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Importance of Glow Plugs in Automotive Diesel Engines: A Review

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ABSTRACT

The importance of glow plugs used in automotive diesel engines is reviewed based on published literature. A glow plug resembles a short metal pencil. The heating filament is fitted into its tip. Glow plug filaments made of certain materials, like platinum and iridium, that are resistant to high temperature. Glow plugs have high resistance to chemical, mechanical, and thermal loads and provide long life for diesel engines.

Keywords--- Automotive, Glow Plug, Diesel Engines, High temperature

I. INTRODUCTION

A glow plug is a heating device used to starting diesel engines. In cold weather, high speed diesel engines can be difficult to start because the mass of the cylinder block and cylinder head absorb the heat of compression, preventing ignition (which relies on that heat). Pre-chambered engines make use of small electric heaters inside the pre-chambers glow plugs while, the direct-injected engines have these glow plugs in the combustion chamber. The glow plug is a pencil-shaped piece of metal with a heating element at the tip (Figure 1). This heating element, when electrified, heats due to its electrical resistance and begins to emit light in the visible spectrum, hence the term "glow"-plug. The visual effect is very similar to that of a toaster. The fuel injector spray pattern then impinges directly upon the hot tip of the glow plug during the injection of fuel at top dead center. This enables the fuel to ignite even when the engine is insufficiently hot for normal operation. This reduces the cranking time needed to start the diesel engine [1].

Figure 1: Glow plug used in Diesel Engines

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II. OVERVIEW

Diesel engines, unlike gasoline engines, do not use spark plugs to induce combustion. Instead, they rely solely on compression to raise the temperature of the air to a point where the diesel will combust spontaneously when introduced to the hot high pressure air. The high pressure and spray pattern of the diesel ensures a controlled, complete burn. The piston rises, compressing the air in the cylinder; this causes the air's temperature to rise. By the time the piston reaches the top of its travel path, the temperature in the cylinder is very high. The fuel mist is then sprayed into the cylinder; it instantly combusts, forcing the piston downwards, thus generating power. The pressure required to heat the air to that temperature, however, necessitates the use of a large and very strong engine block [1].

The temperature at the top of the compression stroke is dependent upon many factors, the most influential of which are the compression ratio of the cylinder and the starting temperature of the inducted air. When the engine is cold, the temperature of the inducted air is low and it receives little heat from the engine cylinder walls. In addition, as the air is compressed and becomes heated, some of this heat will be given up to the cold cylinder walls, further reducing the temperature at the top of the compression stroke. This problem is solved by the glow plug. Under these cold conditions, the glow plug is temporarily activated to add a hotspot within the combustion chamber until the residual temperature of the combustion chamber achieves the level required to support self-combustion [1].

For that reason indirect injected diesel engines are manufactured with glow-plugs in each pre chamber, and direct injected diesel engines are manufactured with glow-plugs in each combustion chamber.

III. PARTS/CONSTRUCTION OF GLOW PLUG

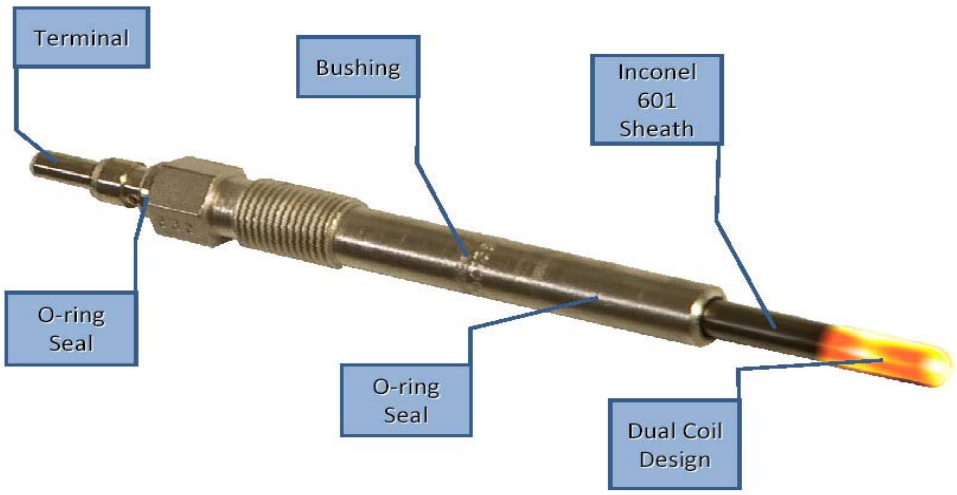

Figure 2: Parts of Glow plug [Source: http://www.dieselrxproducts.com[2]

A glow plug resembles a short metal pencil. The heating filament is fitted into its tip. Glow plug filaments must be made of certain materials, such as platinum and iridium, that are resistant to both oxidation and high temperature [3,1].

