ANALYSIS OF THE TRIBOLOGICAL BEHAVIOR OF TEMPERED SS 420B SAMPLE AT DIFFERENT TEMPERATURE

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Abstract- The wear examination of a stainless steel (SS-420B) against alumina balls (Al_2O_3) was researched in distilled water. The study shows the correlation of Coefficient of Friction (COF) of SS 420B at various appraised temperatures of 300°c, 550°c, 700°c, 1020°c concerning load, sliding rate and time by utilizing Taguchi method. A stable COF property is accomplished in Stainless Steel (SS 420B) sample. From optical magnifying instrument we will watch width of wear track which will assist with investigating the material misfortune.

Index Terms- stainless steel, coefficient of friction, Taguchi technique, load, sliding speed, time, linear reciprocating tribo-meter.

I. INTRODUCTION

The present work covers the evaluation of Statistical techniques which gives effect of input and output parameters for material used in nuclear application. The analyses may be supported by visual/ microscopic examination. SS 420B is a highly alloyed austenitic stainless steel with the additional amount of silicon and manganese which has good mechanical and silicon properties at high s loads and temperature [5]. Due to specialized nature of nuclear reactors mechanisms, tribological data is not commonly available in literature. To evaluate the tribological data for nuclear reactor the material pair is selected as SS 420B against Alumina (Al2O3). SS 420B is compared to variety of stainless steel and other alloys it shows excellent corrosion and wear resistance.

Table 1 Properties of Materials

Properties	Value	
Material	AISI 420B SS	Alumina
Density (gm/cc)	7.8	3.9
Elastic Modulus, GPa	200	375
Poisson's Ratio	0.28	0.22

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 [7]. 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 have done, if force-cooling done it will create surface and edge compression. Which process is

required rest on the specific application of the glass [3] Subsequently, the austenitized specimens were tempered at 300, 550 and 700^{o}C for a period of 2.5h followed by air cooling [1]. The austenitization and tempering heat treatments were chosen based on reported studies on AISI 420B SS [2]. Hereafter these austenitized and tempered specimens are designated as austenitized, T300, T550, and T700 and referred so in the subsequent sections[6].Heat treatment could be any of an assortment of controlled warming activities used to change the physical properties of a metal there are five distinct kinds of heating processes. These would be case hardening, normalizing, hardening and tempering. Even though they all differentiate in results, they all share three simple steps: heating, soaking and cooling [4].

II. EXPERIMENT

The linear reciprocating tribo-meter is typically floor standing model, having interfaced with a PC for sequence control and statistics 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 sample 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 upper and lowest specimens are used to calculate wear volume and wear rate during test.

The linear moment of reciprocation is by oscillatory moment of linear actuator. The rectilinear actuator is attached on the base plate and linked to reciprocating arm. The loading is achieved through dead weight which pulls down the upper specimen and presses it against the bottom specimen. Also, the bottom specimen is seated with holder and it is in the form of shallow bath having capacity to hold lubricating oil/water. The specimen holder is clamped above the flexure with a heater block below it, heater block has a hole for location for the heat sensor used to measure lower specimen temperature. Another two-temperature sensor is provided, one for measuring lubricating temperature and another for measuring the heater temperature. Above the heater holder cooling jacket, having inlet and outlet port to pass water for cooling it is the fastened over flexure, the flexure is parallel beam arrangement and one of its beam piezo sensor is fastened to measure instantaneous frictional force. A peristaltic inflate is mounted in side panel of instrument which circulates the water to bottom specimen. The operation of instruments is by WINDUCOM 2010 software, the software has multiple screens, one screen to input test parameter for operation of test ring and simultaneously acquire sensor output to store and display on screen. The other display is for post evaluation/compare file for test result and third screen for report generation and the fourth screen for calibration of test rig.

