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A Review on Design and Development of Capsule Vehicle

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Abstract— the designing and development of hybrid electric vehicles in recent years have targeted for the reduction of on road emissions produced by the conventional IC-engine powered vehicles. This report presents designing and development of a hybrid electric two wheeler vehicle so that the overall efficiency of the vehicle (HYBRID) can be improved. The project utilizes a 160cc gasoline powered engine with a combination of a BLDC electric motor to further enhance the overall fuel efficiency of the system, particularly the fuel consumption rate. The vehicle can be propelled on both the electric and the normal conventional internal combustion engine. The power can be switched to which ever mode the driver requires or desires. There is a provision for the switch over of the propulsion of transmission from IC-engine to Electric drive or Electric drive to the IC-engine.

1. INTRODUCTION

The invention of the Internal Combustion engine is one of the greatest invention of all time. The conventional internal combustion engine provides a good performance and long operating range. However they have caused and are continuously causing environmental problems. The hybridization of the modern day conventional internal combustion engine is a must now a days because to reduce the emissions and to increase the fuel economy.

The hybrid vehicle concepts were 1st introduced in 1950 in cars, since then the modifications are therefore being under developmental phases and there-on. These hybrid vehicles come in to many different categories such as – micro-hybrid, semi-hybrid etc.

The hybrid systems are introduced for only four-wheelers and not been implemented on to the two-wheeled vehicles. Our team has made an attempt to introduce the concept of hybrid function into the two wheelers / four wheelers. In micro/semi hybrid systems, the auxiliary systems such as steering, braking, battery charging and other auxiliary works are being handled by the electrical system (hybrid system), while the transmission and mobility of the vehicle is controlled by the normal conventional internal combustion engine as well as the electric propulsion.

In our project, we have made an attempt to propel the vehicle in Hybrid power. The vehicle can be propelled on both the electric and the normal conventional internal combustion engine. The power can be switched to which ever mode the driver requires or desires. There is a provision for the switch over of the propulsion of transmission from IC-engine to Electric drive or Electric drive to the IC-engine.

In this project, both the wheels are power transmission capable. I.e. in Electric drive, the front wheel acts as driver and the rear wheel acts as the driven. Whereas in petrol drive, the rear wheel acts as the driver and the front wheel acts as the driven.

2. BASICS OF IC ENGINES

An Internal Combustion Engine (ICE) is a heat engine in which the combustion of a fuel occurs with an oxidizer (usually air) in a combustion chamber that is an integral part of the working fluid flow circuit. In an internal combustion engine, the expansion of the high-temperature and high-pressure gases produced by combustion applies direct force to some component of the engine. The force is applied typically to pistons, turbine blades, rotor or a nozzle. This force moves the component over a distance, transforming chemical energy into useful work.

The first commercially successful internal combustion engine was created by Étienne Lenoir around 1860 and the first modern internal combustion engine was created in 1876 by Nikolaus Otto (also known as Otto engine).

The term internal combustion engine usually refers to an engine in which combustion is intermittent, such as the more familiar four-stroke and two-stroke piston engines, along with variants, such as the six-stroke piston engine and the Wankel rotary engine. A second class of internal combustion engines use continuous combustion: gas turbines, jet engines and most rocket engines, each of which are internal combustion engines on the same principle as previously described

3. BASICS OF 4-STROKE ENGINE.

The top dead center (TDC) of a piston is the position where it is nearest to the valves; bottom dead center (BDC) is the opposite position where it is furthest from them. A stroke is the movement of a piston from TDC to BDC or vice versa, together with the associated process. While an engine is in operation, the crankshaft rotates continuously at a nearly constant speed. In a 4-stroke ICE, each piston experiences 2 strokes per crankshaft revolution in the following order. Starting the description at TDC, they are as

