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Influence of Different Treatments on High Speed Steel

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Abstract: Improvement in wear resistance and hardness of cutting tool material is one of the most important challenges in machining operation. This issue can be overcome by improving the wear resistance and hardness by cryogenic treatment of High-Speed Steel. In this work it is tried to study the effect of different soaking periods in cryogenic treatment of HSS. The experiments were conducted at temperature range -80C , -50C at different soaking period of 6hrs on commercially used HSS. Further efforts were made to quantify and confirm the effect of different soaking period along with the mechanism responsible for change in the hardness and wear resistance by measuring Rockwell hardness and weight loss during wear test. For a better reference the experiment is also contrasted with the heat treatment process.

1. INTRODUCTION

Nomenclature

CT Cryogenic treatment
UT Untreated sample
HT Heat treatment
CT1 Cryogenic treated sample in 6 Hr observation
HT1 Heat treated sample

Metal 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 these tool materials must have are as follows

- Performance at elevated temperatures during high speed cutting operations
- High resistance to brittle fracture
- Resistance to thermal and mechanical shock
- easily fabricated and Cost effective

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Development in the field of cutting tools is more focused by the extreme conditions of Stress and temperature produced at the tool-work piece interface. Due to the presence of tool at such conditions wear and tear of tool occurs by complex mechanisms i.e. Abrasive wear, chipping at the cutting edge, thermal cracking, and etc. tools is more focused by the extreme conditions of stress and temperature produced at the tool-work piece interface. Due to the presence of tool at such conditions wear and tear of tool occurs by complex mechanisms i.e. Abrasive wear, chipping at the cutting edge, thermal cracking, etc.

2. MATERIAL AND METHODS

2.1 Material samples

High Speed Steel

High-speed steel (HSS or HS) is a subset of tool steels, commonly used as cutting tool material. It is often used in power-saw blades and drill bits. It is superior to the older high-carbon steel tools used extensively through the 1940s in that it can withstand higher temperatures without losing its temper (hardness). This property allows HSS to cut faster than high carbon steel, hence the name high-speed steel. At room temperature, in their generally recommended heat treatment, HSS grades generally display high hardness (above Rockwell hardness 60) and abrasion resistance (generally linked to tungsten and vanadium content often used in HSS) compared with common carbon and tool steels.

Table-1 sample used in te experiments

S.No.	Test Parameters	Test Method	Units	Specifications as per ASTM A600 - HSS M2 grade	Results
1	Carbon as C	IS 8811:1998	% by mass	0.78 - 0.88	0.86
2	Manganese as Mn	IS 8811:1998	% by mass	0.15 - 0.40	0.26
3	Phosphorus as P	IS 8811:1998	% by mass	0.030 Max	0.012
4	Sulphur as S	IS 8811:1998	% by mass	0.030 Max	0.027
5	Silicon as Si	IS 8811:1998	% by mass	0.20 - 0.45	0.35
6	Chromium as Cr	IS 8811:1998	% by mass	3.75 - 4.50	4.07
7	Vanadium as V	IS 8811:1998	% by mass	1.75 - 2.20	1.80
8	Tungsten as W	IS 8811:1998	% by mass	5.50 - 6.75	5.94
9	Molybdenum as Mo	IS 8811:1998	% by mass	4.50 - 5.50	4.91

The above chemical composition is meeting to ASTM A600 - HSS M2 grade material.

2.2 ***Cryogenic Treatment***

The CT1 sample is put into the setup of the manually made cryogenic chamber for 6 hours. For making a cryogenic chamber, the following are the steps:

1. Take a container and put a block of dry ice having temperature of -78.5C.
2. Add Iso Propyl Alcohol into the container.
3. Within 4 seconds of span the temperature of the setup drops to -50C
4. Drop the CT1 sample into the setup.
5. The working temperature lies in the range of -71C - -61C.
6. Let the sample be soaked for 6 hrs in the same setup and keep a regular check on the temperatures.

