Throttle body injection

A cutting model of an injected motor directly from gasoline Fuel injection is the introduction of fuel into an internal combustion engine, most commonly automotive engines, through an injector. This article focuses on injecting fuel into reciprocal piston and rotary piston engines. All Diesel engines (compression-ignition) use fuel injection, and many Otto engines (spark ignition) use fuel injection of one type or another. Mass-produced diesel engines for passenger cars (such as the Mercedes-Benz OM 138) were available in the late 1930s and early 1940s,[1] the first fuel injected engines for passenger car use. In passenger car gasoline engines, fuel injection was introduced in the early 1950s, and gradually gained prevalence until it largely replaced fuels in the early 1990s. [2] The main difference between carburization and fuel injection is that fuel injection atomizes fuel through a small nozzle under high pressure, while a carburetor relies on suction created by accelerated air through a Venturi tube to draw fuel into the air. The term fuel injection is vague and comprises several different systems with fundamentally different functional principles. In general, the only thing in common all fuel injection systems have is the lack of fuel. There are two main functional principles of mixing training systems for internal combustion engines: internal mixing formation, and external mixing formation. A fuel injection system that uses external mixing formation is called a multiple injection system; there are two types of multiple injection systems: multi-point injection (port injection), and single-point injection (accelerator-body injection). Internal mix formation systems can be separated into direct and indirect injection systems. There are several different varieties of direct and indirect injection systems, the most common internal mixing training fuel injection system is the common lane injection system, a direct injection system. The term electronic fuel injection refers to any fuel injection system that has an engine control unit. Fundamental consideration An ideal fuel injection system can provide precisely exactly the correct amount of fuel under engine operating conditions. This usually means precise control of the air fuel ratio (lambda), which allows, for example: easy engine operation even at low engine temperatures (cold start), adaptation to a wide range of environmental altitudes and temperatures, exactly governed engine speed (including inactive and red speeds), good fuel efficiency, and only a few exhaust emissions (because it allows emission control devices as a catalyst in three ways to function properly). In practice there is no ideal fuel injection system, but there is a variety of different fuel injection systems with certain advantages and harismtages. More More these systems were obsolete by the common rail direct injection system that today (2020) is used in many passenger cars. The common lane injection allows direct injection of gasoline, and is even more suitable for direct fuel injection of the diesel engine. However, common rail injection is a relatively complex system, so in some passenger cars that do not use diesel engines, a multiple injection system of various points is used. When designing a fuel injection system, a variety of factors must be taken into account, such as: System cost engine performance and vehicle drive (ease of start, smooth operation, etc.) exhaust emissions Diagnostic provisions and ease of service Fuel efficiency Reliability Capacity to run on various components of the fuel system All fuel injection systems comprise three basic components : they have at least one fuel injector (sometimes called an injection valve), a device that creates enough injection pressure, and a device that measures the correct amount of fuel. These three basic components can be separate devices (fuel injector, fuel distributor, fuel pump), partially combined devices (injection valve and an injection pump), or fully combined devices (unit injector). The first mechanical injection systems (except air blast injection) usually use injection valves (with needle nozzles) in combination with a relatively sophisticated propeller-controlled injection pump that both measured fuel, and created injection pressure. They were suitable for intermittently injecting multi-point injection systems, as well as all kinds of conventional direct injection systems, and chamber injected systems. Advances in