DOWNLOAD PDF DIESEL COMBUSTION PROCESSES

Chapter 1 : Diesel cycle - Wikipedia

The application of laser-sheet imaging to the conventional diesel combustion process in the s was key to greatly increasing the understanding of this process. This paper will review the most established combustion model for the conventional diesel engine.

Caterpillar started building diesels for their tractors. Beardmore Tornado diesel engines power the British airship R Yanmar is the first Japanese company to introduce the "HB" series for commercial use. The engine represented a major improvement in power-to-weight ratio and output flexibility over previous generation diesels, drawing the interest of railroad executive Ralph Budd as a prime mover for lightweight trains. First turbo diesel engine for a railway train by Maybach. First streamlined, stainless steel passenger train in the US, the Pioneer Zephyr , using a Winton engine. First tank equipped with diesel engine, the Polish 7TP. Junkers Motorenwerke in Germany started production of the Jumo aviation diesel engine family, the most famous of these being the Jumo , of which over examples were produced by the outbreak of World War II. Mercedes-Benz built the D diesel car. The airship Hindenburg was powered by diesel engines. First series of passenger cars manufactured with diesel engine Mercedes-Benz D, Hanomag and Saurer. BMW experimental airplane diesel engine development. General Motors forms the GM Diesel Division, later to become Detroit Diesel , and introduces the Series 71 inline high-speed medium-horsepower two stroke engine, suitable for road vehicles and marine use. The established the reliability of diesel power in rail service, lending impetus to the dieselization of American railroads. First turbo diesel engine of Saurer. Tatra started production of Tatra with air-cooled V12 diesel engine. Turbo -diesel truck for Mercedes in small series. Turbo-diesel truck in mass production by Volvo. First diesel engine with an overhead cam shaft of Daimler Benz. Every subsequent engine and would incorporate this turbocharger. The diesel drive displaced steam turbines and coal fired steam engines. A diesel compression braking system , eventually to be manufactured by Jacobs of drill chuck fame and nicknamed the "Jake Brake", was invented and patented by Clessie Cummins. Peugeot introduced the first small cars with a transversally mounted diesel engine and front-wheel drive. DAF produced an air-cooled diesel engine. Tested a diesel engine for the Volkswagen Golf passenger car. Peugeot , the first turbo-diesel car to be sold in Europe. Audi , the first passenger car in the world with a turbocharged direct injection and electronic control diesel engine. European emission standards Euro 1 met with the truck diesel engine of Scania. Pump nozzle injection introduced in Volvo truck engines. Unit injector system by Bosch for diesel engines. Mercedes-Benz unveils the first automotive diesel engine with four valves per cylinder. First successful use of common rail in a production vehicle, by Denso in Japan, Hino "Rising Ranger" truck. First diesel engine with direct injection and four valves per cylinder, used in the Opel Vectra. First common rail diesel engine in a passenger car, the Alfa Romeo The combination of high-performance with better fuel efficiency allowed the team to make fewer pit stops during the long endurance race. Volkswagen introduces three and four-cylinder turbodiesel engines, with Bosch-developed electronically controlled unit injectors. Piezoelectric injector technology by Bosch, [52] Siemens and Delphi. The same car won the 24 Hours of Le Mans. Euro 5 for all Iveco trucks. Subaru introduced the first horizontally opposed diesel engine to be fitted to a passenger car. This is a Euro 5 compliant engine with an EGR system. The achievements are repeated in the following season. Volkswagen won the Dakar Rally held in Argentina and Chile. The first diesel to do so. Race Touareg 2 models finished first and second. Mitsubishi developed and started mass production of its 4N13 1. Piaggio launches a twin-cyinder turbodiesel engine, with common rail injection, on its new range of microvans. Common rail systems working with pressures of 2, bar launched. In the Volkswagen emissions scandal , the US EPA issued a notice of violation of the Clean Air Act to Volkswagen Group after it was found that Volkswagen had intentionally programmed turbocharged direct injection TDI diesel engines to activate certain emissions controls only during laboratory emissions testing. Over 80 years of emphasis on two-stroke diesel power by EMD and its ancestral companies comes to an end. Operating principle[edit] p-V Diagram for the Ideal Diesel cycle. The cycle follows the numbers 1â€"4 in clockwise direction. The horizontal axis is Volume of the cylinder. In the diesel cycle the combustion occurs at almost constant pressure. On this diagram the work that is generated for each cycle corresponds to the area within the loop. Diesel engine model, left side Diesel engine model, right side See also: Diesel cycle and Reciprocating internal combustion engine The diesel internal combustion engine differs from the gasoline powered Otto cycle by using highly compressed hot air to ignite the fuel rather than using a spark plug compression ignition rather than spark ignition. In the true diesel engine, only air is initially introduced into the combustion chamber. The