The International Journal Of Engineering And Science (IJES)
||Volume||3 ||Issue|| 1||Pages|| 20-22||2014||
ISSN(e): 2319 – 1813 ISSN(p): 2319 – 1805

Experimental Study to Determine the Variation over the Material While Exposed To Magnetic Field

Chilambarasan C[1],Shiva Shankare Gowda A S[2],Senthilkumar S[3],Suresh C[4]
[1]*Post Graduate Scholar, Department of Aeronautical Engineering*
[2]*Professor, Department of Aeronautical Engineering*
[3]*Assistant Professor, Department of Aeronautical Engineering*
[4]*Assistant Professor, Department of Aeronautical Engineering*
Nehru Institute of Engineering and Technology, Coimbatore-641105

--ABSTRACT--
Magnetism is a phenomenon through which materials assert an attractive or repulsive force. However, the underlying principles and mechanisms that explain the magnetic phenomenon are complex. Iron, some steels and rare earth minerals exhibit magnetic attraction. Thus, a piece of mild steel in its lowest energy state ("non-magnetized") generally has little or no net magnetic field. However, if it is placed in a strong enough external magnetic field, the domain walls will move, reorienting the domains so more of the dipoles are aligned with the external field. The domains will remain aligned when the external field is removed, creating a magnetic field of their own extending into the space around the material, thus creating a "permanent" magnet. The domains do not go back to their original minimum energy configuration when the field is removed because the domain walls tend to become 'snagged' on defects in the crystal lattice, preserving their parallel orientation. By using the magnetic field the material's mechanical property like yield strength, hardness, toughness, ductility, ultimate strength, fatigue, Young's modulus can be enhanced. While comparing the properties of magnetized and non-magnetized specimen, if the properties of the magnetized specimen are enhanced it can be used for aircraft applications. Due to its enhanced property it can withstand more shear load, tension, bending, because of its improved fatigue, impact strength and hardness.

KEYWORDS: *Magnetostriction, Enhanced, Domains, Magnetic Property*

Date of Submission: 08 January 2014 ⟺ Date of Acceptance: 20 January 2014

I. INTRODUCTION

Magnetostriction is a property of the ferromagnetic materials that causes them to change their shape when the ferromagnetic materials subjected to magnetic field. A magnetostrictive material develops large mechanical deformations when subjected to an external magnetic field. This phenomenon is attributed to the rotations of small magnetic domains in the material. which are randomly oriented when the material is not exposed to a magnetic field. The orientation of these small domains by the imposition of the magnetic field creates a strain field. As the intensity of the magnetic field is increased, more and more magnetic domains orientate themselves so that their principal axes of anisotropy are collinear with the magnetic field in each region and finally saturation is achieved. Magnetostriction is the coupling between the magnetic and elastic regimes in a magnetostrictive material. Magnetostriction is an intrinsic property of magnetic materials. Magnetostriction is the phenomenon where there will be change in length of the ferromagnetic specimen during the process of magnetization$\frac{dl}{l}$.

II. LITERATURE REVIEW

[1]Effects of B (boron) and Cr (chromium) additions on magnetostriction and the mechanical properties of polycrystalline Fe(iron)83 Ga(gallium)17 alloy were investigated. Small addition of B increased magnetostriction of Fe83Ga17 alloy slightly, and improved the room temperature ductility and tensile strength significantly. The elongation and tensile strength of the (Fe83Ga17)99B1 alloy increased to 3.56% and 548 MPa compared with that of Fe83Ga17 alloy respectively. The Cr addition was shown to improve the room temperature mechanical properties of Fe83Ga17 alloy beneficially. The maximum magnetostriction of (Fe83Ga17)98Cr2 alloy was 70×10^{-6}. The influences of B and Cr additions on the fracture mode of Fe83Ga17Alloy, etc., [2] thesis deals with Several advanced technologies are introduced in automotive

