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MODERNIZATION OF THE DIRECT OPERATION FUEL FEEDING SYSTEM OF DIESEL ENGINE

Evgeni A. Salykin, Viktor M. Slavutskij, Valentin I. Lipilin, Denis S. Berezjukov[*)] Aleksey A. Skorobogatov

Volgograd State Technical University, Department of Car-and-Tractor Engines
Department of Heat Engineering and Hydraulics[*)]
Russia, 400005, Volgograd, Lenin Avenue 28
tel.: +7 (8442) 248161, +7 (8442) 248156
e-mail: atd304@vstu.ru

Abstract

This paper describes the way of modernization of the direct operation fuel feeding system of diesel engine. Effective, ecological and economical characteristics of a modern diesel engine are greatly de-termined by parameters of using fuel-feeding system. Thus, in modern conditions, fuel-feeding systems have to fulfil specified requirements, which are mainly connected with fuel supply process intensification, possibility of adaptable regulation of fuel injection lead angle, cycle fuel delivering and injection characteristic at full range of engine operation regimes. At present time accumulator fuel feeding systems Common Rail type, fulfil these requirements best of all. However, despite its advantages, those kinds of systems have number of disadvantages. The main ones are high price and structural complexity of the system elements. Because of this Common Rail does not have wide using in the diesel engines with number of cylinders less than three. Although that type of diesels exactly is universal mechanical energy, source and can be used in many types of machinery, including ones with strict ecological norms. However, up to now these engines are equipped with the direct operation fuel feeding system that despite its high reliability and low price is worse than accumulator systems in the injection pressure level and possibilities of fuel feeding process control. Thus, main objective of a modernization of the direct operation fuel feeding system is topical. Speed forcing of high-pressure fuel pump was used. Maximal injection pressure is successfully increased 1.42 times. It provides intensification of fuel injection process. Implementation of the electronic control allows counting this method of fuel feeding system modernization promising for small diesel engines.

Keywords: *direct operation fuel feeding system, speed forcing of high pressure fuel pump, fuel feeding*

Effective, ecological and economical characteristics of a modern diesel engine are greatly determined by parameters of using fuel-feeding system. Thus, in modern conditions, fuel-feeding systems have to fulfil specified requirements, which are mainly connected with fuel supply process intensification, possibility of adaptable regulation of fuel injection lead angle, cycle fuel delivering and injection characteristic at full range of engine operation regimes. At present time accumulator fuel feeding systems Common Rail type, fulfil these requirements best of all [1].

However, despite its advantages, those kinds of systems have number of disadvantages. The main ones are high price and structural complexity of the system elements. Because of this Common Rail does not have wide using in the diesel engines with number of cylinders less than three. Although that type of diesels exactly is universal mechanical energy, source and can be used in many types of machinery, including ones with strict ecological norms. However, up to now these engines are equipped with the direct operation fuel feeding system that despite its high reliability and low price is worse than accumulator systems in the injection pressure level and possibilities of fuel feeding process control. Thus, main objective of a modernization of the direct operation fuel feeding system is topical.

Effective method of the fuel injection pressure increase in the direct operation system of the divide type is the speed forcing of the high-pressure fuel pump (HPFP) [2]. Scheme of this system

is presented at Fig. 1. Doubling of HPFP shaft 2 rotation speed and its balancing with the crankshaft speed 1 provides increasing of plunger 3 speed at pressure stroke 2 times. That increase results in rising of feeding volume velocity. It, in turn, causes increasing of the average injection pressure 1.4-1.6 times. Also decreasing of the injection duration at crankshaft turn angle is provided [3]. At the same time loads increasing in the HPFP plunger drive mechanism at rotation speed raising that negatively affects on system lifetime, can be reduced due to specified profiling of plunger drive cam.

At the HPFP speed, forcing two-plunger pressure strokes (main and additional) accords to one operating cycle of four-stroke diesel. At the main stroke, fuel feeding is performed due to injector to diesel cylinder. Because of additional plunger stroke accords to the exhaust stroke, steps for prevention of injector 6 opening are necessary. Bypass valve 8 are provided for this in the fuel feeding system. Bypassing of some fuel from the high-pressure line provides the regulation of initial pressure in this line for improvement of fuel injection.

