 ISBN: 978-81-910765-1-6

Investigation of Cryogenic Treated Drill Bit

Mr.J.Sebastinjoyal M.E/Assistant professor /MECH
S.Anandhakumar, M.Selvakumar,A.K.Shameer,A.Sriram
IndraGanesan College of Engineering, Trichy
joyalmech52@gmail.com, anandhakumarstcy@gmail.com,selvakumarmtcy@gmail.com,
shameervirat18@gmail.com ,sriramanbu@gmail.com

Abstract: ***We look into brief introduction of cryogenic treatment. Our focus throughout the report is more on cryogenic treatment of cobalt steel tool steel and high speed steel. In metal forming industry tools are exposed to very complex and rough surface conditions, which are the result of different effects (mechanical, thermal and chemical) and thus require well defined mechanical properties. Different approaches are followed to increase the surface properties of tool steels. The surface hardening treatments of steel has shown significant improvement of various properties including wear and fatigue resistance. Cryogenic treatment is yet another approach acknowledged by some to extend the tool life of many cutting tools. We will describe the complete procedure and investigate the effects on the metallurgical changes in the tool steel. However real mechanisms behind the better performance of tools are still in doubt. Studies in the given references on cryogenically treated tool steel shows micro structural changes in material that can influence the tool life. However little is gained from the experimental results showing involvement of carbide precipitations. A cryogenic treatment of carbides has yet to be extensively studied. In this paper drill bits are treated with cryogenic method and to predict the hardness, wear strength and other re***

I.INTRODUCTION

TheMetal cutting process form the basis of engineering industry and is involved either directly or indirectly in the manufacture of nearly every product we use in our daily life. Over the years of demand and economic competition a lot of research is done leading to the increased performance of tools and increase in overall productivity. As manufacturers always need new materials that are lighter, stronger and more fuel efficient, it is clear that such materials must be so developed to give highest productivity. The most important part of designing of such cutting tools is material construction by careful selection.

The properties that a drill bit 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 tool materials are guided by the knowledge of the extreme conditions of stress and temperature produced at the tool-work piece interface. Tool wear occurs by one or more complex mechanisms which includes abrasive wear, chipping at the cutting edge, thermal cracking etc. Since most of these processes are greatly accelerated by increased temperatures, the more obvious requirements for tool materials are improvements in physical, mechanical and chemical properties at elevated temperature.

Drilling is a process to make a well bore in ground to reach a typical targeted depth where we can extract crude oil, natural gas and petroleum. A Drill bit is set at end of drill string that breaks apart, cuts or crushes, rock structure when drilling a well bore. The drill bits are hollow and allow expulsion of drilling fluid at high velocity and high pressure helps to clean the bit and take apart the drilled cuttings.

II.EXISTING SYSTEMS

- Transforms almost all soft retained austenite to hard marten site,
- Increases abrasive wear resistance,
- Increases tensile strength, toughness and stability,
- Decreases residual stresses,
- Effective Micro Structural changes.
- Decreases brittleness,
- The result is a larger contact surface area that reduces friction, heat and wear
- Increases durability or wear life,

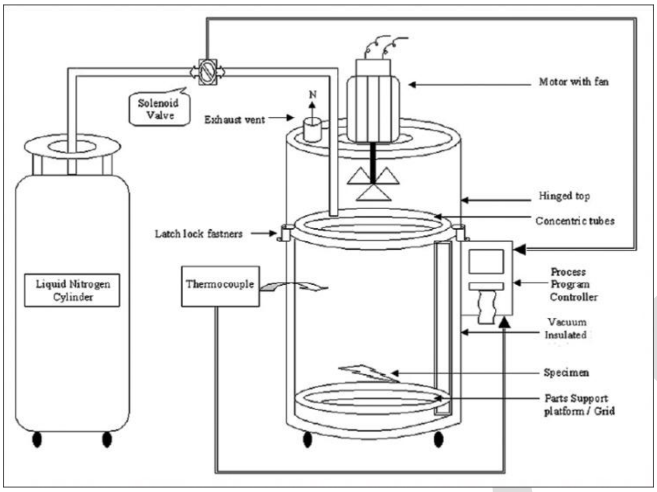
Reduction of ideal time of machine parts for replacement

III. PROPOSED SYSTEM

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, cryogen cists 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. The workers at the National Institute of Standards and Technology at Boulder, Colorado have chosen to consider the field of cryogenics as that involving temperatures below –180 °C (93.15 K). This is a logical dividing line, since the normal boiling points of the so-called permanent gases (such as helium, hydrogen, neon, nitrogen, oxygen, and normal air) lie below -180 °C while the Freon refrigerants, hydrogen sulfide, and other common refrigerants have boiling points above -180 °C.
storage tanks.