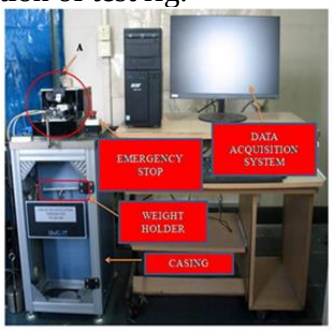


Fig. 1 Experiental setup

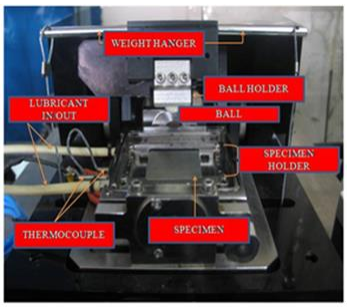


Fig. 1 Tribo-meter

To carryout tribo-consumption examination, AISI 420B SS and Alumina is chosen as plate and ball material individually. Experimentations were accomplished on rectangular shaped samples of SS-420B. Where polishing was carried on varies tempered sample i.e. 300, 500, 700 and 1050°C. The specimens of 20 mm (L) × 20 mm (W) × 5 mm (T) prepared before the experiments. Polishing should start with the rough abrasive paper of 80 grit paper and then subsequently will increase fine abrasive paper of 180, 400, 600, 800 and 1000 grit, the cleaning was conveyed in Sic (Silicon Carbide) paper until level surface was happen and eliminate defects inside the metal surface like pits, scratches, lines and scratches, the cleaning done inside a couple of moments in water has no unfriendly consequences for example and any constituents of microstructure.After polishing, they were primarily cleaned by water and soap solution and formerly ultrasonically washed with acetone used done10 min. The counterpart for this study taken is of alumina ball of Ø9.525 mm. The electrolyte for this study was taken of solution of nitric acid (HNO3) of concentration 5.0% of weight.Ultrasonic cleaners are utilized to clean several types of articles, including adornments, focal points and other optical parts, watches, dental and careful instruments, devices, coins, wellspring pens, golf clubs, fishing reels, window blinds, guns, vehicle fuel injectors, instruments, gramophone records, mechanical machine parts and electronic gear. They are utilized in numerous adornments workshops, watchmakers' foundations, and electronic fix workshops. The ultrasound can be utilized with simply water, yet utilization of a dissolvable suitable for the item to be cleaned and the kind of ruining present upgrades the impact. Cleaning ordinarily endures wherever in the range of three and six minutes, yet can likewise surpass 20 minutes, contingent upon which item need to be washed.

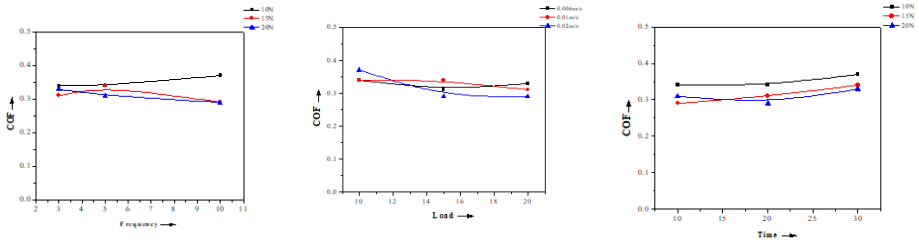
Examinations were directed dependent on the arrangement of investigations produced through Taguchi's strategy. A L27 Orthogonal exhibit was chosen for examination of the information, examination to discover the impact of applied burden, sliding separation & sliding velocity on wear rate.Taguchi practice is an optimization tool for solving design problems. Before this the initial load, time and sliding speed is decided by trial and error method. In pin on plate type experiment water is used as a lubricant. The wear test is carried out at different sliding speed, contact pressure and sliding distance. Wear rate is evaluated by experimentally and graphically. The designed plane for all SS 420 B heated at 1020°C, 700°C,550°C and 300°C temperatures is as below,

Table 2Designed Plan

Load (N)	Frequency (Hz)	Time (min.)
10	3	10
10	5	20
10	10	30
15	3	20
15	5	30
15	10	10
20	3	30
20	5	10
20	10	20