the field of microelectronics allowed injection system manufacturers to significantly improve the accuracy of the fuel metering device. In modern engines, fuel measurement and injection valve drive is usually performed by the engine control unit. Therefore, the fuel injection pump should not measure fuel or activate injection valves; just provide injection pressure. These modern systems are used in injected engines of various points, and engines injected by common rail. Unit injection systems have turned it into series production in the past, but have proven inferior to common rail injection. Classification summary The overview below illustrates the most common types of mixing training systems in internal combustion engines. There are several ways to characterize, group and describe fuel injection systems, the clade is based on a differentiation between internal and external mix formation systems. Overview Mixing training systems Internal mixing formation Indirect injection Whirlpool camera[3] Pre-combustion-chamber injection[3] Injection of air cell chamber[4] Hot bulb injection[5] hot[5] Air blast injection[6] Hydraulic injection Distributed injection by M-System wall[7] Air injection Air distributed injection pump system Pumpe-Düse[8] Pump-rail-nozzle system[8] Air-guided injection[9] Wall-guided injection[9] Conventional pump-pump systems[8] Helix-controlled injection Lanova direct injection[1 [10] Postcambra injection[11] G-System (sphere combustion chamber)[12] Gardner system (hemisphere combustion chamber)[12] Saurer system (torus combustion chamber)[12] Flat piston (chamber combustion between piston and head) Formation of external mixture Carburettors In the constant vacuum carburettor Multistage carburettor Carburettor Multi-barrel carburettor Float-chamber-less injection of membrane carburetor[13] Single-point injection[13] Multi-point injection[13] Continuous injection[14] Intermittent injection[14] Formation of bmw M88 motor external mixing with injection of several points Main article: Multiple injection In an engine with external mixing formation , air and fuel are mixed out of the combustion chamber, so an award-winning mixture of air and fuel is sucked into the engine. External mix formation systems are common in gasoline engines such as the Otto engine, and the Wankel engine. There are two main external mixing training systems in internal combustion engines: carburetors, and multiple injection. The following description focuses on the latter. Multiple injection systems can also be considered indirect injection, but this article primarily uses the term indirect injection to describe internal mixing training systems that are not direct injection. There are two types of multiple injection: single-point injection, and injection of several points. [13] They can use several different injection schemes. Single-point injection The single-point injection uses an injector into an acceleration body mounted similarly to a carburetor in an admission collector. As with a carburted induction system, the fuel is mixed with the air before the admission collection enters. [13] Single-point injection was a relatively low-cost way for automakers to reduce exhaust emissions to comply with tightening standards, while providing a better unit (easy to start, run smoothly, the freedom to hesitate) than could be obtained with a carburetor. Many of the carburetor support components - such as the air cleaner, admission collection and fuel line routing - could be used with few or no changes. This postponed the costs of redesigning and tooling these components. Single-point injection was used extensively in American passenger cars and light trucks during 1980-1995, and in some in the early and mid-1990s. Injection of various points The injection of various points injects fuel into the admission ports only upstream of the admission valve of each cylinder, rather than at a central point within an admission collector. Normally, multi-point injected systems use multiple fuel injectors,[13] but some systems such as GM central port injection use tubes with poppet valves powered by a central injector instead of multiple injectors. [15] Injection schemes Multiple injected engines can use various injection schemes: continuous and intermittent (simultaneous, batch, sequential and single-cylinder). In a continuous injection system, fuel flows at all times from fuel injectors, but to a variable flow rate. The most common automotive continuous injection system is