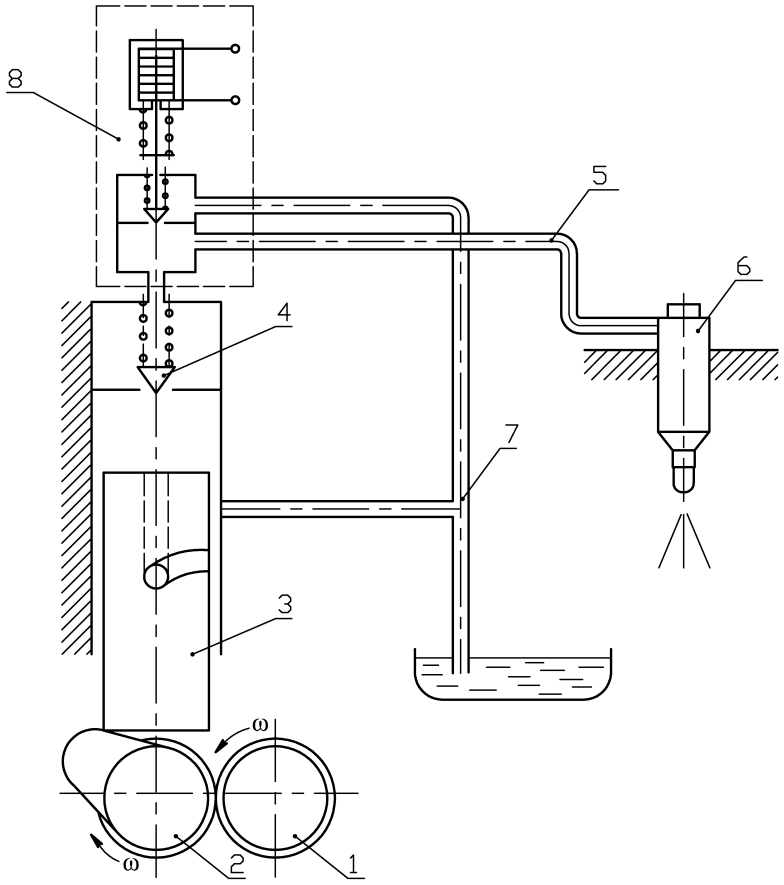

Fig. 1. Scheme of modernized fuel feeding system with HPFP speed forcing: 1 – engine crankshaft; 2 – HPFP shaft; 3 – plunger; 4 – pressure valve; 5 – pressure line; 6 – injector 7 – low pressure line; 8 – bypass valve with electronic control

For assessing of efficiency of modernization by means of the proposed method experimental researches of impact of HPFP shaft speed increasing on fuel feeding process were performed. The fuel feeding system of one-cylinder diesel engine Kipor KM 186FA on engineless test stand KI-15716 was used as research object. This engine has plunger with diameter 6.5 mm and working stroke 6 mm. Mechanical injector is designed for opening pressure 210 bar. To obtain characteristics of the fuel feeding process on high-pressure line sensor Bosch 0281002504 was installed close by injector. Sensor readings were recorded by means of digital oscillograph DiSco. Parameters of injection process were assessed at increase of HPFP shaft rotation speed from 1000 up to 2000 min^{-1} at maximal fuel feeding during research.

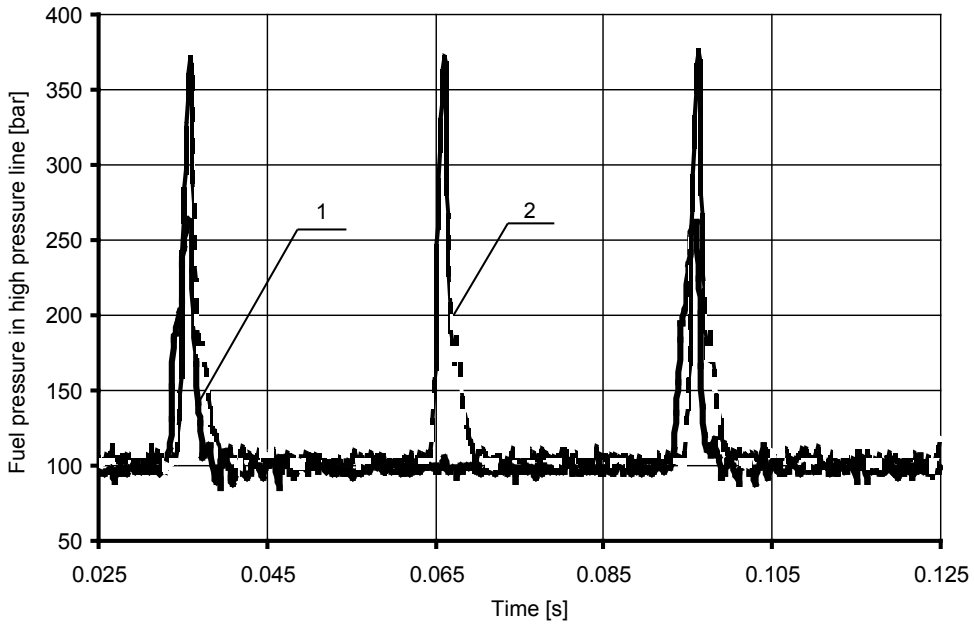

Fig. 2. Oscillograms of fuel pressure in high-pressure line:
1 – at HPFP shaft rotation speed 1000 min^{-1}
2 – at HPFP shaft rotation speed 2000 min^{-1}

Oscillograms of fuel pressure in high-pressure line at the HPFP shaft rotation speed 1000 min^{-1} and 2000 min^{-1} are presented at Fig. 2. Increase of maximal pressure was about 110 bar; it is 1.42 times greater. When rotation speed increases from 1000 up to 2000 min^{-1} maximal pressure in system rises at all speed regimes (Fig. 3) and cycle feeding increases (Fig. 4).

