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Researh Paper on Use of Material D3 for Developing Spindle and Determining the Life of Spindle

Sameer S Pawar
Nashik, India

Abstract:- The spindle used here is mainly used in high rpm operations and where heat is produced immensely. The speed of about 2800-5600 rpm induces heat and the to and fro motion of the spindle causes its walls to brush against the cage bearing balls surfaces which are mainly made up of carbide. Due to this the problem of indentation arises after a considerable time period on materials which are used in developing the spindle. This spindle problem came to attention after observing ball bearing indentations on the spindle surfaces which became visible as the time progressed. The original spindle costs very high as it is imported, so it was decided to develop a spindle in house. This indented spindle can be brought into use again by another method which is hard chrome plating, but the life of this spindle is not as much as the original one and have to be reground and re-chrome plated till the spindle can suffice. Thus the study made observations that the original spindle after indentation is not suitable for use and cause disruption in process parameters and the actual production process is hampered. The study was made by visualization and hand feeling of the indentation, the decision of new spindle developed in house resulted into a far greater efficiency of the spindle and costs much less than the original one and gave better reliability and durability than the chrome plated spindle.

I. INTRODUCTION

The spindle shown in figure. Is a standard part which is used as a tool holding device in a rotary indexing machine the dimensions of the spindle are as follows-

L: 240mm
Diameters- 42mm
Id: 34mm
Other useful dimensions: 10mm holes, 4 nos

This particular alloy needs heat treatment before being used. This heat treatment ensures good durability of the material in any working conditions on par with the normal. As observed the other oil hardened steels an alloy steels do not give the needed output of life span of the spindle, due to low content of carbon and elements like chromium, manganese and vanadium.

These all elements result in hardening of the steels and increases their durability by many folds. Thus composition of the spindle matters and a very decent composition is of d3 where all these elements are close to the ratio of what is required.

II. METHOD

A. Procurement of Raw Material
B. Turning
C. Facing
D. Drilling
E. Counter Boring
F. Heat Treatment
G. Surface Grinding

A. Procurement of Raw Material

The raw material is procured in the form of a bar of size this bar is processed for de burring and cut into the required size of the material procured is d3 which is not season hardened.

B. Turning

Turning is performed on the bar to reduce its diameter to the required size and bring the required finish for further operations

C. Facing

The facing operation is done to reduce the size of the spindle to the required length.

D. Drilling

Drilling is done using carbide drills of given sizes

Through drilling is performed on the spindle as per the requirement.

The hole sizes are: 40mm, 34 mm

E. Counter Boring

This is done to achieve a particular fastening requirement for the spindle to hold the stud and the tool.

F. Heat Treatment

This is done after the process mentioned above but before the cylindrical grinding process. This is because the hardened steel can be machined for cylindrical grinding but cannot be drilled and turned or facing cannot be done due to its increased hardness.

D3 steel is LIQUID-quenched; small parts can be gas quenched after austenitization using vacuum chamber. As a result, tools made with type d3 steel tend to be brittle during hardening. Type d2 steel is the most commonly used steel among the group d steels. The d3 steels contain 1.6 to 2.45% of carbon and 12.48% of chromium. D3 tool steel requires hardening and tempering to achieve the best properties suitable for working. For best possible results,

the parts of D3 tool steel should be stress relieved after roughing operations. Stress should be relieved at 650°c (1205°f) for a considerable time and then normalised slowly.

