Cryogenic Hardening of EN 19 Alloy Steel

Karthik Pandiyan .G, Prabaharan. T

Abstract — This paper includes the study of heat treatment process that we carried out on En 19 steel in cryogenic atmosphere. Cryogenic treatments of alloy steels have been significantly increase wear resistance and toughness. These investigations of warmth treatment cryogenic medicines of amalgam steels have been asserted to altogether expand wear protection and sturdiness. Cryogenic handling is a supplementary procedure to customary warmth treatment process in steels. The cryogenic treatment on apparatus materials builds the life of instruments, gear, parts and materials by boosting elasticity, sturdiness and strength. This cryogenic hardening process is an onetime treatment influencing the whole part — not only the surface. Cryogenic treatment has been broadly embraced as a cost decrease and execution upgrading innovation. Cryogenic treatment is likewise utilized as an empowering innovation, when its pressure alleviating benefits are used to allow the manufacture (or machining) of basic resistance parts. With regards to great outcomes about the use of profound cryogenic treatment (DCT) on materials, the impact on the microstructure and properties (hardness, strength and the substance of held austenite) are observed to be made strides. Cryogenic treatment has been distinguished to improve the properties of Tools steels. It is discovered that cryogenic treatment confers almost 110% change in apparatus life.

Keywords : Cryogenic atmosphere, Deep cryogenic treatment (DCT)

I. INTRODUCTION

The word CRYOGENICS begins from the Greek words 'kryos' signifying "ice" and 'genic' signifying "to create." Thus Cryogenics is the investigation of the generation of to a great degree icy temperature. This field of science likewise takes a gander at the end result for a wide assortment of materials from metals to gases when they are presented to these temperatures. Temperatures underneath - 190 degrees Fahrenheit (- 123 degrees Celsius) is considered to be cryogenics. Cryogenic treatment employments of condensed gases like nitrogen under the ideal weight conditions.

A. Cryogenic Range on Temperature Scales

The specialists at the National Institute of Standards and Technology at Boulder, Colorado have considered the field of cryogenics as that including temperature −180 °C (93.15 K).

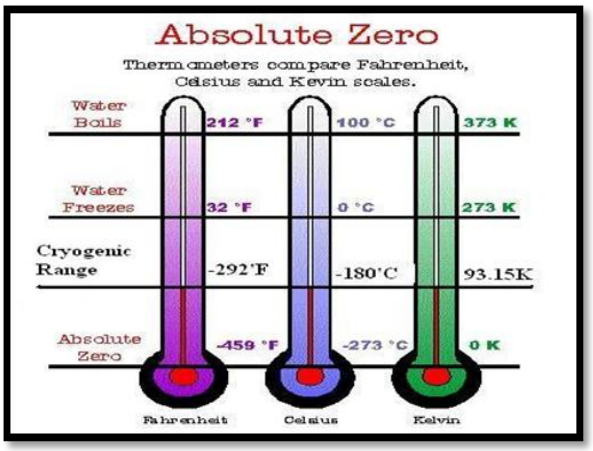

Figure 1 schematic diagram of Absolute zero temp.,

This legitimate separating line, since the ordinary breaking points of the alleged lasting gases, (for example, helium, hydrogen, neon, nitrogen, oxygen, and air) lie underneath −180 °C while the Freon refrigerants, hydrogen sulfide, and normal refrigerants have breaking points above −180 °C.

B. Impediments Of Customary Solidifying

At the point when steel is at the solidifying temperature, there is a strong arrangement of Carbon and Iron, known as Austenite. The measure of Martensite shaped at extinguishing is an element of the most minimal temperature experienced.

At any given temperature of extinguishing there is a sure measure of Martensite and the adjust is untransformed Austenite. This untransformed austenite is exceptionally fragile and can cause loss of quality or hardness, dimensional insecurity, or splitting. High carbon and high compound steels have held Austenite at room temperature. To wipe out held Austenite, the temperature must be brought down.

Requirement for cryogenic solidifying

At the point when metals are solidified cryogenically, the quality of their atomic structure can expand, making the metal itself be more grounded and more sturdy. Some top of the line metal items might be subjected to cryogenics as a major aspect of the treating procedure. The procedure is likewise utilized as a part of the arrangement of specific prescriptions, and in safeguarding of an extensive variety of materials. In Cryogenic treatment the material is liable to profound stop temperatures of as low as - 185°C (- 301°F), however for the most part - 75°C (- 103°F) is adequate. The Austenite is shaky at this temperature, and the entire structure moves toward becoming Martensite. In this manner cryogenic treatment advances the extra change of RA (Retained Austenite) into martensite.

