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"WEAR OF MATERIALS AA2014 : A REVIEW OF THE LITERATURE"

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ABSTRACT

In the industrial products of aerospace, automobile, railway, structure, manufacturing, marine, Cell phone, defense have very general phenomenon occurring in the almost all the known materials metal, nonmetal, ceramic, composite components. In that components the contact surfaces have two region stick and slip region. The slip occurs at the trailing region of the contact zone causing rise on both longitudinal creep and tangential forces. Due to increases in the tangential force, the slip region advances resulting in the rolling and sliding contact. At the saturation value of tangential forces, the stick region disappears, resulting in a pure sliding contact such as ex-wheel rail contact. For this estimation of the wear behavior of AA2014 hybrid composite materials literature is reviewed.

Key Words: *Wear, Slip region, Ultrasonic cleaning*

I. INTRODUCTION

Wear is very general phenomenon occurring in the almost all the known materials metal, nonmetal, ceramic, composite etc., that are used in the industry like aerospace, automobile, railway, structure, manufacturing, marine, Cellphone, defense, or denture etc. [Kennedy and Hashmi (1998)] [Liu et al. (2018)]. In aerospace the turbine and rotor blade are fixed on the shaft of a specific material of high strength low weight ferrous composites. The machine components have vibration and also they are at high temperature making a pitting action on the surface. The surface pitting reduces its endurance strength along with the creep resistance. So that's the reason that the titanium a very high strength low weight ration material is used in the blade material. In the automobile industry the wear has much scope. It happens in the clutch system [Marklund and Larsson (2008)]. Wet clutches are generally used in vehicle gear drive. The performing circumstances of different clutches in the transmission depend on the application. Wet clutches in the automatic gear transmission system lock up clutch are used. There the initial sliding velocity of clutch interface may be drastically high. Either full or mixed lubrication is provided for the clutch depending upon the working condition [Marklund and Larsson (2008)]. In the railways the wear happens between trains and rail. Wheel rail contact has two regions stick and slip region. The slip occurs at the trailing region of the contact zone causing rise on both longitudinal creep and tangential forces. Due to increases in the tangential force, the slip region advances resulting in the rolling and sliding contact. At the saturation value of tangential forces, the stick region disappears, resulting in a pure sliding contact. In the Case of wheel rail contact, the contact geometry results in a certain amount of sliding especially for the wheel flange–gauge corner contact. For these types of contacts, most of the wear occurs in the sliding part of the contact). In the universe no any surface is perfectly smooth. Every surface has some irregularity. When the surface comes into the contact with the other surface there irregularities come into contact with each other. The surface irregularity entangle with each other than due to relative motion between the surfaces the peaks and crater of the irregularities break which causes the material removal from the surface. This phenomenon is called Abrasive wear. But

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At the elevated temperature the abrasive wear takes place along with along with another well-known phenomenon adhesive wear. At high temperature, it depends upon the surfaces in contact. This happen because of the material at high temperature surface softening takes place. So not only abrasion but the surface stars adhesion on the mating surface [Selvakumar et al. (2017)].

II. LITERATURE REVIEW

Pin on disc is the method widely used in the field of wear test measurement. In this section we shall discuss some of pin on disc arrangement. Our focus will be constraint up to the experimentation part done with different material and hybrid composites. Wear test of AA7075 was investigated by the **[Baradeswaran and Perumal (2014)]**. A specimen of AA7075 Alumina hybrid composites having a diameter of 5mm and the height of 15mm was used as pin material whereas the OHNS (Oil Hardened Nickel steel) was used to make the disc of diameter 55mm. The test was conducted on the different load that were 10N, 20N, 30N. The sliding speed was also variable which had the value of 0.6m/s, 0.8m/s, 1m/s respectively. The sliding distance which he kept, was 2000 mm. The entire 2.1 test was conducted at the 30degC having the atmospheric condition of relative humidity of 60Pr-65Pr. The observation of the material removed was estimated by the electronic weighing machine with a least count of 0.0001g. the test of specimen was conducted for a short time after then the material was washed with the help of acetone solution. After then the weight was investigated.

[Bortoleto et al. (2013)] performed an ASTM G99 stranded Pin on Disc test. The pin specimen was AISI 4140 steel (430 HV hardness), and disc of another AISI H 13 material (430 HV hardness) tool steel material. The dimension of the pin was taken as the 5 mm diameter and the 22 mm height, Whereas the diameter of the disc is 60mm. The entire test was performed at the room temperature of 25^{0}C.