➢ *Annealing*

The three stages of the annealing process are in steps as the temperature of the process increases are:

1) Recovery,
2) Recrystallization,
3) Grain growth. The first stage results in softening of the metal, removal of primarily linear defects called *dislocations* and the internal stresses are relieved. Recovery occurs at the low temperature stage of all annealing processes and before the appearance of strain-free grains. The grain size and shape do not change.[4] the second stage is recrystallization, where new strain-free grains nucleate and grow to replace those deformed by internal stresses.[2]

➢ *Tempering*

Tempering is accomplished by controlled heating of the oil quenched work-piece to a temperature below its "lower critical temperature". This is also called the lower transformation temperature or lower arrest temperature; the temperature at which ferrite, cementite and austenite begin to combine under the ongoing process. Heating more than arrest temperature can destroy the phase of the material called as martensite so to avoid this, it should heated below this temperature. [3]

When tempering is performed the elements like chromium, vanadium, and molybdenum combine with the carbon. If the steel contains fairly low concentrations of these elements, the softening of the steel can be delayed until much higher temperatures are reached, when compared to those needed for tempering carbon steel. This specific process allows the steel to be hard in very high temperatures and high friction applications. This requires very high temperatures during tempering, to achieve a required softness and plasticity. If the steel contains large amounts of these elements, tempering will produce hardness continuously until a specific temperature after this the hardness will start to decline and will be taken over by softness in the material.

➢ *Hardening*

Hardening is metallurgical process used to increase the hardness of a metal. The hardness of a metal is directly proportional to the uniaxial yield stress at the location of the imposed strain. The harder the metal is the more it will be brittle and the less it will be plastically deformed.

A diffusion less transformation is a phase change that occurs without the long-range diffusion of atoms, homogeneous movement of many atoms that results in a change in crystal structure. These movements are very small, generally less than the interatomic spaces, the ordered movement of large numbers of atoms led some to refer to these as military transformations in contrast to civilian diffusion-based phase changes. [6]

ELEMENT	CONTENTS
C	2.01-2.42
Mn	0.62
Si	0.62
Cr	11.10-13.40
Ni	0.35
W	1.00
S	0.03
Cu	0.25
P	0.04

Table 1:- Standard Chemical Composition

PROPERTIES	METRIC	IMPERIAL
DENSITY	7.775X1000 Kg/m^3	0.278 lb/in^3
MELTING POINT	1422°C	2590°f

PROPERTIES	METRIC	IMPERIAL
IZOD IMPACT TEST	28.0 J	21.2 FT-LB
ELASTIC MODULUS	180-205GPA	27755-30510KSI
POISSON'S RATIO	0.28-0.29	0.28-0.295

PROPERTIES	CONDITIONS T(°C) TREATMENT
THERMAL EXPANSION	12X10^6/ºC 20-100

Table 2:- Physical Properties

G. Cylindrical Grinding

Cylindrical grinding is done to improve he surface finish of the cylindrical parts. The surface finish resulting from this process is very fine and is helpful in the operations where there should be minimum friction.

III. RESULTS

The life of the spindle made from D3 gives improved life, reliability. It is cost effective as much as 30 times less expensive and no need to wait for importing. This increased the lifespan of the machine and its original components without hampering the production and reduced the hefty maintenance costs. The life of spindle increased from 6 months to 1.5 years and could even be more if scheduled proper maintenance.

IV. CONCLUSION

From this study and development we can come to the results which signifies the importance of Heat Treatment of the materials pertaining to their usage. This Material used in the development is cost effective and reliable, the material D3 I also best suitable and can be easily machined and heat treated and the availability of this metal is more than the conventional metal.

REFERENCES

[1]. https://www.azom.com/article.aspx?articleid=6215
[2]. verhoeven, J.D. fundamentals of physical metallurgy, Wiley, New York, 1975, p. 3263 steel metallurgy for the non-metallurgist by john d. Verhoeven - asm international 2007 page 99-105
[3]. 4steel heat treatment: metallurgy and technologies by George e. Totten -- crc press 2007 page 6, 200--203
[4]. steels: microstructure and properties: microstructure and properties by harry bhadeshia, Robert honeycombe -- Elsevier 2006page 191--207
[5]. d.a. porter and k.e. Easter ling, phase transformations in metals and alloys, chapman & hall, 1992, p.172 ISBN 0-412-45030-5.