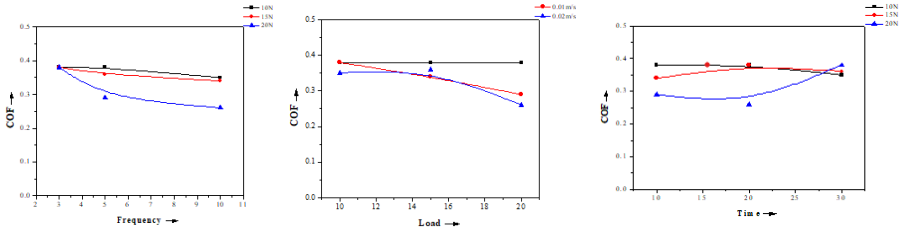
III. RESULT AND DISCUSSION

The accompanying chart is plotted for COF versus Load, frequency and time by utilizing Origin professional programming, information is collected from the WIDCOM programming which gathers the all running examination information from information acquisition framework in tribo-meter. The underneath results are for SS 420B warmed at 1020℃, 700℃,550℃ and 300℃.



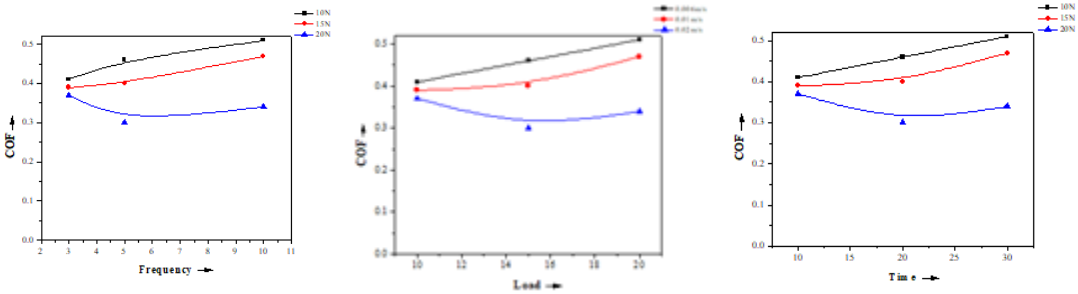
(A) (B) (C)

The chart (A) shows the connection between COF versus Frequency at 10N, 15N, and 20N separately, we can reason that as recurrence builds the COF diminishes.The chart (B) shows the connection between COF versus Load at 0.006m/s, 0.01m/s, and 0.02m/s speed separately, we can presume that as burden builds the COF diminishes.The chart (C) shows the connection between COF versus Time at 10N,15N, and 20N separately, we can infer that as time expands the COF additionally increments. The above all charts shown for SS 420B 300℃.



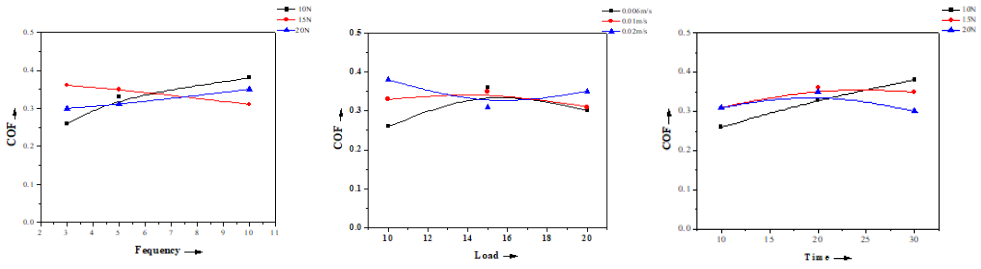
(A) (B) (C)

The chart (A) shows the relation between COF vs Frequency at 10N, 15N, & 20N respectively, we can conclude that as frequency increases the COF decreases. The graph (B) shows the relation amongst COF vs Load at 0.006m/s, 0.01m/s, & 0.02m/s speed respectively, we can conclude that as load increases the COF decreases. The chart (C)indicates the relation among *COF* vs Time at 10N,15N, & 20N respectively, we can conclude that as time increases the COF decreases. The above all charts shown for SS 420B 550℃.