The rotational speed was 40rpm. The sliding distance was kept 25 mm, resulting the sliding speed 0.1m/s. The applied load varied from 5N to 140N at the 25^0 C temperature. The material removal rate was observed after weighing the specimen on the electronic weighing machine of precision 0.00001g, after each test the specimen was cleaned with the acetone solution. **[Cui et al. (2018)]** studied the wear behavior of different inorganic chemical compound which is useful for hot rolling. The oil was diluted with the distilled water. The compound was weighed previously on the weighing machine of accuracy upto ± .001g. The lubricant performance was evaluated on a pin on disc apparatus in which the pin specimen was made up of High speed steel of hardness 699 ± 33 Hv, and the disc specimen was made up of mild steel of hardness 190 ± 10 HV, respectively, but at a very high temperature of 900^{0}C

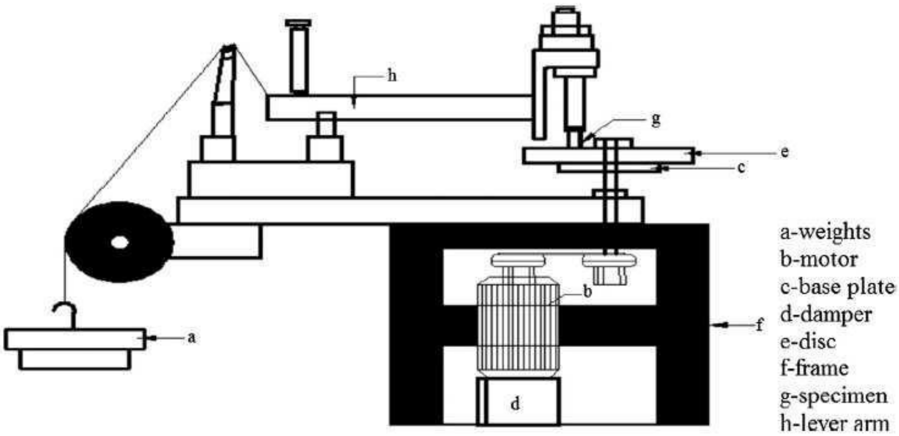

Fig. 1: Pin on disc arrangement Baradeswaran and Perumal (2014)

The test was carried out for 5 min.the lubricant continuously poured at the constant pressure of 1.3GPa of supply rate of .05 L/s. **[Cueva et al. (2003)]** investigated wear resistance of cast iron. Which is used in brake disc rotates. The three type of grey cast iron was taken for the test. These three were named as one grade 250 (GI250), one high carbon (GIHC), One alloyed with Ti (GI250Ti) and a compact graphite iron. The all sample Microstructure was identical consisting of basically pearlite and graphite flake form. The Content Of graphite was producing the basic Difference.

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The pin on disc wear test was performed in a PLINT TE67 wear testing machine, where the load applied pneumatically, because this is brake material test, the pin specimen were manufactured from brake pad that are used in Mercedes Benz sprite van. The specimen have square base area 144 mm^2 and that were ground with sand paper grade 400. but disc specimen were manufactured having dia of 70 mm and thickness 7 mm having the surface finite. The test carried out at a different cyclic pressure of .7 MPa, 2MPa, and 4MPa, having the spinning rotor (500 rpm) time for application of pressure is 1 min. Every cycle contain 4 min. The test was carried out for 20h have 30 cycles. The temperature reached by pin was calculated by thermocouple attached along with pin. The normal and tangential load were recorded by using the load cell and dynamo meter. **[Abbasi et al. (2012)]** investigate the pin on disc wear measurement of airborne wear particle emission of railway breaking material. In the test the horizontal rotating disc was used and pin was dead loaded. Test apparatus was so much sophisticated. Except pin on disc arrangement the author have also used the supply air containing only wear particle. So to make air clean the whole setup is kept in the sealed box. The normal load of 100 N is exerted at the constant speed of 3000 rpm. A Load cell is attached to measure the tangential component of load. A fan eject the air into the box or chamber before sending the air is well mixed with slurry particle. The air supply was with a flow rate of 7.7 m^3/h. The exchange rate was 77/h, having a time constant.