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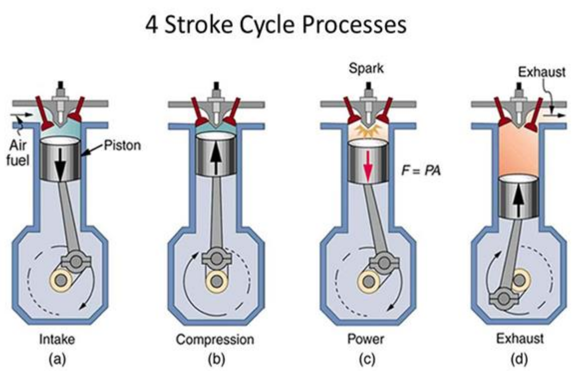
follows:

Intake, Induction or Suction: The intake valves are open as a result of the cam lobe pressing down on the valve stem. The piston moves downward increasing the volume of the combustion chamber and allowing air to enter in the case of a CI engine or an air fuel mix in the case of SI engines that do not use direct injection. The air or air-fuel mixture is called the charge in any case.

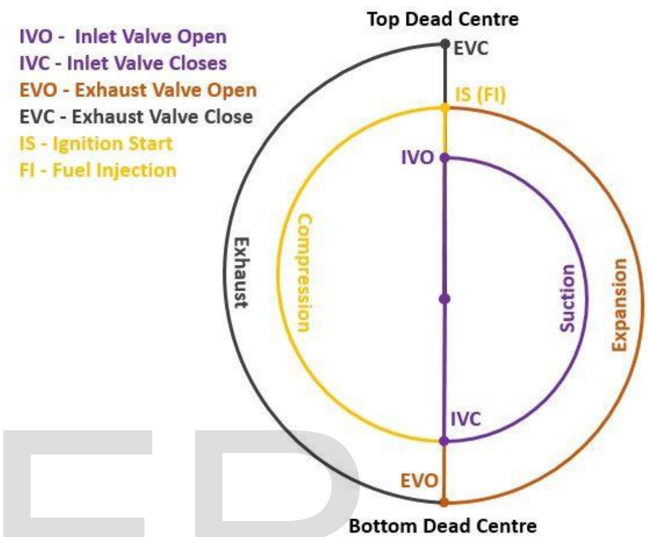


Compression: In this stroke, both valves are closed and the piston moves upward reducing the combustion chamber volume which reaches its minimum when the piston is at TDC. The piston performs work on the charge as it is being compressed; as a result its pressure, temperature and density increase; an approximation to this behavior is provided by the ideal gas law. Just before the piston reaches TDC, ignition begins. In the case of a SI engine, the spark plug receives a high voltage pulse that generates the spark which gives it its name and ignites the charge. In the case of a CI engine the fuel injector quickly injects fuel into the combustion chamber as a spray; the fuel ignites due to the high temperature.

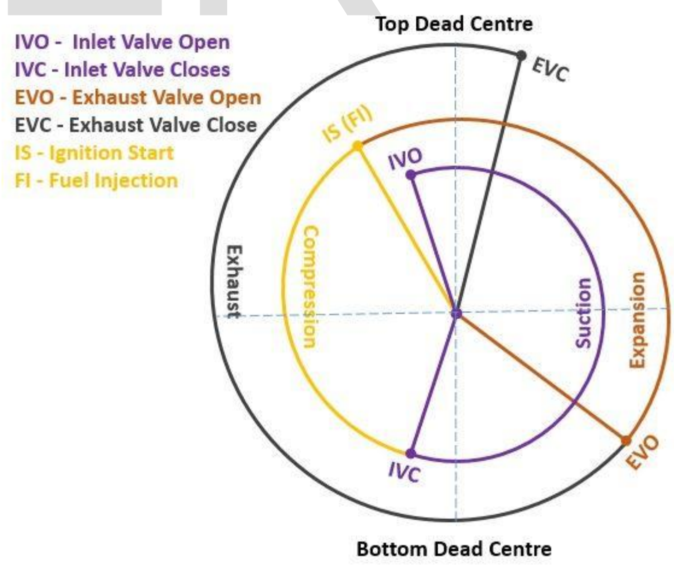
Power or Expansion stroke: The pressure of the combustion gases pushes the piston downward, generating more work than it required to compress the charge. Complementary to the compression stroke, the combustion gases expand and as a result their temperature, pressure and density decreases. When the piston is near to BDC the exhaust valve opens. The combustion gases expand irreversibly due to the leftover pressure—in excess of back pressure, the gauge pressure on the exhaust port—; this is called the blow down.

