ISSN 2395-1621

Design, Development of Dual Mass Flywheel and Comparative Testing with Conventional Flywheel

[#1]N. N. Suryawanshi,[#2]Prof. D. P. Bhaskar

[1]nikhil23031992@gmail.com

[#1]Student Mechanical Engineering Department, SRE'S C.O.E, Kopargaon,

ABSTRACT

The Dual Mass Flywheel (DMF) is primarily used for dampening of oscillations in automotive power trains and to prevent gearbox rattling. We explained detailed initial model of the DMF dynamics is presented. This mainly includes the two arc springs and two masses in the DMF and their behavior. An experimental the DMF model is compared to convention flywheel. Finally the observation of the engine torque using the DMF is discussed. For this purpose the DMF is manufactured and done experiment or testing to see the results. And then results are compare with the conventional flywheel.

***Keywords*— Spring mass flywheel, concept, design, experimental study.**

ARTICLE INFO

Article History

Received :18th November 2015

Received in revised form :

19th November 2015

Accepted : 21st November , 2015

Published online :

22nd November 2015

I. INTRODUCTION

There are two schools of thought concerning light flywheels. They do not contribute to power output. The second is that they do. Both are correct.

If we measured the power output of an engine first with light flywheel and then again with the standard part on an engine dyno, no change in power will be occur. It appears that the light flywheel has done nothing and was a total waste of money. A dyno that shows max power at constant revs does not demonstrate what happens to an engine's power output in real life situations - like acceleration. If an engine is accelerated on a dyno (I am talking about a rate of around 2000rpm a second) it would show a power output of around 20%-25% less than at the constant rev state.

The reason for this is that when accelerating a vehicle the engine not only has to push the total mass of the car but the internal components of the engine need to be accelerated also. This tends to absorb more extra power is used accelerating the internal mass of the engine components and is why a motor accelerating on a dyno will produce less power than at constant revs. Also it remembered that the rate of acceleration on the engine internals is much greater that the rest of the car. This would then suggest by lightening the flywheel, less power required to accelerate it and therefore more power would be available to push the car along.

All engines have flywheels or weighted crankshafts that balance out compression and power strokes, maintain idle, aid reduce component wear. If the flywheel is light the motorcycle requires more effort to start, idles badly. Weight is not the important factor, but inertia. Inertia is stored energy, not directly proportional to flywheel weight. It's possible to have a light weight flywheel with more inertia than a heavier flywheel. The motor develops more accelerate the flywheels before leaving the sprocket shaft, and any used in bring the flywheel up to level of speed is not available at the rear wheel. This shall not show up on a steady-state or rear wheel dyno or simple desk-top dyno program, but is detectable in a transient dyno that accelerates the engine at a specific rate (300 or 600

© 2015, IERJ All Rights Reserved

ISSN 2395-1621

RPM per second are common). Flywheel inertia is stored when you rev the engine slightly before letting the clutch out - this small amount of extra power helps in getting the motorcycle underway with minimal effort. By "borrowing" power for a less time, the engine has to develop less to move from a standing start. Once the clutch is completely engaged, inertia can no longer be borrowed - the motorcycle can only use what it produces in "real time". In any event, when the clutch is slipped all flywheel weight reduces acceleration.

Thus it is safe to correct the above discussion that the flywheel inertia plays a major role in vehicle optimized performance and by suitable modifying the flywheel mass of flywheel can be reduced by still maintaining the inertia.

The arrangement of the DMF is an suitable answer to the above problem statement where in the inertia is increased using two set of masses phased opposite to each other .

II. LITERATURE REVIEW

1. Ulf Schaper, Oliver Sawodny, Tobias Mahl and Uti Blessing

They explains the DMF along with its application and components. Afterwards a detailed model of the DMF dynamics is presented. This mainly includes a model for the two arc springs in the DMF and their friction behaviour. Both centrifugal effects and redirection forces act radially on the arc spring which induces friction. The numerical method is used to measure model validation.[1]

2. Bjorn Bolund, Hans Bernhoff, Mats Leijon

This paper explains the use of flywheel. Nowadays flywheels are complex construction where energy is stored mechanically and transferred to and from the flywheel by an integrated motor or generator. The wheel has been replaced by a steel or composite rotor and magnetic bearings have been introduced. By increasing the voltage, current losses are decreased and otherwise necessary transformer steps become redundant.[2]

