



EFFECTS OF CRYOGENIC TREATMENT ON TOOL STEEL AISI-D6

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Abstract

In present technological modern age. All the manufacturers adopt that process which governs to higher productivity that has been achieved by the various treatment of tool steel. These conventional processes improve no of characteristics to fulfill desired purpose. But all these process does not provided fully satisfaction from conventional heat treatment process. Thus a new process is being additionally employed for improving mechanical properties called cryogenic treatment process or sub-zero treatment of tool steels. During this process tool steel is proceed below Atmospheric tem. That is in minus about (-196⁰ C or 310⁰ F). Due to cooling, steel alter their mechanical properties like wear resistance, Hardness, toughness, fatigue life micro-structure alteration etc. Cryotreatment not only improve its mechanical properties but also improve thermal properties, electrical properties & easier machining etc. in this paper cryogenic treatment of tool steel AISI-D6 is perform and study is made for wear-resistance, Hardness, toughness, with respect to untreated test specimen of same, we have got improved wear-resistance capacity improve hardness as well as toughness.

Keywords – AISI-D6 tool steel, cryogenic process, wear resistance, Hardness, Toughness.

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1. INTRODUCTION

Cryogenic treatment process is associated with the Heat treatment process. Additionally throughout this process work piece is processed in the presence of liquid nitrogen below Atmospheric tem. Or -196°C (310°F) the cryogenic technology established process for the production of tool steel for the most different technical application (1-4). In previous duration of technology Heat treatment of steel was done to achieved improved wear-resistance capacity improved toughness, stress relieving also. All the properties are improved but their Austenitic crystal structure remain same after the process which is soft in nature. After applying the cryo-treatment Austenite is permanently transform into the martensite structure which represent permanent change in micro structure. This martensite structure definitely increased wear-resistance capacity, toughness, microstructure relieve all the stress thus mechanical property is in increasing order Basically All these improved characteristics are result of formation OR transformation of martensite from Austenite structure which is soft phase of iron and carbon atom {8}. This un-transformed Austenite is Brittle and lack of undurability, which allows the metal to break under minimum application of loads. Due to phase transformation conversion of Austenite to martensite take place, which has tetragonal crystal structure martensite is Harder material (appear carbide) having a high wear resistance Better stability, represent- better resistance to plastic deformation due to closed packed iron atoms with the carbon atoms. Cold treatment is generally classified as either sub-zero

treatment or sleep cryogenic treatment. After cryo-treatment. We can controlled the desired property that is not eliminated through conventional heat treatment, getting reduced tool consumption and now time for equipments setup thus leading to cost reduction of about 50%. The

Greatest improvement in properties is obtained by selecting proper heat treatment process sequence, soaking time, stabilization, hardening temperature, heating and cooling Rate [7, 8, 9, 10]. The cryogenic treatment is conducted on tool steel margining material tool, cost steel carburized. This process is also used in Aircraft automobile industries as well as many others area to enhance mechanical process application. Cryogenic processing (CP) is presently employed in the field like aero-space & manufacturing industries sports and music industries fire arm etc. In the last decade a good no of Investigators have been directed to improve the tribological properties like wear resistance of steel die steel by cryotreatment. Treatment of tooling is a proven technology to increase war resistance. Extent interval between component replacements for dies, punches, drill bits end mills cutter. Bearing cams crunch-shaft blocks pistons blades etc. controlled C.P. is commonly applied in between conventional hardening and tempering for tool die steel.² AISID₆ tool steel process high wear and abrasion resistance, high alloys contents excellent dimensional stability. Following are the major field of application measuring tool, blanking dies, forming dies, coining forming rolls, master tool, shear blades intricate punches, wear parts, mill rolls etc.

