Industrial Engineering Journal
ISSN: 0970-2555
Volume : 54, Issue 3, No.2, March : 2025

EFFECT OF NICKEL CHROMIUM CARBIDE (CR_3C_2-NICR) ON INCONEL SPECIMEN 600, 625, AND 718 BY VICKERS HARDNESS TEST, ELECTROCHEMICAL TEST, AND WEAR PERFORMANCE BY DOE METHOD

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ABSTRACT:
In this paper, we examined the effect of coated Cr3C2-NiCr of three Inconel specimens 600, 625 and 718 using electrochemical test and vicker hardness test further Design of experiment was used to investigate the effects of process parameters on the response characteristics. The effect of each parameter on both response characteristics namely the orange peel defect and DFT was studied using orthogonal array, S/N ratio and ANOVA. Optimal combination of parameters was found for optimum response characteristics. The optimum combination was verified experimentally and it was confirmed that Design of experiment method successfully improved the quality of Inconel coated specimen 625. Also linear regression equation and analysis of variances (ANOVA) showed that the main effect of coated Cr3C2NiCr of three Inconel Specimen 600, 625 and 718, load and speed variable are more pronounced on the wear behaviour of the three Inconel specimens. Also, the result showed that the Inconel 625 improved the wear resistance as compared to Inconel 600and 718 as the wear parameters such as speed, load and time varied.
Key words*:* Wear, VHN, ANOVA, DOE, Inconel Specimens 600, 625 and 718.

1. Introduction

When environmental elements oxidise a material, the result is corrosion, which results in the material losing electrons. When a substance is exposed to a certain environment, it begins to deteriorate and undergo chemical breakdown, which is known as corrosion. The ability of a metal to retain its binding energy and withstand degradation and chemical breakdown that would otherwise take place when exposed to such an environment is known as corrosion resistance. Industrial factory equipment corrosion, as well as corrosion in thermal furnaces, boiler tube applications, internal combustion engine parts, and many other automobile and industrial machines, is a serious issue because it causes periodic shutdowns and downtime, which in turn raises the cost of operating power plants and purchasing new parts for heavy machinery equipment. Numerous incidents that resulted in fatalities and/or the damage of engines and/or infrastructure were caused by the hot corrosion's inability to be completely prevented or to be detected at an early stage. In order to defend against hot corrosion in energy conversion systems and other similar high temperature applications under simulated conditions, coatings are being created with the goal of extending the life of the substrate.
A substance's hardness is determined by its capacity to withstand repeated deformation caused by events like indentation, wear, abrasion, and scrape. Because of the connection between hardness and other material qualities, hardness testing is crucial. For instance, results from the hardness test and the tensile test may be surprisingly similar when assessing a metal's resistance to plastic flow. Because it is simple, straightforward, and essentially destructive-free, the hardness test is chosen. Today, a variety of hardness tests is in use.

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The application of thick coatings to change the surface properties of the component using thermal spraying is efficient and affordable. Coatings are utilised in a variety of applications, such as ships, aircraft engines, boiler parts, power generation equipment, automotive systems, and equipment used in chemical processes. [1]. Detonation Gun Spray and High Velocity Oxy Fuel (HVOF) Spray are the best options among commercially available thermal spray coating processes to obtain the requisite hard, dense, and wear-resistant coating. [2]. D-Gun (Detonation Gun) One of the thermal spray techniques is spraying, which provides a very strong adhesive bond, very little porosity, and a coated surface with compressive residual stress. [3]. the Detonation Gun (D-Gun) provides the maximum velocity (800–1200 m /s1) for the sprayed powders, which is not possible under plasma or HVOF conditions. Higher particle velocity during coating deposition produces desired coating properties like lower porosity and increased hardness. [4]. Inconel 625 exhibits exceptional erosion-corrosion resistance when powder coated with various metallic or non-metallic alloys. [5]. According to the literature, Inconel 600/625/718 is a popular engineering material because of its superior hot corrosion resistance, high temperature strength, and weldability. 7. Since Cr3C2-NiCr coatings have a good thermal stability; they are frequently used at high temperatures. [6] [7].
Wear characteristics of the grey cast iron composition under dry lubrication. We looked into how the wear rate of grey cast iron was impacted by sliding speed, applied stress, time, and the proportion of ferrosilicon additive. The experimental data were gathered in a methodical and organised manner. The samples' morphology and worn-out surfaces were analysed using a scanning electron microscope. The major effects of silicon additions, load, and speed factors are more pronounced on the wear behaviour of the grey cast iron, according to a linear regression equation and analysis of variance (ANOVA). The results also showed that silicon additives improved the wear resistance of grey cast iron under varying wear factors such as speed, load, and time. The wear transition allegedly occurred at a silicon increase of 3.2%, according to the study.
With an increase in load, the wear volume and wear depth rise linearly, and in general, linear wear rate and wear rate due to time grow linearly with increasing loads. As the load increases, increases the linear wear resistance, and as the linear wear resistance increases, so does the wear rate over time. Universal testing machine (UTM) and Vickers hardness tester tensile and hardness tests were performed on unreinforced aluminium alloy and composite, respectively. Taguchi and grey relational grade analysis are combined to find the best process parameters (like 10N load, 100-rpm speed, and 90°C temperature) for the pin-on-disc tribometer's lowest wear and friction rates. In comparison to speed and temperature, load is the most important parameter. S/N ratio, ANNONA, and regression mathematical modelling are used to confirm it. [8-11].