air is then compressed with a compression ratio typically between This high compression causes the temperature of the air to rise. At about the top of the compression stroke, fuel is injected directly into the compressed air in the combustion chamber. This may be into a typically toroidal void in the top of the piston or a pre-chamber depending upon the design of the engine. The fuel injector ensures that the fuel is broken down into small droplets, and that the fuel is distributed evenly. The heat of the compressed air vaporizes fuel from the surface of the droplets. The vapour is then ignited by the heat from the compressed air in the combustion chamber, the droplets continue to vaporise from their surfaces and burn, getting smaller, until all the fuel in the droplets has been burnt. Combustion occurs at a substantially constant pressure during the initial part of the power stroke. The start of vaporisation causes a delay before ignition and the characteristic diesel knocking sound as the vapour reaches ignition temperature and causes an abrupt increase in pressure above the piston not shown on the P-V indicator diagram. When combustion is complete the combustion gases expand as the piston descends further; the high pressure in the cylinder drives the piston downward, supplying power to the crankshaft. Increasing the compression ratio in a spark-ignition engine where fuel and air are mixed before entry to the cylinder is limited by the need to prevent damaging pre-ignition. Since only air is compressed in a diesel engine, and fuel is not introduced into the cylinder until shortly before top dead centre TDC , premature detonation is not a problem and compression ratios are much higher. The pâ€”V diagram is a simplified and idealised representation of the events involved in a Diesel engine cycle, arranged to illustrate the similarity with a Carnot cycle. Starting at 1, the piston is at bottom dead centre and both valves are closed at the start of the compression stroke; the cylinder contains air at atmospheric pressure. Between 1 and 2 the air is compressed adiabaticallyâ€”that is without heat transfer to or from the environmentâ€”by the rising piston. This is only approximately true since there will be some heat exchange with the cylinder walls. During this compression, the volume is reduced, the pressure and temperature both rise. At or slightly before 2 TDC fuel is injected and burns in the compressed hot air. Chemical energy is released and this constitutes an injection of thermal energy heat into the compressed gas. Combustion and heating occur between 2 and 3. In this interval the pressure remains constant since the piston descends, and the volume increases; the temperature rises as a consequence of the energy of combustion. At 3 fuel injection and combustion are complete, and the cylinder contains gas at a higher temperature than at 2. Between 3 and 4 this hot gas expands, again approximately adiabatically. Work is done on the system to which the engine is connected. During this expansion phase the volume of the gas rises, and its temperature and pressure both fall. At 4 the exhaust valve opens, and the pressure falls abruptly to atmospheric approximately. This is unresisted expansion and no useful work is done by it. Ideally the adiabatic expansion should continue, extending the line 3â€”4 to the right until the pressure falls to that of the surrounding air, but the loss of efficiency caused by this unresisted expansion is justified by the practical difficulties involved in recovering it the engine would have to be much larger. After the opening of the exhaust valve, the exhaust stroke follows, but this and the following induction stroke are not shown on the diagram. If shown, they would be represented by a low-pressure loop at the bottom of the diagram. At 1 it is assumed that the exhaust and induction strokes have been completed, and the cylinder is again filled with air. The piston-cylinder system absorbs energy between 1 and 2â€”this is the work needed to compress the air in the cylinder, and is provided by mechanical kinetic energy stored in the flywheel of the engine. Work output is done by the piston-cylinder combination between 2 and 4. The difference between these two increments of work is the indicated work output per cycle, and is represented by the area enclosed by the pâ€”V loop. The adiabatic expansion is in a higher pressure range than that of the compression because the gas in the cylinder is hotter during expansion than during compression. It is for this reason that the loop has a finite area, and the net output of work during a cycle is positive. Major advantages[edit] Diesel engines have several advantages over gasoline-powered engines: Diesel fuel has higher energy density and a smaller volume of fuel is required to perform a specific amount of work. Diesel engines inject the fuel directly into the combustion chamber, have no intake air restrictions apart from air filters and intake plumbing and have no intake manifold vacuum to add parasitic load and pumping losses resulting from the pistons being pulled downward against intake system vacuum. Cylinder filling with atmospheric air is aided and volumetric efficiency is increased for the same reason. Heavier fuels like diesel fuel have higher cetane ratings and lower octane ratings, resulting in increased tendency to ignite spontaneously and burn completely in the cylinders when injected.

