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Paper Authors

SYED DANISH MEHDI, DR.VINOD KUMAR NEMA, DR.MOHD MOHINODDIN

Mewar University,Chittorgarh, Rajasthan

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EXPERIMENTATAL ANALYSIS OF MODIFIED FLUID COUPLING

SYED DANISH MEHDI*[1], DR.VINOD KUMAR NEMA[2], DR.MOHD MOHINODDIN[3]
[*1]Ph.D Scholar, Mewar University,Chittorgarh, Rajasthan
[2]Ph.D Supervisor, Mewar University,Chittorgarh, Rajasthan
[3]PhD Co Supervisor, Mewar University,Chittorgarh, Rajasthan
danish.mehdi24@gmail.com

Abstract-As there is an increased attention towards the development of the Gear-less two-wheeler automobiles [scooters] which have automatic-transmissions, using centrifugal-clutch systems. These clutch systems have high wear and tear and hence the present research work is taken up to replace the said clutch system with a modified fluid coupling which can be more efficient in the wear-free transmissions and it wil also provide a smooth & controlled acceleration with effective damping of the shocks, load fluctuations and the torsional vibrations. The attention is therefore laid on developing a highly-efficient modified fluid coupling. This coupling would capture the mechanical power from the main source, namely the I.C. engine and then transmits it to the rear wheels via an automatic gear box[2]. The fluid coupling has an advantage over the mechanical coupling in the following areas. There is effective dampening of shocks, effective load fluctuations and effective torsional vibrations. Smooth and controlled acceleration without jerks in transmission of the vehicle. There is Wear-free power transmission present because of absence of mechanical connection [no metal-to-metal contact] between the input elements and output elements. But as the Conventional-fluid couplings have relatively less transmission efficiency, the challenge lies in developing an efficient modified fluid coupling which would flow the mechanical power with minimum transmission losses in the case of Two-Wheeler automobiles especially the Gear-less Scooters like activa. Presently these vehicles are using a Centrifugal-clutch which has maximum wear and tear frequently. The computational study was helpful in making an initial estimate of the efficiency of a basic modified-fluid coupling design without vanes and consequently in making recommendations on scope for further design improvements i.e. using vanes on the two discs(about 24 vanes)].Based on the recommendations from the computational study a conventional fluid coupling with one driver shaft and one driven shaft was fabricated and tested. The experimental study was conducted on disks with radial vanes and with micro clearance between the driver and driven disks of the fluid coupling. The clearance is varied with different spaces and the fluid in coupling is also varied .Then finally the experimental and software readings were validated using minitab software.

1. INTRODUCTION

. Auto mobiles of 1940 models featured the hydra matic drive of which the first mass production was fully automatic transmissions. Initially the old exclusive hydra matic had the fluid coupling (not a torque converter) and there were three planetary gear sets providing four speeds plus reverse[4]. Hydramatic was eventually adopted by two persons Cadillac and Pontiac, and was then sold to various other automakers, including the Bentley, the Hudson,the Kaiser,the Nash and the Rolls-royce.From the year 1950 to 1954 Lincoln cars were also made available with GM hydra matic.The

Mercedes benz subsequently devised a four speed fluid coupling transmission system that was very much similar in principle to the hydra matic but it did not share the same design. The first torque converter was automatic buicks dyna flow,which was introduced for the 1948 year model[3]. It was followed by the Chevrolets power glide and packards ultramatic for the 1950 model year. Each of these transmissions which had only two forwarded speeds and which were relying on the torque converter for additional gear reduction. In the early 1950s the Borg-warner developed a series of the three speed torque converter of automatics for the ford motor company.The Studebaker and the several foreign independent makes Chrysler was late in developing its own true automatic system, introducing the two-speed torque converter power in late 1953 and the three speed power flite in the year 1956[5]. By late 1960s most of fluid coupling four speed transmissions and two speed transmissions had then disappeared in favor of three speed units with the torque converters. By the early 1980s these were then being finally supplemented and being eventually replaced by the over drive equipped transmissions providing the four or more forward speeds. Many of the transmissions also adopted the lock-up torque converter to improve the fuel economy. As engine computers became more and more capable and even more of the valves the body functionality was offloaded to them. These transmissions were introduced in the late 1980s and year 1990s remove all of the control logic from the valve body and then placed it in into the engine computer. In this case solenoids turned them on and off by computer control shift patterns and the gear ratios rather than the spring loaded valves inside the valve body. ZF Friedrichshafen AG and the BMW were responsible for introducing the five speed automatic and the six speed (ZF 6HP26 in the 2002 BMW E65 7 series). The Mercedes Benz was the first seven speed in 2003 with the Toyota motor company introducing the 8 speed in the year 2007 on Lexus LS.

Fluid coupling

The fluid coupling or the hydraulic coupling is a hydrodynamic device which is used to transmit therotating mechanical power. It has been used in automobile transmissions such as an alternative to the mechanical clutch[6]. It also has widespread application in the field of marine engine and the industrial machine drives, where the variable speed operation and the controlled start-up with-out the shock loading of the power transmission system is essential.

