

# Braking Energy Recovery System Design

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**Abstract.** Nowadays, the energy consumption and environmental pollution pressure cars bring has become a global challenge. In order to ease the pressure of energy and environment, the loss energy during automobiles braking can be regenerated and reused when the automobile starts or accelerates. By this way, not only benefit the environment, but also prolong the life of vehicle's braking parts. At present, there are four kinds of energy storage devices on the research, flywheel storage, hydraulic energy storage, electrochemical energy storage, and pressure storage. This paper makes a simple analysis of these four ways, and design a regenerative braking system based on the flywheel storage devices.

## Introduction

In the 21st century, the impact of energy on human life, social development is growing. Automobiles bring convenience to human while cause a great burden to energy and the environment. From the energy point of view, more than a third of the world's oil production for car use; From an environmental perspective, the pollutants produced by cars has become a major source of urban air pollution. Vehicle braking energy is the energy of a need to be developed. Through the braking energy recovery and utilization can greatly improve the vehicle energy comprehensive utilization, and can decrease the emissions from automobiles. With the development of hybrid and electric vehicle, regenerative braking system has become a general configuration of such vehicles. However, the theory of regenerative braking energy recovery and utilization is far from perfect [1]. Regenerative braking technology is one of the types of vehicle braking in a certain way, absorb and store part of the kinetic energy during the process of automobile brake or slow down through the energy recovery system. On the one hand, the vehicle's kinetic energy is converted into other forms of energy recycled, rather like mechanical friction brake the vehicle kinetic energy into heat energy wasted. On the other hand reduce the mechanical friction brake wear, increases the life span of the friction brake. Therefore, the research on regenerative braking technology has great practical significance [2].

## Research Status

In the United States at the university of Wisconsin, NormanHBeachley, a. a. Frank and other scholars put forward the earliest hydraulic type and battery type braking energy recovery system, and carefully demonstrate the feasibility [3].

In 1979, Danish researchers G.Christensen and others proposed the theory of braking energy recovery, and carried on the experimental analysis on ford Escort with the hydraulic energy storage system, which showed that the fuel can be saved up to 30% [4].

In 1987, the Japanese itsubishi company installed hydraulic energy storage system on the bus and tried an experiment which showed that bus installed the system can save fuel by 30% [5].

Since 1990, research on the braking energy recovery system has made a breakthrough. The recovery system has been successfully used in the hybrid cars,such as Honda Prius, Estima and Toyota Insight. Their plan is to use a hybrid car motor, the electric motor drag from the car during braking, and become generator, after voltage regulation and integer, the battery of electricity

feedback to cars through the motor [6].

Domestic scholars on the basis of fully absorbing foreign research results, focused on the control process of the accumulator and hydraulic energy storage type braking energy recovery system and put forward two kind of new way of energy storage called flywheel energy storage type and air pressure energy storage type, achieving good research results [7]. However, compared to the foreign, domestic researchers study of braking energy recovery system is in the primary stage, did not reach the level of application practice. Electrical energy storage type braking energy recovery system has only been applied in a few of buses, in addition, the hydraulic energy storage and flywheel energy storage braking energy recovery system only stay in the laboratory stage.

### Flywheel Storage

The basic working principle is to convert the kinetic energy of the car during braking or deceleration into a high-speed rotational kinetic energy. when the car started to accelerate, the high-speed rotation of the flywheel stored kinetic energy is converted into the car's auxiliary driving force. Flywheel device is simple, low cost, but the weight and volume is big, to improve the efficiency of flywheel energy storage is the major problem in the research.

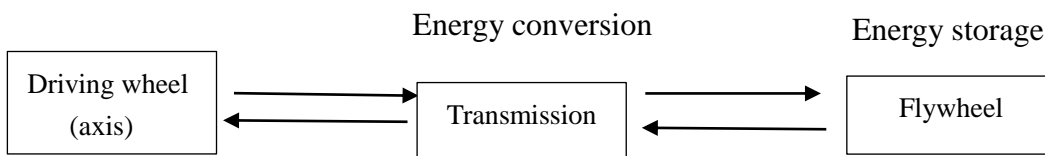


Figure 1. The principle diagram of the flywheel energy storage type

### Hydraulic Energy Storage

Its working principle is to convert kinetic energy into hydraulic energy, and the hydraulic energy storage in the hydraulic accumulator. When the car start to accelerate, the hydraulic energy in accumulator can be applied to automotive auxiliary accelerate. The storage device has fewer parts, low cost, high reliability characteristics. But when recycling is inevitably accompanied by the loss of friction and heat sealing properties, and the event of leakage greatly affect its performance and cause environmental pollution.