applications. Higher energy density and dynamic performance are demanding new and cost effective actuator structures. Magnetostriction (MS), change in shape of materials under the influence of an external magnetic field, is one of these advanced technologies. Good understanding of specific design constrains is required to define and optimized a magnetostrictive actuator. In comparison with other magnetostrictive materials Terfenol-D (Tb0.3D0.7Fe1.9) shows a good trade-off between high strain and high Curie temperature. The alloy formulation is known as Terfenol-D, where "Ter" is from Terbium, "Fe" is the chemical symbol for iron, "NOL" is derived from Naval Ordnance Laboratory and "D" is for Dysprosium (Ter+Fe+Nol-D). When a magnetic field is established in the opposite direction, the field is understood to be negative, but the negative field produces the same elongation in the magnetostrictive material, as a positive field would. The shape of the curve is reminiscent of a butterfly and so the curves are referred as butterfly curves. [3] Some regions or domains, each of which is magnetized to saturation level, but the direction of the magnetization from domain to domain need not be parallel. Thus a magnet, when demagnetized, was only demagnetized from the viewpoint of an observer outside the material. Man-made fields only serve as a control in changing the balance of potential energy within a magnet. This theory still provides the basis of our highly sophisticated body of knowledge that explains quite satisfactorily the observed properties of ferromagnetic materials and provides an intelligent guide for the search for improved materials. The inherent atomic magnetic moment associated with such elements as iron, cobalt, nickel and many compounds is believed to originate from a net unbalance of electron spins in certain electron shells. For example, in iron in the third shell there are more electrons spinning in one direction than in the opposite direction. Having an inherent atomic magnetic moment is a necessary but not a sufficient condition for ferromagnetism to be exhibited.

III. MATERIALS USED FOR AIRCRAFT CONSTRUCTION

The metals that are used to make airplanes are titanium, steel, aluminium or alloys of aluminium. In older aircraft, manufacturers used wood for frames, cloth to cover wings, metal (steel or aluminium) for various structural parts, rubber for wheels, etc. In modern aircraft, everything from plastics to various polymers to titanium is used. Main various grade aluminum alloys for the structure and either stainless steel or titanium for the firewalls around the engines. Composites are very common for fairings. Modern aircraft have many plastics, ceramics and composite materials in them. Aluminum is used in airplanes for a number of reasons. Aluminum does no trust, is incredibly strong, and is the most common metal in the world.

3.1 Metals Types

Metals are classified into two general classifications. They are ferrous and non-ferrous metals.Ferrous metals are those composed primarily of iron and iron alloys. Nonferrous metals are those composed primarily of some element or elements other than iron. Nonferrous metals or alloys sometimes contain a small amount of iron as an alloying element or as an impurity.

3.2 Ferrous Metals

Ferrous metals include all forms of iron and steel alloys. A few examples include wrought iron, cast iron, carbon steels, alloy steels, and tool steels. Ferrous metals are iron-base alloys with small percentages of carbon and other elements added to achieve desirable properties. Normally, ferrous metals are magnetic and nonferrous metals are nonmagnetic.

IV. MILD STEEL MATERIAL

Mild steel is an alloys of Fe and C.

- ✓ Plain carbon steels (less than 1.7% carbon)
- ✓ Low Carbon (less than 0.3% carbon)
- ✓ Med Carbon (0.3% to 0.6%)
- ✓ High Carbon (0.6% to 0.95%)

Mild steel is made of low carbon components of ingot iron. This is a chemically pure type of iron which is heated with coke and gypsum or lime at high temperatures in a blast furnace. The right balance of carbon in the mixture must be attained as too much will make the steel brittle while too little will make it too soft. Mild steel is a mild piece of steel. Mild steel is made from Iron and Carbon Mild steel is steel that is mild. Mild steel can be used for a variety of purposes. Some of these items include bolts, nuts, chains, hinges, knives, armour, pipes, and magnets. Mild steel, also called plain-carbon steel, is the most common form of steel because its price is relatively low while it provides material properties that are acceptable for many applications, more so than iron. Low-carbon steel contains approximately 0.05–0.3% carbon making it malleable and ductile. Mild steel has a relatively low tensile strength, but it is cheap and malleable; surface hardness can be increased through carburizing. It is often used when large quantities of steel are needed, for example as structural steel. The density of mild steel is approximately 7.85 g/cm^3 like all steels, is 210 GPa (30,000,000 psi).Low-carbon steels suffer from yield-point run out where the material has two yield points. The first yield point is higher than the second and the yield drops dramatically after the upper yield point. If low carbon steel is only stressed to some point between the upper and lower yield point then the surface may develop Luder bands.

