e-ISSN: 2582-5208
International Research Journal of Modernization in Engineering Technology and Science
(Peer-Reviewed, Open Access, Fully Refereed International Journal)
Volume:05/Issue:01/January-2023 Impact Factor- 6.752 www.irjmets.com

CONTINUOUS VARIABLE TRANSMISSION (CVT) IN AUTOMOBILES – ASSESMENT ON FUEL CONSUMPTION, PROBLEMS, SYMPTOMS AND SOLUTIONS

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DOI : https://www.doi.org/10.56726/IRJMETS33167

ABSTRACT

In today's modern, emerging world, scientists and engineers have come up with advanced transmission technolgies. Continuous Variable Transmission (CVT) is a transmission system which eliminates the need of shifting gears by introducing infinite gear ratios. It uses a metallic belt consisting of 400 segments and laminated rings fixed over 2 pulleys which can continuosly change its diameter. The frictional force which is generated between the belt and the pulley is used for the transmission of power. Suitable torque is proveded to the system with the help of continuous adjustment of diameters of the two pullleys. CVT is included in the automatic transmission category of automobiles and is one of the most used automatic transmission technologies.CVT is more fuel efficient compared to manual transmission. With new technologies comes new problems and in case of CVT some of the most common problems include overheating, slipping and sudden loss of acceleration. The aim of this research paper is to asses the fuel consumption property of CVT, discuss various problems assosciated with it and find an appropriate solution to it.

Keywords: Automatic Transmision, Belt, CVT, Fuel, Gear ratio, Pulley.

I. INTRODUCTION

Continuous Variable Transmission(CVT) includes two pulleys and a metallic bet strapped upon it. In manual transmission different gear ratios are used to control speed and torque delivered to the system and it is achieved by the shifting of gears. CVT on the other hand offers infinite gear ratios which eliminates the need to shift gears. It is done by introducing two pulleys which can adjust its diameter based on the correct amount of torque required. It consists of a drive pulley which is connected to the engine and a driven pulley. The metallic belt is used to transmit power.

In addition, many types of CVTs have been developed with higher efficiency and better performance than other common transmissions. In general, CVT has two large and small variable diameter pulleys for power transmission, combined with a chain or metal belt, but it is not as popular as belt and chain CVT. The two pulleys each comprise a pair of pulleys, one fixed and the other axially movable. Also reduce the effective radius of the larger pulleys and increase the effective radius of the smaller pulleys, or vice versa, to achieve better speed regulation.

Generally, the parallel hybrid electric vehicle consists of the internal combustion engine connected with the fuel tank. In addition, the CVT gearbox is placed between the speed-coupling device and the driveshaft, the other side is connected to the differential and the wheels. The CVT gearbox allows the engine in optimal transmission operation to propelling the vehicle. The IC engine is coupling with the electric motor by flywheel, the battery is considered as a supply power source connected to the DC-DC voltage converter on the other side. This configuration has the ability to propel the vehicle by the IC engine and the electric motor.

II. METHODOLOGY

CVTs offer different drive ratios by changing the position of a high-strength steel belt between two metal pulleys. The sides of the pulley are hydraulically controlled. One of the pulleys is connected to the engine output and the other to the gearbox output. The CVT gear ratio can be changed steplessly according to driving conditions. In addition to speed ratio control, CVTs have a significant impact on fuel consumption.

Circuitry

This type of belt uses an electronic circuit to continuously change the distance between pulleys depending on engine power. This type of push-he belt has attracted attention from car manufacturers for its superior

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advantages. The belt is clamped between the sheaves of each pulley by hydraulic pressure in a hydraulic chamber, creating tension in the string. A CVT enables power transmission in combination with thrust between thrust belt elements. Generally, a hydraulic actuation system is used to control the actuation ratio of the CVT and provide clamping control force. In addition to controlling, the fluid is pressurized into and out of the piston of each pulley.

III. MODELING AND ANALYSIS

The most common type of CVT is the pushbelt type, where the belt consists of steel block segments gathered in a steel band. Also, the CVT push belt has up to 400 steel parts. This push belt transmits torque from one pulley to the other.