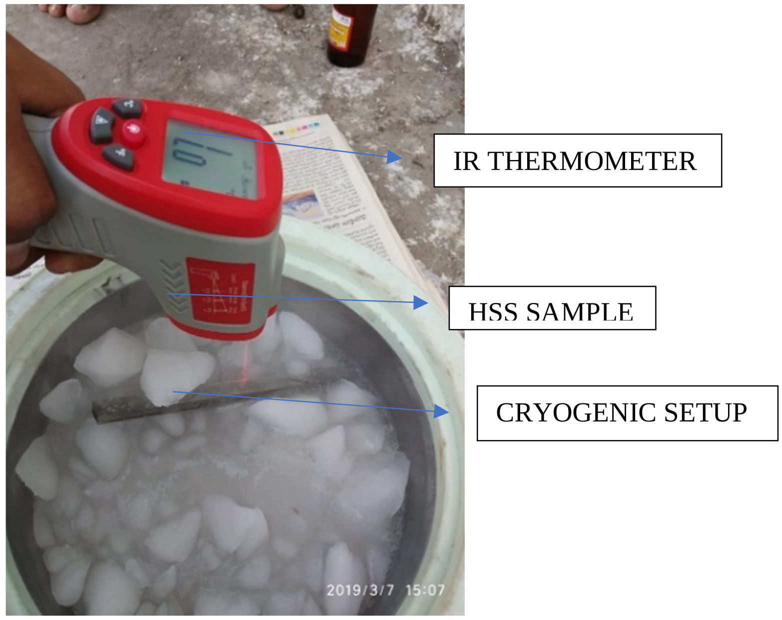

Fig-1-measuring the temperature

2.3 Heat Treatment

In materials science, quenching is the rapid cooling of a workpiece in water, oil or air to obtain certain material properties. A type of heat treating, quenching prevents undesired low-temperature processes, such as phase transformations, from occurring. It does this by reducing the window of time during which these undesired reactions are both thermodynamically favourable, and kinetically accessible; for instance, quenching can reduce the crystal grain size of both metallic and plastic materials, increasing their hardness.

In metallurgy, quenching is most commonly used to harden steel by introducing martensitic, in which case the steel must be rapidly cooled through its eutectoid point, the temperature at which austenite becomes unstable. In steel alloyed with metals such as nickel and manganese, the eutectoid temperature becomes much lower, but the kinetic barriers to phase transformation remain the same. This allows quenching to start at a lower temperature, making the process much easier. High speed steel also has added tungsten, which serves to raise kinetic barriers and give the illusion that the material has been cooled more rapidly than it really has. Even cooling such alloys slowly in air has most of the desired effects of quenching.

1. Use another HSS tool sample (HT1) and heat it into the muffle furnace up to 400C and record the time taken to heat it
2. Immediately put the heated specimen down the running water and cool the specimen and complete the quenching process.

Fig-2 muffle furnace for heat treatment

Fig-3 Quenching

2.3 Hardness test

Rock well hardness tester was used to measure the hardness according to ASTM B294-10 standard. A minor load of 98.07N was applied to set the sample and major load of 588.4 N was then applied to measure hardness for 30s duration for HRA scale. The hardness was measured for five times to get average value.

3. RESULT AND DISCUSSION

The following were the matters of discussion during the operations of the experiments:

- Determination of the temperature of the cryogenic setup at constant periods of time because of the atmospheric conditions.
- Handling of the cryogenic setup.

Table-2 comparisons of the hardness after treating the samples:

Sl no.	Type of treatment	Operation temperature	Duration of treatment	Rockwell Hardness Number
1	Quenching	400C	16mins 42secs	50
2	Cryogenic	-71C - -61C	6 hours	58

4. CONCLUSION

Based on the results obtained in this study, following conclusions can be drawn regarding the effect of different soaking period on wear characteristic and the mechanism of change in the improvement of hardness after the Cryogenic Treatment of HSS.