2. Experimental Work

2.1 Material Selected for the Specimens

Inconel 600, 625, and 718 substrates were chosen as substrates for D Gun coating process.

1) Inconel 600: At higher temperatures, the nickel-chromium alloy Inconel 600 has good resistance to oxidation. Inconel 600 is a nickel-chromium alloy that can withstand temperatures between 1000°C and 1200°C. Because of the alloy's high nickel concentration, it resists corrosion from both organic and inorganic substances. Inconel 600 is nonmagnetic and easily wieldable, has outstanding mechanical attributes, a combination of both good workability and high strength. Alloy 600's cold forming properties are comparable to those of chromium-nickel stainless steels. Before carrying out any heading operations on bar stock, it could be necessary analysing or stressing relax it.



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Figure 1: Inconel Specimen of 600, 625 and 718

2) Inconel 625: Inconel Alloy 625, a super alloy of nickel with the UNS code N06625, exhibits extraordinary strength and great temperature tolerance. Additionally, it has outstanding resistance to oxidation and corrosion. Due to its ability to withstand very high stress and a wide variety of temperatures, it is an appropriate choice for nuclear and maritime applications. Both in and out of water, as well as corrosion when exposed it to very acidic conditions.
Because of its high strength, great fabricatability, and exceptional corrosion resistance, Inconel nickel-chromium alloy 625 is employed. Cryogenic temperatures up to 982°C are used in service. Because molybdenum and niobium have a stiffening impact on the nickel-chromium matrix of Inconel alloy 625, precipitation-hardening procedures are not necessary.
3) Inconel 718: The nickel-based super alloy Inconel 718 is perfect for wide range of applications require a high strength over a wide temperature range, between cryogenic and 760°C. Inconel 718 also offers exceptional impact strength and tensile strength. Inconel 718 is a nickel-chromium-molybdenum alloy designed to survive pitting, crevice corrosion, as well as a number of severely hostile environments. This nickel steel alloy also exhibits extremely strong yield, tensile, and creep-rupture characteristics at high temperatures.
2.2 Nickel Chromium Carbide (Cr_3C_2-NiCr) to be coated on the Substrates: The three elements nickel, chromium, and carbon make up thermal spray powder. The nickel is alloyed with the first portion of the chromium in an alloy matrix, and the chromium is made up of a first portion and a second portion. The second component and the carbon are mixed to create chromium carbide, which is essentially in the form of precipitates that range in size from 0.1μm to 5μm and are evenly dispersed throughout the alloy matrix.

3. Detonation Spraying (D-Gun) Method

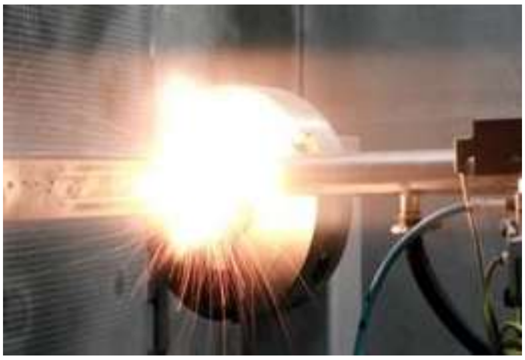

Figure 2 shows the details of the detonation spraying process.

Operation cycle of D-Gun process is as follows.
1) Feeding and mixing oxygen and fuel
2) lighting the fuel-gas combination and powder feeding
3) detonation of fuel-gas mixture, acceleration of powder
4) Creating a layer of coating on a substrate.

The present work objective is to produce a thermal spray powder made of nickel-chromium and chromium carbide that is less expensive and produces coatings that are thermal sprayed that have high temperature properties that are better than the coatings made from conventional powders of a similar composition. Other items are produced using a thermal spray powder made of nickel, chromium, and carbon that has a size that is mostly between 10 and 125 micrometres.
The nickel is alloyed with the first portion of the chromium in an alloy matrix, and the chromium is made up of a first portion and a second portion. The second component and the carbon are mixed to create chromium carbide that is essentially dispersed evenly throughout the alloy matrix as precipitates

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between 0.1m and 5m in size as Cr_3C_2 and combination thereof. Between 6 and 12% should be the chromium to carbon weight ratio.