The fluid coupling consists of the three components, plus the hydraulic fluid:

- The housing, which is also known as the shell which should have an oil-tight seal around the drive shafts, contains the fluid and the turbines.
- The Two turbines (fan like components):

One of which is connected to the input shaft; also known as the *pump* or *impellor*, the *primary wheel input turbine* The other one which is connected to the output shaft,also known as the *turbine*, the *output turbine*, the *secondary wheel* or the *runner.*

The driving turbine,which is known as 'pump', or the *driving torus* is rotated by the prime mover,for which is an internal combustion engine or an electric motor.

The impellors motion then imparts both the outwards linear and the rotational motion to fluid.

The hydraulic fluid which is then directed by the 'pump' and whose shape forces the flow in the direction of 'output turbine' or the *driven torus*. Here, any of difference in the angular velocities of the 'input stage' and the 'output stage' results in a net force on the 'output turbine' causing the torque; thus causing to rotate in the same direction as of that of the pump

2. EXPERIMENTAL SETUP

The recommendations of using radial vanes and micro clearances between the disks from the computational analysis were tested experimentally. The experiments were carried out by fabricating a conventional fluid coupling with radial vanes and with a micro clearance between the vanes of the two disks. Figures show the photographs of the experimental setup of this fluid coupling. The driver shaft powered by induction motor drives the pump. The turbine is coupled to the driven shaft on which the brake load is applied for conducting the brake test. The pump and the turbine consist of impellers with radial vanes as shown in figure .

Figure 1:Induction motor with fluid coupling

Figure 2: Fluid coupling

Figure 3: Wattmeter connected to motor

Figure 4 : Impeller of pump and turbine

The casing housing is filled with oil with the following specifications given in Table5.1.

Table1: Specifications of the oil used in fluid coupling

Oil name	Castrol Hyspin VG46
Density at 15^0 C	879 kg/m^3

CALCULATIONS OF OUTPUT POWER AND EFFICIENCY

- The brake load in grams is converted in Newton's.
- The speeds of input shaft and output shaft are calculated using a tachometer.
- The output power is calculated using 2*3.14*N*T/60.
- The output torque is given as a product of load and radius (w*R).
- The output power is obtained in Watts.
- The efficiency is calculated as output power/input power.

S. NO	INDUCTION MOTOR	INDUCTION MOTOR	BRAKE LOAD	FLUID COUPLING	FLUID COUPLING	Torque	EFFICIENCY	EFFICIENCY (software)
	POWER P_I (W)	SPEED N_I (RPM)	W NEWTONS/gms	SPEED N_O (RPM)	POWER P_O (W)	(N-m)	(P_O/P_I)	(Po/Pi)
1	12	1200	2.05/210	920	3.95	0.041	32.9%	38
2	15	1258	3.04/310	1381	8.79	0.0608	58.6%	63.6
3	17	1310	4.02/410	1375	11.57	0.0804	68.05%	72.6
4	20	1360	5/510	1372	14.36	0.1	71.8%	75.5
5	24	1375	5.98/610	1370	17.15	0.1196	71.45%	76.5
6	30	1390	6.96/710	1365	19.89	0.1392	66.3%	72.6
7	38	1392	7.94/810	1298	21.58	0.1588	56.78%	65.8
8	46	1396	9.80/1000	1122	23.02	0.196	50.04%	55.7

Table 5.2: Experimental table

5.3SAMPLE CALCULATIONS

FOR 1ST READING:

Po=2*π*N*T/60

Po=2*π*(920)*w*R/60

Po=2*π*(920)*2.05*0.02/60

Po=3.95W

FOR 2ND READING:

Po=2*π*N*T/60

Po=2*π*(1381)*w*R/60

Po=2*π*(1381)*3.04*0.02/60

Po=8.79W

CONCLUSIONS

1.In the present work three cases has been discussed with respect to the design of impeller and turbine runner that is straight or radial,15 degrees and 30 degrees vane angle.

2.After considering and analysing the three cases we came to a conclusion that the radial vanes(straight vanes) are optimum and suitable for further research work compared to 15 degrees and 30 degrees vanes.

3.The transmission efficiency obtained is 71 %(highest) which is about 20% higher than that of the conventional fluid couplings at higher input power (as per the data available on the research papers referred).

4.Even at higher loads applied to the test model the efficiency slightly decreases from 71% to 50% but it indicates that the said modified fluid coupling has high load bearing capacity with respect to the conventional fluid coupling.

5.The automatic transmission fluid which we have used is similar to SAE10.

6.We have also used Water and SAE20 but SAE20 was more viscous and less force was exerted.

7.So it was decided to use oil similar to SAE10.

8.The results of regression analysis for experimental validation shows that the error in percentage of experimental and software(Minitab) readings is 0.06%.

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