Chapter 2 : What Are Diesel Emissions

Diesel combustion, which is in principle unsteady turbulent diffusion combustion, is fundamentally controlled by the mixing process of fuel with air in the combustion chamber.

Experiments with diesel-engine locomotives and railcars began almost as soon as the diesel engine was patented by the German engineer Rudolf Diesel in Attempts at building practical locomotives and railcars for branch-line passenger runs continued through the s. The first successful dieselâ€¦ Diesel combustion The diesel engine is an intermittent-combustion piston-cylinder device. It operates on either a two-stroke or four-stroke cycle see figure ; however, unlike the spark-ignition gasoline engine , the diesel engine induces only air into the combustion chamber on its intake stroke. Diesel engines are typically constructed with compression ratios in the range Both two-stroke and four-stroke engine designs can be found among engines with bores cylinder diameters less than mm 24 inches. Engines with bores of greater than mm are almost exclusively two-stroke cycle systems. Four-stroke diesel engineThe typical sequence of cycle events involves a single intake valve, fuel-injection nozzle, and exhaust valve, as shown here. Injected fuel is ignited by its reaction to compressed hot air in the cylinder, a more efficient process than that of the spark-ignition internal-combustion engine. 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. 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 precombustion chamber or directly into the piston-cylinder combustion chamber. With the exception of small, high-speed systems, diesel engines use direct injection. Diesel engine fuel-injection systems are typically designed to provide injection pressures in the range of 7 to 70 megapascals 1, to 10, pounds per square inch. There are, however, a few higher-pressure systems. Precise control of fuel injection is critical to the performance of a diesel engine. Since the entire combustion process is controlled by fuel injection, injection must begin at the correct piston position i. At first the fuel is burned in a nearly constant-volume process while the piston is near top dead centre. As the piston moves away from this position, fuel injection is continued, and the combustion process then appears as a nearly constant-pressure process. The combustion process in a diesel engine is heterogeneousâ€”that is, the fuel and air are not premixed prior to initiation of combustion. Consequently, rapid vaporization and mixing of fuel in air is very important to thorough burning of the injected fuel. This places much emphasis on injector nozzle design, especially in direct-injection engines. Engine work is obtained during the power stroke. The power stroke includes both the constant-pressure process during combustion and the expansion of the hot products of combustion after fuel injection ceases. Diesel engines are often turbocharged and aftercooled. Addition of a turbocharger and aftercooler can enhance the performance of a diesel engine in terms of both power and efficiency. The most outstanding feature of the diesel engine is its efficiency. By compressing air rather than using an air-fuel mixture, the diesel engine is not limited by the preignition 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. The principal drawback of diesel engines is their emission of air pollutants. These engines typically discharge high levels of particulate matter soot , reactive nitrogen compounds commonly designated NOx , and odour compared with spark-ignition engines. Consequently, in the small-engine category, consumer acceptance is low. A diesel engine is started by driving it from some external power source until conditions have been established under which the engine can run by its own power. The simplest starting method is to admit air from a high-pressure sourceâ€"about 1. The compressed air becomes heated sufficiently to ignite the fuel. The selection of the most suitable starting method depends on the physical size of the engine to be started, the nature of the connected load, and whether or not the load can be disconnected during starting. Major types of diesel engines Three basic size groups There are three basic size groups of diesel engines based on powerâ€"small, medium, and large. The small engines have power-output values of less than kilowatts, or horsepower. This is the most commonly produced diesel engine type. These engines are used in automobiles , light trucks , and some agricultural and construction applications and as small stationary electrical-power generators such as those on pleasure craft and as mechanical drives. They are typically direct-injection, in-line, four- or six-cylinder engines. Many are turbocharged with aftercoolers. Medium engines have power capacities ranging from to kilowatts, or to 1, horsepower. The majority of these engines are used in heavy-duty trucks. They are usually direct-injection, in-line, six-cylinder turbocharged and aftercooled engines. Some V-8 and V engines also belong to this size group. Large diesel engines have power ratings in excess of kilowatts. These