Using alumina grits, the specimens are shot with grit at a pressure of 3 kg/cm2 (grit size of 60). For blasting, a standoff distance of between 120 and 150 mm was maintained. The substrates surfaces were roughly 5 Ra (The Ra number Represents the length of the measurement's average surface roughness) value rough. An ultrasonic cleaning system used acetone to clean the surface of the specimen that had been grit-blasted. Cleaning was followed right away by D-Gun and figure 3 and 4 shows the Inconel substrate before and after coating.

Figure 3: Inconel Substrates before Coating

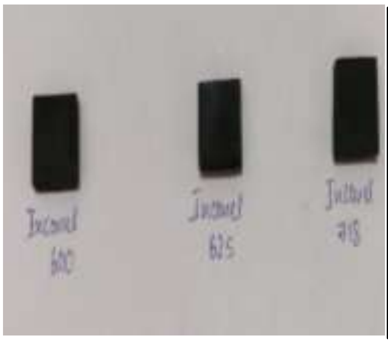


Figure 4: Inconel Substrates after Coating

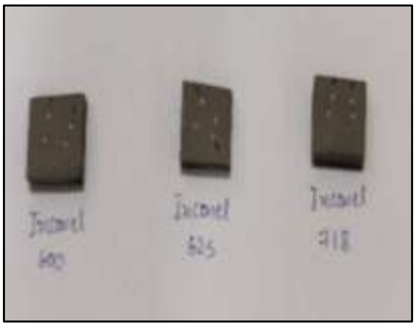
Figure 5: Tubular furnace for heat Treatment proces

4. Heat Treatment of the Coated Inconel substrates in Tubular Furnace

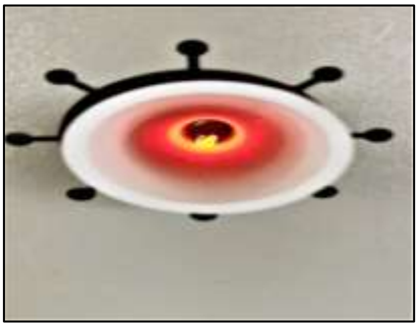
A tubular furnace is electric heating equipment is used to carry out inorganic compound synthesis and purification, as well as occasionally organic compound synthesis. One of the potential design features heating coils encircling a cylindrical hollow that are encased in a thermally insulating matrix. The feedback from a thermocouple can be used to manage temperature. The use of two or more heating zones in more complex tube furnaces for transport studies. RS232 (is an interface for the interchange of serial binary data between two devices) interfaces are offered by some digital temperature controllers, which enable the use to configure parts for sintering, ramping, soaking and other uses. Modern heating equipment to generate operating temperatures of maximum up to 1800°C, such as the molybdenum disilicide that is available in different versions. This makes it easier to use more complex programs. High-quality materials are frequently used in reaction tubes.

4.5.1 Images of the Inconel Specimens Heat Treatment

Step 1 - Heat Treatment (Before) Colour: Light Grey and Temperature: Room Temperature



Step: 2 – During Heat Treatment of the Inconel Specimens in Tubular Furnace Colour: Bright Orange and Temperature: 1000ºc



STEP: 3 – After Heat Treatment of the coated Inconel Substrates in Tubular Furnace Colour: Dark Grey and Temperature: Room Temperature.

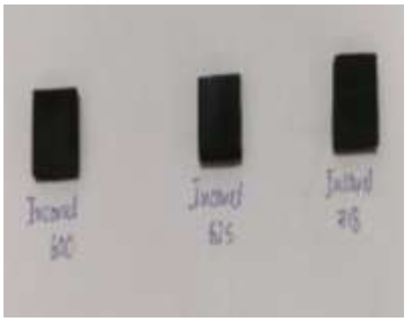


Figure 6: Nickel Chromium Carbide (Cr_3C_2 –NiCr) coated Inconel Substrates

Figure 7: Coated Inconel Specimens 600, 625, and 718 during Heat Treatment in Tubular Furnace

Figure 8: Coated Inconel Specimens 600, 625, and 718 after Heat Treatment (1000^0C)

5. Vickers Hardness Test

Hardness is the ability of a substance to resist persistent deformation, such as indentation, wear, abrasion, and scratch. Hardness testing is important because of the relationship between hardness and other material properties. A metal's resistance to plastic flow, as determined by the hardness test and the tensile test, may, for instance, yield findings that are quite comparable. The hardness test is preferred because it is uncomplicated, straightforward, and essentially destructive-free. There are many hardness tests in use today.