IV.BLOCK DIAGRAM



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 -80º C.Once the subzero temperature is reached, specimens are transferred to the nitrogen chamber or soaking chamber wherein they are stored for 24 hours with continuous supply of liquid nitrogen. Figillustrates the entire set up for cryogenic treatment. The entire process is schematically.

V.COMPONENTS ANDTECHNOLOGIES

HSS DRILL BIT

High speed steel (HSS) is a form of tool steel. HSS bits are much more resistant to heat. They can be used to drill metal, hardwood, and most other materials at greater cutting speeds than carbon steel bits.HSS tools are so named because they were developed to cut at higher speeds. Developed around 1900 H S S is the most highly alloyed tool steels. The tungsten (T series) was developed first and typically contains 12 - 18% tungsten, plus about 4% chromium and 1 - 5% vanadium. Most grades contain about 0.5% molybdenum and most grades contain 4- 12% cobalt. Cryogenic treatment on HSS will result in the conversion of retained austenite into martensite. This results in increase in hardness of HSS drill bit due

to increase in density of dislocation and gaps.

.

HIGH SPEED COBALT (COBALT)

Cobalt drill bits are made from cobalt steel blended with a fairly large percentage of cobalt. The cobalt actually makes the drill bit incredibly hard, with an abrasion quality. Cobalt bits are also superior for their resistance to heat.Cobalt drill bits are particularly successful in cutting through hard metals such as stainless steel and cast iron, although they can be used for softer materials, too. The main effect of cobalt in highspeed tool steel is to increase the hot hardness and thus to increase the cutting efficiency when high tool temperatures are attained during the cutting operation. Cobalt raises the heat-treating temperatures because it elevates the melting point. Hardening temperatures for cobalt high-speed tool steels can be 14 to 28 °C (25 to 50 °F) higher than would be normal for similar grades without cobalt. Cobalt additions slightly increase the brittleness of highspeed tool steels.

Different types of drill bits are used to cut holes in different types of materials. Diamond drill bits are used for materials such as glass and tile; black oxide bits are common for plastics and carbon. Cobalt drill bits are particularly successful in cutting through hard metals such as stainless steel and cast iron, although they can be used for softer materials, too. Cobalt drill bits are not made of pure cobalt, but rather a steel alloy with 5 to 8 percent cobalt. The 5-percent alloy is known as M35 grade, and the 8-percent alloy is M42. The cobalt increases the strength of the steel and makes it more heat-resistant; this is an important factor in drilling hard materials because the friction of metal against metal can produce high temperatures that damage the material or the drill bit. Bosch, for instance, makes a cobalt drill bit that can withstand temperatures of up to 1,100 degrees Fahrenheit (593 degrees Celsius).
New cobalt drill bits are a dull gold colour, making them distinctive on the shelf (or in your toolbox). The colour occurs when the drill bits are baked in the process of production; it’s not a paint or plating -- cobalt drill bits are cobalt alloy through and through. For this reason, they can be sharpened relatively easily with cutting fluid while retaining their strength and durability (although the gold colour may wear off)

ISBN: 978-81-910765-1-6

HARDNESS

Resistance to penetration by diamond-hard indenter, measured at room temperature hot hardnessthe ability to retain high hardness at elevated temperatures

WEAR RESISTANCE

Resistance to abrasion, often measured by grind ability,metal-tometal, or various other types of tests to indicate a relative rating

TOUGHNESS

Ability to absorb (impact) energy the relative importance of these properties varies with every application. High machining speeds require a composition with a high initial hardness and a maximum resistance to softening at high temperatures. Certain materials may abrade the cutting edge of the tool excessively; hence, the wear resistance of the tool material may well be more important than its resistance to high cutting temperatures. Hardness is necessary for cutting harder materials and generally gives increased tool life, but it must be balanced against the toughness required for the application.

