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Review on Different Techniques to Reduce and Detect Knock and Misfire

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Abstract – The improvement in performance of IC engine with reduction in exhaust emissions at the same time is a very crucial task which has to undertake by researchers because of fossil fuel depletion and global warming. Different industrial and academic researchers are working on different approaches to complete this task, these approached includes alternative Biofuels, EGR, combustion chamber design variations, etc. It is also observed that efficient combustion process and controlled combustion timing also have a great impact on the efficiency and emissions of IC engines. This can be achieved by using different coatings on spark plug as well as providing variation in spark plug voltage.

This work provides a review on different techniques used for reducing and detecting knock and misfire in IC engine which further also lead to reduction in emissions and improved performance of IC engines.

Keywords — IC Engine, Knock, Misfire, Exhaust Emissions, Spark Plug Voltage

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1. INTRODUCTION

At present, engineers have the most interesting areas of research, on various operating conditions of I.C. Engine. Presently, pollution due to the I.C. Engine has got more attention, so most of the topics involved are, to reduce the pollution and maximize the fuel efficiency of the engine. There are several parameters involved to search on these areas like most of the researches are going on combustion analysis, in which the study is based on exhaust gases emitted from I.C. engine and the ignition analysis in which the study is based on to run the engine at various operating conditions. But in the performance of IC engine the reduction and detection of knock is very important task as knocking in engine will lead to vibrations and high emission, knocking also leads to low fuel efficiency. Hence, for better working of engine knocking should be reduced.

2. I. C. ENGINE

An **internal combustion engine** (ICE) is a heat engine that converts chemical energy in a fuel into mechanical energy, usually made available on a rotating output shaft. Chemical energy of the fuel is first converted to thermal energy by means of combustion or oxidation with air inside the engine. This thermal energy raises the temperature and pressure of the gases within the engine and the high-pressure gas then expands against the mechanical mechanisms of the engine.

3. KNOCK

The knock is produced due to abnormal combustion of fuel mixture before normal combustion can occurs which also leads to rapid energy release which is much higher compared to the normal combustion. This phenomenon causes high frequency pressure oscillations inside the cylinder noise and vibrations. The vibrations are measured using vibration meter which will show the intensity of knock occurred during combustion. Also by using noise meter noise in the combustion chamber can be measured which can show the intensity of knock.

4. REDUCTION IN KNOCK

Use of alternative fuels like bio diesel, LPG can reduce knock and misfire as well as additionally they enhance efficiency of the IC engine. Shankar K.S. et al. [1] investigated the MPFI gasoline engine combustion, its performance and emission characteristics by using LPG as fuel. The work has been carried out on four cylinder MPFI SI engine which is retrofitted to run with LPG injection and its combustion, performance and emission characteristics are studied. This experimental result shows that the higher thermal efficiency and therefore improved fuel economy can be obtained from SI engines running on LPG as compared to Gasoline. Also by providing variation in spark plug voltage can reduce the knock and misfire, as reduced voltages will give steady and uniform combustions.

5. METHODS TO KNOCK AND DETONATION DETECTION

In this field of IC engines detection of Knock is very crucial task. Ying Wang et al. [2] investigated detection of knock and misfire in the SI engine. Two methods are used in this experiment .One is the ionic current method in which high frequency signals are added to the ionic current signals where knocking is happened, which can be detected by picking up these signals. The other is engine block vibration method. In misfire experiment, misfire can occur because of gap in the spark plug, adding carbon deposits and cutting out high voltages. The experiment proves that using the ionic current method we can easily detect the knock and misfire of I.C. Engine.

J.O.Che et al. [3] investigated the detonation by using gas density fluctuation in a cylinder of I.C. engine by using spark plug. Most of the engine control systems do not have the any detonation sensors at all but they used spark plug as pick up for gas density. The voltage drop between the spark plug electrodes depends on the local gas density. Variation of gas density will affect the current and therefore, the voltage drop on the spark plug. They found the correlation between the pressure and voltage signals in experiment where detonation induced. Therefore spark plug is used as sensor for detecting detonation. Guoming G.Zhu et al. [4] presents a stochastic ignition limit control strategy utilizing the stochastic properties of the knock intensity feedback signal and demonstrates that the control system is able to operate the engine at its borderline knock limit smoothly despite the cycle to cycle combustion variability and inherent ionization signal variations owing to that stochastic nature. Morito Assano et al. [5] presents the development of an Ion current combustion control system with the better knock control method with better accuracy even in presence of tolerances variances, the time gaps as well as other environmental condition changes. In order to increase the accuracy of knock control they focused on spark plug and ignition coil. Chae et al. [6] investigates misfire diagnostics of I.C. engine on breakdown voltage measurement. They used spark plug as ion probe for investigating the knock in I.C. Engine. The new method modulation of break down voltage used for detecting the misfire of engine. In this work, applying a heightened voltage between the electrodes of the spark-plug serving as an ion probe, they have observed a new effect correlating with the misfire occurring in an engine. This new effect can be used in systems of engine control and measurement for a diagnostic of the abnormal combustion. The signals obtained by the new method are much more stable and informative than signals of ionic current.

Zdenek et al. [7] presents the Ion based High-Temperature pressure sensor in which spark plug is used as pressure sensor to the pulse detonation engine. A high speed, durable, ion probe based pressure sensor is being investigated for use in pulse detonation engines. The environment encountered in such engines necessitates high temperature and durable (vibration resistant) devices. This investigation builds upon these capabilities to examine the quantitative pressures. In the current design, the ion probe acts as a charged capacitor. When an ionized field nears the probe, the electrical circuit is connected. The electrode on the probe discharges through the ionized field to a grounded plate. The rate of discharge indicates the strength of the ionized field which decays according to pressure.

Ingemar Andersson et al. [8] investigates cylinder pressure and Ionization current modelling for spark ignited engine. His goal is to investigate the models for ionization current and make a connection to combustion pressure and temperature. A model for the thermal part of an ionization signal is presented, that connects ionization current to cylinder pressure and temperature. The parameterized ionization current model is composed by four parts; a thermal ionization model, a model for formation of nitric oxide, a combustion temperature model and a cylinder pressure function. Two main results are that the pressure model itself well captures the behavior of the cylinder pressure, and that the parameterized ionization current model can be used with an ionization current as input and work as a virtual cylinder pressure sensor and a combustion analysis tool. This ionization current model not only describes the connection between the ionization current and the combustion process, it also offers new possibilities for EMS to control the internal combustion engine. Lars Nielsen et al. [9] presents an Ion-Sense Engine fine tuner in which they focuses on closed loop ignition control by ionization current interpretation. The sections deal with the basics of ionization currents, spark advance control, especially principles relating pressure information to efficiency, the structure of ion sense spark advance controller, experimental demonstrations. For detecting the ions, a DC bias is applied to the spark plug, generating an electrical field. The electrical field makes the ions move and generates an ion current.

6. CONCLUSIONS

As per the above literature survey, it is concluded that most of the work has been carried out to investigate knock and misfire of I.C. engine by using ionization current method in which spark plug is used as ion probe and the study focused on ignition analysis, but the combustion analysis is also a very important parameter in I.C. Engines, for reducing the pollution and increasing the fuel economy. Knock can be detected by measuring vibrations, noise or by using ion current method.

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