EXPERIMENTAL AND INVESTIGATION FOR IMPROVING LIFE OF SPARK PLUG USING Ni, Cr, Zn COATING

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ABSTRACT

The improvement of a high performance, long life Spark plug has become necessary in response to these condition. While improve performance (high ignitability and low required voltage), the emission part of the Spark plug needs to be reduced in size. But, in the past this has been hard because of the limitations in terms of wear. It has been difficult to achieve both smaller discharge parts and longer life. To forceful improve wear resistance, in this paper researched materials that are both resistant to oxidation and have a high melting point. This research resulted in our development of a various completion. Through this development it was able to produce a various coating that exceed the conventional platinum technology. The coating is now being used in high volume vehicle production. This paper is divided into the following three parts and describes the development of the new generation of coating spark plug. This paper discussed about the zinc,chromium and nickel Coating on the Spark Plug and to evaluate the Knoop Hardness and carbon deposition properties.

Keywords: *zinc, chromium, nickel, pvd, test.*

1.0 INTRODUCTION

Today, more expertness is being need of the essential requirements of engines in terms of performance, which are "high power" and "low fuel consumption". At the same time, a closer eye is being kept on global environmental problems than in the past, and "lower emissions" are becoming necessary. A Spark plug is a device for various electric current from an ignition system to the combustion chamber of a spark ignition engine to ignite the compressed air/fuel mixture by an electric spark, while control combustion pressure within the engine. A spark plug has metal threaded shell, electrically isolated from a central electrode by a porcelain insulator. Spark plugs are under constant chemical, thermal, physical and electrical attack by corrosive gases at 4500 degrees Fahrenheit, crushing pressure of 2000 pounds per square inch (PSI), and electrical discharges up to 18000 volts.The electrodes in a spark plug typically consist of high-nickel alloys, while the insulator is specifically made of aluminum oxide ceramic and the shell is made of steel wire. Selections of materials for both the electrodes and the insulator have exhausted much research and development time and cost. One major spark plug manufacturer claims to have tested 2000 electrode materials and over 25000 insulator combinations. As electrodes erode, the gap between them alter and it takes more voltage than the ignition system can provide to fire them. High-nickel alloys have been improved and thicker electrodes have been used to reduce engine performance loss. In addition, valuable and exotic metals are progressively being used by manufacturers. Many modern plugs attribute silver, gold and platinum in the electrodes, not to mention center electrodes with copper cores. Silver has superior thermal conductivity over other electrode metals, while platinum has excellent Corrosion resistance

Lin et al. processed spark plug made up of iridium in natural gas for reciprocating engine,with reference to him we have made spark plug by coating with zinc,chromium and nickel in the place of iridium.

Armando et al. observed that a ordinary spark pulg was failed after 100hrs of operation so he covered the insulator with matter contianing iron oxide, with reference to him increase the life time of the spark pulg by coating with zinc,chromium and nickel.

F.A. Soldera et al, studied with a high-speed camera and an oscilloscope. The discharges were done using samples of nickel alloys and platinum as cathode in air at pressures ranging from 100 to 900 kPa. For low pressures (100 kPa), a glow discharge occurs after the breakdown. For higher pressures, a material follows the breakdown and changes into a glow discharge when the current decreases.

Gravalos et.al studied experimentally on emissions characteristics of lower-higher molecular mass alcohol blended gasoline fuels is presented in this paper. The alcohol component of the blends consists of methanol, ethanol, propanol, butanol and pentanol.

Zareei et.al studied on the spark ignition engine on the action and emission characteristics. For achieving his goal, at a speed of 3400 rpm, the ignition timing has been changed in the range of 41° BTDC to 10° ATDC and for modify operation, ignition timing has been designed at wide-open throttle and at last, the performance characteristics such as power, torque, BMEP, volumetric efficiency and emissions are obtained and discussed.

Amitesh Paul et.al analyse the effect of Ethanol gasoline mixture onn Carburettor type SI engine (Maruti 800) and also with MPFI engine. The results have represented that by increasing the ethanol percentage gives raise to the complete combustion and also reduction in the pollution. 20% ethanol blend with gasoline gives the best performance for both MPFI as well as the Carburettor SI engine.

Adrian Irimescu et.al studied the effect of fuelling a port injection engine with iso-butanol, as compared to gasoline operation. Performance levels were maintained within the same limits as with the fossil fuel without change to any engine component. An special electronic module was used for increasing fuel flow by extending the injection time. Fuel conversion efficiency decreased when the engine was fuelled with iso-butanol by up to 9% at full load and by up to 11% at part load.

Mallikarjuna et.al studied on single cylinder four stroke spark ignition engine with the computer simulation to modify the inlet valve closer timing and Permission volume for the better part load performance. The experiments are conducted by varying the inlet valve closer timing, clearance volume and geometric increase ratio of the engine.

