International Research Journal in Global Engineering and Sciences. (IRJGES)
ISSN : 2456-172X | Vol. 4, No. 2, June-Aug 2019
Pages 166-176 | Cosmos Impact Factor (Germany): 5.195
Received: 02.08.2019 Published:28.08.2019

ANALYSIS OF SURFACE PREPARATION IN EN8 STEEL MATERIALS BY USING COATING METHODS

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Abstract

In this present paper thermal spray surface modification technique has been used to enhance the corrosion resistances of EN8 steel substrate. After an exhaustive literature survey alloy powder Al_2O_3, TiO_2 have been selected to deposit on the substrate steel specimen with help of thermal spray techniques. The corrosion resistance of the coated and uncoated specimens was investigated according to ASTM standard AISI1040. An aim of the present study is to analyze of various coating powder like aluminium oxide, Titanium oxide and zirconium are used to compare the better coating thickness range by using ANSYS software. It can be designed using CATIA software and imported the model to ANSYS work bench software. From the result it can be choosing the better coating powder on the EN8 steel to be investigated in this project. It has been concluded that the alloy powder deposited with the help of thermal spray coating process have been found very useful to minimize the corrosion problem of carbon steels.

Keywords: Thermal spray coating, plasma spray, hardness and corrosion resistances.

1. INTRODUCTION

It is an unalloyed medium carbon steel. EN8 is a medium strength steel, good tensile strength, its suitable for automobile components likes shaft, stressed pin, studs, keys etc. EN8 is a very popular grade of through hardening medium carbon steel, which is readily machinable in any condition. Wear, friction and corrosion resistances are responsible for many problem and large costs in a modern civilization and engineers and designers always must take these factors into account when constructing different equipments [1]. It can be further surface- hardened typically to 50-55 HRC by induction processes components with enhanced corrosion resistances. For such application the

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use of EN8D (080A42) is advisable. It is also available in a free-machining version, EN8 (212A42) in its heat treated forms possesses good homogenous metallurgical structure, giving consistent machining properties. Functionally graded materials are of widespread interest because of their superior properties such as corrosion, erosion and oxidation resistance, high hardness, chemical and thermal stability at cryogenic and high temperatures. These properties make them useful for many applications, including Thermal Spray Coating techniques on metallic substrates used at high temperatures in the fields of aircraft and aerospace, especially for thermal protection of components in gas turbines and diesel engine [2]. Thermal Spray coatings have been successfully applied to the internal combustion engine, in particular the combustion chamber in order to simulate adiabatic changes.

In this paper, the main emphasis is placed on the study of thermal behavior of functionally graded coatings obtained by means of using a commercial code, ANSYS on aluminum and steel surfaces and the results are verified with numerical and experimental works [3]. In metallurgy, stainless steel, also known as inox steel or inox from French "inoxydable", is a steel alloy with a minimum of 10.5% chromium content by mass. Stainless steel does not readily corrode, rust or stain with water as ordinary steel does. However, it is not fully stain-proof in low-oxygen, high-salinity, or poor air-circulation environments. There are different grades and surface finishes of stainless steel to suit the environment the alloy must endure [4]. Stainless steel is used where both the properties of steel and corrosion resistance are required.

1.1 Method to Reduce Corrosion Resistances

Although corrosion cannot be eliminated completely, yet it can be reduced to some extent.

Few of such methods are stated below:

1. Better Material
2. Lubrication
3. Contact pressure
4. Temperature
5. Environment
6. Maintenances
7. Coatings

Based upon the above said techniques to reduce the corrosion problem in machinery parts, coating is preventive method and optimum technique, which is mostly used in practical field of application.

2. COATING TECHNIQUE

A coating can be defined as a layer of material, formed naturally or synthetically or deposited artificially on the surface of an object made of another material, with an aim of obtaining required technical or decorative properties. If a material is added or deposited onto the surface of another material (or the same material), it is known as a coating. Coatings are frequently applied to the surface of materials to serve one or more of the following purposes:

A. Thermal Spray Coatings

Thermal spraying was first discovered and used in the beginning of last century and research in this field progressed ever since. The recognized beginning of Thermal Spraying is believed to be in 1911 in a flame spray process that was developed by Dr. Max Schoop from Switzerland. Other major thermal spray processes include wire spraying detonation gun deposition, plasma spray, and high velocity oxygen Fuel.