Figure 9: Vickers hardness test

Material	Load in kg	Vickers hardness number	Average VHN
Inconel 600	0.1	871HV	1069HV
	0.2	1013 HV	
	0.3	1323 HV	
Inconel 625	0.1	1136HV	1834.6HV
	0.2	1852 HV	
	0.3	2156 HV	
Inconel 718	0.1	886HV	1115.3HV
	0.2	1032 HV	
	0.3	1428 HV	

Table 1: VHN for coated Inconel specimen 600, 625 and 718

Hardness testing is now split into two categories: macro hardness and micro hardness. The term "macro hardness testing" refers to testing with applied stresses on the indenter of more than 1 kg, which includes, for example, testing of tools, dies, and sheet material in the heavier categories. The material being examined in micro hardness tests is very thin (down to 0.0125 mm, or 0.0005 in.), with applied stresses of 1 kg or less. Applications include plated surfaces, incredibly small parts, thin, superficially hardened sections, and individual material components.

The Vickers hardness test method is conducted and it is also referred to as a micro hardness test method, is mostly used for small parts, thin sections, or case depth work etc.

In this experiment, material used is Cr_3C_2-NiCr coated Inconel 600, 625 and 718 used. The purpose of conducting this test is to know the hardness strength of all three Inconel coated specimen.

The Vickers indenter is a diamond pyramid with a 1360 square base. This procedure is more accurate because the Vickers indenter produces a clearer impression than the Brinell indenter does. The constant load 100, 200 and 300gm is applied with a help of indenter on all three-coated Inconel specimen 600, 625 and 718 for 30 seconds. And the Average of three readings in each specimen at different places was taken and The Vickers number (HV) is noted.

The Vickers Tester typically includes a microscope that is used to measure the length of the impression diagonal. Hence, it is concluded that Inconel 625 is got good hardness as compared to as compared to remaining two Inconel 600 and 718 specimens and values shown in table 1.

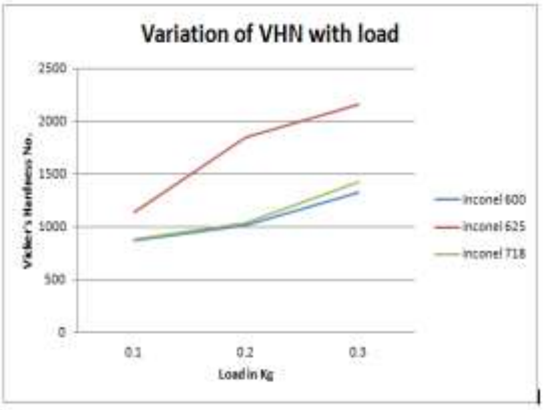


Figure 10: Variation of VHN with load

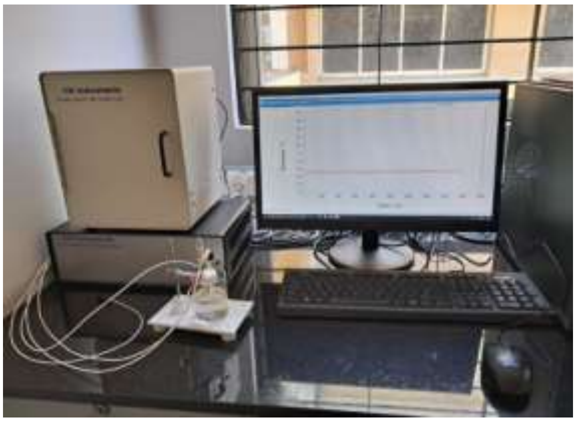


Figure 11: Electrochemical Corrosion test setup

It is concluded that the Vickers hardness number for the three different grade Inconel specimens 600, 625 and 718 coating with Nickel Chromium Carbide. The highest hardness has been observed for Inconel 625 coated substrate as shown in figure 10.

6. Electrochemical Corrosion Test

Electrochemical corrosion test is carried out (CHI660E serial -|1318 US model) on coated Nickel chromium carbide (Cr3C2NiCr) of Inconel 600, 625 and 718 specimens at room temperature to understand corrosion rate of all three-coated material. Figure 12 shows the electro chemical test setup.