unique engines are used for marine, locomotive, and mechanical drive applications and for electrical-power generation. In most cases they are direct-injection, turbocharged and aftercooled systems. They may operate at as low as revolutions per minute when reliability and durability are critical. Two-stroke and four-stroke engines As noted earlier, diesel engines are designed to operate on either the two- or four-stroke cycle. In the typical four-stroke-cycle engine, the intake and exhaust valves and the fuel-injection nozzle are located in the cylinder head see figure. Often, dual valve arrangementsâ€"two intake and two exhaust valvesâ€"are employed. Use of the two-stroke cycle can eliminate the need for one or both valves in the engine design. Scavenging and intake air is usually provided through ports in the cylinder liner. Exhaust can be either through valves located in the cylinder head or through ports in the cylinder liner. Engine construction is simplified when using a port design instead of one requiring exhaust valves. Fuel for diesels Petroleum products normally used as fuel for diesel engines are distillates composed of heavy hydrocarbons , with at least 12 to 16 carbon atoms per molecule. These heavier distillates are taken from crude oil after the more volatile portions used in gasoline are removed. Thus, their evaporation temperature is much higher than that of gasoline, which has fewer carbon atoms per molecule. Grade Low Sulfur No. It is also suitable for use in non-automotive applications, especially in conditions of varying speed and load. Water and sediment in fuels can be harmful to engine operation; clean fuel is essential to efficient injection systems. Fuels with a high carbon residue can be handled best by engines of low-speed rotation. The same applies to those with high ash and sulfur content. Diesel realized that the electric ignition process of the gasoline engine could be eliminated if, during the compression stroke of a piston-cylinder device, compression could heat air to a temperature higher than the auto-ignition temperature of a given fuel. Diesel proposed such a cycle in his patents of and Originally, either powdered coal or liquid petroleum was proposed as fuel. Diesel saw powdered coal, a by-product of the Saar coal mines, as a readily available 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. He continued to introduce the fuel into the engine with compressed air. The engine operated successfully for years and was the forerunner of the Busch-Sulzer engine that powered many submarines of the U. Navy in World War I. The diesel engine became the primary power plant for submarines during World War I. It was not only economical in the use of fuel but also proved reliable under wartime conditions. Diesel fuel, less volatile than gasoline, was more safely stored and handled. At the end of the war many men who had operated diesels were looking for peacetime jobs. Manufacturers began to adapt diesels for the peacetime economy. One modification was the development of the so-called semidiesel that operated on a two-stroke cycle at a lower compression pressure and made use of a hot bulb or tube to ignite the fuel charge. These changes resulted in an engine less expensive to build and maintain. Fuel-injection technology One objectionable feature of the full diesel was the necessity of a high-pressure, injection air compressor. Not only was energy required to drive the air compressor, but a refrigerating effect that delayed ignition occurred when the compressed air , typically at 6. Diesel had needed high-pressure air with which to introduce powdered coal into the cylinder; when liquid petroleum replaced powdered coal as fuel, a pump could be made to take the place of the high-pressure air compressor. There were a number of ways in which a pump could be used. In England the Vickers Company used what was called the common-rail method, in which a battery of pumps maintained the fuel under pressure in a pipe running the length of the engine with leads to each cylinder. From this rail or pipe fuel-supply line, a series of injection valves admitted the fuel charge to each cylinder at the right point in its cycle. Another method employed cam-operated jerk, or plunger-type, pumps to deliver fuel under momentarily high pressure to the injection valve of each cylinder at the right time. The elimination of the injection air compressor was a step in the right direction, but there was yet another problem to be solved: 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. The result was improper burning of the fuel. The usual design of a fuel-injection nozzle introduced the fuel into the cylinder in the form of a cone spray, with the vapour radiating from the nozzle, rather than in a stream or jet. Very little could be done to diffuse the fuel more thoroughly. Improved mixing had to be accomplished by imparting additional motion to the air, most commonly by induction-produced air swirls or a radial movement of the air, called squish, or both, from the outer edge of the piston toward the centre. Various methods have been employed to create this swirl and squish.