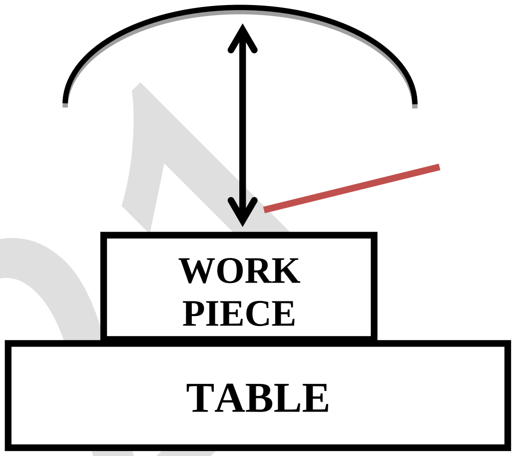
VI.THE MAKING OF LIQUID NITROGEN

A common method for production of liquid nitrogen is the liquefaction of air. Liquefaction is the phase change of a substance from the gaseous phase to the liquid phase. In the liquid nitrogen compressors or generators, air is compressed, expanded and cooled via the Joule-Thompson's effect as depicted and **the set up for making nitrogen.** Since nitrogen boils at a different temperature than oxygen, the nitrogen can be distilled out of the liquid air, recompressed and re-liquefied. Once liquid nitrogen is removed from the distillation chamber it is stored in a pressurized tank or a well-insulatedDewarflask.Liquid nitrogen is converted to a gas before it enters the chamber so that at no time does liquid nitrogen come in to contact with the parts assuring that the dangers of cracking from too rapid cooling are eliminated.

EXPERIMENTAL TESTING

HARDNESS TEST

This gives the metals ability to show resistance to indentation which show it's resistance to wear and abrasion. Hardness testing of welds and their Heat Affected Zones (HAZs) usually requires testing on a microscopic scale using a diamond indenter.



VII.SELECTION OF TEST

ROCKWELL HARDNESS TEST

Stanley P. Rockwell invented the Rockwell hardness test. He was a metallurgist for a large ball bearing company and he wanted a fast non-destructive way to determine if the heat treatment process they were doing on the bearing races was successful. The only hardness tests he had available at time were Vickers, Brinell and Ceroscopy. The Vickers test was too time consuming, Brinell indents were too big for his parts and the Ceroscopy was difficult to use, especially on his small parts

To satisfy his needs he invented the Rockwell test method. This simple sequence of test force application proved to be a major advance in the world of hardness testing. It enabled the user to perform an accurate hardness test on a variety of sized parts in just a few seconds.

TYPES OF THE ROCKWELL TEST

There are two types of Rockwell tests: 1. Rockwell: the minor load is 10 kgf, the major load is 60, 100, or 150 kgf. 2. Superficial

Rockwell: the minor load is 3 kgf and major loads are 15, 30, or 45 kgf. In both tests, the indenter may be either a diamond cone or steel ball, depending upon the characteristics of the material being tested.If no specification exists or there is doubt about the suitability of the specified scale, an analysis should be made of the following factors that control scale selection:

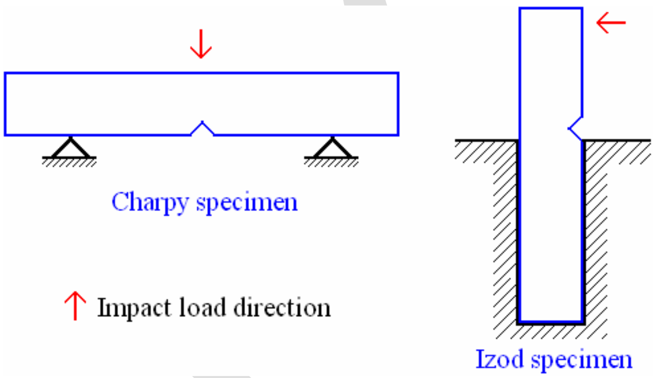
- Type of material
- Specimen thickness
- Test location
- Scale limitations

PRINCIPE OF THE ROCKWELL TESTS

- The indenter moves down into position on the part surface
- A minor load is applied and a zero reference position is established
- The major load is applied for a specified time period (dwell time) beyond zero
- The major load is released leaving the minor load applied The resulting Rockwell number represents the difference in depth from the zero reference position as a result of the application of the major load.

TOUGHNESS TEST

The principal measurement from the impact test is the energy absorbed in fracturing the specimen. Energy expended during fracture is sometimes known as notch toughness. The energy expended will be high for complete ductile fracture, while it is less for brittle fracture. However, it is important to note thatmeasurement of energy expended is only a relative energy, and cannot be used directly as design consideration. Another common result from the Charpy test is by examining the fracture surface. It is useful in determining whether the fracture is fibrous (shear fracture), granular (cleavage fracture), or a mixture of both.