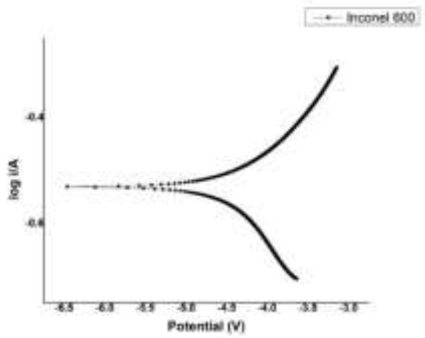


Figure 12: Tafel Polarization curve of Inconel 600

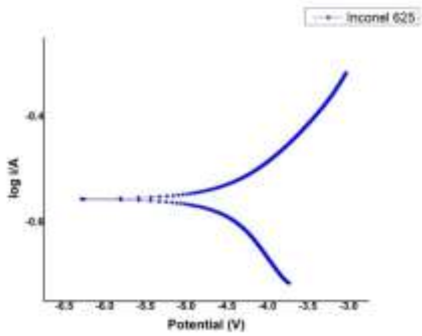


Figure 13: Tafel Polarization curve of Inconel 625

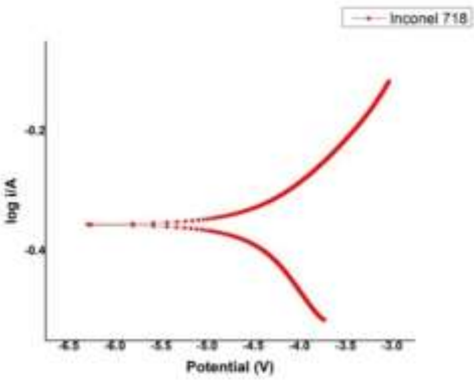


Figure 14: Tafel Polarization curve of Inconel 718

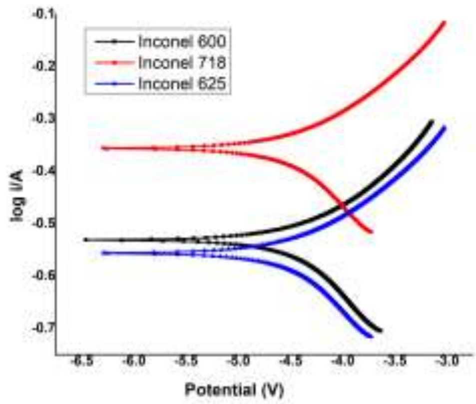


Figure 15: Comparison Tafel Polarization curve of Inconel 600, 625 and 718

Figure 12, 13 and 14 shows the Tafel polarization curve and Figure 15 shows the comparison of corrosion rate and it is clear that Inconel 625 has a lower rate of corrosion. as compared to other Inconel 600 and 718.

Electrochemical test were conducted in the NaCl solution with 3.5 wt % concentrations at room temperature. Before conducting, the specimens were cleaned as per ASTM standard G1-90 using emery paper and polished on 1cm2 areas on all three specimens and then corrosion rate is examined of all three-coated specimen and At the end of the test corrosion rate was calculated in miles per year (mpy) of all three Inconel specimen. i.e found corrosion rate less in Inconel 625 (1.76 mpy) than other two specimens that is in Inconel 600 (7.85 mpy) and 718 (7.35 mpy) The electrochemical behavior of the coated all three specimen is studied by means of Tafel method and electrochemical impedance spectroscopy.

7. Analysis of Optical Microstructure of Inconel 600, 625 and 718

Optical Microstructure analysis was carried out on the NIKON Epiphot 200 model this machine has a spatial resolution of 2.8m and focusable lens of 12mm with a 1920x1080 high-resolution monitor. The Optical microstructure is the most common and basic instrument for analyzing surface microstructures in sample specimens. And the micrographs of the specimens were analyzed with various magnifications (100X, 200X, 500X).

Figure 16: Optical microstructure (NIKON Epiphot 200 model)

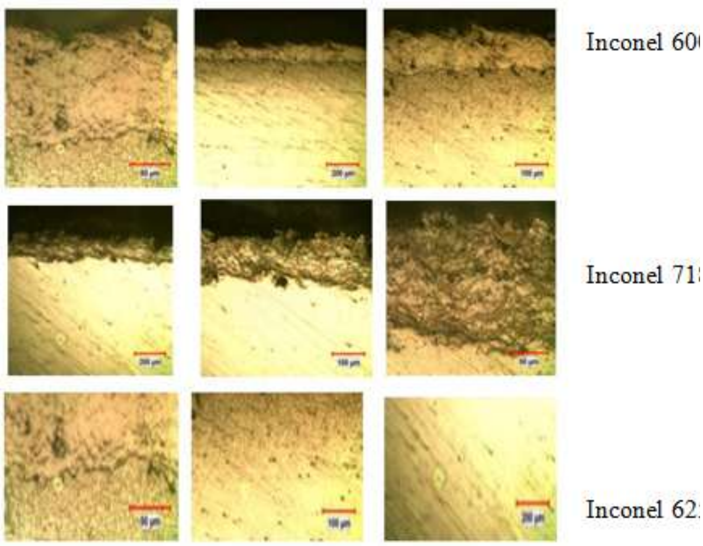


Figure 17: Optical micrographs showing microstructures of coated Inconel 600, 625 and 718

Microstructures and porosities of the samples were observed under optical microscope. For porosity measurement, a cross section images were taken for different magnification from the coating region of all three specimens, observed the porosity levels of all three specimens, and found the Inconel 625 coatings is lower porosity than Inconel 600 and 718 specimens.

