



# WEAR ANALYSIS OF VARIES TEMPERED SAMPLE OF STAINLESS STEEL 420B

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**Abstract**—Stainless steel widely used because it has good mechanical property and moderate corrosion resistance. Till the date lot of research work on medical, automobile and submarine has been done, but in nuclear plant limited work on Wear and lot of more research work need to be study. (E.g. Nuclear reactor, Piston cylinder, Mixer blade). The wear analysis of a stainless steel (SS-420B) against alumina balls was investigated in nitric acid solution. The present study aims to compare the coefficient of friction of varies austenized tempered sample of SS-420B at rated temperature. Wear analysis was investigated of 300°C, 550°C, 700°C, 1020°C and degradation was observed in scanning electron microscope in 50ml Nitric acid solution

**Keywords**— Linear Reciprocating Tribometer, Wear, Scanning electron microscope, Nitric acid

## I. INTRODUCTION

Stainless Steel can be defined as iron based alloys that contain a minimum of about 12 wt.% Cr, the amount needed to guarantee a high corrosion resistance by the formation of a passivating oxide film [10]. This amount of Cr needs to be dissolved within the metallic matrix in order to ensure passivation. While the Fe–Cr system forms the basis, modern stainless steels, besides Cr, also contain other alloying elements. Martensite stainless steel that provides increase strength and hardness [1, 3]. That why will we understand mechanical properties was changed ion heat treatment [1]. In heat treatment process annealing, hardening tempering are included. Stainless steel mostly commonly used in steam generator, dental, surgical, pump shaft, plastics molds and dies, piston cylinder [1-5].

The aim of research is to analyzed the effect of autenized and tempering sample of mechanical properties based on wear morphology

## II. EXPERIMENTATION

### A. Chemical Analysis and Material preparation –

The energy dispersive X-ray fluorescence spectroscopy (XRF) is a method for measuring thickness of coatings and for analyzing materials composition. It can be used for the qualitative and quantitative determination of the elemental composition of a material sample as well as for measuring coatings and coating systems.

The Stainless steel SS-420B was analyzed by using XRF. The table 5.2 shows the results of XRF analysis. The experimental steel are performed in vacuum furnace. The chemical composition of stainless steel 420 B as shown in table

Sr. No	Element	Composition(% or ppm)
1	Si	126 ppm
2	P	212 ppm
3	V	165 ppm
4	Cr	10.9%
5	Fe	80.5%
6	Ni	0.2%
7	Cu	0.1%
8	Mo	0.1%
9	C	4511 ppm
10	S	45 ppm

A cutting sample is sealed in a quartz tube with helium gas for the austenitization heat treatment. Austenitization was done at 1020°C for 30 minutes. Tempering and annealing both processes take place on the same processing equipment and involve heating the glass to approximately 1020°C for 30 min and then air cooling will done, if force-cooling done it will create surface and edge compression. Which process is required depends on the specific application of the glass. Subsequently, the austenitized specimens were tempered at 300, 550 and 700°C for a period of 2.5h followed by air

cooling. The austenitization and tempering heat treatments were chosen based on reported studies on AISI 420B SS [1].



Fig. 1. Mini Vacuum Furnace

### B. Experimental Procedure –

The current setup is linear reciprocating tribometer setup with lubricant testing facility is available at BARC, Mumbai. The linear reciprocating tribometer is typically floor standing model, having interfaced with a PC for sequence control and data acquisition facility with software for determining frictional force and coefficient of friction to estimate the wear characteristics of a sample material. The principle is to press a top specimen against a bottom specimen under dry, lubricant (oil and water) and heated condition. The upper specimen moves in linear reciprocating motion under different conditions set with load, frequency and temperature while stroke length fixed at 0.5, 1.0, 1.5 and 2mm. The load is applied by upper specimen pressing horizontal mounted flat bottom specimen. The frequency, stroke length, temperature and test duration are input into the software, load is applied via dead weight and value is entered into the software for the calculation of coefficient of friction. After test dimensional changes/mass losses for both top and bottom specimen are used to calculate wear volume and wear rate during test.

The experiments were carried out in stainless steel (SS-420B) of varies tempered sample of 1020°C, 550°C, 700°C and 300°C of 100N load at operating speeds of 25Hz respectively. The stroke length of reciprocating tribometer is kept at 1mm. The plan is based on study of behavior of stainless steel of varies tempered sample along with constant sliding velocity and constant stroke length. The each experiment was carried out for duration of 90 minutes. All experiments are carried out at room temperature of 25°C. The experiment was carried in nitric acid solution.

