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An analysis of the efficiency of two-wheelers powered by continuously variable transmissions in the face of a failing centrifugal clutch

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Abstract- In the current climate, a 150cc 4-stroke gasoline engine with a gearbox achieves around 15% better fuel efficiency than a CVT basic gearless two-wheeler. Every year, the demand for gearless two-wheeler scooters in India exceeds 5 million units. The most important variables influencing fuel economy, according to an analysis of pertinent tests and real-time data, are gasoline quality, road load condition, driving circumstances, vehicle load loading, and driveline type. The transmission systems of current two-wheeler scooters are built on continuously variable transmissions (CVTs), which use a dry centrifugal clutch. Three main components make up a mechanically based continuously variable transmission (CVT): a driving pulley for speed sensing, a driven pulley for torque sensing, and a V-type rubber belt that connects them. The driven and driving pulleys experience axial loads and torque while the machine is in operation. One of the main components of a CVT is a dry centrifugal clutch, which is responsible for transferring torque. Complete engagement, partial engagement, and slippage are the three possible states of a dry centrifugal clutch. The characteristics of the dry centrifugal clutch are affected by regular, moderate driving, which in turn affects the power gearbox and fuel efficiency. This research use an experimental foundation approach to ascertain the effects of clutch characteristic degradation on fuel economy and how it changes.

Keywords–Fuel economy, centrifugal clutch, two-wheeler

INTRODUCTION

CVT(Continuouslyvariabletransmission)

A continuously variable transmission (CVT) is an automatic transmission that can change seamlessly through a continuous range of gear ratios. This contrasts with other transmissions that provide a limited number of gear ratios in fixed steps. The flexibility of a CVT with suitable control may allow the engine to operate at a constant RPM while the vehicle moves at varying speeds. CVTs are used in automobiles, tractors, motor scooters, snowmobilesand earthmoving equipment. The most common type of CVT uses two pulleys connected by a belt or chain, inwhich dry centrifugal type clutch is use.

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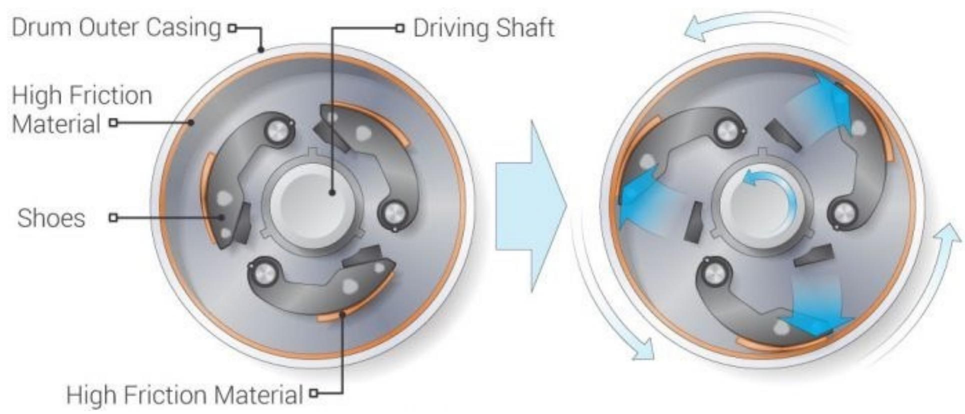
DryCentrifugalclutch

Acentrifugalclutchisa clutchthat uses centrifugal forceto operate.Theoutput shaftisdisengaged atlowrotational speedandengages moreas speedincreases. It is often used in mopeds, under bones, lawn mowers, go-karts, chainsaws, mini bikes, and some parameters and boats to keep the engine from stalling when the output shaft is slowed or stopped abruptly, and to remove load when starting and idling. It has been superseded for automotive applications by the fluid coupling. [12]



Revolving clutch (Fig. 1) [12]

Controlling the clutch

The clutch's input is linked to the pulley that is powered by the CVT, and the clutch's output may be used to drive a shaft, chain, or belt. The clutch engages when the input shaft rotations per minute rise because the clutch's weighted arms move forward. Radially mounted shoes or friction pads contact the inside of a housing's rim in the most frequent variants. A clutch shoe is connected to a variety of extension springs that are mounted on the central shaft. Clutch shoes contact the friction face when springs stretch in response to a sufficiently rapid central shaft rotation.

Centrifugal clutch's drawbacks

Because of slippage, the centrifugal clutch can only transmit so much power. You can't get a lot of torque out of a centrifugal clutch.

• Slipping and friction cause a substantial drain of electricity.

• The capacity of the centrifugal clutch to transfer torque decreases dramatically as the applied load approaches its limit; engagement of the clutch is dependent on the engine reaching a certain angular speed.

Section II: Literature Review

The fuel efficiency of a CVT-driven scooter is greatly affected by the worn clutch friction liner and rubber belt, according to research by Dhruv Panchal et al. [1]. The clutch friction liner impacts the fuel economy decline with a contribution of 62.40%, according to the analysis of variance that was used to evaluate the contribution of components and interactions on the root cause. There is a 31.16 percent contribution from rubber belts and a 1.87% contribution from CVT fly masses. The combined impact of the rubber belt and clutch friction liners may be predicted by using a theoretical model to investigate their interaction. To keep the fuel efficiency of a CVT-driven scooter, it is possible to identify the main elements that cause the friction liner and rubber belt to deteriorate, and then optimise those parameters.