8. Tensile Strength

Figure 18: Fractured tensile specimens

Table 2: UTS versus loading rate mm/min loading rates tested at room temperature (30°C).

Expt. No	Inconel	Loading Rate (mm/min)	Tensile Strength (MPa)
1	Inconel 600	200	670
2		400	708
3		600	695
4		800	688
5		1000	714
6		1200	700
7		1400	667
1	Inconel 625	200	700
2		400	780
3		600	755
4		800	735
5		1000	840
6		1200	760
7		1400	728
1	Inconel 718	200	700
2		400	750
3		600	730
4		800	715
5		1000	762
6		1200	710
7		1400	685

The Table 2 gives the details tensile strength of Cr_3C_2-NiCr coated Inconel substrates. The achieved tensile properties, particularly the elongation values, are comparable to those of the fully age-hardened bar although being somewhat lower Different crystallographic textures, grain sizes, and the shape and distribution of precipitates and other defects are frequently blamed for variations in tensile performance.

The degradation of the plastic behaviour of the deposited material in contrast to the base metal can be attributed to the other reasons indicated since changes in crystallographic texture were not seen in the current investigation. Additionally, it might be caused in part by the variation in the number of twin

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ISSN: 0970-2555
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boundaries, while scarcely any were observed in the coating, the substrate was found to contain a significant number of twin boundaries. These twin boundaries are the result of the deformations that occur during the forging process, which enhances the base's plastic nature. Coated Inconel 625 which measured 780MPa displayed the maximum tensile strength and highest UTS. The homogeneous coating on the substrate that provides additional strength may be the cause of the tensile strength.

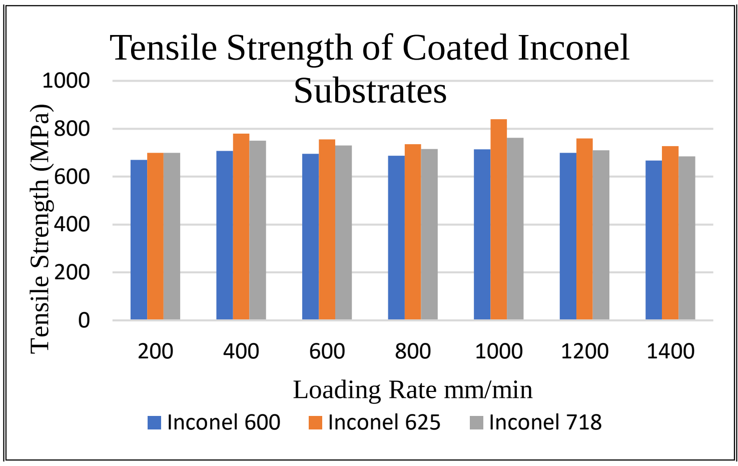

Figure 19: Comparison of Tensile Strength of Coated Inconel Substrates

From table 3 it is observed that Inconel 625 specimen has achieved high strength compared to remaining two Inconel specimens 600, 718, and same as showed in figure 19.

9. Analysis by Design of Experiment (DOE) Method

In this approach, the experimental data is converted into an S/N (signal to noise) ratio. The lower-the-quality characteristic was adopted in this study as a result of the investigation of the particular wear rate of Inconel Coated 600, 625 & 718. For each level of process parameters, the S/N ratio is calculated. Statistical analysis of the variance is conducted to determine the statistical significance of the parameters. The best combination of test parameters is predicted in Table 3.