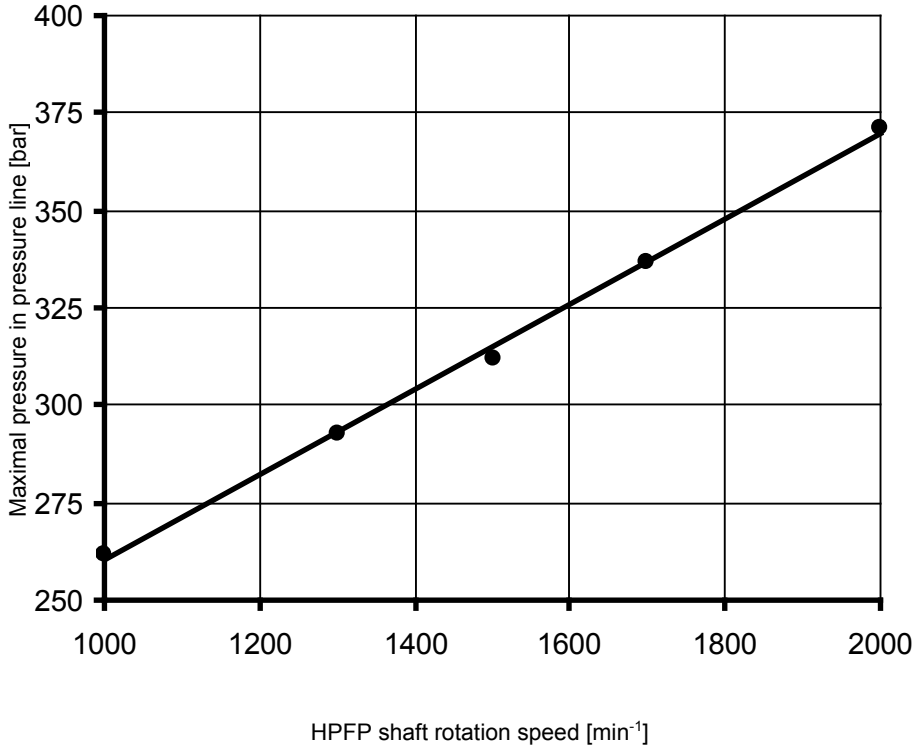

Fig. 3. Dependence of maximal pressure in pressure line on HPFP shaft rotation speed

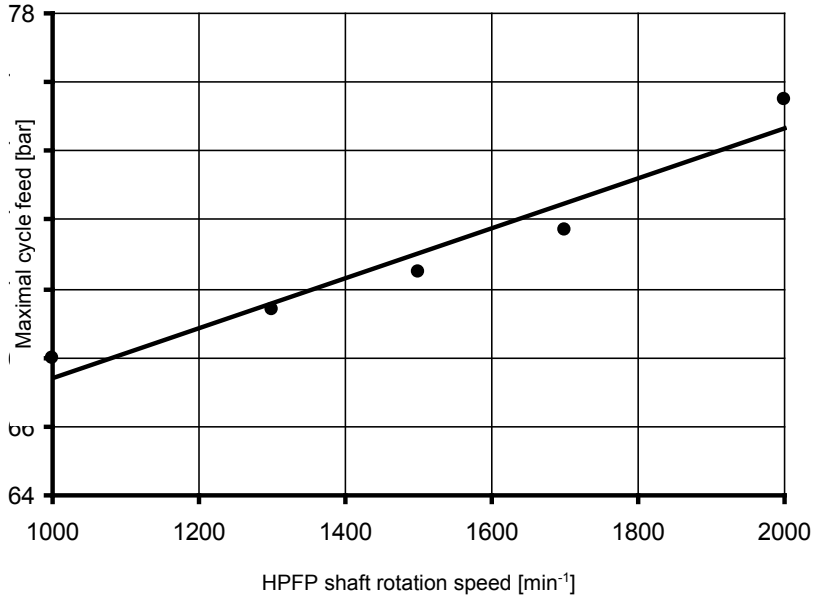

Fig. 4. Dependence of maximal cycle feed on HPFP shaft rotation speed

Modernization of the fuel system for further researches intends to use in it injector with piezodrive Bosch CRI 3.3 as bypass valve. Control of this injector is planned to perform by means of an electronic unit based on microcontroller with dependence on signal of HPFP shaft speed and displacement sensors.

So, performed researches allows to affirm that the modernization of the direct operation fuel feeding system of diesel engines with using of the HPFP speed forcing provides intensification of fuel feeding process due to increasing of pressure level in system. Further researches of system are necessary taking into account of bypass valve operation and control process organization.

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