Based on their modelling findings, C. H. ZHENG et al. [2] determined that, with a constant friction coefficient between the belt and the driven pulley, the radius of the driven pulley rises with increasing torque applied to the CVT output shaft. To further enhance the overall economy of cars fitted with CVTs, the CTCF (Coefficient of Torque Capacity Factor) was also established. An perfect CTCF allows the power source to operate within its effective zone, and the operating points are determined by the CTCF value.

According to research by C. ZHU et al. [3], adjusting factors such as engagement speed, shift speed, load situation, ratio range control, and CVT components might potentially increase efficiency. The effectiveness of a rubber V-belt CVT may be significantly enhanced by using a belt with a high elastic modulus or by fine-tuning the belt tension in conjunction with a complex multi-angle torque cam, axial pressure control, and shims tuned on a secondary pulley. The rubber belt CVT will also be able to find further uses in automobiles when structural upgrades to the driven and driving pulleys, as well as the creation of a high-strength belt, make it possible.

In order to determine the highest possible p*/p value and maximum temperature increase for the specimens, Tse-Chang Li et al. [4] performed Clutch experiments. The maximum temperature increase was typically minimal for specimens with big maximum p*/p. For the most part, specimens exhibit the trait that higher judder is achieved with a bigger maximum p*/p and a larger dμ/dVx. According to these results, out of the three objective functions, the moulding pressure of the frictional lining has the most impact. Among the five control elements, moulding pressure has the largest value and is most strongly correlated with the maximum profitability.

According to research by N. Karthikeyan et al. [5], the air flow guide plays a crucial role in attaining the intended thermal impact. To improve the flow through the clutch housing, an axial guide is installed across the intake side. There is a 40% improvement in clutch housing flow with an 184% increase in output area. From the first design to the final one, the clutch surface's temperature drops by 8 degrees Celsius.

According to research by Oday I. Abdullah et al. [6], the outer disc radius is where the most contact pressure occurs, whereas the inner disc radius is where the least penetration occurs. Because the clutch parts are under such intense strain, a negligible amount of slip happens between them, causing contact friction stresses to be generated. The inner and outer disc radii have the highest contact friction stresses, whereas the clutch disc's mean radius has the lowest. Considering the clutch's contact surfaces' persistent deformations and thermal fractures would alter the distribution of contact pressure and the actual contact area.

According to rig testing by Sujit Mohire et al. [7], which is based on a schedule created from RLD utilising the energy dissipation theory, it offers a faster way to evaluate the clutch life. In terms of wear rate and friction lining condition, the test technique demonstrates a strong connection with field data. The same approach may be used successfully to evaluate clutch failures in the event of certain field misuse situations. Under such circumstances, RLD need to be gathered under abusive circumstances. The suggested approach allows for the simulation of failure on the test rig. Using the suggested technique, we may evaluate the efficacy of any clutch design improvement to solve any particular field problem with clutch friction life on the test rig. A CVT Test Rig, according to Vivek Adyanthaya et al. [8], allowed researchers to analyse the transmission's properties and accurately quantify its efficiency across a range of driving modes. This CVT underwent adjustments to its centrifugal roller weight, roller track angle, torque sensor helical ramp, and driven spring. This led to improved acceleration and tractive effort on wheels during WOT operations while also achieving excellent fuel efficiency during half throttle operations due to reduced engine speeds.

The kinetic coefficient of friction for the clutch friction lining material in contact with the sinusoidal wavy and rough surface of the pressure plate decreases with rising contact temperatures and increasing slip speeds, according to research by E. Humphrey et al. [9]. This material lines the clutch and interacts with the plate. When applying a clamp force, the coefficient of friction rises, smoothing out uneven surfaces via deformation; however, this comes at the cost of increased traction. The experimental findings corroborate these contact properties, which are in line with tractive contact mechanics including creep under slip scenarios.

In order to accurately estimate fuel usage, Moawad A. et al. [11] found that the number of shifting occurrences is a significant element. Since maximising engine efficiency is the primary function of gearboxes, it stands to reason that a larger number of shifting events would result in reduced fuel consumption. The issue has been well reported for

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CVTs, or continuously variable gearboxes, may lead to subpar driving performance when engineers optimise engine operating conditions by constantly adjusting the transmission's ratios. The vehicle industry has to tread carefully when deciding how to prioritise fuel economy and the quality of the drive in relation to the benefits of a larger number of shifting occurrences.

This power usage comparison highlights the investigation of Robin TEMPORELLI et al. [10] into the potential benefits of electrifying a recreational vehicle's clutch. It is clear that the new electromechanical technology uses far less energy than the old hydro-mechanical technology when comparing their power usage. During the steady phase, the most typical clutch operating phase in a vehicle's working cycle, the low energy consumption of electromechanical technology becomes even more apparent. Finally, according to WMTC 3.2, an electric clutch may reduce a recreational vehicle's fuel usage by 6.2%.

CONCLUSION

• Research shows that the fuel efficiency of scooters with continuously variable transmissions drops by around 37% after extended usage. Estimating the contribution of key variables to the reduction in fuel economy is vital, given the millions of used scooters on the road.
Changing the components of CVTs, adjusting the engagement speed and shift speed, managing the ratio range, and the load situation are all ways to potentially increase efficiency.
The fuel efficiency of a scooter operated by a continuously variable gearbox is greatly affected by the worn-out clutch friction liner and rubber belt. Which may be remedied using a variety of approaches that need to be discovered. To preserve and improve fuel economy, it is necessary to determine the causes of clutch degradation and implement optimisation measures.
Alterations to the centrifugal clutch and continuously variable gearbox may increase fuel efficiency.

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