The flow rate measured was performed with the help of U tube manometer having calibrated capacity of 2-50 m^3/h, having some interval. The H13 filter having 99.55 percentage collection efficiency was used to ascertain the particle free inlet air **[Federici et al. (2018)]** investigated the pin on disc test to understand the behavior of brake friction. The cylindrical pin specimen was of diameter 30mm having height 15 mm. The test was performed to obtain coefficient of friction, by performing a dry sliding test, the disc material have hardness value of 209±3 HV 30 and dimensional specification of the disc 140mm in dia and thickness of 15mm. The average surface roughness of disc RA was equal to 2.2±.2micrometer as measure from the surface roughness tester. The material of disc and pin supposed to 15Kpa, 30 KPa, and 50KPa. The sliding velocity was 2.88m/s, which was kept constant.

The time for test was kept as 1hr. To form a friction layer on the pin surface preliminary run in stage was done at 200 rpm. To estimate a wear of pin was calculate after the test by analytical balance, which have a precision of .0001, then the data wear converted into equation wear volume using below equation

$$KA = \frac{V}{SF_N}$$

Where

KA -The specific wear coefficient

V - Wear Volume

S -The sliding distance

F_N-nominal contact force

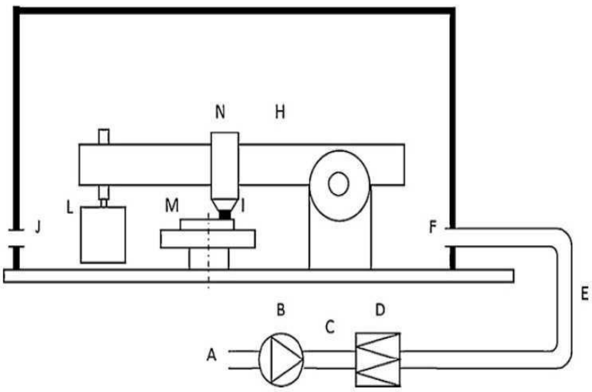

Fig. 2: Pin on disc arrangement [Abbasi et al. (2012)]

Lyu et al. (2015) carried the experiment in which the author performed a pin on disc apparatus to determine the wear behavior of wheel and rail. The disc material used was R7 wheel which is actual material of wheel. The chemical composition of mechanical property are shown below in table

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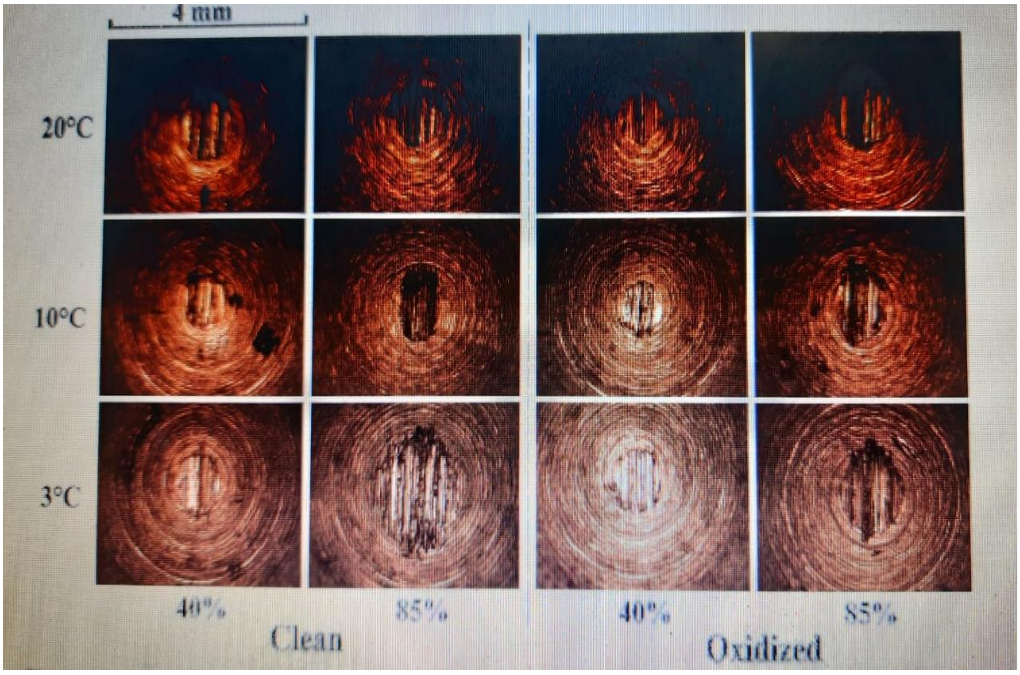

