Recovery of Kinetic Energy in Small Vehicles: A Review

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Abstract— In order to increase efficiency of small vehicles like bicycles, mopeds kinetic energy recovery is essential. By using kinetic energy recovery devices like flywheels one can recover this kinetic energy. As in conventional designs of such a small vehicles there is no provision of flywheel or any other kinetic energy recovery system, large part of this kinetic energy is remained unrecovered. Hence there is a possibility to increase efficiency of these vehicles by using flywheels. The aim of this paper is to provide a review on literature present, on application of kinetic energy recovery in small vehicles and possibilities of its implementation.

Key words: Flywheel, Kinetic Energy Recovery, Small Vehicles

I. Introduction

Small vehicles like moped, bicycles always have energy or power fluctuation issues, due to their small power source or manual driving systems. Due to these fluctuations it is difficult to operate these small vehicles at hilly, bumpy road or at upstream. Because in these situations more power is required than usual driving conditions hence by generating more power this problem can be overcome but this solution will require extra or bigger size of engine and gearing system in case of bicycle, which will further lead to increase in size of driving mechanism. With increase in size and weight of driving mechanism again more power will require to drive the system. Hence alternately another solution of kinetic energy recovery can be obtained where a kinetic energy recovery device can be used to recover extra energy which will otherwise go wasted in plain road or downstream. In this system, flywheel will be attached to these small vehicles which will work to recover this kinetic energy.

II. Flywheel

Flywheels are used as energy storage devices in many applications. These kinetic energy recovery devices are used to store energy for very long period, flywheels has history of thousands years. Flywheels are used long before the invention of internal combustion engines. It is a simple form of kinetic energy storage. [1] As flywheels has high power density it can be used in heavy vehicles, machineries etc.

Energy is stored by causing a heavy disk or rotor to spin on its own axis. Energy stored in disk is proportional to the flywheel's moment of inertia and square of its velocity. Flywheel rotates continuously around its axis to store energy. Flywheels have many types according to their application, size and speed. All these variations of flywheels can be used at suitable places. In our system, a light weight, low speed flywheel can be used to recover kinetic energy from the small vehicle. [2]

III. Kinetic Energy Recovery System

Kinetic Energy Recovery System (KERS) is a system for recovering the moving vehicle's kinetic energy under braking and also to convert the usual loss in kinetic energy into gain in kinetic energy. When riding a bicycle, a great amount of kinetic energy is lost while braking, making start up fairly strenuous. [3] Here we used mechanical kinetic energy recovery system by means of a flywheel to store the energy which is normally lost during braking, and reuse it to help propel the rider when starting. The rider can charge the flywheel when slowing or descending a hill and boost the bike when accelerating or climbing a hill. The flywheel increases maximum acceleration and nets 10% pedal energy savings during a ride where speeds are between 12.5 and 15 mph.

IV. Application of KERS in Bike

KERS is a collection of parts which takes some of the kinetic energy of a vehicle under deceleration, stores this energy and then releases this stored energy back into the drive train of the vehicle, providing a power boost to that vehicle. For the driver, it is like having two power sources at his disposal, one of the power sources is the engine while the other is the stored kinetic energy. Kinetic energy recovery systems (KERS) store energy when the vehicle is braking and return it when accelerating. During braking, energy is wasted because kinetic energy is mostly converted into heat energy or sometimes sound energy that is dissipated into the environment. Vehicles with KERS are able to harness some of this kinetic energy and in doing so will assist in braking. By a proper mechanism, this stored energy is converted back into kinetic energy giving the vehicle extra boost of power. There are two basic types of KERS systems i.e. Electrical and Mechanical. The main difference between them is in the way they convert the energy and how that energy is stored within the vehicle. Battery-based electric KERS systems require a number of energy conversions each with corresponding efficiency losses. On reapplication of the energy to the driveline, the global energy conversion efficiency is 31–34%. The mechanical KERS system storing energy mechanically in a rotating fly wheel eliminates the various energy conversions and provides a global energy conversion efficiency exceeding 70%, more than twice the efficiency of an electric system.

This design of KERS bicycle was motivated by a desire to build a flywheel energy storage unit as a proof of concept. On a flat road, the cyclist can maintain a fixed cruising speed to get from point to point. Globally all roads are flat with impediments such as intersections, cars, and turns that force the cyclist to reduce speed, then accelerate. A flywheel can temporarily store the kinetic energy from the bicycle when the rider needs to slow down. The energy stored in the flywheel can be used to bring the cyclist back up to cruising speed. In this way the cyclist recovers the energy normally lost during braking. In addition to increased energy efficiency, the flywheel-equipped bicycle is more fun to ride since the rider has the ability to boost speed.

A crank wheel connected to the rear wheels always rotates the clutch plate, connected in the flywheel axle. This is being achieved by using chain transmission at a specified gear ratio, crank to clutch sprocket helps us to increase the overall speed of flywheel. Now at a time when a speed reduction is required, clutch is applied which makes the contact between the clutch and flywheel. Then the flywheel starts rotating, also the speed of bicycle is decreased. Thus a regenerative braking system is achieved. On course energy is stored in flywheel. In case the brake has to be applied fully then after flywheel rotations clutch is disengaged and the brake is applied. Now when we again rides the bicycle during which we would apply clutches at this time as rear wheel rotation is lesser compared to flywheel the energy gets transmitted from the flywheel to the wheels. Now also we can reduce the overall pedalling power required in course of overrides by having clutch fully engaged. We can reduce overall pedaling power by 10 per cent. Also situation arises such as traffic jam, down climbing a hill where we do not intend to apply brake fully. For such cases we can apply our smart braking system which would allow us to decelerate and allow us to boost acceleration after this during normal riding and distance that can be covered by pedaling can also improve. During normal rides situations may arise we need to reduce the speed without braking fully such as traffic jams taking turns etc. we can store the energy that would normally be wasted due to speed reduction by the application of clutch. When the clutch is engaged that time due to initial engage the flywheel rotation consumes energy which would result in speed reduction thus a braking effect. After some instances the energy is being stored in the flywheel this can be reused by the engage of clutch plate and energy transfer from the flywheel occurs whenever the rotation is high enough to rotate rear wheel.[4] Thus if sudden braking then applied we can disengage the flywheel connections so that flywheel energy is not wasted and going to take ride the speed of rear wheel is null and hence engage would help in returning the energy from the flywheel to rear wheel. While riding downhill we always use braking for allowing slowdown. This is the best case where we can store maximum amount of energy in our flywheel. The flywheel can be engaged for full downhill ride and after all for some distance we need not ride the bicycle which would be done by the flywheel. This is the main advantage area of KERS bicycle. During long drive the engage can be made full time. This will help in reducing the overall pedalling effort. It has been found that the pedalling power can be reduced by 10 per cent during long drives. Also this would help in avoiding pedalling effort at some points of ride.

The main objective of this work is to reduce the overall pedaling power required by the rider. Also situation arises such as traffic jam, down climbing a hill where we do not intend to apply brake fully. For such cases we can apply our smart braking system which would allow us to decelerate [5] and allow us to boost acceleration after this during normal riding and distance that can be covered by pedalling can also improve.

V. Conclusion

From all above literature survey it can be concluded that with the application of kinetic energy recovery system in small vehicles like bike; bicycle etc in the form of flywheel one can recover kinetic energy lost in traffic jams, braking and bumpy roads. By using KERS system efficiency of bike can be increased and driver's efforts can be reduced considerably.

Application of KERS will lead to better driving experience, increased efficiency of the bike and better life of vwhicle.

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