ANALYSIS OF TENSILE STRENGTH IN EN8 STEEL AFTER CRYOGENIC TREATMENT

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Abstract—
In an effort to achieve more efficient machining at a lower cost, an investigation into the tensile strength of EN8 steel that has been cryogenically treated is being conducted. In the traditional method of heat treatment, the material is brought to a very high temperature before being cooled by being quenched in oil. At a temperature as low as -190oC to - 273oC, a material may be subjected to the Cryogenic Treatment, which is a method that involves treating the material while it is encased in a chamber that is filled with liquid nitrogen.In this study, a standard heat treatment and a deep cryogenic treatment are compared to each other in terms of their effects on the tensile strength of EN8 steel. It has been found that when EN8 steel is treated to a deep cryogenic treatment, there is a considerable enhancement in the material's tensile strength.

Tensile strength, EN8 steel material, and deep cryogenic treatment are some keywords to look for.
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1. INTRODUCTION

GENERAL STUDY

Metal cutting process forms the basis of the engineering industry and is involved either directly or indirectly in the manufacture of nearly every product of our modern civilization. The cutting tool is one of the important elements in realizing the full potential out of any metal cutting operation. Over the years the demands of economic competition have motivated a lot of research in the field of metal cutting leading to the evolution of new tool materials of remarkable performance and vast potential for an impressive increase in productivity. Changes in workpiece materials, manufacturing processes and even government regulations catalyze parallel advances in metal cutting tooling technology. As manufacturers continually seek and apply new manufacturing materials that are lighter and stronger and therefore more fuel efficient it follows that cutting tools must be developed that can machine new materials at the highest possible productivity. The most important elements in the design of cutting tools is the material construction and their judicious selection. The properties that a tool material must process are as follows:

- Capacity to retain form stability at elevated temperatures during high cutting speeds.

• Cost and ease of fabrication
• High resistance to brittle fracture
• Resistance to diffusion
• Resistance to thermal and mechanical shock.

Developmental activities in the area of cutting tool materials are guided by the knowledge of the extreme conditions of stress and temperature produced at the tool-workpiece interface. Tool wear occurs by one or more complex mechanisms which includes abrasive wear, chipping at the cutting edge, thermal cracking.

EN8 steel offers a moderate wear resistance.

2. INTRODUCTION TO EN8 MATERIAL

EN8 is an unalloyed EN8 steel grade that contains between 0.36 and 0.44 percent carbon. En8 steel has good tensile strength and is often used in applications such as shafts, gears, pins, studs, bolts, keys, etc. En8 steel is readily machinable.

EN8 steel is composed of 0.42% of carbon, 0.20% of silicon, 0.45% of manganese, 0.026% of phosphorus, 0.015% of sulphur, 0.01% of chromium and 0.01% of nickel.

3. METHODOLOGY

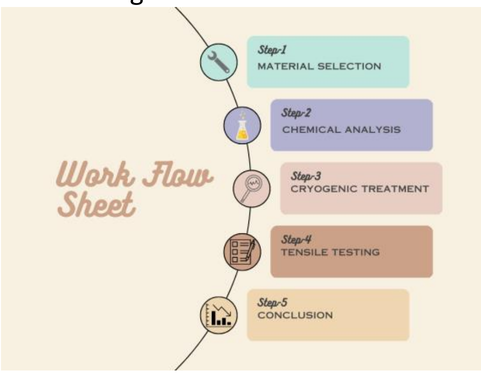
Cryogenics is defined as the branches of physics and engineering that study very low temperatures, how to produce them, and how materials behave at those temperatures. Rather than the familiar temperature scales of Fahrenheit and Celsius, cryonicists use the Kelvin and Rankine scales. The word cryogenics literally means "the production of icy cold"; however the term is used today as a synonym for the low-temperature state. It is not well-defined at what point on the temperature scale refrigeration ends and cryogenics begins.To eliminate retained Austenite, the temperature has to be lowered. Liquefied gases, such as liquid nitrogen and liquid helium, are used in many cryogenic applications. Liquid nitrogen is the most commonly used element in cryogenics and is legally purchasable around the world. Liquid helium is also commonly used and allows for the lowest attainable temperatures to be reached. These gases are held in either special containers known as Dewar flasks, which are generally about six feet tall (1.8 m) and three feet (91.5 cm) in diameter, or giant tanks in larger commercial operations. Cryogenic transfer pumps are the pumps used on LNG piers to transfer Liquefied Natural Gas from LNG Carriers to LNG storage tanks.

4.EXPERIMENTAL PROCEDURE

The experiment conducted goes in the following procedure ,

First the materials which are needed to be treated are selected according to the experiment. Then these materials are undergone for chemical composition. Later the materials are tested by Traditional heat treatment and Deep cryogenic treatment. After completion of both the tests these materials are put to Mechanical testing i.e., tensile test, where these test results are compared. Later keeping these results to consideration we draw conclusions and the benefits of cryogenic treatment.