Fracture toughness test

The fracture toughness of the composite specimenswasmeasured using Fracture Tester (MTS 810 material testsystem) as shown in Figure 7. The specimens were cutaccording to dimensions as specified by the ASTM E1820;this test method is for the opening mode (Mode I) of loading.The objective of this test method is to load a fatigue precrackedtest specimen as shown in Figure 8 to induce eitheror both of the following responses:

- Unstable crack extension, including significant pop-in,referred to as "fracture instability" in this test method;
- Stable crack extension, referred to as "stable tearing" inthis test method.

Toughness determined at the point of instability. Stabletearing results in continuous fracture toughness versus crackextensionrelationship (R-curve) from which significantpoint-values may be determined. Stable tearing interruptedby fracture instability results in an R-curve up to the point of instability. This investigation split into two majorcomputation scopes to estimate the fracture toughness andenergy release rate: it includes the experiment data for fiber reinforcement epoxy composites specimens. Meanwhile, the compact tension (CT) specimenwas instructed according to the ASTM E 1820 standard forthe fracture toughness measurement. The thickness was 10mm for all the specimens, while the initial notch length to specimen was between 10mm and the notch tip wassharpened with a razor blade to simulate a sharp crack.

VIII. CONCLUSION

Comparative study on the hardness and toughness of cryogenically treated Cobalt steel drill bit with that of untreated drill bit. In the sliding wear test, the weight loss of cryogenically treated drill bits is more as compared to that of untreated drill bits. By this technique specially hardness,wear resistance, corrosion resistance, toughness increases. Cryogenics materials will be part of the dynamicfuture. We must not only continue to make incrementalimprovements in present materials but develop whole newtechnologies of manufacturing and processing for to achievethe highest performance in cryogenics materials field.Cryogenics-based technologies have applications in widevariety of areas as metallurgy, chemistry, power industry,medicine, rocket propulsion and space simulation, foodprocessing.

IX. REFERENCES

- K. Surekha and A. Els-Botes, "Effect of Cryotreatment on ToolWear Behavior of Bohler K390 and AISI H13 Tool Steel During Friction Stir Welding of Copper", Transactions of The IndianInstitute of Metals, Vol. 65, No. 3, pp. 259-264, 2012, DOI: 10.1007/s12666-012-0127-8 SusheelKalia, "Cryogenic Processing: A Study of Materials atLow Temperatures", Journal of Low Temperature Physics, Vol.158, No. 5-6, pp. 934-945, 2010, DOI: 10.1007/s10909-009-0058-x
- Lakhwinder Pal Singh, Jagtar Singh, "Effects of CryogenicTreatment on High-speed Steel Tools", J Eng. Technol, vol.1,Issue 2, pp. 88-93, 2011.
- D.S. Nadig, S. Jacob, R. Karunanithi, R. Manjunatha, D. Subramanian, M.V.N. Prasad, GeethaSen, Abhay K. Jha, "Studies of cryotreatment on the performance of integraldiaphragm pressure transducers for space application",Cryogenics, Vol. 50, Issue 9, pp. 561–565, 2010.
- K. Surekha and A. Els-Botes, "Effect of Cryotreatment on ToolWear Behavior of Bohler K390 and AISI H13 Tool Steel During
- Friction Stir Welding of Copper", Transactions of The

 ISBN: 978-81-910765-1-6

IndianInstitute of Metals, Vol. 65, No. 3, pp. 259-264, 2012, DOI: 10.1007/s12666-012-0127.

- Collins D.N., “Deep cryogenic treatment of tool steels: a review”, Heat Treat. Met. (1996) (2): pp. 40–42.
- Seah, Rahman ,Yong, “Performance evaluation of cryogenically treated tungsten carbide cutting tool inserts”. Journal of Engineering Manufacture. Volume No. 1, (2003): pp. 29–43.
- S.H. Avner. Introduction to physical metallurgy. New York: McGraw-Hill, 1982. [35] Flavio J. da Silva, “Performance of cryogenically treated HSS tools”. Journal of Engineering Manufacture. Volume No. 1, (2006): pp. 50–59
- K. Seah,Rahman,Yong, “Performance evaluation of cryogenically treated tungsten carbide tools in turning”. Journal of Engineering Manufacture. Volume No. 2, (2006): pp. 40–46
- Flavio J. da Silva, “Performance of cryogenically treated HSS tools”. Journal of Engineering Manufacture. Volume No. 1, (2006): pp. 50–59