Table 3: Response and S/N ratio of Inconel 600, 625 and 718

SL No	Inconel	Speed, rpm	Load in N	WR (mm3/m)	WRP ((mm3/m)	S/NRA	S/NRAP	PER error WR	PER error SNR
1	600	200	10	0.0084	0.0080741	41.514414	42.436755	4.036697248	-2.173447743
2	600	200	20	0.0099	0.0099185	40.087296	40.259336	-0.186706497	-0.427329304
3	600	200	30	0.0141	0.0144074	37.015618	35.921237	-2.133676093	3.046611759
4	600	300	10	0.0051	0.0061519	45.848596	44.12315	-17.09813365	3.910525277
5	600	300	20	0.0069	0.007463	43.223018	42.513389	-7.543424318	1.669191018
6	600	300	30	0.0114	0.0097852	38.861903	41.29698	16.50264951	-5.896500435
7	600	400	10	0.0043	0.0035741	47.330631	48.133737	20.31088083	-1.668489237
8	600	400	20	0.0056	0.0050185	45.036239	45.573829	11.58671587	-1.179601827
9	600	400	30	0.0065	0.0078074	43.741733	42.401037	-16.74573055	3.161941411
10	625	200	10	0.0042	0.0050741	47.535014	46.171033	-17.22627737	2.954192098

11	625	200	20	0.0071	0.0071185	42.974833	42.959101	-0.260145682	0.03662143
12	625	200	30	0.0095	0.0086074	40.445528	41.825241	10.37005164	-3.298757432
13	625	300	10	0.0051	0.0040519	45.848596	47.732827	25.86837294	-3.947452728
14	625	300	20	0.0062	0.005563	44.152166	45.088553	11.45139814	-2.076772257
15	625	300	30	0.0032	0.0048852	49.897	47.076383	-34.49583017	5.991576162
16	**625**	**400**	**10**	**0.0027**	**0.0028741**	**51.372725**	50.852475	-6.056701031	1.023056949
17	625	400	20	0.0039	0.0045185	48.178708	47.258054	-13.68852459	1.948142695
18	625	400	30	0.0051	0.0043074	45.848596	47.289501	18.40068788	-3.046985227
19	718	200	10	0.0069	0.0063519	43.223018	43.664659	8.629737609	-1.011436561
20	718	200	20	0.0077	0.007663	42.270185	42.113878	0.483325278	0.371154859
21	718	200	30	0.0068	0.0073852	43.349822	43.064489	-7.923771314	0.662570536
22	718	300	10	0.0063	0.0062963	44.013189	43.854405	0.058823529	0.362070527
23	718	300	20	0.007	0.0070741	43.098039	42.871282	-1.047120419	0.528924912
24	718	300	30	0.0047	0.0046296	46.558043	46.943584	1.52	-0.821285335
25	718	400	10	0.0043	0.0048519	47.330631	47.047774	-11.3740458	0.601211105
26	718	400	20	0.0058	0.005763	44.73144	45.114505	0.642673522	-0.849094096
27	718	400	30	0.0043	0.0037852	47.330631	47.230423	13.60078278	0.212168652

Level	**INC**	**Speed (rpm)**	**Load in N**
1	0.008022	0.008289	0.005256
2	0.005222	0.006211	0.006678
3	0.005978	0.004722	0.007289
Delta	0.002800	0.003567	0.002033
Rank	2	1	3

Table 4: Response Table for Means

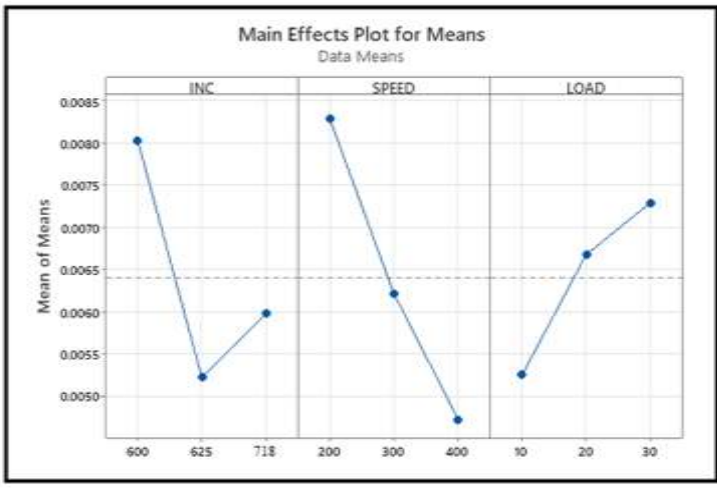

Figure 20: Main effect plot for means–wear rate

This is caused by the variance in the amount of time the spent in contact with the counter face. The contact period between interacting objects at 200 rpm.
Surfaces are greater increasing the specimen's surface contact with the counter face. as aresult, a high

wear rate is projected and recorded in the graph, Inconel Material ranks second, and load is exhibiting less impact.

Table 3 lists the rate of wear as determined by sixteen experimental runs using the L27 orthogonal array. Using the equation below, the signal to noise ratio (S/N) of matching test runs is determined for the smaller the better feature of the response variable, wear.

$SN = -10\log[1(\Sigma y2)]$ -------------------------------------[1]

Where n is the number of observations for a test run and y is the observed value.