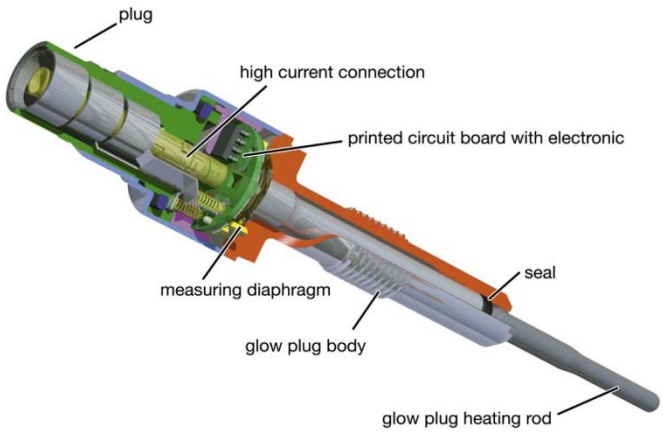

Figure 3: Construction of Glow plug [Source: http://www.motor-car.co.uk [3]].

IV. FUNCTION OF GLOW PLUGS

The central function of glow plugs is to provide additional energy for the start. Glow plugs from NGK are the required energy source. Before the start of the engine, the glow plug is energized and the glow tube heats up to more than 800 °C. This heat improves the engine's ability to cold-start considerably. The glow plug's heat development also optimizes the combustion, so that the development of smoke and other emissions is reduced [4].

V. METHOD OF OPERATION

Pre-heating

Figure 4: Glow plug indicator light in a diesel car [Source: en.wikipedia.org[1]]

In older generation diesel-engine vehicles, unlike in a gasoline-engine vehicle, the operator did not simply turn the key to the "start" position and have the engine immediately start. Instead, the operator turned the key to the "on" position for a long duration; the glow plug relay switches the glow plugs on, and a light (Figure 4) on the instrument cluster illuminates. This process is called "pre-heating" or "glowing". According to Bosch: "Older engines used a glow period of up to 21 seconds whereas more modern engines use around a 6 to 8 second heat period and provide after glow at a reduced voltage" [5].

Starting

When a pre-set time has elapsed, the glow plug relay switches off the "wait-to-start" light. A pre-heating cycle usually lasts for 2 to 5 seconds. The operator then proceeds to turn the key to the "start" position. The relay switches off the glow plugs after the engine is running (or, in older cars, at the same time the "wait to start" light goes out). In some cars, glow plugs continue to operate for up to 180 seconds after engine start to keep the engine within emissions regulations, as combustion efficiency is greatly reduced when the engine is very cold [1].

Warm engine start

If the car had been running very recently, or if the ambient temperature was hot, the "wait to start" light might not come on. In this case, the operator may proceed to turn the key to the "start" position and start the engine without having to wait [1].

VI. HOW GLOW PLUG WORKS

When the glow plug is turned on, the heating element at its tip gets heated. This heat is focused into the engine cylinders and heats the engine block that surrounds them. While generating heat, glow plugs also emit light causing them to glow. When the engine reaches a certain temperature, fuel mist is sprayed into the cylinder causing it to combust and power the engine [6].

VII. IMPORTANCE OF METAL SHEATHED-ELEMENT GLOW PLUG

The metal sheathed-element glow plug Dura term high Speed has been developed for low-voltage applications and works at a nominal voltage of either 4.4 or 5 V. Its particular strengths include high preheating and afterglow temperatures [7]:

- Heats to over 1,000°C in less than 3 seconds
- Afterglow of up to 6 minutes
- Low-voltage design for low energy consumption and less drain on the vehicle electrical system
- Reduced fuel consumption at the same performance level
- Improved cold-running characteristics
- Engine starting almost like a gasoline engine
- Longer service life[7]

VIII. FEATURES/BENEFITS OF GLOW PLUGS

- Start engines quickly and smoothly.
- Offer an excellent post-glow function.
- Have a long service life.
- Saves energy
- Environment friendly
- Suitable for a wide range of diesel engines
- Manufactured using superior dual coil technology
- Offer the latest in high technology for today[8,9].

IX. CONCLUSION

Glow plugs guarantee comfortable starting, stable cold-running characteristics and low emissions. Because they are wearing parts, their functional performance should be regularly checked by an expert. Sheathed-element glow plugs score high with their optimal property profile, which perfectly combines an operating voltage, maximum preheating temperature, heating time, and afterglow period to meet the requirements of every vehicle model. Additionally, they have a high resistance to chemical, mechanical, and thermal loads and a long service life [7].

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