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WEAR ANALYSIS OF U- JOINT NEEDLE BEARING

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Abstract: Failed U-joint is the most common vehicles driveline problem. The entry of dirt and water, as well as grease leakage caused by improper lubrication and sealing lead to corrosion and wear of U-joint bearings. When signs of excessive wear occur U-joint lose operational ability. Investigations have shown that proper motion transmission between shafts and U-joint operational ability significantly depends on its dimensions. Therefore, it is necessary to replace failed U-joint by a new one or to repair it. The repair is restoring to worn elements their useful properties and elemental functions through reconstruction of shape and dimensions. But when does the U-joint is going to repair is the important thing to be determine. This paper gives the analysis to determine repair life of U-joint. This can be done by finding wear after certain revolution of rotation of needle bearing.
Keywords: Wear, Pin on disc tester, repair life.

Introduction

U-Joint Needle Bearing: The simplest form of U-joint consists of two shaft yokes at right angle to each other and cross, which connects the yokes. The cross arms situated at right angle to each other rides inside four needle roller bearings pressed into the yokes bores [3]. The bearing assembly consists of cap and set of needle rollers without cage (Fig.4). Needles are cylindrical rollers with very small diameter compared with their length. Therefore, needle bearings are suitable for bearing arrangements with limited radial space.

Fig. Typical U-joint needle bearing Assembly.

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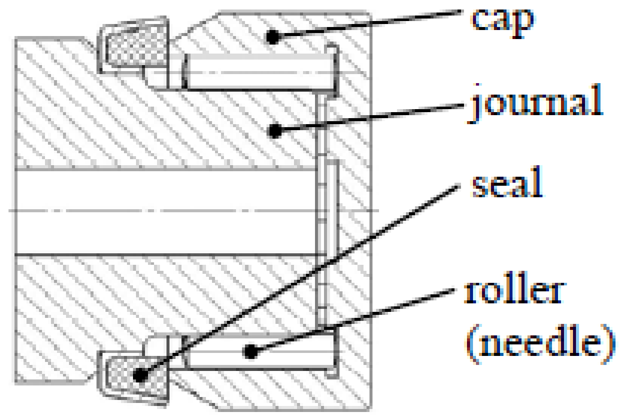


Fig. Cross Sectional view of U-joint needle bearing Assembly.

Problem Statement: Failed U-joint is the most common vehicles driveline problem. Drive shaft and U-joint yoke failures are commonly occurred because of excessive torque load and vibrations, shock loads, improper application, and fatigue. The entry of dirt and water, as well as grease leakage caused by improper lubrication and sealing lead to corrosion and wear of U-joint bearings. When signs of excessive wear occur U-joint lose operational ability. Investigations have shown that proper motion transmission between shafts and U-joint operational ability significantly depends on its dimensions. Therefore, it is necessary to replace failed U-joint by a new one or to repair it. The repair of worn out U-joint implies that damaged surface layers of material have to be removed. Due to remanufacturing, dimensions of U-joint parts are changed, but appropriate relations between dimensions have to be unchanged. With good lubrication and sealing, the life of U-joint is limited by material fatigue after millions of reversals. However, in many cases U-joint does not achieve its predicted (calculated) fatigue life. When the lubrication is inappropriate and/or the sealing is not efficient enough the entry of water and dirt, as well as the leakage of grease can occur. Consequently, the effects of corrosion and wear limit U-joint service life. The manufacturers have rather improved U-joints design, sealing and lubrication, but wear cannot be avoided quite. Wear of U-joint parts (cross journals, caps and needle rollers) leads to increase of both radial and circular internal clearances between rollers in the bearing. Consequently, inequality of load distribution between rollers is increased and bearing service life is decreased.

Repair life Estimation: From the above explanation we can see that Total Tolerance (T_e), should be mate as with dimensions of unworn U-joint needle bearing for it's effective operation. The repair is restoring to worn elements their useful properties and elemental functions through reconstruction of shape and dimensions. But when does the U-joint is going to repair is the important thing to be determine. This work is concentrated on this thing. We have to determine exactly after what service life in terms of revolutions, the U-joint is put to repair. For doing same, wear of recess as well as journal, which are the most important dimensional element of U-joint, is to be determine for estimation of it's repair life. This work is done by taking a simulated system of U- joint needle bearing.