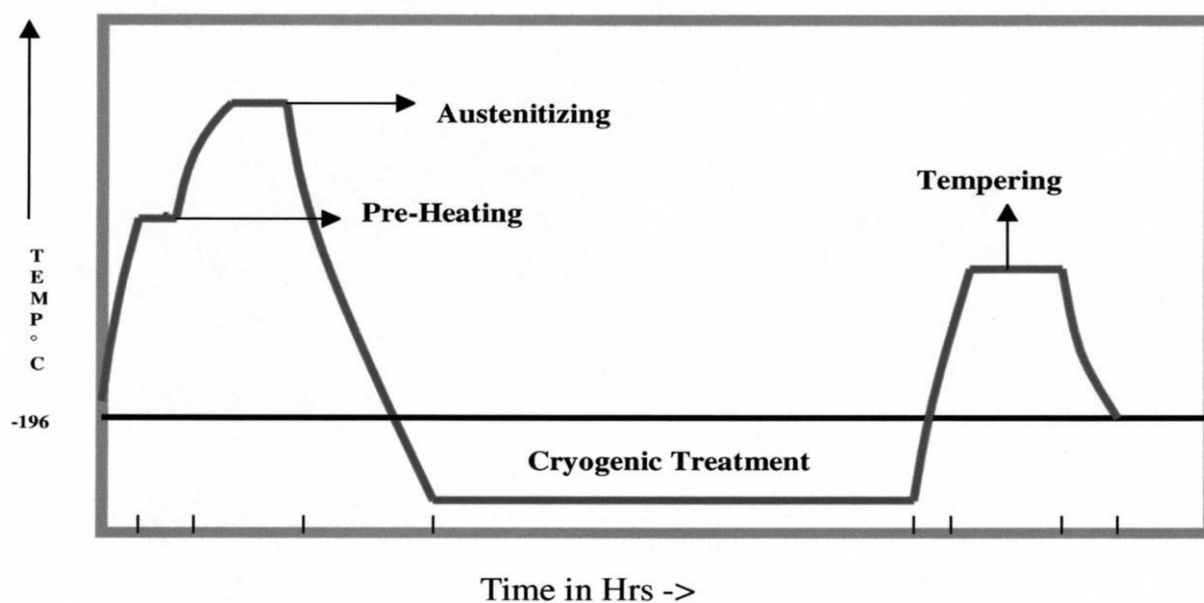


Fig1.Cryogenic Treatment Cycle

2. CRYOGENIC TREATMENT PROCEDURE OR METHODOLOGY

In this paper test specimen of AISi-D₆ is processed length of atom (20mm Dia & 45 mm length) has been taken, the liquid N₂ as generated from the N₂ plant is store & storage vessels with the help of transfer lines it is directed to a closed vaccum evacuated chamber called freezer through the nozzles. The supply of liquid N₂ into the cryo-freezer is operated with the help of solenoid valves. Inside the chamber gradual cooling occurs at a predefined rate/min of the room temperature of supply of LN₂. For cryotreatment cryoprocessor is

used which can employed for cooling at shallow subzero, deep subzero, cryogenic treatment having a computerized software program that control LN₂ flow through solenoid valve as per the demand OR rate at which it requires. When LN₂ enters the cryo-processor, it gasified immediately through multi hole slitter & cooling of spacemen takes place. Temperature both is sensed using Resistance temperature detected. Which provide online feedback of temperature of the both to regulate flow of liquid Nitrogen the schematic diagram is given below.

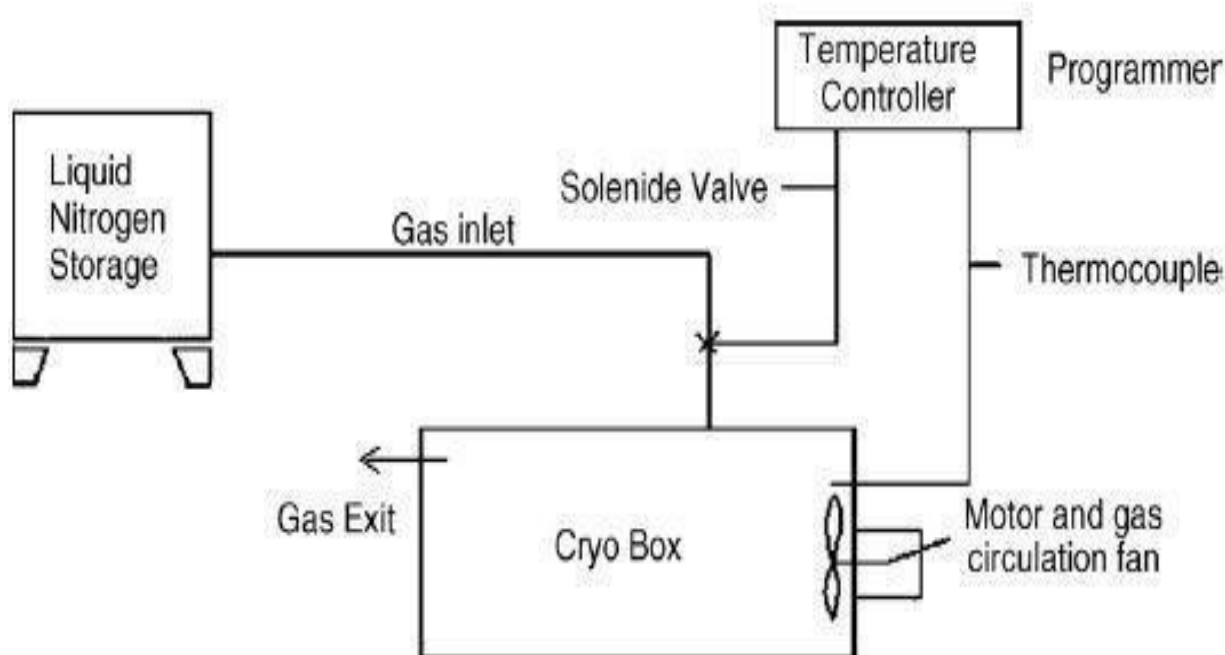
-187⁰C. Once the subzero temperature is reached specimen hold up to 36 Hrs in cryo- freezer with continuous