the Bosch K-Jetronic, introduced in 1974, and used until the mid-1990s by several automakers. Intermittent injection systems can be sequential, in which the injection is chronicled coinciding with the admission stroke of each cylinder; in which the fuel is injected into the cylinders in groups, without precise synchronization to the admission stroke of any particular cylinder; simultaneously, in which fuel is injected at the same time into all cylinders; or individual cylinder, in which the engine control unit can adjust the injection for each cylinder individually. [14] Internal formation of the mixture In an engine with an internal mixing training system, air and fuel are mixed only inside the combustion chamber. Therefore, only the air is sucked into the engine during the admission blow. The injection scheme is always intermittent (either sequential or cylinder-individual). There are two different types of internal mix formation systems: indirect injection and direct injection. Indirect injection Air Cell Chamber Injection – the fuel injector (right) injects the fuel through the main combustion chamber into the air cell chamber on the left. This is a special type of indirect injection and was very common in early American diesel engines. Main article: Indirect injection This article describes indirect injection as an internal mixing training system (typical of Akroyd and Diesel engines); for the external mixing training system which is sometimes called indirect injection (typical of Otto and Wankel engines), this article uses the term multiple injection. In an indirect injected engine, there are two combustion chambers: a main combustion chamber, and a pre-chamber, which is connected to the main one. The fuel is injected only into the pre-chamber (where it begins to combust), and does not in the main combustion chamber. Therefore, this principle is called indirect injection. There are several slightly different indirect injection systems that have similar characteristics. [3] All Akroyd (hot bulb) engines, and some Diesel engines (compression ignition) use indirect injection. Direct Direct Direct injection means that an engine has only one combustion chamber, and that the fuel is injected directly into that chamber. [16] This can be done either with an air explosion (air blast injection), or hydraulically. The latter method is much more common in automotive engines. Typically, hydraulic direct injection systems spray fuel into the air inside the cylinder or combustion chamber, but some systems spray fuel against combustion chamber (M-System) walls. Direct hydraulic injection can be achieved with a conventional propeller-controlled injection pump, unit injectors, or a sophisticated common lane injection system. The latter is the most common system in modern automotive engines. Direct injection is suitable for a wide variety of fuels, including gasoline (see direct gasoline injection), and diesel fuel. Main article: Common rail injection In a common railway system, fuel from the fuel tank is supplied to the common headwaters (called the accumulator). This fuel is sent through the tube to the injectors, which inject it into the combustion chamber. The header has a high pressure relief valve to keep the pressure on the head and return excess fuel to the fuel tank. The fuel is sprayed with the help of a nozzle that opens and closes with a needle valve, operated with a solenoid. When the solenoid is not activated, the spring forces the needle valve to the nozzle step and prevents the injection of fuel into the cylinder. The solenoid lifts the needle valve from the valve seat, and the under-pressure fuel is sent to the engine cylinder. [17] Common third-generation rail diesels use piezoelectric injectors for greater precision, with fuel pressures of up to 300 MPa or 44,000 lbf/in2. [18] History and development of the 1870s – 1920s: Early systems Air Blast Injection System for an 1898 diesel engine In 1872, George Bailey Brayton obtained a patent on an internal combustion engine that used a pneumatic fuel injection system, also invented by Brayton: injection [19] In 1894,[20] Rudolf Diesel copied Brayton's air blast injection system for the diesel engine, but also improved it. Above all, Diesel increased the air blast pressure from 4-5 kp/cm2 (390-490 kPa) to 65 kp/cm2 (6,400 kPa). [21] The first multiple injection system was designed by Johannes Spiel at Hallesche Maschinenfabrik in 1884. [22] In the early 1890s, Herbert Akroyd Stuart