3. Jordan Firth, Jonathan Black

This paper explains the vibration interaction in a multiple flywheel system. Flywheels can be used for kinetic energy storage. In this paper one unstudied problem with vibration interaction between multiple unbalanced wheel. This paper uses a linear state space dynamics model to study the impact of vibration interaction. Specifically, imbalanced induced vibration inputs in one flywheel rotor are used to cause a resonant whirling vibration in another rotor. Vibration is most severe when both rotors are spinning in the same direction.[3]

III. PROBLEM STATEMENT

To investigate the performance characteristics of Dual mass flywheel over conventional flywheel. And compare which one is efficient for use.

IV. FINDING

In the planetary dual mass flywheel, the planetary gear and the torsional damper are incorporated into the flywheel. For this purpose, the flywheel is divided into a primary and a secondary mass, hence the name exists planetary "dual mass flywheel". Rattle and booming noise are now a thing of the past which is rectified by DMF. Again By reducing the mass and keeping the Inertia factor same we will be able to optimize the Dual mass flywheel giving the better results than that of conventional flywheel.

V. DESIGN OF CONVENTIONAL FLYWHEEL

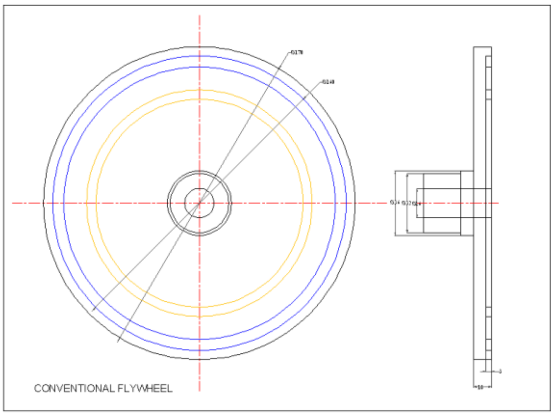


Figure no. 1 Conventional Flywheel

VI. DESIGN OF DUAL MASS FLYWHEEL SYSTEM

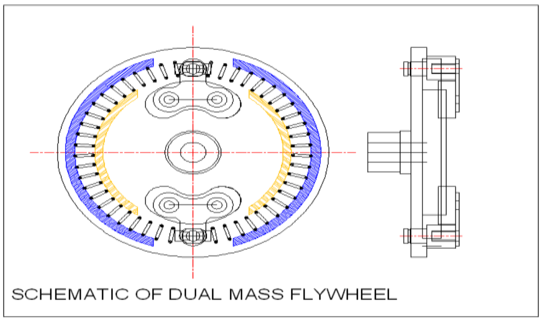


Figure no.2 Dual Mass Flywheel

VII. EXPERIMENTAL SETUP

© 2015, IERJ All Rights Reserved

Figure no.3 Experimental Setup

VIII. EXPERIMENTAL RESULT

Effect Of Increased Inertia Of Dual Mass Flywheel-

The effect of inertia augmentation can be seen by the difference in the fluctuation of energy in the Dual mass flywheel and the Conventional flywheel

Let, Maximum fluctuation of energy of Dual mass flywheel = $\nabla E_{dmf} = mR^2 \omega_{dmf}{}^2 Cs$

Where , $m = mass\ of\ flywheel = 1.9Kg$

R= Mean Radius of rim = 68 mm = 0.068

ω_{dmf} = mean angular speed of dual mass flywheel

$$= \frac{2\pi(N_1 + N_2)}{2} = \frac{2\pi(1430 + 930)}{2}$$

ω_{dmf} =7414 rad/sec

Cs = Coefficient of fluctuation of speed = $N_1 - N_2/N$

Where N= $\frac{(N_1 + N_2)}{2}$ = 1180

Cs = 1430-930 /1180 =0.423

$\nabla E_{dmf} = mR^2 \omega_{dmf}{}^2 Cs$ = 1.9 x 0.068^2 x 7414^2 x 0.423 = 204.27 KJ