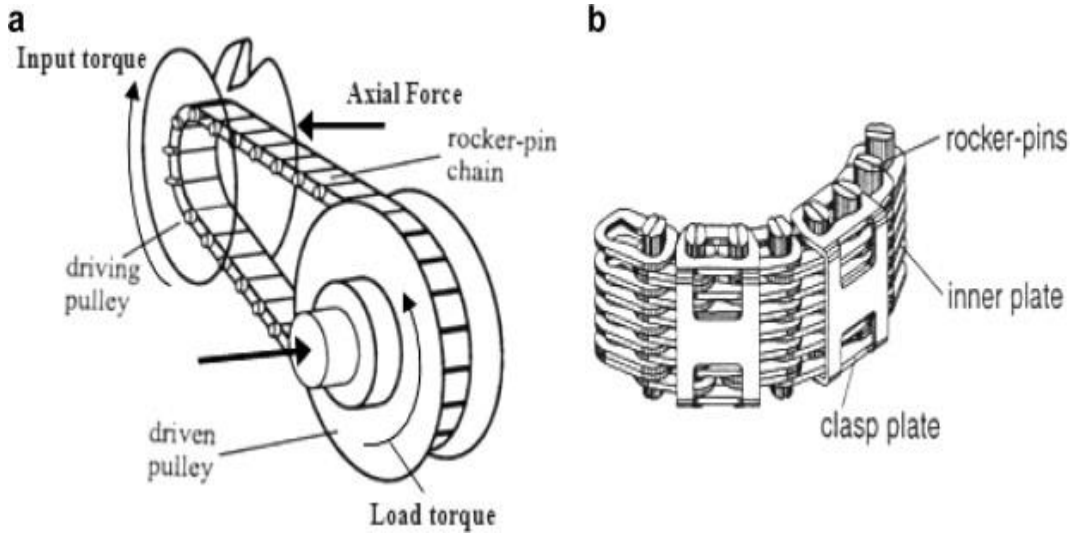

Figure 1: CVT Chain Drive. (a) basic configuration; (b) chain structure

IV. RESULTS AND DISCUSSION

Many researchers have studied transmission efficiency and fuel economy by running real gasoline engines as power sources, dynamometers as load sources, and performing bench tests in addition to transmissions and drive axles. Achieving a drive cycle in bench testing is relatively more complex than simulation models. Bench tests with gasoline engines and dynamometers are replaced by predictive simulation models. Moreover, comparison of system parameters with existing test data for powertrain components using simulation models is more convenient than bench testing. The simulation test is intended to validate the predictive accuracy of an automotive powertrain simulation model based on bench test measured CVT efficiency. The fuel economy test includes driving cycles and constant speed conditions. The CVT efficiencies for the simulated driving cycles are shown in Figures 1, 2, 3, 4, 5, 6, 7, 8 with CVT ratio, input speed, and input torque. When the vehicle speed is 0 km/h, the CVT input speed is 0 rpm and the CVT efficiency is 100%. When the driver model outputs braking force, the car slows down and the engine produces braking torque. This is indicated by negative values in the figure. Urban driving cycles are being characterized by complex road conditions. As shown in Figures 1, 2, 3, and 4, the CVT box changes gear ratios frequently and significantly, resulting in significant changes in CVT efficiency. Engines mostly operate in an uneconomical range with relatively low output torque, while CVTs operate in high gear ratios. The result is lower CVT efficiency, higher CVT torque losses, and increased fuel consumption. Therefore, the fuel consumption of a city driving cycle is higher than a suburban or highway driving cycle. Conditions for EUDC and HWFET test cycles are more stable than those shown for NEDC and UDC test cycles. After 200 seconds (high-speed period), the input torque of EUDC and HWFET changes greatly, but the input torque of CVT remains sufficiently high. The engine runs almost at an economical point. At this point, the gear ratio is low enough to maintain high CVT efficiency for a relatively long time, reduce CVT torque losses, and reduce fuel consumption.

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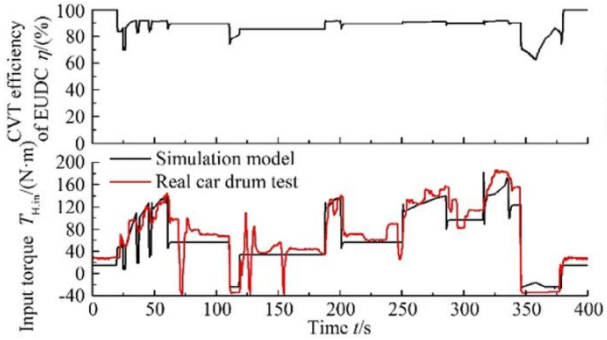

Fig. 1. Simulation results of NEDC(a)