B. Plasma Spray Coating Process

Thermal spray is a generic term for a group of processes that utilize a heat source to melt material in powder, wire or rod form. The molten or semi-molten material is propelled toward a prepared surface by expanding process gases [5]. The particles quench rapidly, upon impact with the surface, and bond with the part. Subsequent impacting particles create a coating buildup. Thermal spray processes include, Plasma spray is the most versatile of the all the thermal spray processes. Plasma spray coatings can be employed on all materials considered spray able. The materials capable of being thermal sprayed are almost limitless, making thermal spray coating technologies extremely powerful in providing engineering and design solutions for protecting components and enhancing their performance.

3. PROBLEM IDENTIFICATION

Form the literature review its clear that the wear behavior is the main problem associated with the cast iron and in steel material in many applications. It can be used as an alternative to cast iron

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because of its higher strength, hardness and high corrosion resistance capacity, by using coating method to improve mechanical properties but the only restricting factor is its corrosion behavior. From the literature review we also noted that the coating will increase its corrosion behavior and hardness of steel than cast iron material than heat treatment process. So in this work had chosen the coating method is improving the surface behavior of EN8 steel. The aim of applying coatings is to improve surface properties of a bulk material usually referred to as a substrate. One can improve appearance, adhesion, wet ability, corrosion resistance, wear resistance, and scratch resistance.

4. EXPERIMENTAL OVERVIEW

4.1 selection of the substrate material

Selection of the substrate material for the present study has been made on the basis chemical analysis. The above chemical composition meets the requirement of BS 970grade EN8.

Element	Specified value	Observed value
Carbon	0.35 - 0.45	0.416
Silicon	0.05 - 0.35	0.219
Manganese	0.60 - 1.00	0.911
Sulphur	0.060 max	0.027
Phosphorus	0.060 max	0.009

4.2 Finite Element Analysis

The physical problem is idealized as a mathematical model using certain assumptions, which together leads to differential equations governing the mathematical model. The finite element analysis solves this mathematical model. In brief the basis of finite element analysis is the representation of the body or structure by an assembly of subdivisions called finite elements. These elements are considered as interconnected at the joints, which are called nodes or nodal points. The finite element method is a numerical analysis technique for obtaining approximate. Solution to be used a wide range of engineering problem.

4.3 Performing of Static Analysis

The procedure for a static analysis consists of these tasks:

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Build the Model

Set Solution Controls

Set Additional Solution Options

Apply the Loads

Solve the Analysis

Review the Results.

4.4 Material Properties

1. Gray cast iron

Density: 7200kg/m^{-3}

Young's modulus: 110Gpa

Poission ratio: 0.28

Isotopic thermal conductivity: 47 W/m K

Thermal co-efficient: 5.8e^{-6} W/m K

2. EN8 Steel

Density: 7800kg/m^{-3}

Young's modulus: 190Gpa

Poission ratio: 0.3

Isotopic thermal conductivity: 37.5 W/m K

Thermal co-efficient: 6.5e^{-6} W/m K

3. Alumina

Density: 3720kg/m^{-3}

Young's modulus: 300Gpa

Poission ratio: 0.21

Isotopic thermal conductivity: 40 W/m K

4. Titania

Density: 4430kg/m^{-3}

Young's modulus: 110Gpa

Poission ratio: 0.32

Isotopic thermal conductivity: 13 W/m K

5. Zirconia

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Density: 6050kg/m^{-3}

Young's modulus: 205Gpa

Poission ratio: 0.3

Isotopic thermal conductivity: 145 W/m K.

4. ANSYS FOR COATED AND UNCOATED MATERIALS

Without coated (Structure analysis for C.I)