Maximum fluctuation of energy of Conventional flywheel = $\nabla E_{cnv} = mR^2 \omega_{cnv}{}^2 Cs$

Where , $m = mass\ of\ flywheel = 1.9Kg$

R= Mean Radius of rim = 68 mm =0.068

ω_{cnv} = mean angular speed of dual mass flywheel

$$= \frac{2\pi(N_1 + N_2)}{2} = \frac{2\pi(1315 + 910)}{2}$$

ω_{cnv} = 6990 rad/sec

Cs = Coefficient of fluctuation of speed =$N_1 - N_2/N$

Where N= $\frac{(N_1 + N_2)}{2}$= 1112

Cs = 1315-910 /1112 = 0.364

$\nabla E_{cnv} = mR^2 \omega_{cnv}{}^2 Cs$ = 1.9 x 0.068^2 x 6990^2 x 0.364 =156.25 KJ

Effectiveness (ἐ) = $\nabla E_{dmf} / \nabla E_{cnv}$ = 204.27 /156.25

=1.30

Thus the Dual mass flywheel is 1.3 times effective than the Conventional flywheel.

IX. OBSERVATIONS

Sample calculations:

a)

$output\ torque = W \times 9.81\ radius\ of\ dyno\ brake\ pulley$
$Top = 4 \times 9.81 \times 0.032 = 1.26\ Nm$

b)

$Efficiency = (Output\ power / input\ power) \times 100 = 152.39/205 = 74.33$

© 2015, IERJ All Rights Reserved

RESULT TABLE

Table no. 1 Result Table of Conventional Flywheel

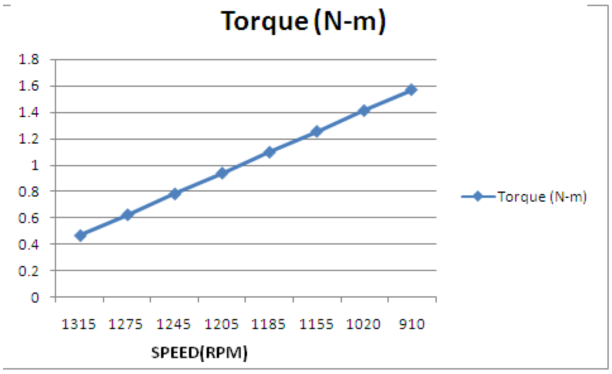
Sr. No	Load(gm)	Speed(rpm)	Torque(Nm)	Efficiency
1	1500	1315	0.47088	31.63494345
2	2000	1275	0.62784	40.89688507
3	2500	1245	0.7848	49.91825678
4	3000	1205	0.94176	57.97734884
5	3500	1185	1.09872	66.51758072
6	4000	1155	1.25568	74.09553296
7	4500	1020	1.41264	73.61439313

Table No.2 Result Table of Dual Mass Flywheel

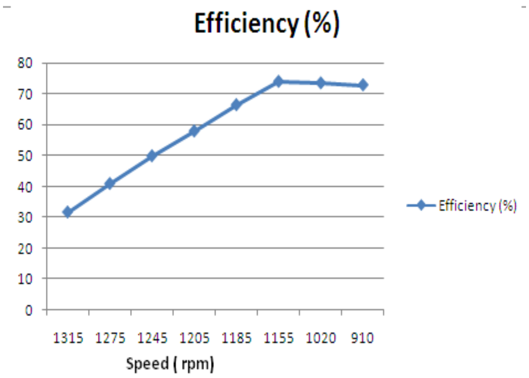
Sr. No.	Load(gm)	Speed(rpm)	Torque(Nm)	Efficiency
1	1500	1425	0.47088	34.2594
2	2000	1345	0.62784	43.1147
3	2500	1365	0.7848	54.6948
4	3000	1315	0.9417	63.2256
5	3500	1285	1.09872	72.085
6	4000	1245	1.25568	79.8184
7	4500	1080	1.41264	77.895
8	5000	930	1.5696	74.5292