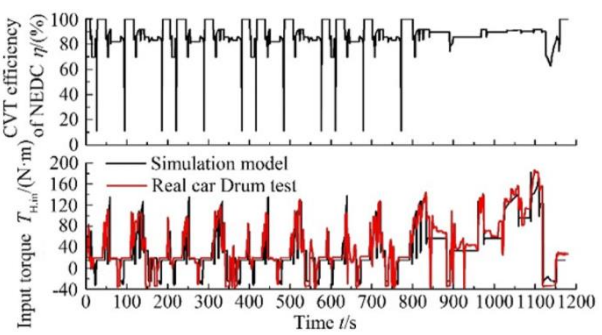

Fig. 5. Simulation results of EUDC(a)

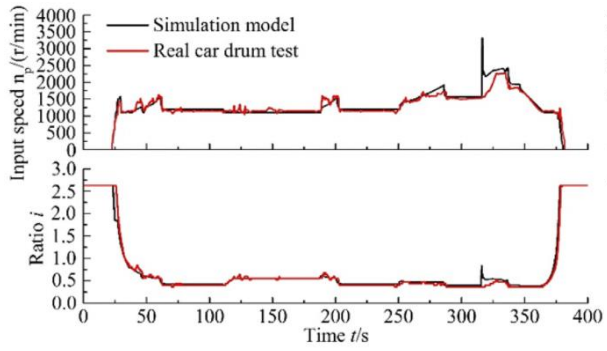

Fig. 2. Simulation results of NEDC(b)

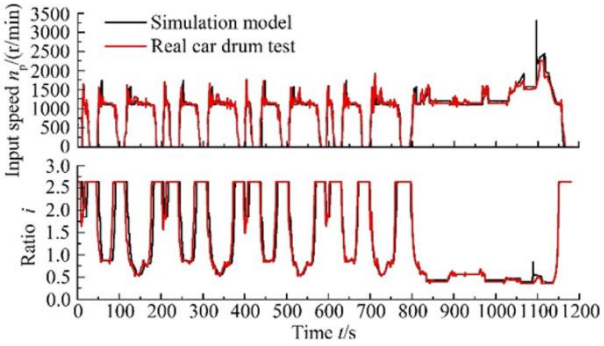

Fig. 6. Simulation results of EUDC(b)

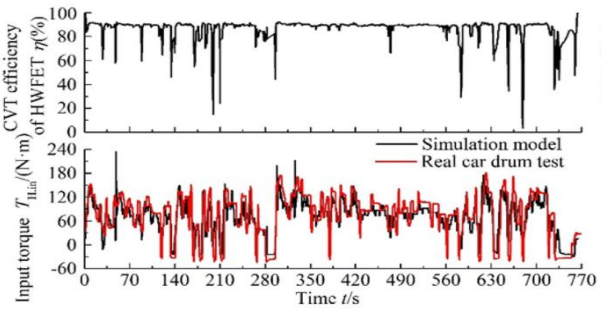

Fig. 3. Simulation results of UDC(a)

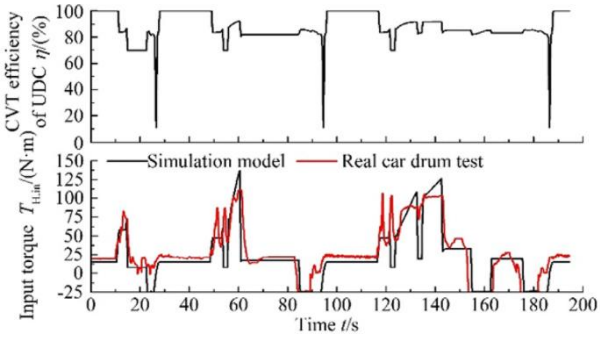

Fig. 7. Simulation results of HWFET(a)

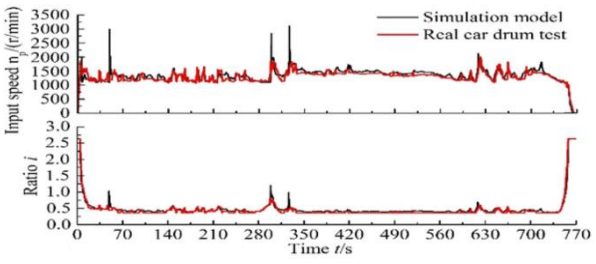

Fig. 4. Simulation results of UDC(b)

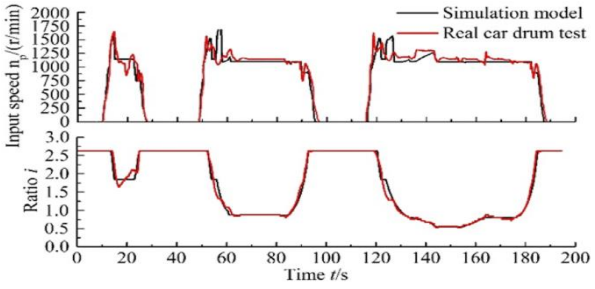

Fig. 8. Simulation results of HWFET(b)

Table 1: Comparative study between fuel emission in different driving cycles.