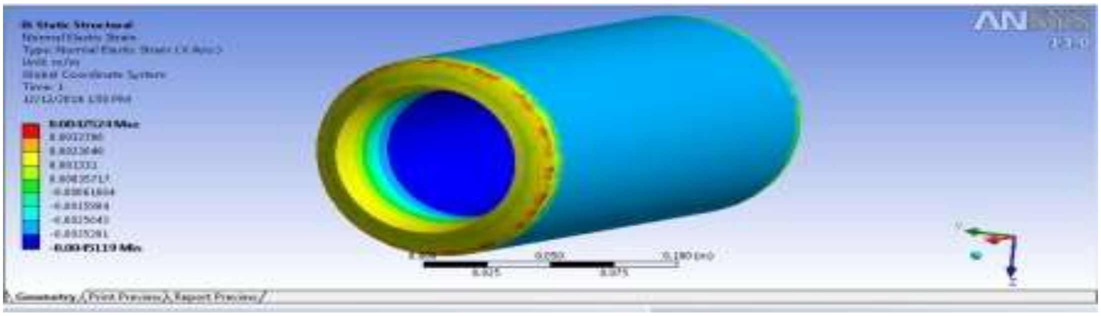

Fig 5.1 Normal Strain

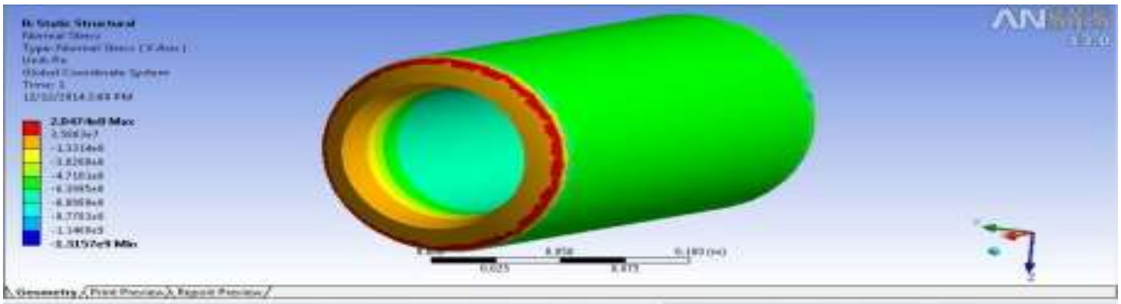

Fig 5.2 Normal Stress

Without coated thermal analysis for C.I

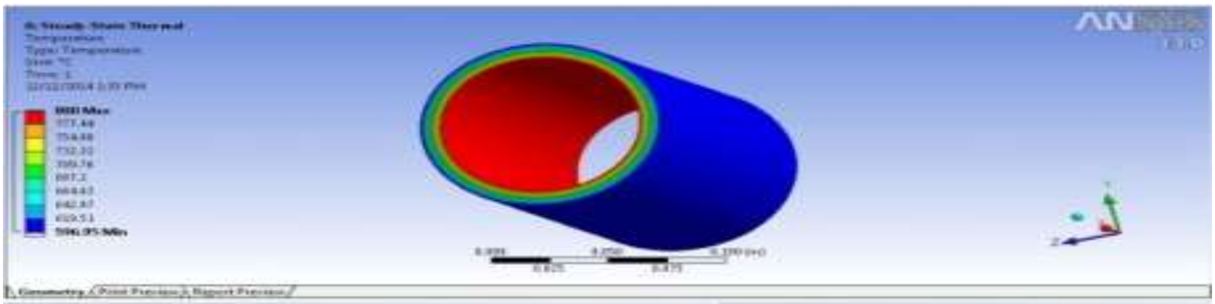

Fig 5.3 Temperature

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Without coated structure analysis for EN8