Fig.1 Work Flow sheet



5.CRYOGENIC TREATMENT

The liquid nitrogen as generated from the nitrogen plant is stored in storage vessels.With help of transfer lines, it is directed to a closed vacuum evacuated chamber called cryogenic freezer through a nozzle.The supply of liquid nitrogen into the cryo-freezer is operated with the help of solenoid valves.Inside the chamber gradual cooling occurs at a rate of 2º C /min from the room temperature to a temperature of -196º C.Once the sub zero temperature is reached, specimens are transferred to the nitrogen chamber or soaking chamber where in they are are stored for 24 hours with continuous supply of liquid nitrogen. This illustrates the entire setup for cryogenic treatment. The control unit interface is shown below

Fig.2 Control Unit Interface

Fig.3 Experiment Setup

6. TENSILE TESTING

The tensile strength of EN8 steel can be calculated by dividing the load at failure by the original cross-sectional area1. EN8 is an unalloyed medium carbon steel grade with reasonable tensile strength. It is normally supplied in the cold draw or as a rolled condition. Tensile properties can vary but are usually between 500-800 N/mm².

The tensile test on metals or metallic materials is mainly based on the standards DIN EN ISO 6892-1 and ASTM E8. The ASTM E8 / ASTM E8M standard describes uniaxial tensile testing of metals at room temperature and the determination of characteristic values including yield strength, yield point, yield point elongation, tensile strength, strain at break and reduction of area. EN8 engineering steel is an unalloyed carbon steel with reasonable tensile strength. It can be flame or induction hardened and is a readily machinable material3. When heat treated, EN8 offers moderate wear resistance.

Fig.4 Test sample

7. DESIGN OF EXPERIMENT

1. Cryogenic treatment is an additional process to conventional heat treatment in material processing technology.
2. It is a one-time process that affects the entire section of the component.
3. Cryogenic treatments are considered to be a good way to reduce the retained austenite content and increase the performance of tools.

4. Furthermore, optimization of tools (normal and cryogenic), pressure and stroke length has been done based on desirability function for the minimization of surface roughness and maximization of stamping depth.

5. Pneumatic powered normal and cryogenic EN8 tools are observed under specific operating conditions.

Table I. Design of Experiment

Experiment No.	Type of Treatment	temperature
Exp.1	Conventional	Room Temperature
Exp.2	DCT-1	DCT temp' 1
Exp.3	DCT-2	DCT temp' 2

DCT- Deep cryogenic treatment
Exp-Experiment

8.EXPERIMENTCONDUCTED

1. In the experiment first we conducted the procedure on the EN8 sample which has gone through conventional heat treatment and tested it for tensile strength.
2. In the second step the EN8 sample undergoes deep cryogenic treatment and after the first treatment it is tested again for tensile strength.
3. The third time the EN8 sample which has undergone deep cryogenic treatment at second temperature range is tested for tensile strength one last time.

Later all these results are compared to draw a conclusion.

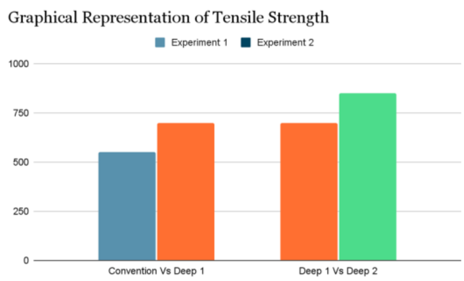
Table II. Experiment Results

Experiment No.	Type of Treatment	Temp' (°c)	Tensile Strength(N/mm^2)
Exp.1	Conventi-onal	22	550
Exp.2	DCT-1	-190	700
Exp.3	DCT-2	-273	850

9. RESULTS

CONVENTIONAL
HEAT TREATMENT
The Tensile Strength of EN8 tool material with Conventional Heat Treatment = 550MPa
DEEP CRYOGENIC TREATMENT-1
The Tensile Strength of EN8 tool material after Deep Cryogenic Treatment 1 = 700MPa
DEEP CRYOGENIC TREATMENT-2
The Tensile Strength of EN8 tool material after Deep Cryogenic Treatment 2 = 850MPa
The tensile strength of EN8 tool material is enhanced from 550 MPa to 850MPa.

Graph.1 Graphical Representation of Tensile Strength



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10. CONCLUSION

After conducting the experiment and performing the Tensile test we conclude that the EN8 tool sample which has undergone the Deep Cryogenic Treatment has improved significantly in tensile strength.
And the sample which is subjected to conventional heat treatment has comparatively less tensile strength than the EN8 tool sample which is treated with deep cryogenic treatment.
From the above table of results where we observe that the tensile strength of the EN8 tool has increased.
Thus we conclude that by performing the Deep Cryogenic Treatment on EN8 tool material increases the tool material properties and thereby

increases the tool life and wear resistance.

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