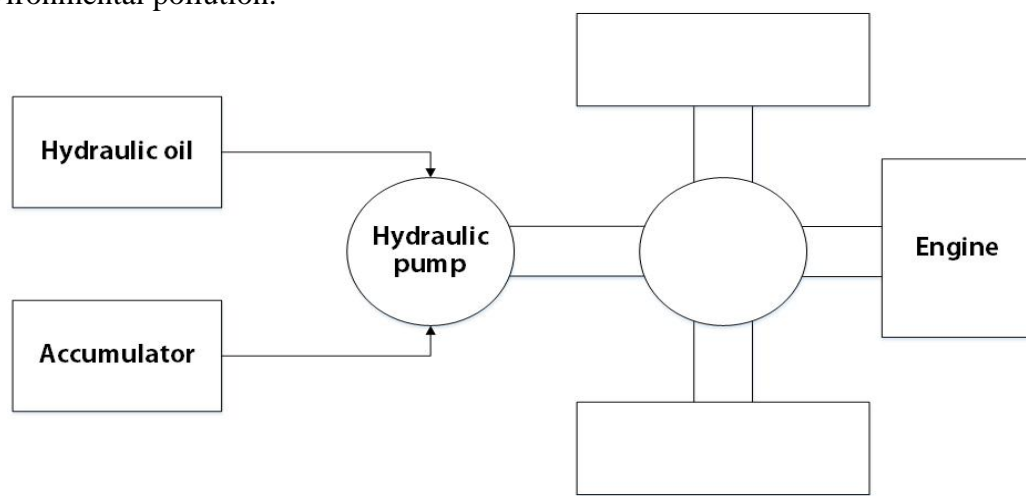


Figure 2. Hydraulic hybrid system schematic diagram

### Electrochemical Energy Storage

Its working principle is to convert the kinetic energy during braking or deceleration into electricity and stored in the accumulator in the form of chemical energy and convert the chemical energy into

the auxiliary motor cars kinetic energy when the car start to accelerate. The scheme has a simple structure, convenient operation, good reliability, and high braking energy recycling efficiency. Technology bottleneck restricting the application of the storage device is the high-performance, low-cost electrochemical energy storage devices and the electrochemical energy storage device to charge and discharge frequently larger influence on their life.

### Pressure Storage

Its working principle is to convert the kinetic energy during braking or deceleration into pressure energy which stored in the gasholder and auxiliary bus accelerate when the car accelerate [8].

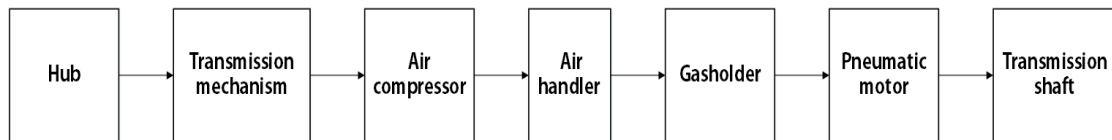


Figure 3. Air pressure energy storage system structure diagram

### Regenerative Braking System Design

We carried on the exploratory design of flywheel energy storage system. According to the function requirement, the system should at least include actuator, energy storage device, energy conversion and retarder device. The structure of braking energy recovery system diagram and the installation position is shown below [9]:

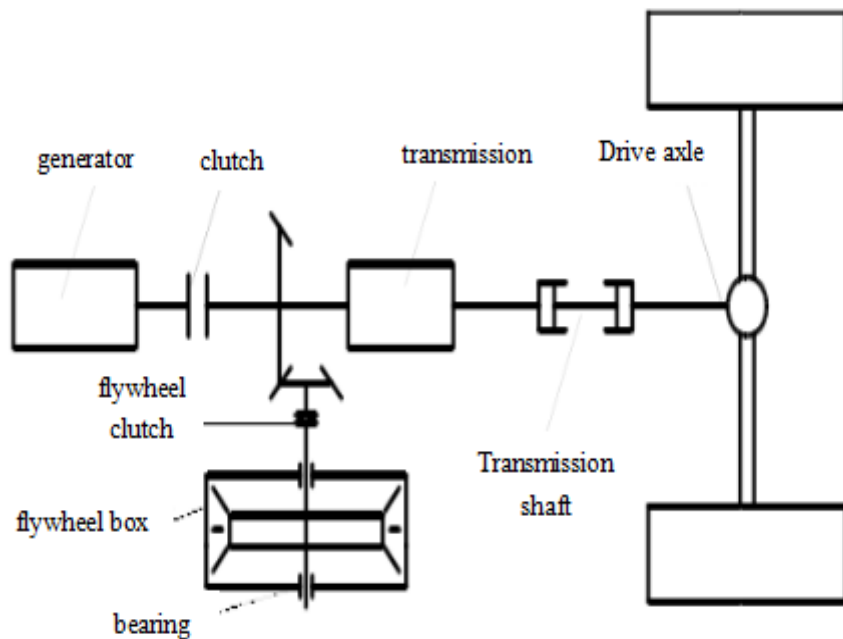


Figure 4. The flywheel energy storage system schematic diagram

Cars drive under different conditions, braking energy recovery system sometimes work and sometimes do not work. Therefore, the car must have the corresponding control system according to the working state to control the running condition of motor vehicle. The control principle diagram is shown in Fig. 5 [10].

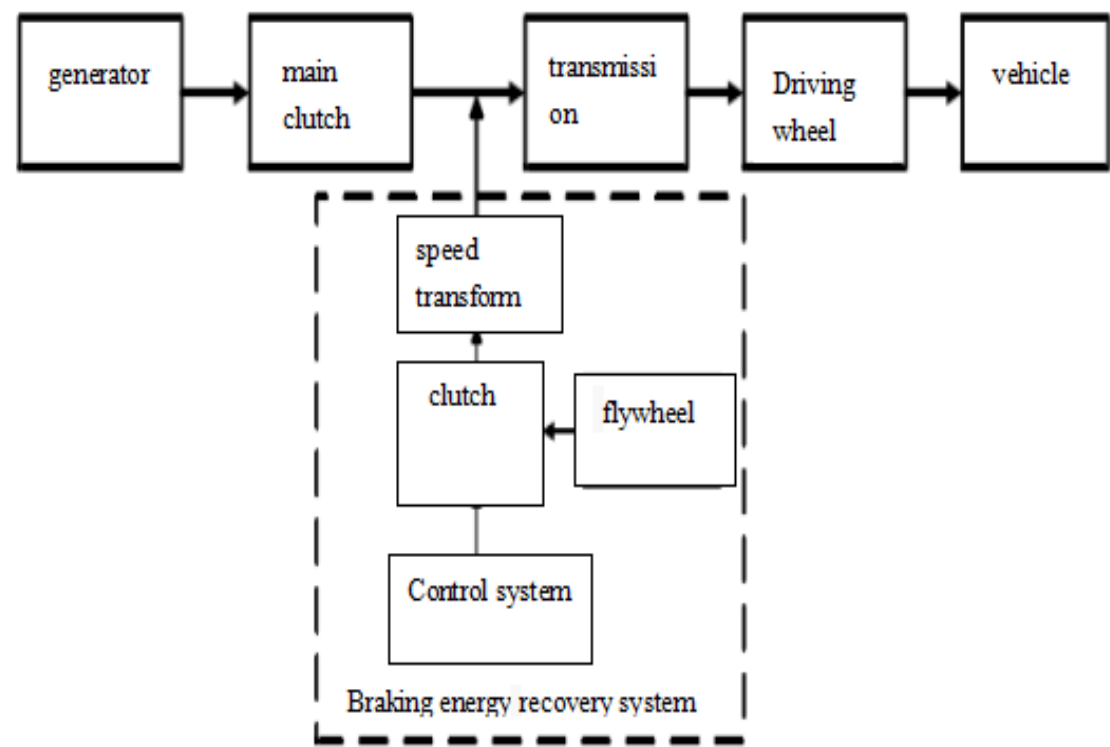


Figure 5. The control principle diagram

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