https://doi.org/10.26160/2474-5901-2021-27-74-76

METHOD FOR OPTIMIZING THE BASIC CHARACTERISTICS OF CONTROL THE FUEL INLECTION IN DIESEL

Valiev A.R., Nurkaev A.M., Rafikova R.R., Rafikov D.I.

Keywords: optimization, nozzle, characteristics map, injection, duration, fuel delivery system (FDS).
Abstract. The article provides a description and the possibility of using methods for optimizing the basic characteristics of the injection of electro-hydraulic injectors, which will allow more accurate correction of the injection by the control unit and improve the quality of the entire system, relying on existing patent methods of individual correction, as well as reduce labor costs for adjustment.

МЕТОД ОПТИМИЗАЦИИ БАЗОВЫХ ХАРАКТЕРИСТИК УПРАВЛЕНИЯ ПОДАЧЕЙ ТОПЛИВА В ДИЗЕЛЯХ

Валиев А.Р., Нуркаев А.М., Рафикова Р.Р., Рафиков Д.И.

Ключевые слова: оптимизация, форсунка, карта характеристик, впрыск, продолжительность, топливоподающая система (ТПС).
Аннотация. В статье приводится описание и возможность использования методов оптимизации базовых характеристик впрыска электрогидравлических форсунок, что позволит более точно производить коррекцию впрыска блоком управления и улучшит качество работы всей системы, опираясь на существующие патентные способы индивидуальной коррекции, а также уменьшатся трудозатраты на регулировку.

Modern fuel supply systems are capable of up to eight injections per cycle, with each separate fuel supply having its own function (Figure 1): preparation for ignition (1), formation of the leading edge of the characteristic (2), main fuel supply (3), subsequent supply for afterburning of combustion products (4), injection at the exhaust stroke for warming up (cleaning) the catalyst and particulate filter (5) [1].

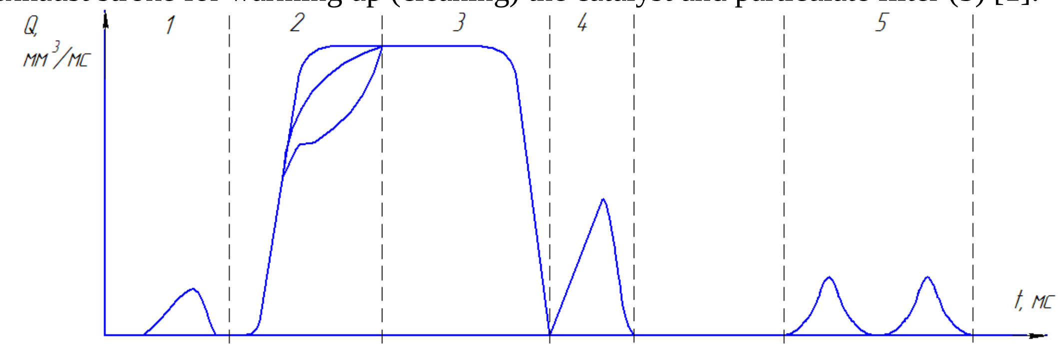
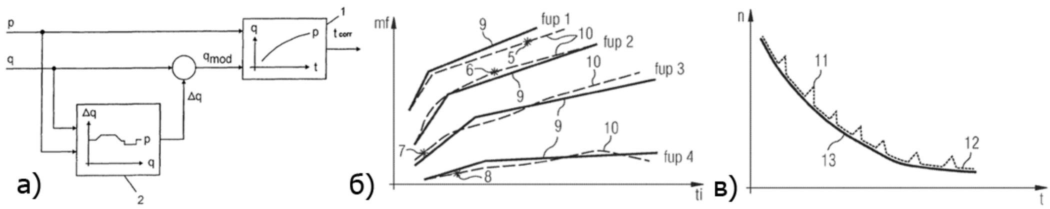


Fig. 1. Injection characteristic of FDS with multi-injection

Accurate control of fuel injection into each cylinder, as well as ensuring optimal workflow in different operating modes and calibration of the control unit for a specific fuel supply system can be achieved by forming individual injection characteristics for each injector. The resulting characteristic is then entered into the electronic engine control unit.

Each nozzle, due to technological tolerances and operational wear, has a different map of characteristics in terms of the amount of fuel injection. To ensure the identity of the cyclic supply of different injectors, manufacturing plants, based on the measured map of injection characteristics, arrange them into certain classes and assign each injector an individual code, which is later entered into the engine control unit. These codes (injection characteristics) are applied in the form of an inscription, barcode or QR code on the injectors themselves, and the information can also be stored using chips built into the injector.