© 2015, IERJ All Rights Reserved

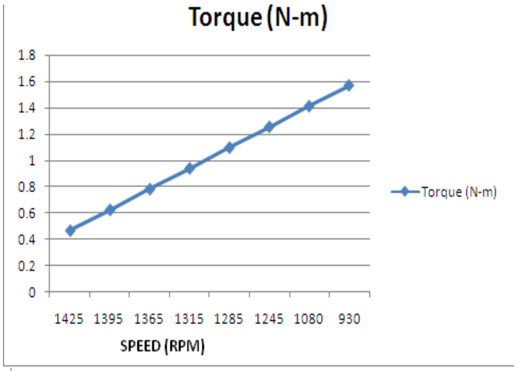
Graph of Torque Vs Speed for Dual Mass Flywheel



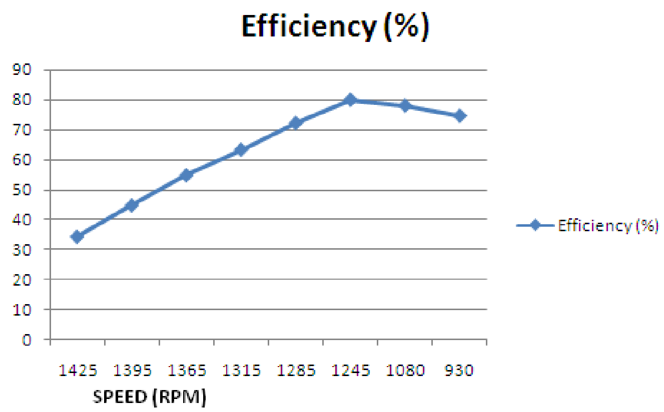
Graph of Efficiency Vs Speed for Dual Mass Flywheel



Graph of Torque Vs Speed for Conventional Flywheel

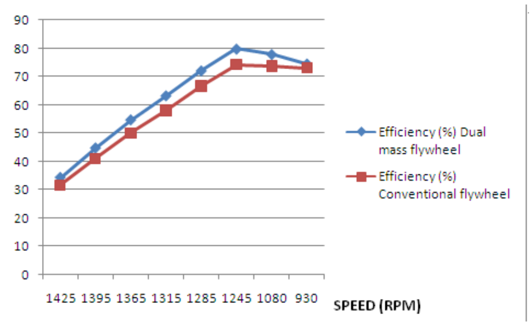


Graph of Efficiency Vs Speed for Convention Flywheel



X. CONCLUSION

Comparison of Efficiency of Conventional and Dual mass flywheel-



It is observed that the Dual mass flywheel is 5 to 6 % efficient than the conventional flywheel which will also result in increasing fuel economy of the engine.

ACKNOWLEDGMENT

I wish to thank my institution, 'SRES'S COE, Kopargaon' for giving me the opportunity to write a this paper. A special thanks to my Project guide Prof. D. P. Bhaskar for encouraging us and his support and guidance throughout and without whom, this work would have not been possible. Last but not the least, I would like to thank the authors of the various research papers that I have referred to, for the completion of this work.

REFERENCES

1. Ulf Schaper, Oliver Sawodny, Tobias Mahl And Uti Blessing, "Modeling And Torque Estimation Of An Automotive Dual Mass Flywheel", American Control Conference, 2009.

2. Bjorn Bolund, Hans Bernhoff, Mats Leijon, "Flywheel Energy And Power Storage Systems", Renewable And Sustainable Energy Reviews, 11(2007) 235-258.

3. Jordan Firth, Jonathan Black, "Vibration Interaction In A Multiple Flywheel System", Journal Of Sound And Vibration, 331(2012) 1701-1714.

4. Paul D. Walker*, Nong Zhang, "Modelling Of Dual Clutch Transmission Equipped Powertrains For Shift Transient Simulations", Mechanism And Machine Theory, 60 (2013) 47-59.

5. Li Quan Song, Li Ping Zeng, Shu Ping Zhang, Jian Dong Zhou, Hong En Niu, "Design And Analysis Of Dual Mass Flywheel With Continuously Variable Stiffness Based On Compensation Principle", Mechanism And Machine Theory, 79(2014) 124-140.

6. Manuel Olivaresa, Pedro Albertosb "Linear Control Of The flywheel Inverted Pendulum", ISA Transactions 53(2014) 1396-1403.

© 2015, IERJ All Rights Reserved