Fig 2.Cryoprocessor

In the present work the specimen were cryo treated – 187⁰C, the soaking time was selected 36 Hrs the both was allowed to cool down slowly (rate3-4⁰C/min) to avoid thermal shocks. After completing

te above process, specimen left to adopt room temperature for about 24 Hrs. a ray diagram gives a clean vision of the process.



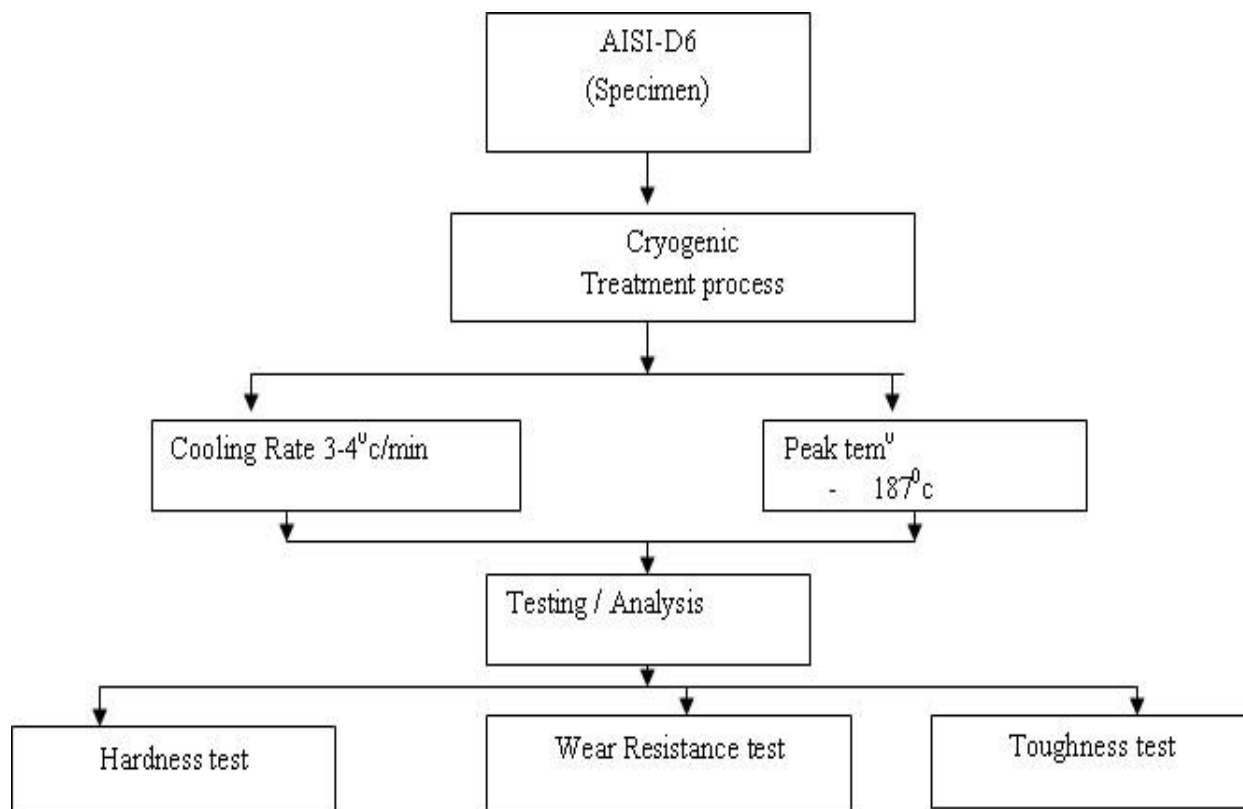


Fig 3. Ray Diagram for Process

2.1 Hardness Testing

Hardness testing of AISI-D6 specimen has been done on a about 745 (VHN) after cryogenic

treatment & Before 720(VHN). vicker hardness testing machine. Hardness is initiated with minor lead 20Kg & major lead of 1200 Kg Hardness is