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It has been demonstrated that cryogenic treatment increment the quality and solidness of the material being treated, ease pressure, make a more uniform material, and miniaturized scale smooth surface.

C. Cryogenic Solidifying

Cryogenic solidifying is a cryogenic warmth treating process where the material is cooled to around −185 °C(−301 °F), more often than not utilizing fluid nitrogen. It can profoundly affect the mechanical properties of specific steels, gave their arrangement and earlier warmth treatment are with the end goal that they hold some austenite at room temperature. It is intended to expand the measure of martensite in the steel's precious stone structure, expanding quality and hardness, at times at the cost of strength. In Cryogenic treatment the material is liable to profound stop temperatures as low as - 185°C (- 301°F), yet normally - 75°C (- 103°F) is adequate. The change of held austenite into martensite - which enhances the elasticity and hardness of the material. It can likewise be connected for pressure alleviation of castings and machined parts.

Figure 2 cryogenically treated En 19 steel specimen

II. EXAMINATION

The cryogenic treatment was conveyed inside 3 to 4 hours of finishing of the warmth treatment process. Warmth exchanger compose cryogenic treatment hardware with fluid nitrogen as the cooling media is utilized for the treatment. This was completed by bringing down the temperature to -195°C and held at this temperature for time of 24 hours.

After the cryogenic treatment, hardening was performed to alleviate any burdens initiated amid the cryogenic treatment**.**

The cryogenic treatment cycle is given below,

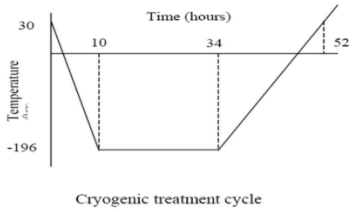

Figure 3 Cryogenic Treatment Cycle

III. MECHANISM OF CRYOHARDENING

In numerous steels, the change of austenite to martensite is finished when the part achieves room temperature. (i.e. different steels, notwithstanding, including numerous device steels, a portion of the milder austenite stage is held). Ensuing cooling to a lower temperature can make extra change of the delicate austenite hard martensite. In any case, it is conceivable likewise to change all (or almost all) of the held austenite in the steel by fitting hoisted temperature hardening medications that convey the additional advantage of diminishing the weakness of the martensite. Change of held austenite at low temperatures in instrument steels by and large is accepted to be needy just on temperature, not on time. Accordingly, only achieving an appropriately low temperature for a moment would create an indistinguishable impact from holding for a few days.

Cryogenic medications can deliver change of held austenite to martensite, as well as can create metallurgical changes inside the martensite. The martensitic structure opposes the plastic disfigurement mush superior to the austenitic structure, in light of the fact that the carbon molecules in the martensitic cross section "bolt together" the iron particles more successfully than in the more open-focused cubic austenite grid.

The investigation distinguished martensite disintegration and precipitation of fine η-carbides as the principle systems in charge of the helpful impacts of profound cryogenics. The precipitation of fine carbides (estimated time of arrival carbides) in the lattice amid this treatment grants high wear protection from the steels.

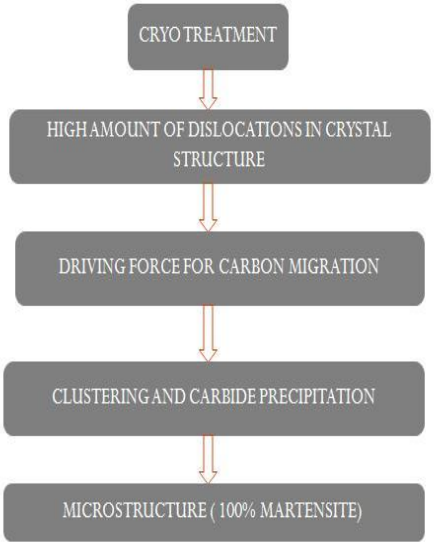

Figure 4 A flow chart showing the Mechanism of Cryogenic Hardening

The development instrument of η-carbides should be as per the following:

1. Iron or substitutional particles grow and contract
2. Carbon particles move marginally because of cross section distortion

IV. RESULTS OBTAINED

A. Impact Strength – Comparison

Table 1. Impact strength comparsion

Specimen	Impact strength
Conventional hardened En 19 steel	18.5 joules
Cryogenically treated En 19 steel	7.5 joules

It is evident from the above table that impact strength decreases after cryogenic treatment.