(A) (B) (C)

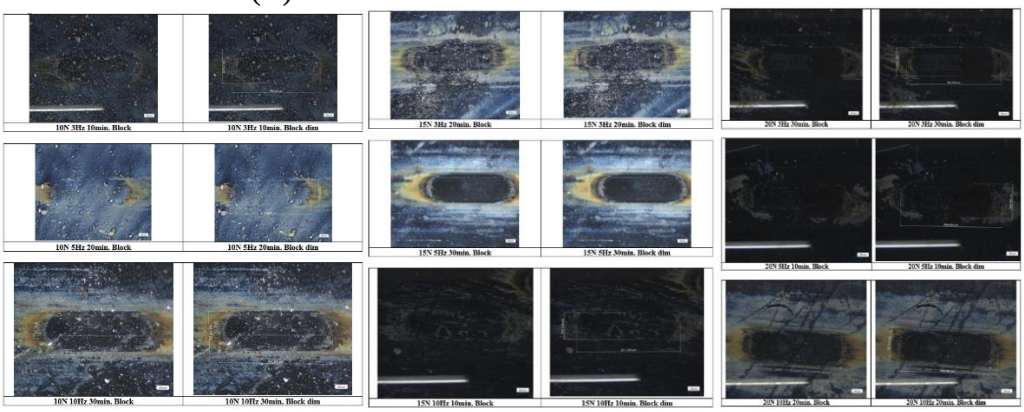
The graph (A) shows the relation between COF vs Frequency at 10N, 15N, & 20N respectively, we can conclude that as frequency increases the COF also increases. The graph (B) shows the relation between COF vs Load at 0.006m/s, 0.01m/s, & 0.02m/s speed respectively, we can conclude that as load increases the COF also increases. The grid (C)indicates the relation between COF vs Time at 10N, 15N, & 20N respectively, we can conclude that as time increases the COF also increases. The above all charts shown for SS 420B 700℃.



(A) (B) (C)

The illustration (A) shows the relation between COF vs Frequency at 10N, 15N, & 20N respectively, we can conclude that as frequency increases the COF also increases. The graph (B) shows the relation between COF vs Load at 0.006m/s, 0.01m/s, & 0.02m/s speed respectively, we can conclude that as load increases the COF decreases. The grid (C)expresses the relation among COF vs Time at 10N, 15N, & 20N respectively, we can conclude that as time increases the COF decreases. The above all charts shown for SS 420B 1020℃.

Subsequent to playing out the tests and plotting diagrams the wear scars are examination is finished by the optical magnifying lens. From this we get the 2D pictures of wear scar and furthermore get the components of the major and minor hub of wear scar framed in the curved shape. The underneath pictures are taken for SS420B, which is warmed at 300°C,550°C,700°Cand 1020°C respectively. The trial performed on various burden, diverse recurrence at various time according to the planned arrangement. Where (A) is for 10N load trials, (B) is for 15N load trials and (C) is for 20N load trials.



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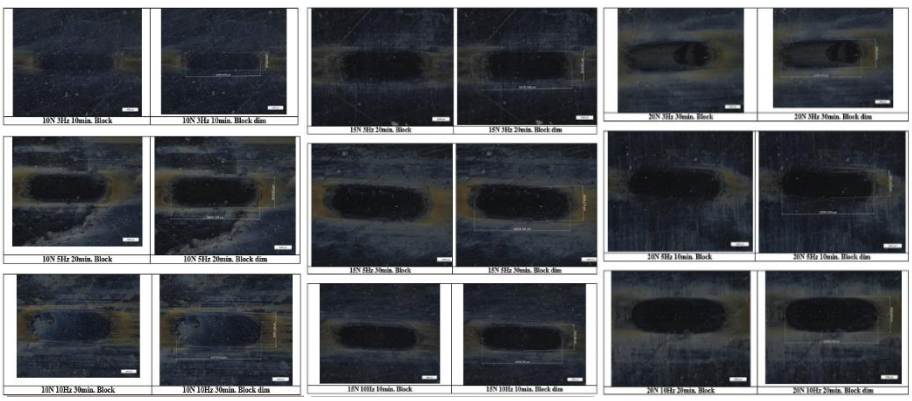