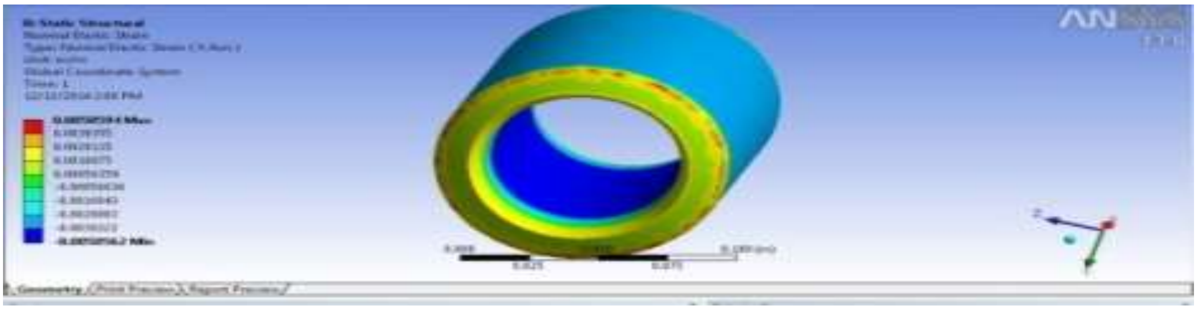

Fig 5.4 Normal Strain

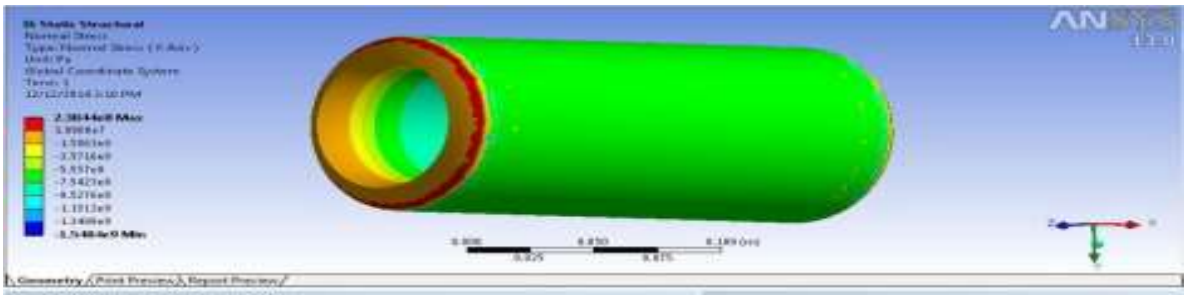

Fig 5.5 Normal Stress

Without coated thermal analysis for EN8

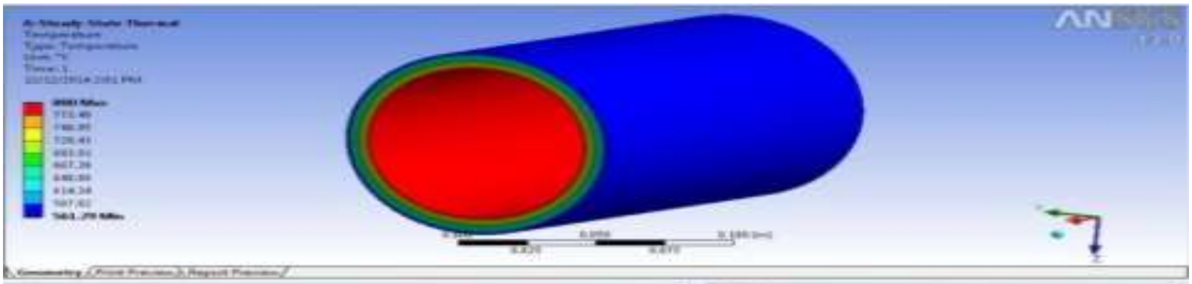

Fig 5.6 Temperature

With Coated (Structure Analysis Titania)