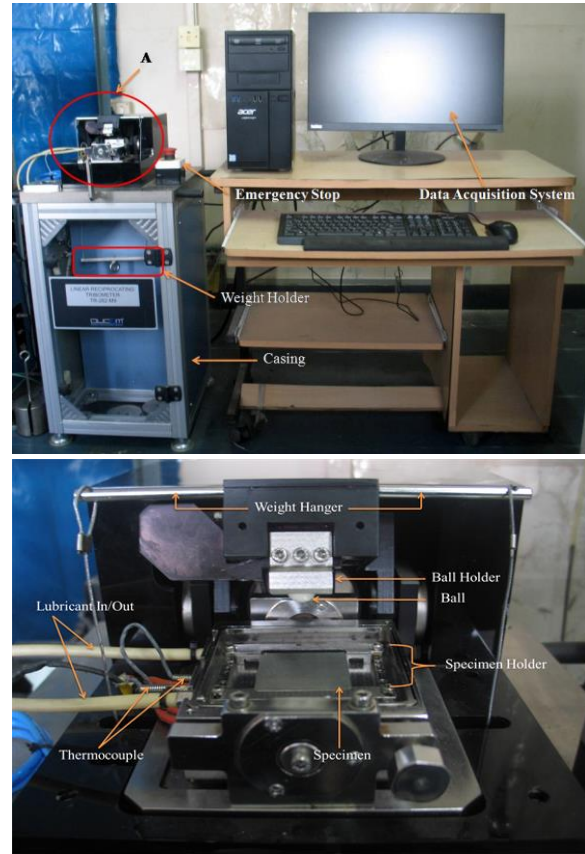


Fig. 2. Linear Reciprocating Tribometer setup

After Conducting test Mass loss measurement using precision balance measured, especially when the worn surface is irregular and unsymmetrical in shape. Sample to be measured is carefully cleaned, and the weight is measured before and after a wear test. The difference between weight before and after test represents the weight loss caused by wear.

A wear test where corrosion is a possible factor is performed after the specimen is cleaned. Volume loss rates per unit exposed area are then calculated. The value of T is obtained from these measurements. By using density and exposed area, weight loss is converted into volume loss/exposed area (mm<sup>3</sup>/mm<sup>2</sup>). The results are shown below.

$$T = \frac{Wt \text{ loss } \text{mm}^3}{[A]_e + P \text{ mm}^2}$$

Where,

$$[A]_e = \text{Exposed area (mm}^2\text{)}$$

$$P = \text{Specific density (g/mm}^3\text{)}$$

### III. EXPERIMENTAL RESULT

#### A. Wear loss result:-

The Experimental sample was tested in Linear reciprocating tribometer are result are shown in data acqusion system. For acquiring result Windicom software was used. After conducting test the Wt. loss was measured, using Wt. loss, exposed area and specific density material loss was obtained. The material loss value of all experimental sample are shown below.

Table No- 1 Experimental Result

Test sample	Wt. ball(Before)	Wt. ball(after)	Wt. before sample	Wt. after sample	Material loss T
1020 °c	1.7851	1.7851	4.1837	4.1750	8.6932*10-4
550° c	1.7851	1.7851	4.5020	4.4989	3.0975*10-4
700° c	1.7851	1.7851	5.1238	5.1209	2.8977*10-4
300° c	1.7851	1.7851	5.4384	5.4370	1.3989*10-4

From above table we will observed that material loss of 300 °c sample having minimum loss as compared to other sample. As well as 700 °c sample having material loss was also minimum compare to 550 °c and 1020°c, then 550 °c and 1020°c.

The autenized stainless steel sample having less mechanical resistance as compare to other and high rate of wear occurs after the dissolution of passive film. The wear loos and corrosive particle gets involved in rubbing surfaces and 1020°c. In stainless steel 300°c sample having good mechanical resistance and less wear was observed after conducting test.