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Chapter 3 : Diesel Engines vs. Gasoline Engines | HowStuffWorks

The Diesel cycle is a combustion process of a reciprocating internal combustion engine. In it, fuel is ignited by heat generated during the compression of air in the combustion chamber, into which fuel is then injected.

This mechanical energy moves pistons up and down inside cylinders. The pistons are connected to a crankshaft, and the up-and-down motion of the pistons, known as linear motion, creates the rotary motion needed to turn the wheels of a car forward. Both diesel engines and gasoline engines convert fuel into energy through a series of small explosions or combustions. The major difference between diesel and gasoline is the way these explosions happen. In a gasoline engine, fuel is mixed with air, compressed by pistons and ignited by sparks from spark plugs. In a diesel engine, however, the air is compressed first, and then the fuel is injected. The following animation shows the diesel cycle in action. You can compare it to the animation of the gasoline engine to see the differences. This content is not compatible on this device. Image courtesy Baris Mengutay The diesel engine uses a four-stroke combustion cycle just like a gasoline engine. The four strokes are: Intake stroke -- The intake valve opens up, letting in air and moving the piston down. Combustion stroke -- As the piston reaches the top, fuel is injected at just the right moment and ignited, forcing the piston back down. Exhaust stroke -- The piston moves back to the top, pushing out the exhaust created from the combustion out of the exhaust valve. Remember that the diesel engine has no spark plug, that it intakes air and compresses it, and that it then injects the fuel directly into the combustion chamber direct injection. It is the heat of the compressed air that lights the fuel in a diesel engine. Compression When working on his calculations, Rudolf Diesel theorized that higher compression leads to higher efficiency and more power. This happens because when the piston squeezes air with the cylinder, the air becomes concentrated. Diesel fuel has a high energy content, so the likelihood of diesel reacting with the concentrated air is greater. Another way to think of it is when air molecules are packed so close together, fuel has a better chance of reacting with as many oxygen molecules as possible. Rudolf turned out to be right -- a gasoline engine compresses at a ratio of 8:

Chapter 4 : Diesel engine - Wikipedia

Enhanced combustion processes and completely new approaches can improve the fuel economy of diesel engines - such as injection-rate shaping and optimized nozzle geometries. In the long term, homogeneous and partly homogeneous combustion processes as well as new fuels will be able to optimize the diesel engine.

