THE CALCULATION OF THE FOUR-STROKE CYCLE OF A DIESEL ENGINE SUPERCHARGED WITH UNEVEN ALTERNATION OF INLETS

A. A. Gavrilov and A. N. Gots

Vladimir State University named after Alexander and Nikolay Stoletovs, 87 Gorky Str., Vladimir 600000, Russian Federation

Abstract: Based on the analysis of the structure of a quasi-stationary mathematical model of the working cycle of a piston engine cycle, the algorithm and method of calculation of working processes in diesel engines with gas turbine charging at nonuniform alternating inlets to the cylinders with fresh charge are presented. It is shown that the efficiency of joint operation of the engine and turbocharger is greatly influenced by the nature of fluctuations during the working cycle of air flow and boost pressure which determine the efficiency of the compressor and the entire power plant. For the coordination of their operation, an approximate calculation using a certain algorithm is proposed. After selecting the turbocharger and charge air cooler, the boost parameters are adjusted to the technical data of the selected turbochargers and the final initial data for the calculation of the engine boost system are drawn up. At further calculation, the flow coefficients in the inlet and exhaust pipelines are corrected which ensures with the accepted relative error coincidence of the specified and calculated average values of pressures and weight of the working body leaving and entering the cylinder. In this case, the fuel injection advance angle, the duration of the ignition delay of the fuel–air mixture, and other parameters are adjusted. The proposed dependence is used to calculate the characteristics of heat release and the rate of heat release in the engine with compression ignition. The latter is not monotonous, since it causes the presence of two maxima of speed: at explosive and diffusion combustion of fuel.

Keywords: diesel engine; turbocharger; charge cooler; injection timing angle; heat release characteristics; release rate of heat

DOI: 10.30826/CE21140205

Figure Captions

Figure 1 Characteristics of heat generation on a diesel D120 depending of the crank angle: *1* — relative heat release x; and *2* — burnout rate $dx/d\varphi$

Figure 2 Movement of the point of joint operation of the diesel engine and the turbocharger at the field of characteristics of the compressor C14-64 with two volumes of the intake pipeline: **1**–**2** — $V_s = 2.5$ dm^3; and **3**–**4** — $V_s = 1.5$ dm^3

Figure 3 Functions $G_{\text{kx}} = f(G_{\text{kx}}/\eta_{\text{kx}})$ for different values of π_k: *1* — 1.2; *2* — 1.5; *3* — 1.6; *4* — 2.0; and *5* — 2.2

Table Caption

Adjusting of the initial variant

References

1. Gavrilov, A. A., and V. V. Efros. 1997. Impul'snaya sistema nadduva chetyrekhtaktnykh malotsilindrovykh dizeley [Pulsed boost system of four-stroke small-cylinder diesels]. *Traktory i sel'skokhozyaystvennye mashiny* [Tractors and Agricultural Machinery] 10:16–18; 11:24–27.
2. Gavrilov, A. A., and A. N. Gots. 2013. Model' turbonadduva v tsikle dvigatelya s peremennym davleniem vozdukha na vpuske [Model of a turbo-supercharging in a cycle of the engine with variable pressure of air upon an admission]. *Fundamental'nye issledovaniya* [Fundamental Research] 8-1:24–28.
3. Gavrilov, A. A., and A. N. Gots. 2013. Vliyanie vneshnikh faktorov na davlenie rabochego tela v tsikle porshnevogo dvigatelya [Influence of external factors on the pressure of the working body in the cycle of the piston engine]. *Materiali V-ї Vseukraïns'ko ї nauch. tekhn. konferentsiї s mizhdunar. uchast. "Suchasni problemi dvigunobuduvannya: stan, ideї, rishennya"* [Materials of the 5th Ukrainian Scientific and Technical Conference "Modern Problems of an Engine Building: A condition, Ideas, Decisions"]. Pervomaisk. 52–59.
4. Gavrilov, A. A., and A. N. Gots. 2014. Modifitsirovannaya matematicheskaya model' tsikla porshnevogo dvigatelya [Modified mathematical model of the cycle of the piston engine]. *Sovremennoe mashinostroenie. Nauka i obrazovanie: Mat-ly 4-y Mezhdunar. nauchn.-prakt. konf.* [Modern Mechanical Engineering. Science and Education: 4th Science and Practical Conference (International) Pro-

ceedings]. Eds. M. M. Radkevich and A. N. Evgrafov. St. Petersburg: Publishing House of Polytechnic University. P. 1239–1249.

5. Kavtaradze, R. Z. 2007. *Lokal'nyy teploobmen v porshnevykh dvigatelyakh* [Local heat transfer in piston engines]. 2nd ed. Moscow: Publishing House of Bauman Moscow State Technical University. 650 p.
6. Kavtaradze, R. Z. 2008. *Teoriya porshnevykh dvigateley. Special'nye glavy* [Theory of piston engines. Special chapters]. Moscow: Publishing House of Bauman Moscow State Technical University. 720 p.
7. Gavrilov, A. A., and A. V. Bolshakova. 2009. Raschet vygoraniya topliva v tsilindre dizelya [Calculation of fuel burn in the cylinder of a diesel engine]. *Aktual'nye problemy ekspluatatsii avtotransportnykh sredstv. Mate-ly 13-y Mezhdunar. nauchn.-prakt. konf., posvyashchennoy 40-letiyu Avtotransportnogo fakul'teta* [Actual problems of operation of vehicles: 13th Science and Practical Conference (International) Dedicated to the 40th Anniversary of the Faculty of Motor Transport Proceedings]. Vladimir: Publishing House of Vladimir State University. P. 262–265.
8. Gavrilov, A. A., and A. N. Gots. 2014. Prodolzhitel'nost' zaderzhki vosplameneniya toplivo-vozdushnoy smesi v porshnevykh dvigatelyakh [Duration of ignition delay of fuel-air mixture in piston engines]. *Fundamental'nye issledovaniya* [Fundamental Research] 6-4:703–708.

Received May 14, 2021

Contributors

Gavrilov Alexander A. (b. 1930) — Doctor of Science in technology, professor, Vladimir State University named after Alexander and Nikolay Stoletovs, 87 Gorky Str., Vladimir 600000, Russian Federation; tdieu@yandex.ru

Gots Alexander N. (b. 1936) — Doctor of Science in technology, professor, Vladimir State University named after Alexander and Nikolay Stoletovs, 87 Gorky Str., Vladimir 600000, Russian Federation; hotz@mail.ru