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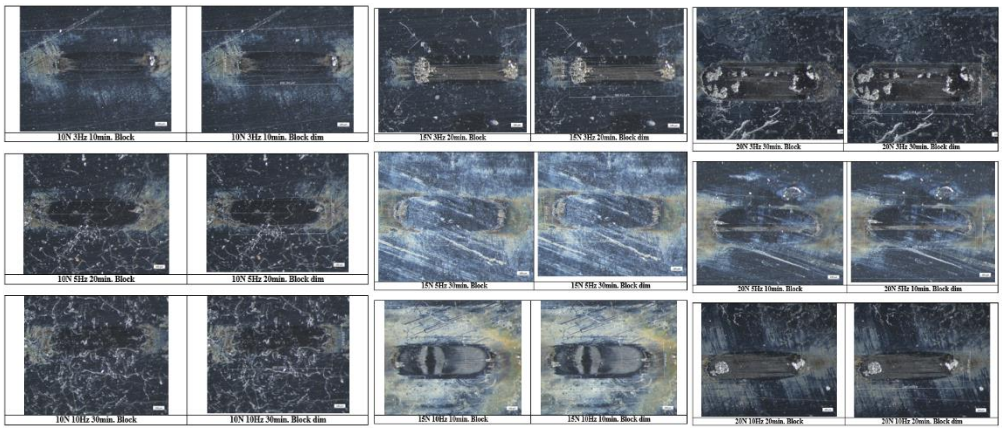

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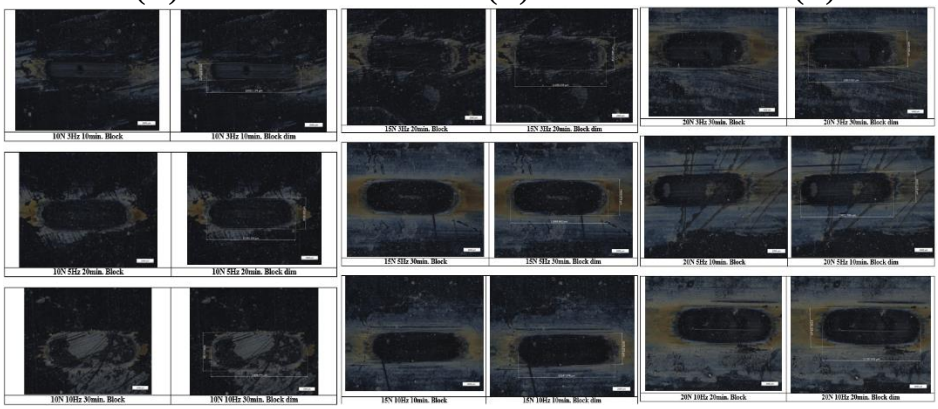

(A) (B) (C)

IV. CONCLUSION

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

1. A stable coefficient of friction properties is achieved in all Stainless Steel (SS 420B) sample expect the 700 ºc SS 420B sample.

2. The behavior of COF vs. Frequency, Load and time Graph of 700 ºc sample are much higher than other three.

3. From optical microscope we will observe higher width of wear track and much more wear occur of 300 ºc SS 420B sample, and 1020 ºc SS 420B sample where 550 ºc SS 420B sample, and 700 ºc SS 420B sample having less wear and wear track width was achieved.

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