



**ISSN: 2454-9940**



**INTERNATIONAL JOURNAL OF APPLIED  
SCIENCE ENGINEERING AND MANAGEMENT**

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## A TENSILE STRENGTH EXAMINATION OF CRYOGENICALLY TREATED EN8 STEEL

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**ABSTRACT**— An examination of the tensile strength of cryogenically treated EN8 steel is being carried out in an attempt to obtain more cost-effective machining. In the conventional heat treatment process, the material is heated to a very high temperature and then quenched in oil to cool it down. A material may undergo the Cryogenic Treatment, which is a process that entails treating the material while it is enclosed in a chamber that is filled with liquid nitrogen, reaching temperatures as low as  $-190^{\circ}\text{C}$  to  $-273^{\circ}\text{C}$ . The impact of deep cryogenic treatment and conventional heat treatment on EN8 steel's tensile strength are compared in this research. Research has shown that subjecting EN8 steel to a deep cryogenic treatment significantly increases the material's tensile strength.

Some terms to search for include tensile strength, EN8 steel material, and deep cryogenic treatment.

### 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

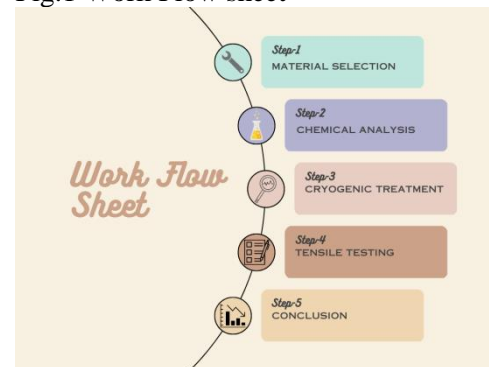
Cryogenics is defined as the branches of physics and engineering that study very low temperatures, how to produce them, and how materials behave at those temperatures. Rather than the familiar temperature scales of Fahrenheit and Celsius, cryonicists use the Kelvin and Rankine scales. The word cryogenics 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 2° C /min from the room temperature to a temperature of -196° C. Once the sub zero temperature is reached, specimens are transferred to the nitrogen chamber or soaking chamber where in they are stored for 24 hours with continuous supply of liquid nitrogen. This illustrates the entire setup



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. EXPERIMENT CONDUCTED

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/m <sup>2</sup> )
Exp.1	Conventional	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

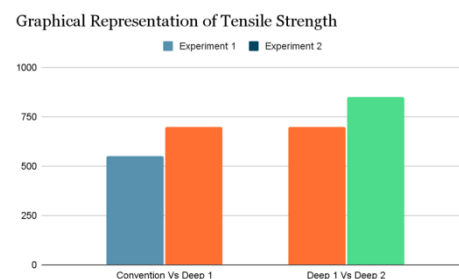
The Tensile Strength of EN8 tool material after Deep Cryogenic Treatment 1 = 700MPa

### 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



## 10. CONCLUSION

We find that the EN8 tool sample that underwent the deep cryogenic treatment has greatly improved in tensile strength after carrying out the experiment and the tensile test.

Furthermore, the EN8 tool sample that undergoes deep cryogenic treatment has a higher tensile strength than the sample that undergoes standard heat treatment.

The EN8 tool's tensile strength has risen, as can be seen in the results table above.

Therefore, we draw the conclusion that applying the Deep Cryogenic Treatment to EN8 tool material improves the material's characteristics, extending the tool's life and enhancing its resistance to wear.

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