#### B. COF Vs. Time Graph:-

The average coefficient of friction is calculated by averaging the set of stabilized data points from plot of coefficient of friction against time. The Coefficient of friction calculated in wet condition (At nitric acid) at varies temperature specimen of stainless steel SS-420B, and compare coefficient of friction is depend or not on material grain structure

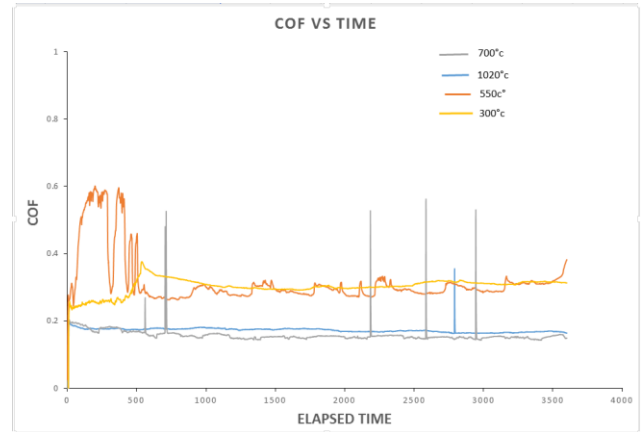


Fig. 3. Coefficient of Friction vs. Time graph

The behavior of coefficient of friction vs. time at 100N load is shown in fig.3. From fig. it has shown that the coefficient of friction 300°c sample higher than other stainless steel sample. This graph shows that higher frictional force in 300°c for 100N when load will increasing the coefficient of friction will decrease. The less coefficient of friction shows it cannot sustained the higher load at desired time because it is inversely proportional to load.

The behavior of coefficient of friction vs time against time at 100N load are very similar to results obtained under load of above fig

#### C. Worm Surface and Wear Debris Morphology:-

The test samples are analyzed by an optical microscope as well as Scanning electron microscope (SEM) with study of interest in wear track and the vicinity of wear track. From SEM we will observe pit, blow holes, starches and corrosion attack on specimen.

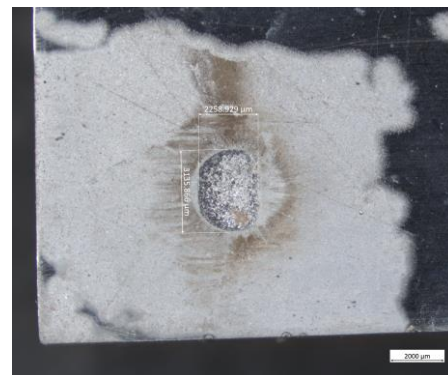


Fig (a) Material loss of 300 °c sample



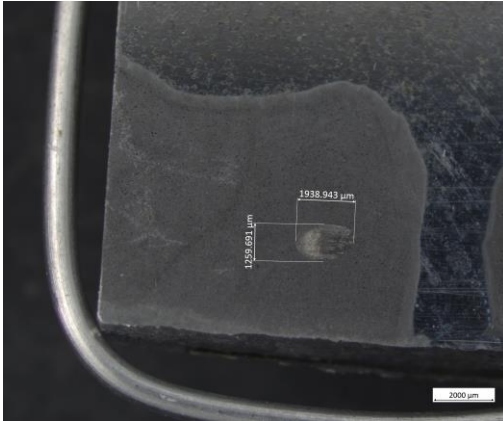


Fig (b) Material loss of 550 °c sample



Fig (c) Material loss of 700 °c sample

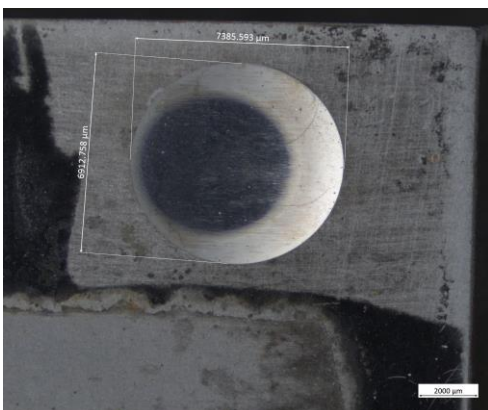


Fig (a) Material loss of 1020 °c sample

From Optical Microscope observed that 1020°C sample having high rate of wear occurs after the dissolution of passive film. The wear loos and corrosive particle gets involved in rubbing surfaces of 1020°C. In 300 °c and 550 °c having less wear are occur and less rate corrosive dissolution are occurs. In 1020 °c sample the depth of wear are also high are wear track

width are also high. In 700 °c and 300 °c sample exposed area was clearly seen, but in 550 °c and 1020 °c sample exposed area was not clearly seen. In 300 °c sample corrosion attack was clearly indicated in brown color other than sample.

#### IV. CONCLUSION

The effect heat treatment parameters on Wear was studied following conclusion:

1. A good Material loss properties are achieved of Stainless Steel (SS 420B) 300 °c and 700 °c sample.
2. The behavior of COF vs. Time Graph of 300 °c sample are higher than other.
3. From optical microscope we will observe higher width of wear track and much more wear occur of 1020 °c sample, and 700 °c sample having less wear and wear track width was achieved.

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