1. Case study

At the time of repair the journal & outer recess are grinded or buffed for smooth surface. Hence In typical bearing journal & recess are made with soft material of brass & rollers are made up of hard material of alloy steel or hardened mild steel. So a specimen of Brass is taken for analysis which is sliding on hardened mild steel material.

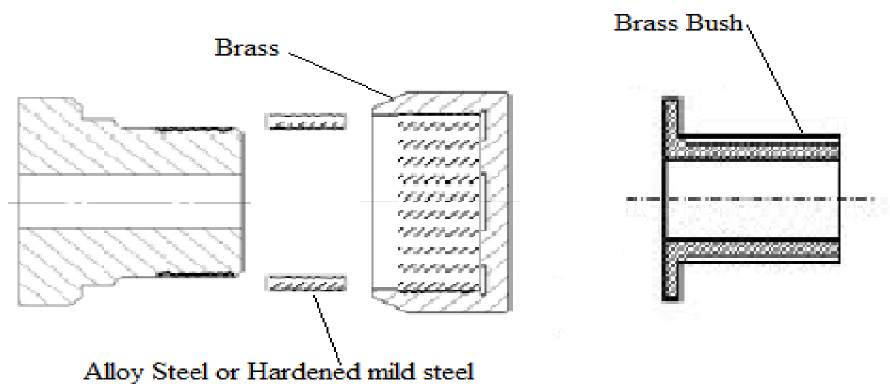


Fig. Needle Bearing with Brass Bush

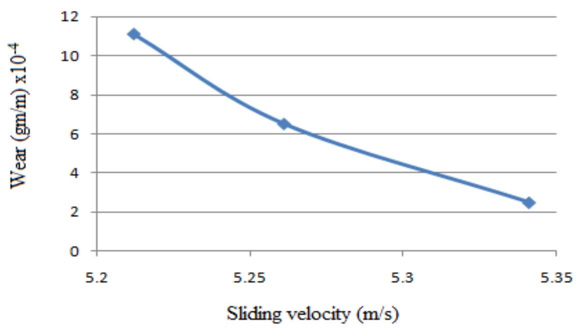
A Pin on Disc tester is used for the analysis. The Pin on Disc tester is of Weight loss method. The surface of brass pin is made round in shape so that it reveals the side surface of U-joint needle bearing outer recess. If we consider the U-joint of small four wheeler automobile, rollers of that U-joint needle bearing are of diameter 4 to 5 mm & have width of 10 mm. So the diameter of machined brass pin is to be considered as equivalent to side width of needle roller which is contacting with recess. So the pin & recess has line contact. Whatever wear obtain after test is taken equivalent to the wear of U-joint needle bearing recess or journal. During test following is taken from Lever type Pin on Disc tester.

Condition	Sr. No.	Weight in pan (Kg)	Load cell reading(Kg)	R.P.M.	Weight before test(gm)	Weight after test(gm)	Time of test(sec)
Dry	1	1	0.85	1020	46.4	45.6	600
	2	2	2.5	1005	45.6	44.6	300
	3	3	3.2	995	44.1	43.2	300
Wet	4	1	0.46	1028	43.2	43.1	300
	5	2	0.95	1026	43.1	42.9	600
	6	3	1.6	1024	42.9	42.6	600

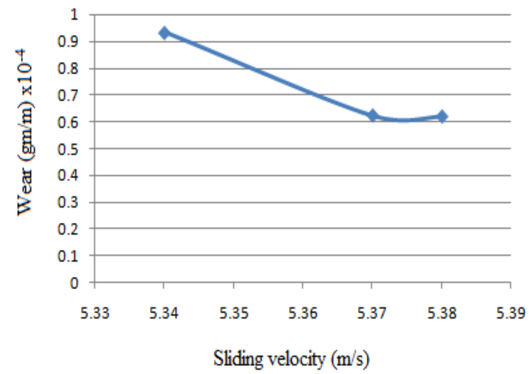
3. Results & Discussion

As a result we will get the amount of wear & variation of wear with load & sliding velocity. It is required that what will be the wear for how much kilogram of load, which can be determine by these graphs. Dry as well as Lubricated or wet conditions are considered for two working conditions of U-joint needle bearing. When the joint is new or newly repaired the lubrication is sufficient to avoid friction in between needle roller & journal as well as outer recess. But as it is expose to application environment where there is dust or foreign matters reduces lubricant, the conditions become whirs & it is considered as dry condition.