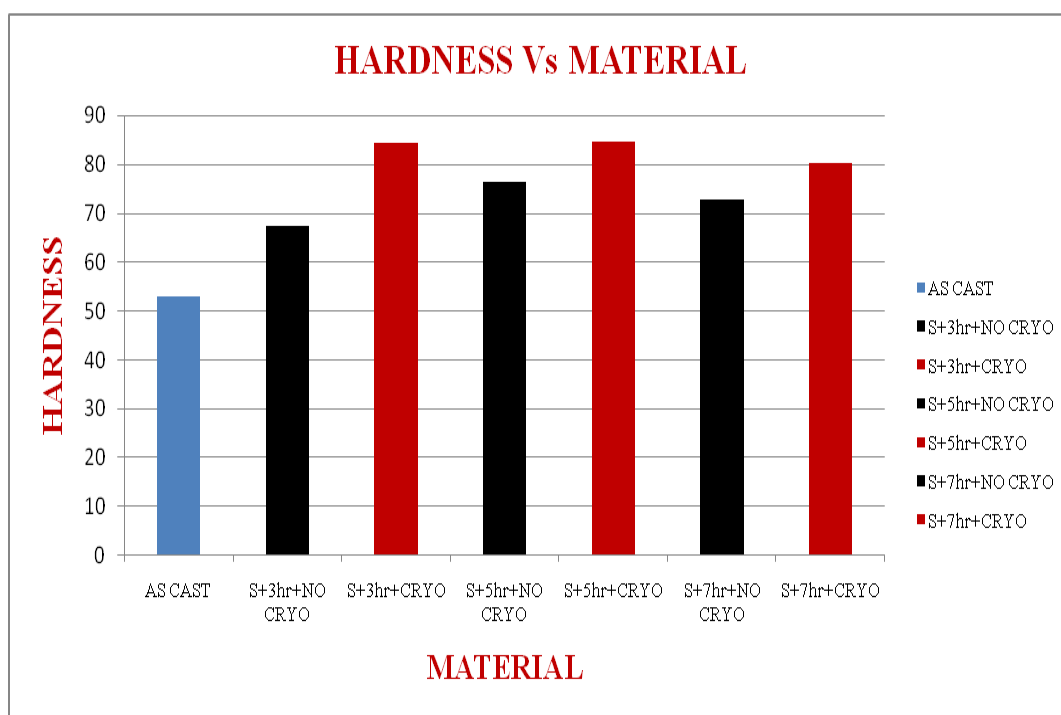


Fig 4. Hardness V/s Load Graph

S.No.	Specimen	Impact Energy(N-m)
1	AS CAST	2.42
2	S+3hr+ NO CRYO	3.16
3	S+5hr+NO CRYO	4.07
4	S+7hr+NO CRYO	4.96
5	S+3hr+ CRYO	2.83
6	S+5hr+CRYO	3.64
7	S+7hr+CRYO	4.38

Table1.Specimen Vs Impact Energy

2.2 Wear Test-

Wear test is investigated for AISI-D₆ I which Disc-&-Pinion method is applied following are the test details govern to this test

S.No.	Normal Load (Kg,N)	Pressure (Mpa)	Velocity V(m/s)
1.	3.1, 30.41	0.4573	1.5
2.	3.1, 3041	0.4572 ↑	2.5
3.	5.1, 50.03	0.7528 ↑	1.5
4.	5.1, 50.03	0.7523	2.5

Wear rates is calculate with help of volumetric method, it is observed that the cryogenically treated specimen have in less wear as compared to conventional heat treatment specimen for conventional heat treatment volume removed is about 10385mm² & 1.692mm³ In case of cryogenically- treated tool steel D-6. Since several researchers' support to the cryogenic treatment process because it improves wears resistance of the material or metals. Throughout the cryo- treatment. All the remaining austenite converted into martensite which has improved crystal structure & their performance.

2.3 Toughness

Toughness test is performed by charpy testing method. It is nothing but also a property of metal to absorbed a energy up to before failure. Toughness of AISI-D₆ is improved due to reduction in retain austenitic decreases & improvement of martensite increases.

3. RESULT & CONCLUSION

Cryogenic treatment procedure is real supplementary process for alerting the mechanical properties of tool steel. Because it transform the Austenite to marten site. Thereby Hardness wear resistance as well as toughness is increases. It is best method should be applied after conventional heat treatment procedure.

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