developed an indirect fuel injection system[23] using an pump to measure high-pressure fuel oil from an injector. the system was used in the Akroyd engine and was adapted and improved by Bosch and Clessie Cummins for use in diesel engines. An Antoinette 8V aviation engine injected, mounted on a preserved Antoinette VII monoplane aircraft. In 1898, Deutz AG began production of series of four-time stationary Otto engines with multiple injection. Eight Eight Later, Grade equipped its two-time engines with multiple injection, and both the Antoinette 8V and Wright aircraft engines were also equipped with multiple injection. The first direct gasoline injection engine was a two-time airplane engine designed by Otto Mader in 1916. [24] Another early use of direct gasoline injection was in the Hesselman engine invented by Swedish engineer Jonas Hesselman in 1925. [25] Hesselman engines use the stratified charging principle; the fuel is injected towards the end of the compression stroke, then ignited with a spark plug. They can run on a variety of fuels. [27] The invention of prosper l'Orange's precombined chamber injection helped diesel engine manufacturers overcome air blast injection problems, and allowed small engines to be designed for automotive use starting in the 1920s. In 1924, MAN introduced the first diesel engine injected directly for trucks. [4] 1930s – 1950s: First direct injection of mass-produced gasoline The direct injection of gasoline was used in notable World War II aeromakers such as the Junkers Jumo 210, the Daimler-Benz DB 601, the BMW 801, the Shvetsov ASh-82FN (M-82FN) German direct injection gasoline engines use injection systems developed by Bosch, Deckel, Junkers and orange from their diesel injection systems. [28] Later versions of the Rolls-Royce Merlin and Wright R-3350 used single-point injection, at the time called Pressure Carburettor. Due to the wartime relationship between Germany and Japan, Mitsubishi also had two radial aircraft engines using direct gasoline injection, the Mitsubishi Kinsei and the Mitsubishi Kasei. The first automotive direct injection system used to run gasoline was developed by Bosch, and was introduced by Goliath for his Goliath GP700, and Gutbrod for his Superior in 1952. It was basically a specially lubricated high pressure diesel direct injection pump of the type that is governed by the vacuum behind an admission acceleration valve. [29] The 1954 Mercedes-Benz W196 Formula 1 car engine used Bosch's direct injection derived from wartime aircraft engines. After this success on the circuit, the 1955 Mercedes-Benz 300SL became the first passenger car with a four-time Otto engine that used direct injection. [30] Later, more mainstream fuel injection applications favored injecting less expensive collectors. 1950s – 1980s: Series Production Multiple Injection Systems A 1959 Corvette Small Block 4.6-Litre V8 with Rochester Double Injection Fuel Without Engine, Continuously Injecting Multi-Point Injection K-Jetronic Throughout the 1950s, several manufacturers introduced their multiple injection systems for Otto engines, including General Motors' Rochester Products Division, Bosch, and Lucas Industries. [31] During the 1960s, additional multi-injection systems such as Hilborn,[32] Kugelfischer, and SPICA systems were introduced. Spica. The first injection system of multiple commercial electronic controls was the Electrojector developed by Bendix and was offered by American Motors Corporation (AMC) in 1957. [33] Initial problems with the Electrojector meant that only preproduction cars had installed so few cars sold[35] and none were made available to the public. [36] The EFI system on the Rambler worked well in warm climates, but it was difficult to start in cooler temperatures. Chrysler offered Electrojector in the 1958 Chrysler 300D, DeSoto Adventurer, Dodge D-500, and Plymouth Fury, possibly the first series production cars equipped with an EFI system. [38] Electrojector's patents were later sold to Bosch, who developed the Electrojector in the Bosch D-Jetronic. The D in D-Jetronic means Druckfühlergesteuert, German for controlled pressure sensor). The D-Jetronic was first used in the VW 1600TL/E in 1967. It was a speed/density system, using engine speed and multiple air density admission to calculate air mass flow speed and therefore fuel requirements. Bosch overstepped the D-Jetronic system with the K-Jetronic and L-Jetronic systems in 1974, although some cars (such as the Volvo 164) continued to use D-Jetronic for the next few years. The L-Jetronic uses a mechanical airflow meter (L for Luft, German for air) that produces a signal proportional to volume flow speed. This approach required additional sensors to measure atmospheric pressure and temperature, to calculate mass flow. L-Jetronic was widely adopted in European cars from that period, and some Japanese models soon after. 