Hz*

	Time in Minutes	Frictional force (N)	Coefficient of friction	Wear in Microns
EN8 STEEL	0	3.34	0.133	38.37
	5	3.83	0.153	115.53
	10	3.80	0.152	211.83
	15	3.70	0.148	306.79
	20	3.68	0.147	401.62
	25	3.68	0.147	498.45
	30	3.65	0.146	591.20

Table 5.1.2 Test results for Chromium

Time in Minutes	Frictional force (N)	Coefficient of friction	Wear in Microns
0	3.32	0.133	18.37
5	3.73	0.123	85.53
10	3.77	0.122	161.83
15	3.72	0.128	186.79
20	3.58	0.122	201.62
25	3.61	0.137	288.45
30	3.62	0.136	301.20

SALT SPRAY TEST AS PER ASTM B117-19			
SL.NO	TEST CONDITION	REQUIREMENTS	ACTUAL
1	Chamber Temperature	35+2°C	34.3 – 35.6 °C
2	pH of solution	6.5 to 7.2	6.3
3	Air Pressure	12 to 18psi	15psi
4	Concentration of sodium chloride	5%	5.0%
5	Collection of solution Per Hour	1 to 2 ml	1.2 ml
	Test Hours	24hrs	24hrs

VI. CONCLUSION

The detailed literature survey revealed the existence of a research gap related to addressing of the effects of corrosion of medium carbon steel during high temperature application. The research work conducted under this background with an aim of improving the corrosion properties of the resultant coating through the introduction of high temperature application scope to bridge the research gap. In this research work, coating of on EN8 steel through Plating process was undertaken for the study of corrosion properties. Analysis is made after plating process. Microstructure by Corrosion test , Hardness test and Wear Test is analysed.

- In corrosion test spots was clearly observed ,no corrosion is observed in Nickel sample i.e no red and white spots is observed. In chromium and zinc Plates only red spot is observed. By comparing Nickel sheets are well suited for EN8 steel plating.
- Rockwell Hardness test for EN8 Steel ,Nickel Plated,Chromium Plated and zinc palted was taken, by comparing the results hardness for Nickel plated sample is increased than chromium and zinc.
- Wear test is taken for EN8 Steel ,Nickel Plated,Chromium Plated and zinc palted was taken, by comparing the results wear on Nickel plated sample is less, then the chromium and zinc.

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