Optimization (adaptation of the ECU) is carried out by various methods and devices. In one of the methods (Figure 2a), the correction is made using a quantitative correction map known as IMA (individual injector performance correction) [2]. The method is as follows: the injection time is corrected in the control unit depending on the nominal map of characteristics for each injector as a function of the set value on the pressure in the rail, thereby approximating the required amount of fuel as close to the nominal value as possible.



a) 1 - nominal map; 2 - corrective map; b) 5, 6, 7, 8 - measured points; 9 - average characteristics ti; 10 - the actual field of characteristics at various pressures. c) 11 - the frequency of rotation of the crankshaft as a result of injection; 12 - change of speed with MFMA; 13 - speed change without MFMA

Fig. 2. Correction schemes

There is also a method based on individual adaptation of the injector injection time based on the connection between the IIC (individual injector correction) and MFMA (minimum fuel mass adaptation) methods [3].

Figure 2b shows the actual fields of the injection characteristics ti for various pressures fup 1, fup2, fup 3 and fup 4, and averaged ones calculated using the IIC method. The correction is carried out on a test bench at four measurement points.

Using the MFMA method, at a certain load mode, small injections are made into the cylinder and, depending on the change in the crankshaft speed, the required duration of the control pulse is calculated. Corrective variables (cycle feed) are generated individually for each tested injector throughout the entire field of characteristics. Figure 2c shows the change in the crankshaft speed with (12) and without (13) MFMA 13. The change in the angular speed of the crankshaft 11 as a result of injection. Period 12 shows the change in speed in the power phase with MFMA.

Analysis of existing optimization methods is the most effective method using individual nozzle correction (IIC) and minimum fuel mass adaptation (MFMA). Taking this method as a prototype, it is necessary to create a device and method that allows testing and adapting injectors of any manufacturer, training the electronic control unit to optimize injection, while taking into account the current wear during the service life.

References

1. Peter Kuegel, Guenter Veit, Ernst Kloppenburg. System und Verfahren zum Korrigieren des Einspritzverhaltens von mindestens einem Injektor. Patent DE 10215610 A1. 2002.
2. Christian Hauser Method for the injector-individual adaption of the injection time of motor vehicles. Patent US, 8775058 B2. 2009.
3. Gabitov I.I. Fuel equipment of autotractor diesel engines: textbook manual for university students / I.I. Gabitov, A.V. Negovora. – Ufa, 2004. – 230p.
4. Negovora A.V. Improving the performance of automotive diesel engines by improving the design and technology of diagnosing the fuel supply system: diss. … doct. of tech. sc. – SPb.: St. Petersburg State Agrarian University, 2004. – 343p.
5. Valiev A.R. Improving the efficiency of repairing electro-hydraulic injectors of accumulator fuel systems of automotive diesel engines: abstract of diss. … cand. of tech. sc. – Ufa: Bashkir State Agrarian University, 2012.

Список литературы

1. Peter Kuegel, Guenter Veit, Ernst Kloppenburg. System und Verfahren zum Korrigieren des Einspritzverhaltens von mindestens einem Injektor. Patent DE, 10215610 A1. 2002.
2. Christian Hauser Method for the injector-individual adaption of the injection time of motor vehicles. Patent US, 8775058 B2. 2009.
3. Габитов И.И. Топливная аппаратура автотракторных дизелей: учеб. пособие для студентов вузов / И.И. Габитов, А.В. Неговора. – Уфа, 2004. – 230с.
4. Неговора А.В. Улучшение эксплуатационных показателей автотракторных дизелей совершенствованием конструкции и технологии диагностирования топливоподающей системы: дисс. … докт. техн. наук. – СПб.: Санкт-Петербургский государственный аграрный университет, 2004. – 343с.
5. Валиев А.Р. Повышение эффективности ремонта электрогидравлических форсунок аккумуляторных топливных систем автотракторных дизелей: автореф. дисс. … канд. техн. наук. – Уфа: Башкирский государственный аграрный университет, 2012.

Валиев Азамат Рамилевич – кандидат технических наук, доцент кафедры автомобилей и машинно-тракторных комплексов, maratovna1985@yandex.ru	**Valiev Azamat Ramilevich** – candidate of technical sciences, associate professor of the Department of Automobiles and Machine-Tractor Complexes, maratovna1985@yandex.ru
Рафикова Регина Радиковна – аспирант, regina.rafikova.2015@mail.ru	**Rafikova Regina Radikovna** – post-graduate student, regina.rafikova.2015@mail.ru
Рафиков Денис Ирикович – магистр, golemden@mail.ru	**Rafikov Denis Irikovich** – master, golemden@mail.ru
Нуркаев Айдар Мударисович – магистрант	**Nurkaev Aydar Mudarisovich** – master's student
Башкирский государственный аграрный университет, Россия, г. Уфа	Bashkir State Agrarian University, Russia, Ufa

Received 21.12.2021