Driving Cycle	CVT				
	FC (L/100km)	HC (g/km)	CO (g/km)	Nox (g/km)	SOC
UDDS	3.4	0.326	2.118	0.239	0.596
HWFET	3.6	0.259	0.984	0.213	0.639
FTP	3.6	0.253	1.649	0.208	0.565

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Common Problems.

1. Slipping, Grinding and jerking- If your CVT feels like it's slipping, you've come to the right place to take steps to diagnose the problem. Excessive gear slip can indicate a serious gear construction problem or gear oil problem. If you don't have enough transmission oil, you may not have enough lubrication for constant adjustment of the CVT pulley and belt or chain. The same is true if the gear oil has deteriorated. Some CVT slippage is normal, but if excessive transmission slippage interferes with your normal driving routine, you will definitely feel it. CVT transmission grinding noise remains a mystery. There is no clear answer as to what is wrong with grinding noise coming from the CVT transmission. any kind of grinding on the CVT is a sign of worn out internal components. the grinding noise could be fixed by shortening the transmission oil interval, but this mostly happens on high mileage vehicles where a transmission change is expected. All types of CVT jerking, twitching, or jumping forward are signs of serious concern. In most cases, the problem is low transmission oil, dirty and worn transmission oil, or the CVT needs reprogramming. We also found reports that certain his CVTs weren't as smooth as his others, and judder was to be expected when the CVT shifted between 'high' and 'low' gears. Lots of people online and at dealerships claim that judder at low speeds is normal.

2. Control Module Problems- Like all automatic transmissions, the CVT has a transmission control module, the TCM. This module collects all signals from various sensors in the car and determines how the gearbox reacts. If there is a fault in the transmission control unit of the CVT transmission, the behavior of the transmission can suddenly change. Delayed engagement, excessive transmission misalignment, and all sorts of other symptoms can occur. If these symptoms appear suddenly and have never been a problem before, you can determine if the faulty component is the transmission control unit. Structural and mechanical damage to CVTs occurs gradually, whereas electronic problems usually occur quickly.

3. Whining, rattling and clunking sounds while driving- Any noise coming from the CVT is a sign of trouble. In some cases, you may simply have used the wrong transmission fluid or the transmission fluid needs to be changed. That's it. A good mechanic would first rule out potential sources of strange noises such as: Bad wheel bearings, suspension problems, brake system problems. These are all much cheaper to fix and can easily be mistaken for transmission problems.

4. Fluid problems in Transmission- Stale, worn gear oil is the number one killer of a CVT transmission. This cannot be overemphasized. Most of the CVT problems and symptoms listed here today are caused by below average CVT transmission fluid levels, worn out CVT transmission fluid, or the wrong CVT transmission fluid. As with any transmission, a healthy and sufficient amount of gear oil prevents mechanical damage to the transmission by cooling and lubricating all moving parts. Regularly check the CVT transmission for leaks and replace his CVT transmission fluid according to the manufacturer's intervals. Many owners choose to shorten the interval between transmission fluid changes as it shows great potential to keep the CVT healthy in the long run.

5. Overheating- All types of automatic transmissions are very sensitive to overheating. CVT transmissions are no exception. Overheating can be caused by improper use (such as heavy towing), lack of gear oil, or worn gear oil. It can also occur if transmission oil circulation is compromised due to oil pump failure. If the CVT overheats, a warning will appear on your car's dashboard. In this case, please stop the car immediately. If overheating is caused by traffic conditions (extreme heat and continuous stop-and-go traffic can overheat the CVT), you can start driving as soon as the CVT cools down. If the transmission overheat warning message occurs repeatedly, there is definitely a problem with the CVT transmission. In this case, the car should go straight to the service center.

6. Slippage of Metallic Belt- Sheet metal chains or belts must be clamped with a constant force to prevent them from slipping on the pulleys that adjust the gear ratio. Some slip is fine and expected from the factory, but too much slip indicates severe transmission damage.

