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Commentary

Mechanism of Diesel Engine Combustion

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DESCRIPTION

Diesel engine, any internal-combustion engine in which air is compressed to a sufficiently high temperature to ignite diesel fuel injected into the cylinder, where combustion and expansion actuate a piston. It converts the chemical energy stored in the fuel into mechanical energy, which can be used to power freight trucks, large tractors, locomotives, and marine vessels. A limited number of automobiles also are diesel-powered, as are some electric-power generator sets.

The diesel engine gains its energy by burning fuel injected or sprayed into the compressed, hot air charge within the cylinder. The air must be heated to a temperature greater than the temperature at which the injected fuel can ignite. Fuel sprayed into air that has a temperature higher than the "auto-ignition" temperature of the fuel spontaneously reacts with the oxygen in the air and burns. Air temperatures are typically in excess of 526 °C (979 °F); however, at engine start-up, supplemental heating of the cylinders is sometimes employed, since the temperature of the air within the cylinders is determined by both the engine's compression ratio and its current operating temperature. Diesel engines are sometimes called compression-ignition engines because initiation of combustion relies on air heated by compression rather than on an electric spark.

In a diesel engine, fuel is introduced as the piston approaches the top dead centre of its stroke. The fuel is introduced under high pressure either into a pre-combustion chamber or directly into the piston-cylinder combustion chamber. With the exception of small, high-speed systems, diesel engines use direct injection. By compressing air rather than using an air-fuel mixture, the diesel engine is not limited by the pre-ignition problems that plague high-compression spark-ignition engines.

Thus, higher compression ratios can be achieved with diesel engines than with the spark-ignition variety; commensurately, higher theoretical cycle efficiencies, when compared with the latter, can often be realized. It should be noted that for a given compression ratio the theoretical efficiency of the spark-ignition engine is greater than that of the compression-ignition engine; however, in practice it is possible to operate compression-ignition engines at compression ratios high enough to produce efficiencies greater than those attainable with spark-ignition systems. Furthermore, diesel engines do not rely on throttling the intake mixture to control power. As such, the idling and reduced-power efficiency of the diesel is far superior to that of the spark-ignition engine.

Originally, either powdered coal or liquid petroleum was proposed as fuel. Compressed air was to be used to introduce coal dust into the engine cylinder; however, controlling the rate of coal injection was difficult, and, after the experimental engine was destroyed by an explosion, Diesel turned to liquid petroleum.

The elimination of the injection air compressor was a step in the right direction, but there was yet another problem to be solved: the engine exhaust contained an excessive amount of smoke, even at outputs well within the horsepower rating of the engine and even though there was enough air in the cylinder to burn the fuel charge without leaving a discolored exhaust that normally indicated overload. Engineers finally realized that the problem was that the momentarily high-pressure injection air exploding into the engine cylinder had diffused the fuel charge more efficiently than the substitute mechanical fuel nozzles were able to do, with the result that without the air compressor the fuel had to search out the oxygen atoms to complete the combustion process, and, since oxygen makes up only 20 percent of the air, each atom of fuel had only one chance in five of encountering an atom of oxygen.

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