V. ASTM TESTING STANDARDS

Material selection is quite frequently a compromise involving various considerations and the more important considerations have historically been those associated with mechanical properties. A list of selection criteria for materials is as follows.

- ✓ E 10 Standard Test Method for Brinell hardness of Metallic Materials.
- ✓ E 18 Standard Test Methods for Rockwell Hardness and Rockwell Superficial Hardness of Metallic Materials.
- ✓ E 8 Standard Test Methods for Tension Testing of Metallic Materials.
- ✓ E23 Standard Test Methods for Notched Bar Impact Testing of Metallic Materials.

VI. TESTING EXPERIMENTS

From the literature review it is known that there will be change in property of the material due to magnetic field. Firstly, the list of materials used for aircraft construction which is listed above is taken. From the list, ferrous materials are chosen because of the attraction of the magnetic field on ferrous materials. In the category of ferrous materials mild steel will be taken for my experiments. Hardness, Impact strength, Toughness, Percentage of Elongation, Yield Stress, and Ultimate stress will be examined by using the experiments. And the experiments are followed by the ASTM Standards.

- ✓ Brinell hardness tester
- ✓ Rockwell hardness tester
- ✓ Charpy impact tester
- ✓ Universal testing machine (UTM)

Two set of experiments will be carried out for this project. One set of experiments will be done by using the untreated magnetized mild steel specimen and the other set of experiment will be done by using the magnetized mild steel specimen. From the above listed experiments by using the brinell and Rockwell, hardness of the mild steel specimen can be found before and after the magnetization. And by using the charpy impact strength of the mild steel specimen can be determined before and after the magnetization. Universal testing machine can be used to determine the ultimate and yield strength of the mild steel specimen before and after the magnetization during both tension and compression. From the results of the list of experiments, change in properties of the mild steel specimen can be determined due to the magnetization. If the material properties of magnetized mild steel is enhanced it can be used for the aircraft applications for better performance.

VII. CONCLUSION

The present work provides the detailed procedure to determine the properties of the material and also the experimental procedure to determine the variation over the material while exposed to magnetic field. And further experimental research will be carried out and published in the future journals.

REFERENCES

[1]. Design and Application of Magnetostrictive MS Materials", A. G. Olabi and A. Grunwald Dublin City University, School of Mechanical and Manufacturing Engineering, Glasnevin, Dublin 9, Ireland, Email: abdul.olabi@dcu.ie
[2]. IEEE TRANSACTIONS ON MAGNETICS, VOL. 37, NO. 5, SEPTEMBER 2001.
[3]. S. Guruswamy, N. Srisukhumbowornachai, A.E. Clark, J.B. Restroff, M. Wun-Fogle, Strong, Ductile and Low-Field-Magnetostrictive Alloys Based on Fe-Ga, Scripta material 43 (2000), pp. 239-244.
[4]. Materials for Engineers and Technicians by Raymond A. Higgins.
[5]. Strength of Materials by R. k. Bansal.
[6]. ETREMA Products Inc., Terfenol-D Magnetostrictive Actuator Information, Specifications, Public domain information, www.terfenoltruth.com, www.etrema.com.
[7]. A. E. Clark, M. Wun-Fogle, J. B. Restorff and T. A. Lograsso: Mater. Trans. 43 (2002) 881–885.
[8]. Definition and Application of Magnetic Material Metrics in Modeling and Optimization Peter R. Wilson, Senior Member, IEEE, and J. Neil Ross.