Table 5: Response Table for Signal to Noise Ratio

Smaller is better

Level	INC	Speed (rpm)	Load in N
1	42.52	42.05	46.00
2	46.25	44.61	43.75
3	44.66	46.77	43.67
Delta	3.73	4.72	2.33
Rank	2	1	3

From above Table 5 the factor combination of 10 N load, 400 rpm speed and Inconel 625 results in minimum wear rate 0.0027 with maximum value of S/N ratio from experimental observations.
The table above shows the results of the response analysis for each component affecting the S/N ratio. The rank in the S/N ratio response table indicates the order of significance among the chosen factors. Rank 1 indicates it as most significant factor among selected factors whose influence is dominant on response variable. Rank is determined using the Delta value. Delta is the maximum and minimum mean value of the S/N ratio. The most important component for the sample in this study's wear is discovered to be the load.
Using a plot showing the primary effects of signal to noise ratio for wear, the factor with the greatest slope is determined to be the most important element. As demonstrated in Figure 21 relative to speed and temperature, load has the steepest slope and is the primary factor for wear of the sample under examination.

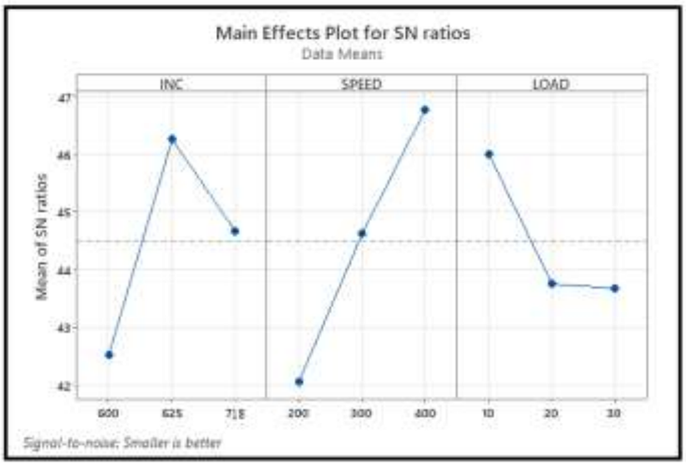

Figure 21: Main effect plot for SN ratios

10. Analysis of Variance

ANOVA analysis of variance has been conducted for significance level 5% and confidence level 95% to gain insight into the significance of the parameters and their relationship to wear rate (Significance level indicates the confidence of reproducing the experimental results). For significance level 5% 95/100 (95% confidence level), similar results are obtained.

Table 6: Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Regression	3	0.000082	0.000027	7.11	0.002
INC	1	0.000006	0.000006	1.62	0.216
SPEED	1	0.000057	0.000057	14.87	0.001
LOAD	1	0.000019	0.000019	4.83	0.038
Error	23	0.000089	0.000004		
Total	26	0.000171			

Null Hypotheses

H0: There is no significant relationship between speed and load on Inconel material Properties

Alternative hypothesis

H1: These exists significant relationship between speed and load on the Inconel material properties.

For significance level 5% 95/100 (95% confidence level), similar results are obtained.

The above table shows the P-values of INC (P = 0.261), speed (p=0.001) and load (p=0.038) with reference to P= 0.05 value.

The INC Value of P = 0.216 indicated that there is a 21.6% is affected by speed, load and the value is lesser than P –value = 0.05 which means there exists significant relationship and it affects INC material Properties.

Therefore It is important to know the inconel material properties before applying the speed and the load, in order to reduce the wear rate of the Inconel material and from table for INC 625, 400 rpm speed with 10N load we achieved Experimental value and Predicted value almost equal with 6% error wear rate and with 1.02%error of S/N ratio.

Additionally, Inconel 625 coated material from Table 5.3 had the highest Brinnel hardness rating of 272.99 BHN, whereas Inconel 625 heat-treated material shown an improvement in the BHN to 371.67 BHN.Vickers hardness test method micro hardness done for 100gm, 200gm, and 300gm load ultimately yielded INC 625 maximum average result of 1834.6HV

Compare to Inconel 600 and 718, Inconel 625 exhibits tensile strength of 780 UTS with this we can conclude that 400rpm speed and 10 N load is plays great impact on Inconel 625 material shows better results in all experiments.

11. Result and Discussion

It is concluded that by conducting vicker hardness test and electrochemical test Inconel 625 is highest 1834.6HV and by electrochemical test a very less corrosion rate found in Inconel 625 and further Design of experiment method successfully improved the quality of Inconel coated specimen 625 also the result showed that the Inconel 625 improved the wear resistance as compared to Inconel 600and 718 as the wear parameters such as speed, load and time varied.

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