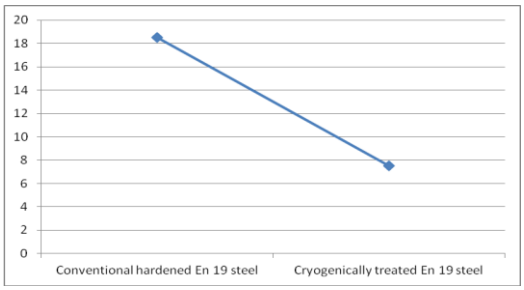

Figure 5 Graphical Representation of impact strength

B. Hardness – Comparison

Table 2 Hardness Comparsion

Specimen	Hardness
Conventional hardened En 19 steel	726 HV
Cryogenically treated En 19 steel	800 HV

It is clear from the above table that hardness increases to a certain extent after cryogenic hardening**.**

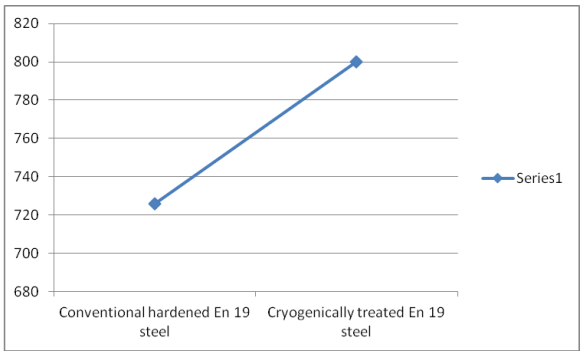

Figure 6 Graphical Representation of hardness

C. Wear Comparison

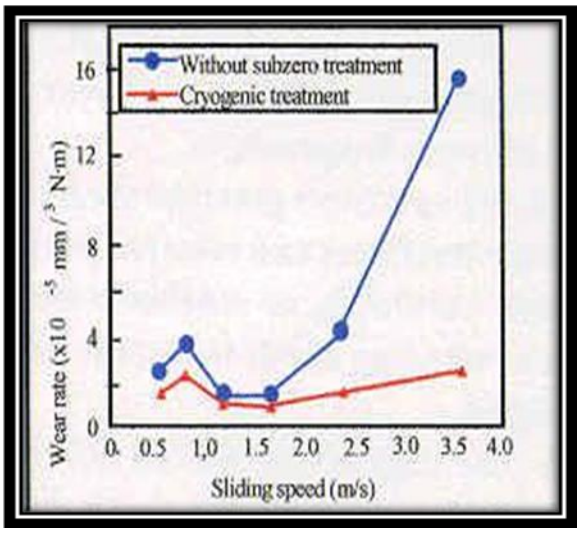

Figure 7 Graphical Representation of wear

The Variation of the wear rate with sliding rates is appeared in fig for examples austenitized at 1293K extinguished to 303K and other example at treated to 93K

D. Advantages Of Cryohardening

1. Cryogenically treated materials have better warm properties, including enhanced warmth dissemination and less twisting or contortion.
2. Longer life because of decreased wear.
3. Less disappointments because of splitting that outcome from the proliferation of stress lines.
4. Better electrical properties with decreased electrical protection.
5. Reduced coefficient of rubbing on cleaned metals.
6. Less crawl and enhanced levelness for basic resistance parts.
7. Easier machining, cleaning and granulating for better edges and wraps up.
8. Stress alleviation splitting of weld zones.
9. Surface completing in any application where long life is required.

V. USES OF CRYOHARDENING

A. Mechanical Applications

Cryogenic treatment deals with cutting tools.tap drill bits end mills, carbide inserts, punch dies, progressive dies, press dies, shear knives, engine blocks, engine components, cam shaft, crank shafts, dental and medical instruments.

B. Therapeutic Applications

Cryogenics has additionally been utilized by the therapeutic business. Surgical instruments utilized by specialists, specialists, dental specialists, and other authorities' would all be able to profit by the expanded wear protection of the treatment. Surgical instruments, in the same way as other modern apparatuses, are costly to supplant, so cryogenic treatment can truly pay off.

C. Games Applications

Aluminum polished ash, golf balls and clubs, nylon string, angling line, angling snares, urethane wheels - inline skate, skate board, orientation and so forth.

VI. CONCLUSION

Cryogenic treatment doesnot replace the heat treating. It is supplement to enhance the materials properties after the usual required heat treatment. Cryogenic handling is a supplementary procedure to customary warmth treatment process. This cryogenic hardening process is an onetime treatment influencing the whole part-not only the surface. The advantages of cryogenic handling stretches out to non-ferrous composites including aluminum, magnesium, titanium, copper, nickel amalgams, plastics and nylon can be dealt with too. Despite the fact that this procedure develops in huge way with numerous logical revelations, the cost factor restrains the value of this procedure in the creation period of the materials business.

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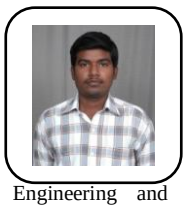
AUTHORS PROFILE



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