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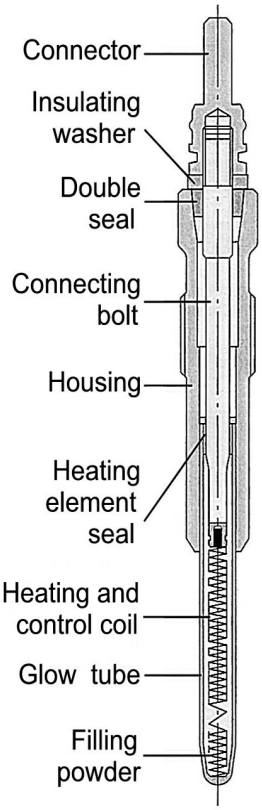
Glow Plug Design and Operation

Diesel engines are considered 'self-igniting' as the injected diesel fuel ignites automatically on contacting the heated air in the cylinder. The elevated cylinder air temperature is the result of the well-known physical phenomena known as Boyle's Law, which states that when a gas is compressed, the temperature of the gas rises in a proportional and predictable way. By design, the air in a diesel engine cylinder is compressed by up to twenty five times and this compression raises the air temperature to between 850°C and 900°C. At the predetermined time or times, the diesel fuel is sprayed into the hot compressed air and it automatically ignites - if the cylinder temperature is sufficiently high.

Cold starting of a diesel engine can be difficult or impeded due to the air in the cylinder not reaching the necessary temperature. This can be the result of a number of causes:

- The air coming into the cylinder is colder than normal.
- The cold walls of the combustion chamber absorb heat from the compressed air in the cylinder.
- At lower temperatures the crankcase oil thickens and battery output drops. The increased drag from the oil and the lower amps for cranking the engine results in slower cranking speed, which in turn results in lower cylinder pressures and temperatures.
- The fuel will be more viscous and the fuel injection process will be less efficient resulting in poor atomisation of the fuel.

Because of these factors, diesel engines typically require glow plugs to help the starting process. In indirect injection engines the sheathed or coiled element of the glow plug protrudes into the precombustion or turbulence chamber and in direct injection engines it protrudes directly into the engine's combustion chamber. For starting of the engine, the glow plugs are typically heated up to 850°C to 900°C - although with some newer technology plugs this can be 1000°C to 1100°C - to ensure the diesel fuel will ignite correctly. The 'preglow' typically lasts for the entire starting process, while in many later model engines the glow plugs continue to glow for up to several minutes more. This continued glow is referred to as the 'post-glow' and assists complete combustion, thus reducing the smoke emission and pollutants in the exhaust gases often associated with diesel engines.



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Sheathed glow plugs (the most popular design today) operate when current is applied to the connector at the top of the coil, while the bottom of the coil is connected to earth through the glow tube and then the housing. The coil must remain electrically insulated from the glow tube and yet it must be positioned close enough to it to facilitate fast heat transfer. The number of turns in the coil determine the power/heat output and these coils must remain electrically insulated from each other. This is achieved through the inclusion of magnesium oxide powder as the insulating medium surrounding the coils. The glow tube itself is constructed from Inconel 601 to provide resistance to the high temperature corrosive environment of the combustion chamber and to resist the tremendous vibration forces generated by the combustion process. The length of the glow tube through the connection point must be correctly designed to provide the appropriate heat transfer path in order to modulate the glow tube temperature.

Sheath type glow plugs are designed to heat up to normal operating temperature in as little as a few seconds and up to 20 seconds. The coil will normally exhibit “positive” temperature coefficient, which merely means that the electrical resistance of the coil will increase with temperature. This effect ensures that when the plug reaches its operating temperature, it will self-stabilize and not overheat.

Glow plugs are exposed to an extremely harsh operating environment whether they are in operation or not. They are exposed to very high operating temperatures, high vibration levels and operate in a very corrosive environment. To ensure optimal operation of glow plugs, the following guidelines should be followed:

- Glow plugs should be replaced every 50,000 kms or two years - whichever comes first.
- Glow plugs should always be replaced in sets.
- Glow plugs should be replaced when an engine is reconditioned.
- Never use glow plugs that have been dropped from a height of more than 150 mm
- Never reuse a glow plug with a ‘bulging’ or damaged glow tube.
- Glow plugs should not be heated longer than designed. This can result in overheating of the glow tube causing it to ‘bulge’, split or burst. This allows air to enter to the coil area causing immediate failure. Further, a burst tube can drop into the cylinder and cause bore and/or ring damage.