7. Problems with Flywheel- CVT transmissions have a flywheel or torque converter similar to those found in standard hydraulic automatic transmissions. There have been some reports of CVT flywheel issues and dealers are suggesting car owners simply replace the entire CVT without paying attention to the CVT flywheel. Real problem part was the failing of CVT flywheel. The symptoms of a failed CVT flywheel can vary and can cause

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problems such as slipping, judder, etc. However, when using diagnostic tools, there is usually no trouble code, so there is a structural problem with the CVT. and often leads dealers to believe they need to be replaced. is needed.

8. Cluth Problems- Most CVTs are equipped with a clutch that stands between the engine and transmission. When you press the accelerator, the clutch slowly engages the engine and transmission for a smoother start. If you're having issues with jerky starts, jerking forward, or lagging engagement, the problem may be with his CVT clutch. In some cases, simply reprogramming the clutch after changing the transmission oil may solve the problem. See this forum thread.

Your car's dashboard will alarm you if the CVT gearbox is overheating. If this does happen, make sure to stop your car as soon as possible. If overheating is caused by any traffic conditions (extreme heat and prolonged stop-and-go traffic can overheat the CVT) you can drive away as soon as your CVT gearbox has cooled down. If. the transmission overheat warning message occurs repeatedly, there is definitely a problem with the CVT transmission. In this case, the car should go straight to the service center.

Locations such as bus stops, highway ramps, intersections, and highways have performance and acceleration issues that put drivers at a higher risk of crashing or causing an accident. If you are looking for a vehicle in the market, you have two options when it comes to train driving: manual or automatic. Also, when it comes to CVT automatics, these are relatively expensive compared to their manual counterparts. If you got a vehicle with a CVT box, be careful. The maintenance costs for this automatic transmission are high. There are fewer moving parts in the CVT box, but that doesn't mean lower maintenance costs. However, if there is a problem with the CVT, the entire unit will have to be replaced. That being said, it takes a lot of money to fix a CVT automatic.Another aspect relates to regular broadcast services. CVTs require special oils and gear oils, which are also more expensive than conventional ones. Ultimately, these services are performed by qualified technicians. Long mileage and comfort come with compromises. Unlike other automatic transmissions, the CVT box is a bit slow to respond to inputs. It has to do with how this transmission works. Because the transmission belt is under constant tension, it takes time for the belt to adjust its ratio. This is called the rubber band effect. Also, if you step on the accelerator suddenly, the belt may slip, which means the engine loses power. CVTs don't work in the same way as other traditional automatic transmissions and can be difficult to get used to. The rubber band effect can make the engine sound monotonous and difficult to switch in manual mode.

Solutions

Overheating: This is a big problem with CVTs. Therefore, it is important that your vehicle has enough fluid. However, care should be taken not to exceed 75% or approximately 3/4 of the reservoir when refilling. It should be at the crosshatch mark. Overfilling the gear reservoir makes things worse. Regular servicing of your vehicle by a qualified mechanic will go a long way in maintaining your transmission. Fluid change schedules: Fluid change schedules vary greatly by vehicle type. However, most vehicles will need replacement once it exceeds 100,000 miles. Please refer to your owner's manual or visit your local auto care center for exact ranges. Overload: Do not overload the vehicle as excessive heat will severely stress his CVT belt. If possible, adhere to the vehicle weight recommended by the manufacturer. fenders: Although neglected, front fenders serve an important function in his CVT-equipped vehicle. Make sure it is properly positioned to prevent dust from accumulating on the CVT. Develop good driving habits: When driving uphill, instead of using the throttle to press the accelerator, press the brake to counteract a backward movement, release the accelerator, and then press the throttle again. Please step on it. As with any automatic transmission vehicle, do not stop the vehicle in neutral. CVT may be damaged.

V. CONCLUSION

A CVT combines the efficiency of a manual transmission with the ease of use of an automatic transmission. The CVT is an advanced technology that features infinite gear ratios and excellent fuel economy in addition to high acceleration capabilities. We propose a method to combine computer simulation predictions with bench testing. Based on his CVT efficiency measured in bench tests and its real CVT car powertrain data, built a car powertrain simulation model to predict the fuel economy of a car equipped with a CVT box. The proposed method and model can simplify the process of investigating the impact of CVT efficiency on vehicle fuel consumption compared to dyno tests and road tests.This paper also discusses the very common problems

associated with CVT and also talks about its solutions. Modern technology or not, everything has its own strengths and weaknesses. But these issues don't mean the CVT is a bad transmission. It has its own fair merits that make it a CVT-equipped car worth buying.

ACKNOWLEDGEMENTS

I do not want to miss the opportunity to thank all faculty in the department for their kind help and cooperation for the further development of my paper. Last but not least, I would like to express my gratitude to my family and friends who worked hard to realize this work.

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