Hashmi et.al analyse experimentally the engine performance andemission characteristics of conventional unleaded gasoline and commercially available ethanol gasoline fuel blend of E10 under part load and full load conditions. In the experiment a single cylinder four stroke S.I. engine is used, the engine performance characteristics like power torque and BSFC are measured at part load and full load operation at funcation.

2.0 MATERIALS

In this work spark plug choosen.Its primary coating elements of chromium, nickel, zinc are coated in the mild steel by chemical vapour deposition process

ZINC

Zinc ASTM A153/A153 and nano size of 40-60nm is used.the rate of corrosion is considerably lower than ferrous materials (10 to 100 times slower depending on the environment).

PROPERTIES

Melting point - 419.5 °C,Atomic number - 30,Boiling point - 907 °C.

CHROMIUM

Chromium Astm B650-95 and nano size of 30-40nm is used, It is a steely-grey, lustrous, hard and brittle metal which takes a high polish, resists tarnishing, and has a high melting point.

PROPERTIES

Density - 7.19 g.cm^{-3} at 20°C, Melting point - 1907 °C, Boiling point - 2672C,

Atomic number 24 .

NICKEL

Nickel Astm B689-97 and nano size of 50-60nm is used, its belongs to the transition metals and is hard and ductile. Pure nickel shows a significant chemical activity that can be observed when nickel is powdered.

PROPERTIES

Thermal conductivity 93.9 W/(m·K), Young's modulus 279 GPa , Bulk modulus160 GPa

Bulk modulusson ratio 0.21.

2.1.SELECTION OF MATERIALS AND COATING

Here some materials are selected based on their properties where comparing to other materials these are economically less and easily available in markets . CVD process is selected for coating purpose because of its various benefits and its working proceses are described below .

2.2.CHEMICAL VAPOR DEPOSITION (CVD)

Chemical vapor deposition is used for the deposition of a solid on a heated surface from a chemical reaction in the vapor phase. It belongs to the class of vapor-transfer processes which is atomistic in nature, that is the deposition species are atoms or molecules or a combination of these. Be CVD, they include various physical vapor deposition processes (PVD) such as evaporation, sputtering, molecular beam growing, and ion plating deposition can also take place due to a chemical reaction between some reactants on the substrate by using the cvd process mild steel is coated with zinc,chromuim and nickel

2.3.TESTING

There are four types of testing used here they are explained as belows..,

2.3.1.CORROSION TEST

Cyclic corrosion testing (CCT) has evolved in recent years, mostly within the moving industry, as a way of fast real world corrosion failures, under laboratory controlled condition. As the name implies, the test respect different climates which are cycled automatically. So the samples under test undergo the same sort of changing environment that would be scrap in the natural world.

2.3.2.KNOOP HARDNESS TEST

The Knoop hardness test is a micro hardness test - a test for mechanical hardness used particularly for very brittle materials or thin sheets, where only a small corrosion may be made for testing purpose. A pyramid diamond point is pressed into the finished surface of the test material with a known (often 100g) Load, for a specified consist time, and the resulting corrosion is measured using a microscope.

2.3.3. CARBON DEPOSITION TEST

Carbon removal generally formulated for removal of completely carbon, grease, oil, paint and other heavy deposits from petrol engine. Its particular combination effectively remove carbon deposits, paint, gummy matter, baked/burnt on grease deposits and all persistent with high economic condition and penetrating capabilities to remove chemical element residue formed by fuel engine part. RXSOL-16-1003-025 is a highly concentrated wetting alter agent which makes this protect water soluble. This powerful action is based on two layer mechanism. The top layer prevents the vapour of the volatile Components in the bottom layer. The bottom layer removes the deposited substances. This way, the deposits are bind and trapped resulting to complete and safe removal. Carbon cleaner is very active which eliminates the need for scrubbing or brushing which can cause mechanical damages to disc and result in poor performances.

2.3.4. WEAR TEST

The scientific meaning of wear resistance is defined as the no specific unit to describe wear resistance. Nevertheless, the reverse of mass loss or volume loss is sometimes used as the (relative) wear resistance.