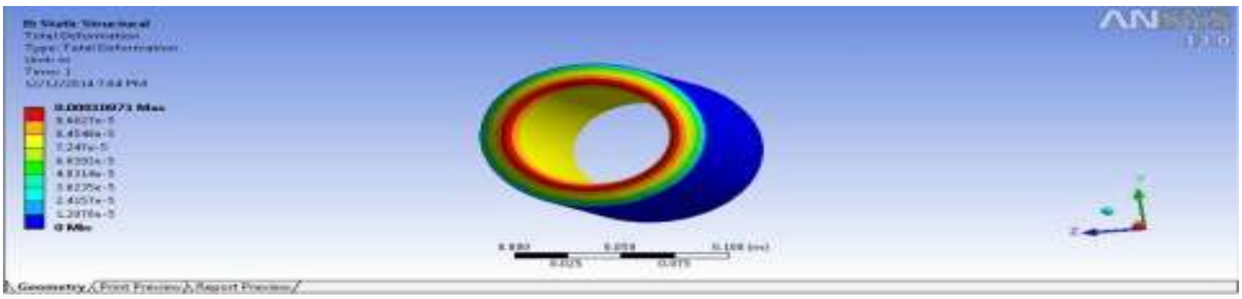

Fig 5.7 Deformation

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Thermal Analysis Titania

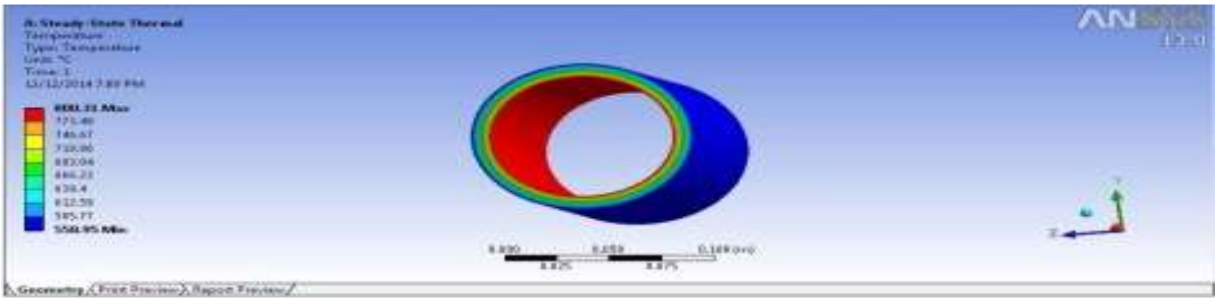

Fig 5.8 Temperature

Structure Analysis Alumina

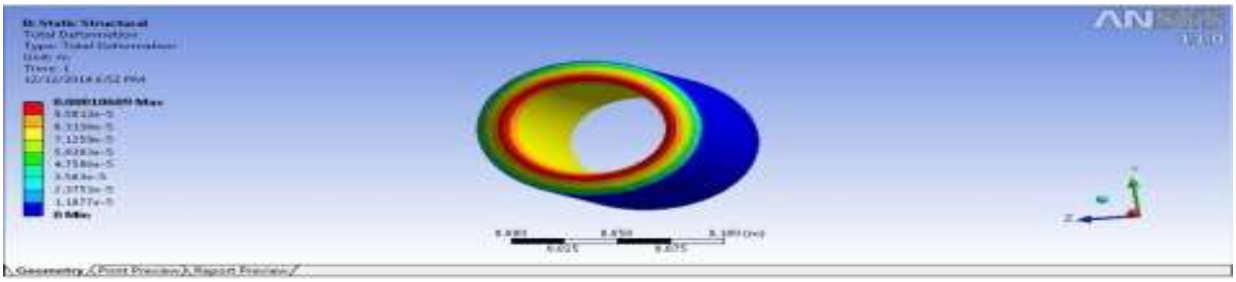

Fig 5.9 Total Deformation

Thermal Analysis Alumina

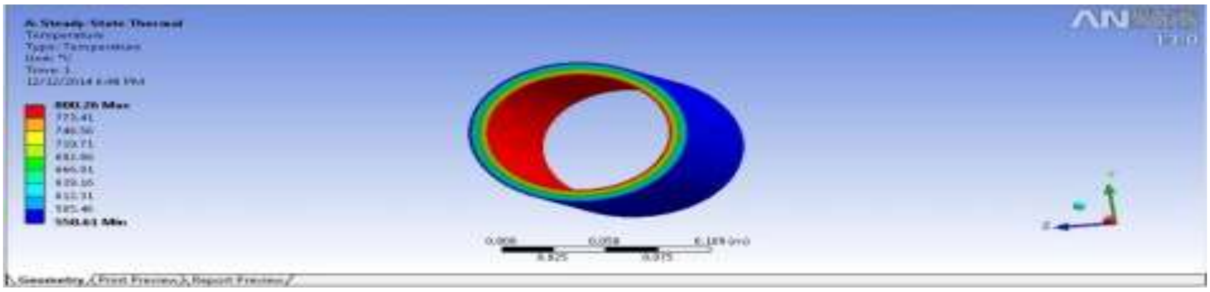

Fig 5.10 Temperature

Structure Analysis Zirconia

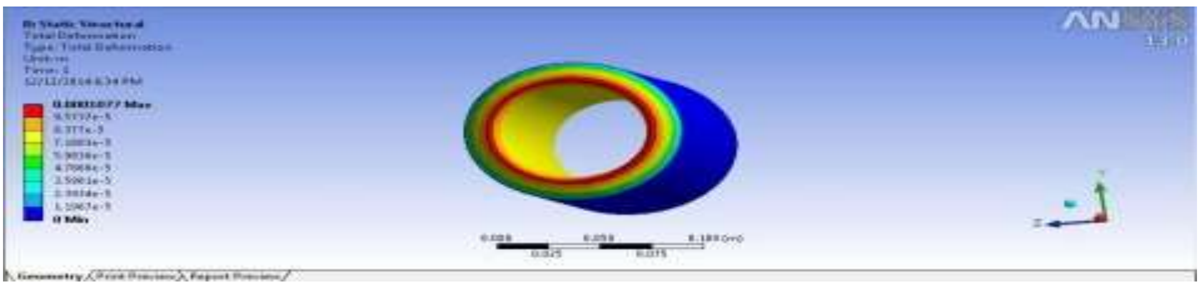

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Fig 5.11 Total Deformation

Thermal Analysis Zirconia

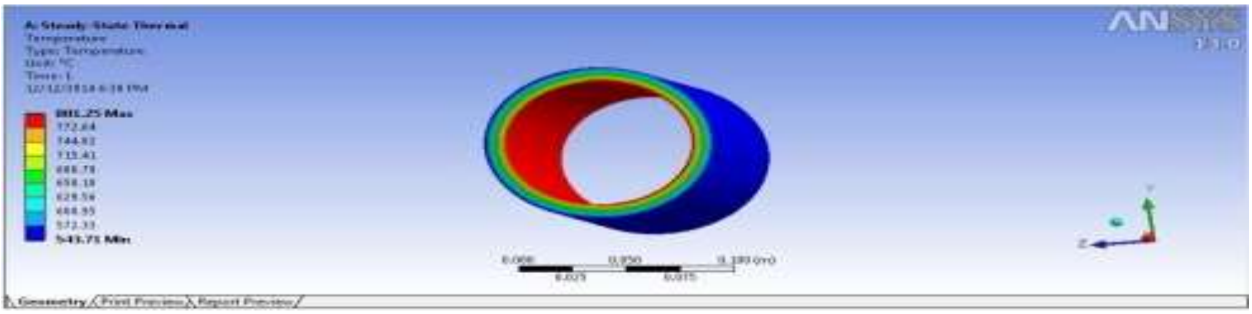

Fig 5.12 Temperature

Graphs

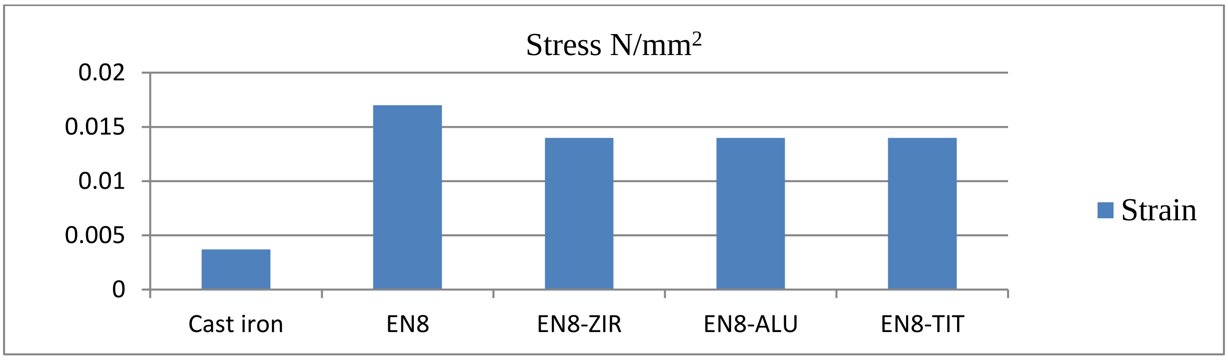

Fig 5.13 Strain and Stress

In the graph result EN8 steel should be replacement of the cast iron to increasing the strength and more hardness by using coating techniques. This result show the two different materials and three coated powder using ANSYS release 13.0 in Bench marking software.

CONCLUSIONS

From the obtained simulation results it was found that, the investigation of EN8 steel can be improving the hardness, strength and wear for replacing the cast iron materials. It can be carried out with a help of the ANSYS software to simulate the suitable coating powder for increasing the surface modification in EN8 steel. In the cast iron and EN8 steel can be analysis the structure analysis and thermal analysis in the mechanical component like cylinder liner, piston ring and gear by using ANSYS based simulation were used and investigated. It can be comparison of three different type of powder for better result on the EN8 steel materials. Due the coating on aluminum and cast iron will improve the mechanical and thermal characterization. This will further improve the hardness, structural grains and thermal properties.

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