Exhaust: The exhaust valve remains open while the piston moves upward expelling the combustion gases. For naturally aspirated engines a small part of the combustion gases may remain in the cylinder during normal operation because the piston does not close the combustion chamber completely; these gases dissolve in the next charge. At the end of this stroke, the exhaust valve closes, the intake valve opens, and the sequence repeats in the next cycle. The intake valve may open before the exhaust valve closes to allow better scavenging.

The Theoretical valve timing diagram of a 4-stroke engine



The actual valve timing diagram of a 4-stroke engine



Valve timing diagram shows the opening and closing of inlet and exhaust valve according to the 4 strokes of engines or we can simply say according to the two revolution of crankshaft.

It is clearly shown in the diagram that inlet valve opens 25 degree before TDC (Top dead center - top edge of the cylinder) and inlet valve closes after suction stage ends i.e. 30

degree after BDC. Similarly fuel injection start and stop and exhaust valve open and close shown according to the 4 stages of Engine cycle.

4. BLDC MOTOR

. In brushless DC motors, an electronic servo system replaces the mechanical commutator contacts. An electronic sensor detects the angle of the rotor, and controls semiconductor switches such as transistors which switch current through the windings, either reversing the direction of the current, or in some motors turning it off, at the correct time each 180° shaft rotation so the electromagnets create a torque in one direction. The elimination of the sliding contact allows brushless motors to have less friction and longer life; their working life is only limited by the lifetime of their bearings.

Brushed DC motors develop a maximum torque when stationary, linearly decreasing as velocity increases. Some limitations of brushed motors can be overcome by brushless motors; they include higher efficiency and a lower susceptibility to mechanical wear. These benefits come at the cost of potentially less rugged, more complex, and more expensive control electronics.

A typical brushless motor has permanent magnets which rotate around a fixed armature, eliminating problems associated with connecting current to the moving armature. An electronic controller replaces the brush/commutator assembly of the brushed DC motor, which continually switches the phase to the windings to keep the motor turning. The controller performs similar timed power distribution by using a solid-state circuit rather than the brush/commutator system.

Brushless motors offer several advantages over brushed DC motors, including high torque to weight ratio, more torque per watt (increased efficiency), increased reliability, reduced noise, longer lifetime (no brush and commutator erosion), elimination of ionizing sparks from the commutator, and overall reduction of electromagnetic interference (EMI). With no windings on the rotor, they are not subjected to centrifugal forces, and because the windings are supported by the housing, they can be cooled by conduction, requiring no airflow inside the motor for cooling. This in turn means that the motor's internals can be entirely enclosed and protected from dirt or other foreign matter.

Brushless motor commutation can be implemented in software using a microcontroller or microprocessor computer, or may alternatively be implemented using analogue circuits, or in digital circuits using a field-programmable gate array (FPGA). Commutation with electronics instead of brushes allows for greater flexibility and capabilities not available with brushed DC motors, including speed limiting, "micro stepped" operation for slow and/or fine motion control, and a holding torque when stationary. Controller software can be customized to the specific motor being used in the application, resulting in greater commutation efficiency.

The maximum power that can be applied to a brushless motor is limited almost exclusively by heat too much heat weakens the magnets and will damage the winding's insulation.

When converting electricity into mechanical power, brushless motors are more efficient than brushed motors. This improvement is largely due to the frequency at which the electricity is switched determined by the position sensor feedback. Additional gains are due to the absence of brushes, which reduces mechanical energy loss due to friction. The enhanced efficiency is greatest in the no-load and low-load region of the motor's performance curve. Under high mechanical loads, brushless motors and high-quality brushed motors are comparable in efficiency. Environments and requirements in which manufacturers use brushless type DC motors include maintenance free operation, high speeds, and operation where sparking is hazardous (i.e. explosive environments) or could affect electronically sensitive equipment.