Si no	materials	% of petroleum	330 k	550 k	600 k
1	chromium	6.2	16.73g/cm2	31.21g/cm2	35.98g/cm2
2	chromium	8.2	18.45g/cm2	32.58g/cm2	42.88g/cm2
3	chromium	10	20.12g/cm2	38.67g/cm2	46.60g/cm2
4	zinc	6.2	18.99g/cm2	33.66g/cm2	37.37g/cm2
5	zinc	8.2	20.92g/cm2	34.13g/cm2	44.78g/cm2
6	zinc	10	22.82g/cm2	40.89g/cm2	48.99g/cm2

7	nickel	6.2	15.27g/cm2	29.45g/cm2	33.36g/cm2
8	nickel	8.2	22.09g/cm2	36.39g/cm2	50.56g/cm2
9	nickel	10	25.94g/cm2	48.76g/cm2	55.89g/cm2

3.0 RESULT AND DISCUSSION

3.1 MECHANICAL INVESTIGATIONS

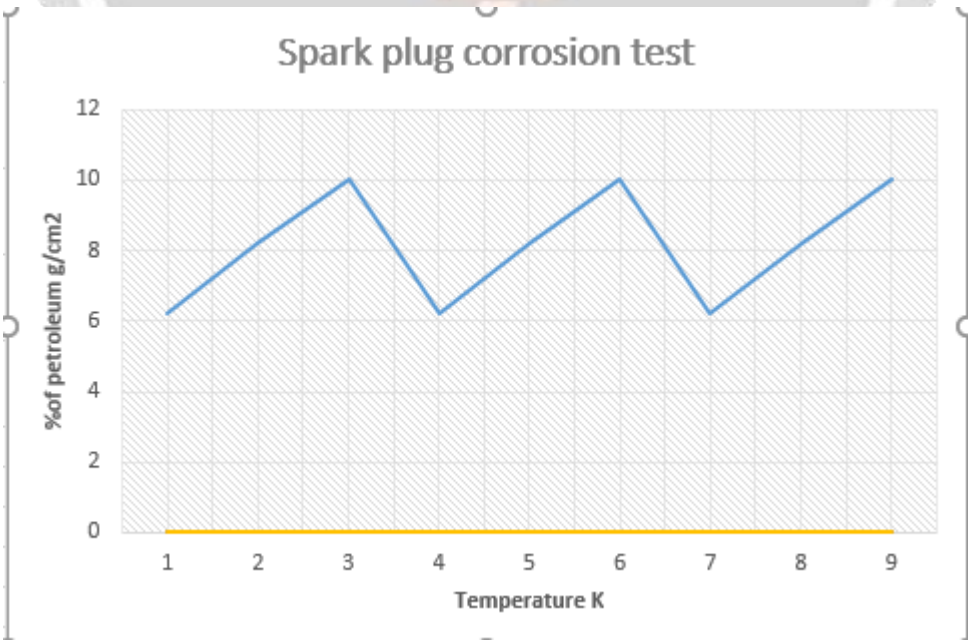
In this work have carried out the mechanical testing of corrsion,wear,carbon deposition and hardness. Here carried out four different testing.

3.2 SPARK PLUG CORROSION TEST

The below tabulation are describe about the Spark plug corrosion test for three specimen of chromium ,zinc and nickel."ASTM B650-95 standard of chromium , ASTM A153/A153M standard of zinc and ASTM B689-97 standard of nickel.

3.2.1TABLE FOR SPARK PLUG CORROSION TEST

3.2.2GRAPH FOR SPARK PLUG CORROSION TEST



3.3 KNOOP TEST

The below tabulation are describe about the Spark plug knoop hardness test for three specimen of chromium ,zinc and nickel."ASTM B650-95 standard of chromium , ASTM A153/A153M standard of zinc and ASTM B689-97 standard of nickel.

3.3.1 TABLE FOR SPARK PLUG KNOOP TEST

MATERIALS	VALUE
NICKEL	623
CHROMIUM	486
ZINC	398

By comparing the hardness of the above materials , nickel has the highest hardness value so it best suited for chosing material for the spark plug

3.4 CARBON DEPOSITION IN %

The below tabulation are describe about the Spark plug carbon deposition test for three specimen of chromium ,zinc and nickel."ASTM B650-95 standard of chromium , ASTM A153/A153M standard of zinc and ASTM B689-97 standard of nickel

3.4.1 TABLE FOR SPARK PLUG CARBON DEPOSITION TEST

MATERIALS	VALUE
MILD STEEL	80%
NICKEL	68%
CHROMIUM	74%
ZINC	72%

By comparing the carbon deposition of above materials ,nickel has the lowest carbon deposition value so it is best suited for chosing material for the spark plug

CONCLUSION

Proper electro deposition of mild steel using zinc, Chromium and Nickel particle was carried out. The Carbon Deposition, Knoop Hardness and Corrosion Test of the resultant deposition were analyse with the following reason: Increasing of Chromium percentage causes decreasing the Corrosion. By using Nickel, Zinc and Chromium the hardness of the ground electrode gets increased. Zinc and Chromium is used to refuse the corrosion in spark plug By coating the Zinc, Nickel and Chromium, the deposition of Carbon content gets decreased.

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