1979 – 1990S The first digital engine management system (engine control unit) was the Bosch Motronic introduced in 1979. In 1980, Motorola (now NXP Semiconductors) introduced its EEC-III digital ECU. [39] The EEC-III a single-point injection system. [40] The injection of multiples was wiped out through the late 1970s and 1980s at an accelerated pace, with German, French and US markets leading the way and the UK and Commonwealth markets falling a bit. Since the early 1990s, nearly all gasoline passenger cars sold in early world markets are equipped with injection of multiple electronics. Fuel remains in use in developing countries where vehicle emissions are unregulated and diagnostic and repair infrastructure is scarce. Fuel injection systems are gradually replacing these nations' fuels as they adopt emissions regulations conceptually similar to those in force in Europe, Japan, Australia and America Since 1990, in 1995, Mitsubishi introduced the first common railroad gasoline direct injection system for passenger cars. It was introduced in 1997. [41] Subsequently, direct injection of common rail was also introduced into passenger car diesel engines, with the Fiat 1.9 JTD being the first mass-market engine. [42] In the early 2000s, several manufacturers tried to use stratified load concepts in their direct injection gasoline engines to reduce fuel consumption. However, fuel savings proved to be almost unreasonable and disproportionate to increasing the complexity of exhaust gas treatment systems. Therefore, almost all automakers have switched to a conventional homognen mix in their gasoline engines injected directly since mid-2010. By the early 2020s, some automakers have still been using multiple injection, especially in economy cars, but also some high-performance cars. Since 1997, automakers have been using direct common rail injection for their diesel engines. Only Volkswagen used the Pumpe-Düse system throughout the 2000s, but they have also been using direct common rail injection since 2010. Notes ^ Hans Kremser (auth.): Der Aufbau schnellaufender Verbrennungskraftmaschinen für Kraftfahrzeuge und Triebwagen in Hans List (ed.): Die Verbrennungskraftmaschine, Vol. 11, Springer, Wien 1942, ISBN 978-3-7091-5016-0, p. 125 ^ Welshans, Terry (August 2013). In 1997, the group was one of the first aircraft manufacturers in the history of aircraft fuels and fuel systems. enginehistory.org: Aircraft Engine Historical Society. Retrieved June 28, 2016. ^ a little 1.0 1.1 Olaf von Fersen (ed.): Ein Jahrhundert Automobiltechnik. Personenwagen, VDI-Verlag, Düsseldorf 1986, ISBN 978-3-642-95773-4. ^ a question Olaf von Fersen (ed.): Ein Jahrhundert Automobiltechnik: Nutzfahrzeuge, Springer, Heidelberg 1987, ISBN 978-3-662-01120-1 p. 130 ^ Friedrich Sass: Geschichte des deutschen Verbrennungsmotorenbaus von 1860 bis 1918, Springer, Berlin/Heidelberg 1962, ISBN 978-3-662-11843-6 p. 417 ^ Rüdiger Teichmann, Günter P. Merker (editor): Grundlagen Verbrennungsmotoren: Funktionsweise, Simulation, Messtechnik , 7th edition, Springer, Wiesbaden, 2014, ISBN 978-3-658-03195-4, p. 381. ^ Hellmut Droscha (ed.): Leistung und Weg – Zur Geschichte des MAN-Nutzfahrzeugbaus, Springer, Berlin/Heidelberg 1991, ISBN 978-3-642-93490-2. ^ awning 1.1 Helmut Tschöke, Klaus Mollenhauer, Rudolf Maier (ed.): Handbuch Dieselmotoren, 8th edition, Springer, Wiesbaden 2018, ISBN 978-3-658-07696-2, p. 295 ^ a b c Richard van Basshuysen (ed.): Ottomotor mit Direkteinspritzung und Direkteinblasung: Ottokraftstoffe, Erdgas, Methan, Wasserstoff, 4th edition, Springer, Wiesbaden 2017, ISBN 978-3-658-12215-7, p. 62 ^ Helmut Hütten: Motoren. Technik, Praxis, Geschichte. Motorbuchverlag, Stuttgart 1982, ISBN 3-87943-326-7 ^ Olaf von Fersen (ed.): Ein Jahrhundert Automobiltechnik: Nutzfahrzeuge, Springer, Heidelberg 1987, ISBN 978-3-662-01120-1 p. 131 ^ a b c Hellmut Droscha (ed.): Leistung und Weg – Zur of MAN commercial vehicle construction, Springer, Berlan/Heidelberg 1991, ISBN 978-3-642-93490-2. P. 429 a b c d e f Kurt Lohner, Herbert Müller (auth): Mixture formation and combustion in the petrol