Combustion Generated Noise Components of Combustion Process Combustion in diesel engines is very complex and until the s, its detailed mechanisms were not well understood. The application of laser-sheet imaging to the conventional diesel combustion process in the s was key to greatly increasing the understanding of this process. This paper will review the most established combustion model for the conventional diesel engine. This is different from combustion strategies that attempt to significantly increase the proportion of premixed burning that occursâ€"such as various flavours of low temperature combustion. The basic premise of diesel combustion is its unique way of releasing the chemical energy stored in the fuel. To perform this process, oxygen must be made available to the fuel in a specific manner to facilitate combustion. One of the most important aspects of this process is the mixing of fuel and air, which is often referred to as mixture preparation. In diesel engines, fuel is often injected into the engine cylinder near the end of the compression stroke, just a few crank angle degrees before top dead center []. The liquid fuel is usually injected at high velocity as one or more jets through small orifices or nozzles in the injector tip. It atomizes into small droplets and penetrates into the combustion chamber. The atomized fuel absorbs heat from the surrounding heated compressed air, vaporizes, and mixes with the surrounding high-temperature high-pressure air. Rapid ignition of some premixed fuel and air occurs after the ignition delay period. This rapid ignition is considered the start of combustion also the end of the ignition delay period and is marked by a sharp cylinder pressure increase as combustion of the fuel-air mixture takes place. Increased pressure resulting from the premixed combustion compresses and heats the unburned portion of the charge and shortens the delay before its ignition. It also increases the evaporation rate of the remaining fuel. Atomization, vaporization, fuel vapor-air mixing, and combustion continue until all the injected fuel has combusted. Therefore, excess air present in the cylinder after the fuel has combusted continues to mix with burning and already burned gases throughout the combustion and expansion processes. At the opening of the exhaust valve, excess air along with the combustion products are exhausted, which explains the oxidizing nature of diesel exhaust. In other words, the majority of the air inducted into the cylinder of a diesel engine is compressed and heated, but never engages in the combustion process. Oxygen in the excess air helps oxidize gaseous hydrocarbons and carbon monoxide, reducing them to extremely small concentrations in the exhaust gas. The following factors play a primary role in the diesel combustion process: The inducted charge air, its temperature, and its kinetic energy in several dimensions. While these two factors are most important, there are other parameters that may dramatically influence them and therefore play a secondary, but still important role in the combustion process. Intake port design, which has a strong influence on charge air motion especially as it enters the cylinder and ultimately the mixing rate in the combustion chamber. The intake port design may also influence charge air temperature. This may be accomplished by heat transfer from the water jacket to the charge air through the intake port surface area. Intake valve size, which controls the total mass of air inducted into the cylinder in a finite amount of time. Compression ratio, which influences fuel vaporization and consequently mixing rate and combustion quality. Injection pressure, which controls the injection duration for a given nozzle hole size. Spray geometry, which directly impacts combustion quality through air utilization. For instance, a larger spray cone angle may place the fuel on top of the piston, and outside the combustion bowl in open chamber DI diesel engines. This condition would lead to excessive smoke incomplete combustion because of depriving the fuel of access to the air available in the combustion bowl chamber. Wide cone angles may also cause the fuel to be sprayed on the cylinder walls, rather than inside the combustion bowl where it is required. Fuel sprayed on the cylinder wall will eventually be scraped downward to the oil sump where it will shorten the lube oil life. As the spray angle is one of the variables that impacts the rate of mixing of air into the fuel jet near the outlet of the injector, it can have a significant impact on the overall combustion process. Valve configuration, which controls the injector position. On the other hand, four-valve designs allow for vertical injector installation, symmetric fuel spray arrangement and equal access to the available air by each of the fuel sprays. Top piston ring position, which controls the dead space between the piston top land area between top piston ring groove and the top of the piston crown , and the cylinder liner. It is therefore important to realize that the combustion system of the diesel engine is not limited to the combustion bowl, injector sprays, and their immediate surroundings. Rather, it includes any part, component, or system that may affect the final outcome of the combustion process.

Chapter 5 : Combustion in Diesel Engines

Combustion Processes in a Diesel Engine Cyril Crua A thesis submitted in partial fulfilment of the requirement of the University of Brighton for the degree of.

Chapter 6 : diesel engine | Definition, Development, Types, & Facts | calendrierdelascience.com

1 Diesel Engine Combustion 1. Characteristics of diesel combustion 2. Different diesel combustion systems 3. Phenomenological model of diesel combustion process.