STUDIES ON ELECTRONIC CONTROL UNIT FOR FAULT DIAGNOSIS OF AUTOMOBILE STARTING SYSTEM

ABSTRACT

The starting system of automobile is used to convert electrical energy of battery into mechanical energy to start the engine. The quality of engine start influences emission and drivability of a vehicle. Improper operation of starting system may cause damage to its parts, decrease its service life and unexpected breakdown. Starting system failures are either electrical faults like increased contact resistance, brush fault, battery fault, armature fault, short circuit fault, open circuit fault and field winding fault or mechanical faults like damaged pinion and drive end housing fracture.

Detection of starting system failure is a complex process, time consuming and laborious. The conventional methods used to detect the faults are intuition method by which the faults are detected with previous experience and experimental way in which electrical parameters are measured by tests. The available test rig has the limitations in which the starter motor alone is tested. It cannot be used to detect the faults of entire starting system. Improper operation of the starting system causes pitting effect at contact points of solenoid switch resulting increase in contact resistance and internal resistance of the battery. As per SAE J544 test standards, it is found that the voltage drop during cranking of the vehicle with used starter motor is higher than that of the vehicle with new one, the peak cranking current and cranking torque during cranking of vehicle with used starter motor is lower than that of vehicle with new one due to increased contact resistance. Based on finite element analysis, a five point sphere-plane type contact is proposed, since its contact resistance is lower than that of existing plane-plane type contact. The contact resistance and contact temperature of one point sphere-plane type model and five point sphere-plane type models are 41°C, 0.08 Ω and 32°C, 0.04 Ω respectively. The current drawn by the starter motor, voltage drop, starter motor speed and torque during cranking were estimated by simulating the starting system of light duty vehicle using MATLAB/Simulink R2010a software.

A safety condition monitoring module was developed based on simulation model of PIC16F877 microcontroller in Proteus Professional 7.7 software to prevent

inadvertent operation of starting system when engine is running and to improve the cold starting performance for safe and reliable start. The peak cranking current and the voltage drop during cranking at various fault conditions of light duty, medium duty and heavy duty vehicles were acquired by conducting experiments as per SAE J544 test method. The engine power and torque of the light duty petrol vehicle is 37 BHP and 59 Nm respectively. The starting system of this vehicle uses a 2.0 kW starter motor supported by a 12V, 50 Ah lead acid battery. The engine power and torque of the light duty diesel vehicle is 42.7 BHP and 102 Nm respectively. The starting system of this vehicle uses a 2.2 kW starter motor supported by a 12V, 70 Ah lead acid battery. The engine power and torque of the medium duty vehicle is 71.3 BHP and 200 Nm respectively. The starting system of this vehicle uses a 2.0 kW starter motor supported by a 12V, 88 Ah lead acid battery. The engine power and torque of the heavy duty vehicle is 145 BHP and 470 Nm respectively. The starting system of this vehicle uses a 2.0 kW starter motor with planetary gear set supported by a 12V, 120 Ah lead acid battery.

It is found that the peak cranking current developed by the starting system of all vehicles at brush fault, battery fault and open circuit fault conditions are lower than that of their normal condition, which leads to either continuous cranking attempt within minimum time interval or prolonged cranking; hence the battery is over loaded. The peak cranking current developed by the starting system of all test vehicles at armature fault, field winding fault and short circuit fault conditions are higher than that of their normal condition, which leads to over loading of the battery. Based on experimental data, a fuzzy logic fault diagnosis system was developed with graphical user interface using MATLAB®GUI software. Hardware implementation of fuzzy logic fault diagnosis system was done through coding in ‘C’ programming language and interfacing with PIC18F4520 microcontroller for all types of vehicles. It was tested on all types of vehicles, and found working properly. It helps the user to take necessary precautions with the help of learning starting system faults before they occur or get worse, overall failure of the vehicle due to malfunction of the starting system in early stages.