engine, a Hans List (ed.): Die Die Die Volume 6, Springer, Vienna 1967, ISBN 978-3-7091-8180-5, p. 64 a b c Konrad Reif (ed.): Ottomotor-Management, 4th edition, Springer, Wiesbaden 2014, ISBN 978-3-8348-1416-6, p. 107 - 1997 Chevrolet Truck Service Manual, page 6A-24, drawing, element (3) Central Sequential Muliport injector. ^ IC Engines. Global Fuel Economy Initiative. Archived from the original on 6 October 2012. Retrieved 1 May 2014. - Helmut Tschöke, Klaus Mollenhauer, Rudolf Maier (ed.): Diesel Engines Manual, 8th edition, Springer, Wiesbaden 2018, ISBN 978-3-658-07696-2, p. 289 - Helmut Tschöke, Klaus Mollenhauer, Rudolf Maier (ed.): Manual Diesel Engines, 8th edition, Springer, Wiesbaden 2018, ISBN 978-3-658-07696-2, p. 1000 - Friedrich Sass: History of German combustion engine construction from 1860 to 1918, Springer, Berlin/Heidelberg 1962, ISBN 978-19183-662-11843-6, p. 413 - Friedrich Sass: History of German combustion engine construction from 1860 to 1918, Springer, Berlin/Heidelberg 1962, ISBN 978-3-662-11843-6. p. 414 - Friedrich Sass: History of German combustion engine construction from 1860 to 1918 Springer, Berlin/Heidelberg 1962, ISBN 978-3-662-11843-6. p. 415 - Richard van Basshuysen (ed.): Petrol engine with direct injection and injection direct: petrol, natural gas, methane, hydrogen, 4th edition, Springer, Wiesbaden 2017, ISBN 978-3-658-12215-7 , p. 6 - Hall, Carl W. (2008). A biographical dictionary of people in engineering: From the first records to 2000 (1st ed). Purdue University Press – via Creed Reference. Richard van Basshuysen (ed.): Gasoline engine with direct injection and direct injection: gasoline, natural gas, methane, hydrogen, 4th edition, Springer, Wiesbaden 2017, ISBN 978-3-658-12215-7, p. 7 in Lindh, Björn-Eric (1992). Scania fordonshistoria 1891-1991 (in Swedish). Jordi. ^ a wholly 6.0 6.1 6.2 6.3 6.4 6.4 6.6 6.6 6.6 6.6 6.6 6.6 6.6 Volvo - Lastbilarna ig'r och idag (Swedish). Förlagshuset North. ISBN 978-91-86442-76-7. Richard van Basshuysen (ed.): Gasoline engine with direct injection and direct injection: gasoline, natural gas, methane, hydrogen, 4th edition, Springer, Wiesbaden 2017, ISBN 978-3-658-12215-7, p. 17-18 - Richard van Basshuysen (ed.): gasoline engine with direct injection and direct injection: gasoline, natural gas, methane, hydrogen, 4th edition, Springer, Wiesbaden 2017, ISBN 978-3-658-12215-7, p. 10 - Richard van Basshuysen (ed.): gasoline engine with direct injection and direct injection: gasoline, natural gas, methane, hydrogen, 4th edition, Springer, Wiesbaden 2017, ISBN 978-3-658-12215-7, p. 19 - Richard van Basshuysen (ed.): gasoline engine with injection direct and direct injection: gasoline, natural gas, methane, hydrogen, 4th edition, Springer, Wiesbaden 2017, ISBN 978-3-658-12215-7, p. 20 A brief history of lucas injection. lucasinjection.com. Retrieved 1 May 2015. How good is fuel injection?. Popular science. 170 (3): 88–93. Retrieved May 1, 2015. ^ Ingraham, Joseph C. (24 March 1957). Automobiles: Racing; Everyone manages to win something in the Daytona Beach contests. The New York Times. Modify score: 153 [Retrieved: 1 May 2015]. ^ 1957 cars. Consumer reports. 22: 154. 1957. ^ Aird, Forbes (2001). Bosch fuel injection systems. Hp Trade. Modify score: ↑ 1.0 1.1 1.2 1.3 1.4 1.4 1.4 1.5 1.5 1.6 1.6 1.6 1.6 1.6 1.6 ↑ Kendall, Leslie. In 1997, the government of Las Vasco da America was the first to do so. Petersen Automobile Museum. Archived from the original on October 27, 2011. Retrieved November 8, 2018. ^ Consumer Guide Auto Editors (August 22, 2007). Rambler measures up. Retrieved May 1, 2015. ^ 1958 DeSoto Electrojector - First injection of electronic fuel?. www.allpar.com. Retrieved 8 November 2018. ^ A time vision of motorola history 1928-2009 (PDF). Motorola. Archived from the original on June 20, 2011. Retrieved January 20, 2014. ^ Olaf von Fersen (ed.): Ein Jahrhundert Automobiltechnik. Personenwagen, VDI-Verlag, Düsseldorf 1986, ISBN 978-3-642-95773-4. ^ Richard van Basshuysen (ed.): Ottomotor mit Direkteinspritzung und Direkteinblasung: Ottokraftstoffe, Erdgas, Methan, Wasserstoff, 4th edition, Springer, Wiesbaden 2017, ISBN 978-3-658-12215-7, p. 138 ^ Günter P. Merker, Rüdiger Teichmann (ed.): Grundlagen Verbrennungsmotoren – Funktionsweise · Simulation · Messtechnik, 7th edition, Springer, Wiesbaden 2014, ISBN 978-3-658-03194-7, p. 179 External links Jetronic system history How Multi Point Fuel Injection System (MPFI) fuel injection systems recovered from