Fig. 3: Disc After Oxidation [Lyu et al. (2015)]

Table: 1-Chemical composition and typical mechanical properties of test samples [Lyu et al.(2015)]

Chemical Composition	**C**	**Si**	**Mn**	**P**	**S**	**Ni**	**Cr**	**Cu**	**Tensile Strength**	**Elongation**	**Hard-ness**
UIC60900	0.6	0.15	0.8	≤	≤			0.15	880	10	260
Arail	0.8	0.5	1.3	.04	.04				-1030		-300
R7	0.52	0.40	.8	≤	≤	0.3	0.3	0.3	820	14	229
Wheel				0.035	0.035				–940		–277

The pin was of 5mm dia round. The test specimen surface roughness have average value of .6 micrometer, this is a general roughness value of train wheel and rail. The disc specimen were prepared sequentially first by cleaning in heptanes for almost 10 min, then ultrasonic cleaning in wheel for another 10 min. Finally the disc is dried for 20 min at 200^0c. The test was carried out at a sliding speed of .01 m/s having a contact pressure of 900 MPa. It is a simulation which actually represent the real rail and wheel . The test was done two times. The measurement of pin was calculated by optical microscopy again the wear equation was used for the estimation of wear.

[Marklund and Larsson (2008)] investigated wet clutch friction characteristics simply by performing pin on disc test. The disc rotation was fixed at 100 rpm, for 10 min. The sliding speed of .15m/s was used a thermocouple fixed at .3 mm from the contact surface. The sintered bronze wsa used for making of friction material on the friction disc. Disc is designed in the holder form in which a piece of steel separator disc was used which is real wet clutch system. The lubricant which was used was same, semi synthetic oil for the hald limited slip coupling. The test during the test the velocity increased from 0 to 0.5 m/s followed by a decrease in speed. Below figure shows the variation in the temperature and sliding velocity during cycle.

The below Table: 2 shows the parameter have taken**[Gonzalez et al. (2005)]** analyzed numerical anlysis on Al-Li/SiC composites after performing a pin on disc test. The specimen was Al-Li alloy 8090 composite which is reinforced with 15 percentage of silicon carbide particle. This alloy have specific significance it shows higher elastic modulus of the composite Al-Li8090 + 15 percent Sic is over 100 GPa. Pin were prismatic shape of material whose characteristics is under consideration having dimension 2.5 *6.3mm. The Disc was made up of carbon steel which rotates at a sliding speed of .1 m/s. The Load were used as 100N, 150N, and 250N, having corresponding pressure of 6.3, 12.5 and 16.5

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MPa. The experience was conducted at 250^0 C. The below fig shows the temperature effect on wear behavior. Table 3 shows the operating condition on test. Table 4 shows chemical composition of HSS Pin material..

Table: 2- Working range and Resolution [Marklund and Larsson (2008)

	Working range	**Resolution**
Nominal surface pressure, P (MPa)	4.0–8.0	
Temperature T(^{0}C)	22–100	0.2
Rotational speed (rpm)	0–318	1.0
Sliding Speed v (m/s)	0–0.5	0.0016
Friction force (N)	0–49	0.015

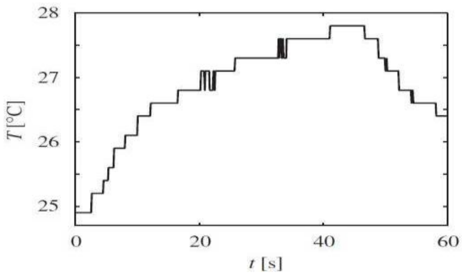

Fig. 4: Variation of Temperature w.r.t t in seconds Marklund and Larsson (2008)

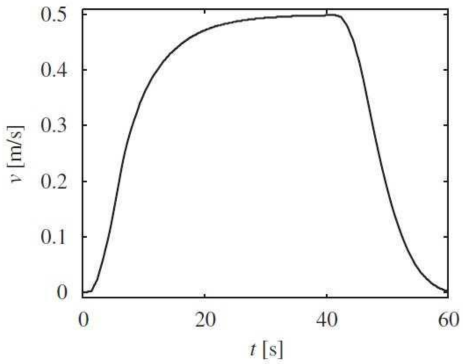

Fig. 5: Variation of velocity of sliding w.r.t Time in seconds [Marklund and Larsson (2008)]