REFERENCES

[1] Production technology , Tata McGraw Hill Education Private Limited (2010), ISBN 13, pp. 1-60

[2] Powder Metal Technologies and Applications, ASM Handbook of vol. 7 (1998) 2334-2354.

[3] P.I. Patil and R. G. Tated, “Comparison of effect of CT on different types of steel” *International Conference In Computational Intelligence* (ICCIA), *Proceeding published in international journal of computer application* (IJCA), (2012) 10-29

[4] S. Singh Gill , H. Sing, J. Singh and R. Singh, “Cry processing of cutting tool materials -Review”, *Springer- Advance manufacturing technology*, (2009) 175-192

[5] S. B. Chaudhari, S. P. Shekhawat , A. S. Kushwaha, “Advance Technology Of Cryoprocessing For Enhancement Of Tool Material Machining Characteristics:-A Review” , *International journal of*

emerging technology and advance engineering, vol.-2, (2012) 612-620

[6] P. Baldissear and C. Delprete,) "Deep Cryogenic Treatment: A bibliographic review" *Open mechanical journal* (2008) 1-11

[7] R. Sing and K. Sing, "Enhancement of tool material machining characteristics with CT-Review", *International conference on industrial engineering and operation management Dhaka Banladesh,* (2010)

[8] C.L. Gogte, D. Peshwe, R. Paretkar, "On the presence of eta in cryogenically treated high speed steel" , *Advance Material Research,* (2013) 356-359.

[9] H. A. Stewart, "Cryogenic Treatment of tungsten carbide reduce tool wear when machining of medium density fiberboard", *Forest product journal,* vol.-52 (2004) 53-56

[10] A. Y. L. Yong, K. H. W. Seah, M. Rahman , "Performance of cryogenically treated WC-Co tools in milling operations" Advance Manufacturing, (2005) 638-643

[11] A.Y.L. Yong, K.H.W. Seah, M. Rahman, "Performance evaluation of cryogenically treated [-185º C] WC-Co tools in turning operation" , *International Journal Of Machine Tools And Manufacturing,* (2006) 2051-2056.

[12] S.S. Gill and R. Singh, "Wear behavior of cryogenically treated WC-Coinserts under dry and wet turning conditions", *International Journal Of Machine And Tools And Manufacturing* , (2009) 256-260

[13] B.R. Ramji, H. N. Narasimha Murthy, M. Krishna,) "Performance analysis of cryogenically treated carbide drills in drilling white cast iron" *International Journal Of Applied Engineering Research,* vol.1 (2010)

[14] S.S. Gill, J. Singh, H. Singh and R. Singh,) "Metallurgical and mechanical characteristics of cryogenically treated WC-Co [WC– Co]", *Springer-International Journal Of Advance Manufacturing Technology,* (2012) 119-131

[15] N. S. Kalsi, R. Sehgal, V. S Sharma ,) "Effect of tempering after CT of tungsten carbide-cobalt bounded inserts", *Bulletin of material science* , vol.37, (2014) 327-335

[16] Element of X- ray Differaction by B.D. Cuttity, *Addidon –Westey Publication,* University Of Notre Dane, USA

[17] N. A. Ozbeka, A. Cicekb, M. Gulesinc, O. O zbekd, *Elsevier* , (2015)

[18] B.R. Ramji H. N. Narasimha murthy M. Krishna "Analysis of forces, roughness, wear and temperature in turning cast iron using cryo treated carbide inserts" , *International journal of science and technology,* (2011) Vol-2 pp. 05-113Jon Rusell Mckey patent on Method of CT of WC-Co contain cobalt Publication Number US 2004/0175284 A1 (2004).

[19] C. Gotgte, D. Peshwe, A. Likite , S. Lomte " On the mechanism of the effect of the cryogenic treatment on high speed steel" *Advance material researches,* (2012) page 7138`