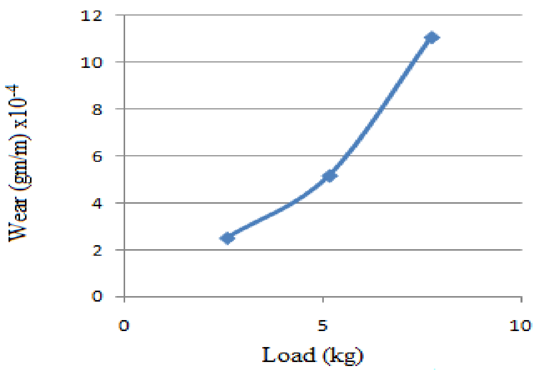
Condition	Sr. No.	Load on Pin, W(kg)	Frictional Force, F_f (kg)	Coefficient of friction, μ	Sliding Velocity, V_r (m/s)	Sliding Distance (m)	Wear (gm/m) $\times 10^{-4}$
Dry	1	2.58	0.493	0.192	5.341	3204.4	2.49
	2	5.16	1.45	0.281	5.26	1528.65	6.54
	3	7.74	1.856	0.299	5.21	1536	11.08
Wet	1	2.58	0.348	0.105	5.38	1614.78	0.619
	2	5.16	0.551	0.107	5.37	3222	0.6207
	3	7.74	0.928	0.119	5.36	3216.9	0.9326



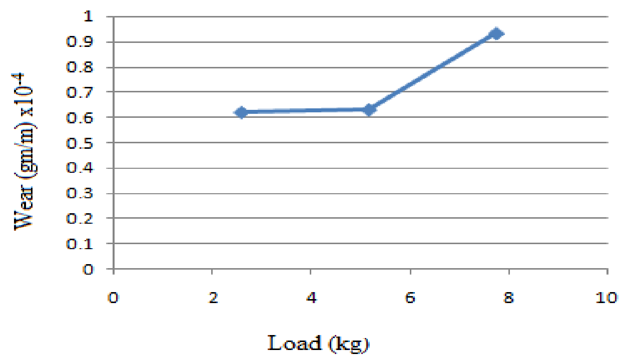
Wear V/s Sliding Velocity in Dry condition.



Wear V/s Sliding Velocity in Wet condition

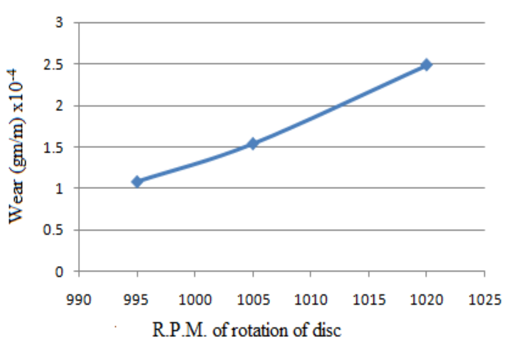


Wear V/s Load in Dry condition.

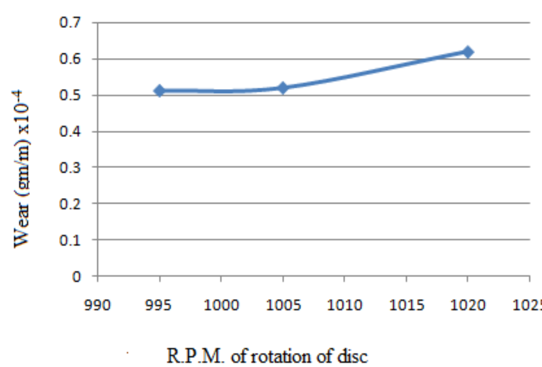


Wear V/s Load in Wet condition.

From the graph it is seen that at constant radius of rotation, Amount of wear is going to increase with increase in load. Rate of increase of wear in dry condition is more, due to direct surface contact.



Progressive wear V/s R.P.M. in Dry condition.



Progressive wear V/s R.P.M. in Wet condition.

As our intimation is to determine amount of wear with life cycle of needle roller, from this graph we can determine after how much revolutions the bearing comes to repair. This case is for dry condition, so due to lack of lubricant amount of wear is more. Hence the U-joint comes to repair very early. This case is for wet condition, as there is sufficient lubricant is present, amount of wear is less. U-joint does not come to repair early.

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