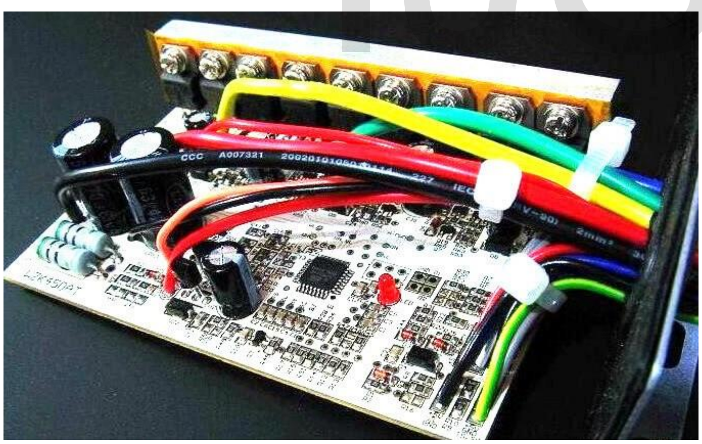
The construction of a brushless motor resembles a stepper motor, but the motors have important differences due to differences in implementation and operation. While stepper motors are frequently stopped with the rotor in a defined angular position, a brushless motor is usually intended to produce continuous rotation. Both motor types may have but generally do not include a rotor position sensor for internal feedback. As a step motor, a well-designed brushless motor can held finite torque at zero rpm.

A brushless DC electric motor (BLDC motor or BL motor), also known as electronically commutated motor (ECM or EC-motor) and synchronous DC motors, are synchronous motors powered by direct current (DC) electricity via an inverter or switching power supply which produces electricity in the form of alternating current (AC) to drive each phase of the motor via a closed loop controller. The controller provides pulses of current to the motor windings that control the speed and torque of the motor.

The construction of a brushless motor system is typically similar to a permanent magnet synchronous motor (PMSM), but can also be a switched reluctance motor, or an induction (asynchronous) motor. They may also use neodymium magnets and be out runners (the stator is surrounded by the rotor) or in runners (the rotor is surrounded by the stator). The advantages of a brushless motor over brushed motors are high power-to-weight ratio, high speed, electronic control, and low maintenance. Brushless motors find applications in such places as computer peripherals (disk drives, printers), hand-held power tools, and vehicles ranging from model aircraft to automobiles.

5. Motor controller

A motor controller is a device or group of devices that serves to govern in some predetermined manner the performance of an electric motor. A motor controller might include a manual or automatic means for starting and stopping the motor, selecting forward or reverse rotation, selecting and regulating the speed, regulating or limiting the torque, and protecting against overloads and electrical faults.



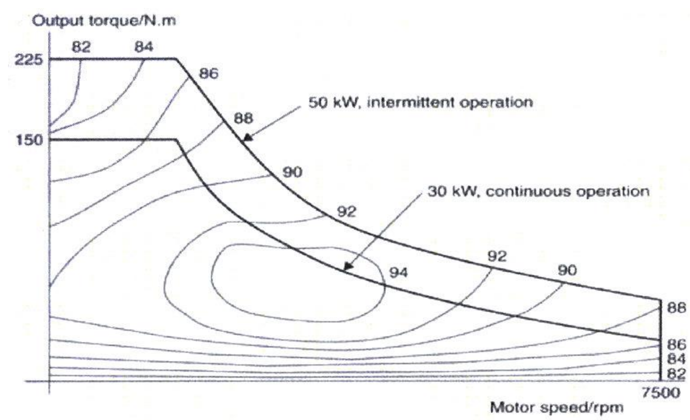
Servo controllers

Servo drive and Servomechanism

Servo controllers are a wide category of motor control. Common features are:

- precise closed loop position control
- fast acceleration rates
- precise speed control Servo motors may be made from several motor types,
- The most common being:

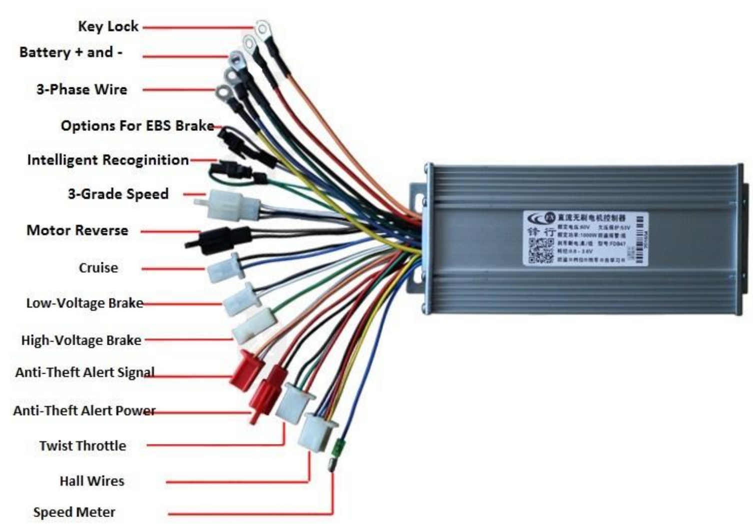
Performance chart of a BLDC motor



- brushed DC motor
- brushless DC motors
- AC servo motors

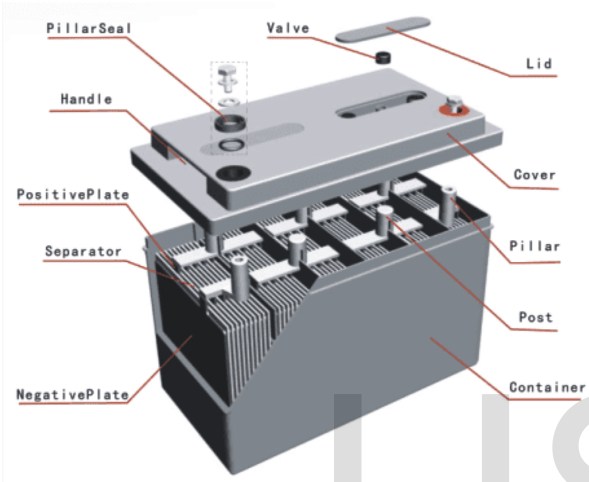
Servo controllers use position feedback to close the control loop. This is commonly implemented with position encoders, resolvers, and Hall Effect sensors to directly measure the rotor's position. Other position feedback methods measure the back EMF in the undriven coils to infer the rotor position, or detect the Kick-Back voltage transient (spike) that is generated whenever the power to a coil is instantaneously switched off. These are therefore often called "sensor-less" control methods. A servo may be controlled using pulse-width modulation (PWM). How long the pulse remains high (typically between 1 and 2 milliseconds) determines where the motor will try to position itself. Another control method is pulse and direction.

The functions offered by controller are:



6. Battery (VRLA type)

A valve regulated lead acid battery (VRLA battery) is a type of lead acid battery characterized by a limited amount of electrolyte ("starved" electrolyte) absorbed in a plate separator or formed into a gel; proportioning of the negative and positive plates so that oxygen recombination is facilitated within the cell; and the presence of a relief valve that retains the battery contents independent of the position of the cells



There are two primary types of VRLA batteries, absorbent glass mat (AGM) and gel cell. Gel cells add silica dust to the electrolyte, forming a thick putty like gel. AGM (absorbent glass mat) batteries feature fiberglass mesh between the battery plates which serves to contain the electrolyte and separate the plates. Both types of VRLA batteries offer advantages and disadvantages compared to flooded Vented Lead Acid (VLA) batteries, as well as to each other. Due to their construction, the gel cell and AGM types of VRLA can be mounted in any orientation, and do not require constant maintenance. The term "maintenance free" is a misnomer as VRLA batteries still require cleaning and regular functional testing. They are widely used in large portable electrical devices, off grid power systems and similar roles, where large amounts of storage are needed at a lower cost than other low maintenance technologies like lithium ion.

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