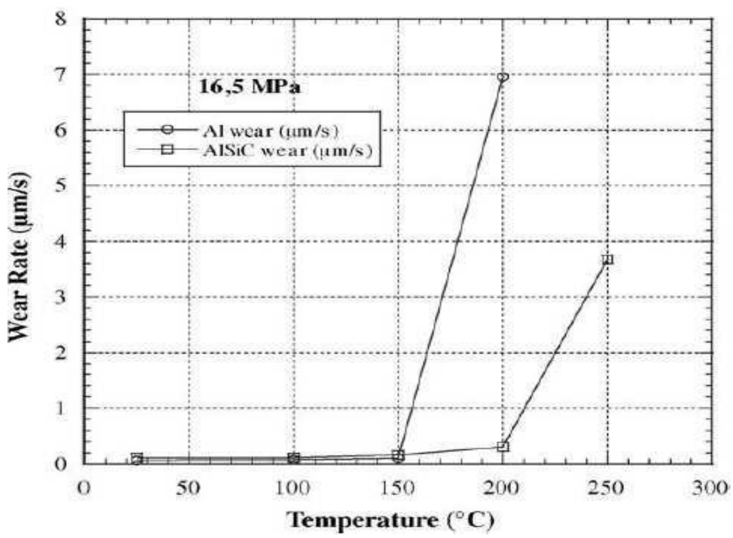

Fig.6: Variation of Wear rate w.r.t Temperature [Gonzalez et al. (2005)]

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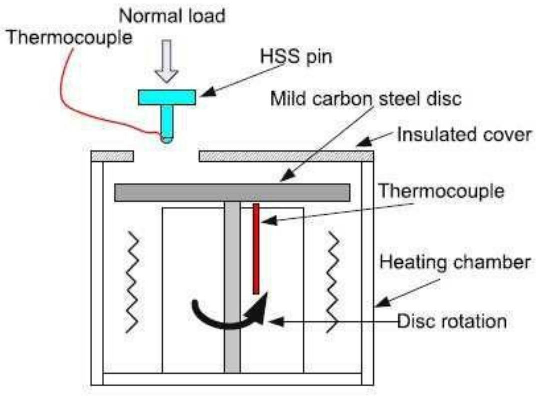

Fig. 7: Scematic configurtion of Pin On Disc test [Zhu et al. (2013)]

Table :3- Operating condition in the test [Zhu et.al.(2013)]

Normal load	Hertzian pressure	Sliding Speed	Disc Temperature	Testing Duration
5N	650MPa	0.05m/s	900 ^{0}C	90s,150s,and 1

Table :4-Chemical Composition of HSS Pin material [Zhu et.al.(2013)]

Fe	C	P	Mn	Si	S	Ni	Cr	Mo	Cu	Al
Balanced	0.2150	.0150	.790	.340	.0290	.0060	.020	≤0.002	0.014	≤ 0.003

Table :5 –Chemical Composition of Disc material [Zhu et.al.(2013)]

Fe	C	P	Mn	Si	S	Ni	Cr	Mo	Cu	Al
Balanced	0.2150	.0150	.790	.340	.0290	.0060	.020	≤0.002	0.014	≤ 0.003

[Zhu et al. (2013)] simulated the wear behavior of high speed hot rolls at high temperature with he help of pin on disc tests. the author have used the apparatus of Pin on disc below fig shows the configuration used. The test temperature was 900deg C, the pin comes in contact with disc. The test duration is upto 1h. The distance from vertical pin of thermocouple was kept 2m. The pin is cooled by air after each test. The heating of disc was maintained at 900deg C.

So this was the some basis and brief description about pin on Disc test performed on differentload, different temperature and different speed, along with different material. All about the pin on disc test that is important making it more vital is the easiness and accuracy of the test. There are also some future scope about the test which will make it more precise and easily performable. The standerd must be followed for this test. We have added some feature in this test.The chemical composition of the disc material is shown in Fig 4.

III. CONCLUSION

A plenty of authors have tested the wear property on the pin on disc wear measurement, Specially aluminum metal matrix which is drastically replacing the steel from so many industries that's why the wear test of all the machinery used material is important. For wear analysis of different specimen the pin on disc arrangement is essential to fabricate. our motto to design this wear machine is to develop such a machine which consist of all the measuring features like measurement of load, measurement of friction coefficient, measurement of the surface roughness. Both dry and wet sliding wear test may be performed .

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