OPPORTUNITIES TO IMPROVE EFFICIENCY AND OTHER ENGINE PERFORMANCE AT LOW LOADS

Abdulaziz Khusanjonov,
Qobulov Makhammadjon,
Jaloldinov Gholibjon
Masters of the Ferghana polytechnic institute
Telephone: +998(91)6616436
abdulazizhusanjonov7777@gmail.com

Annotation. The article analyzes a number of methods and opportunities to improve operational fuel efficiency and reduce the toxicity of internal combustion engine emissions with changes in working volume at the idling mode of the engine and low load mode of the engine.

Keywords. Internal combustion engine, working volume, idling mode, low load mode, fuel efficiency, toxicity of engine emissions, engine control.

There are a number of methods and means to increase the efficiency of the idling mode of the engine (IM) and low load mode of the engine (LLM). Today, one of the promising methods for solving the problem of increasing efficiency, and consequently economy, and reducing the concentration of products of incomplete combustion, as well as nitrogen oxides, at partial loads and idling is the method of turning off the cylinders or the method of controlling the engine by changing its working volume (under the engine's working volume is meant the sum of the working volumes of those cylinders in which the processes of generating mechanical energy occur) [1].

Moreover, for the first time, work in this direction was associated with a change in volume by turning off part of the cylinders. As early as 1905 [3], this method was used on a six-cylinder engine. It is known that at the dawn of engine building, the method of disabling individual cycles of a single-cylinder engine was used to regulate its power. Those. The principle of controlling "skipping flashes" was realized, to which interest is only now again

ISSN: 2581-4230, Website: journalnx.com, June 18th & 19th, 2020

showing [4]. For two-cylinder engines, power was regulated by turning off one cylinder and skipping flares [3, 5].

Most often, a change in engine displacement is achieved by turning off-turning on the groups of cylinders. Less often – one cylinder. In this case, it is possible to turn off the cylinder only by stopping the fuel supply to it, or by applying the shutdown of the fuel supply together with the change of gas exchange phases, or by shutting off the fuel supply, gas exchange phases and stopping the pistons of the cylinders to be switched off, etc. [4, 6].

As positive effects of the engine control method by changing the displacement (turning off part of the cylinders in the IM and LLM modes), not only an increase in fuel economy is noted, but also a decrease in the wear of the cylinder-piston group, a decrease in gum formation, coking of the piston rings and valves, as well as a decrease in lubricant dilution unburned fuel.

The method showed the greatest efficiency when it was used to increase the efficiency of gasoline internal combustion engines (ICE), in which covering the throttle valve at the idling mode of the engine and low load modes significantly increases mechanical (pumping) losses and, accordingly, increases fuel consumption [7, 8]. Quantitative throttle-free regulation of the gas engine power at low load modes, used instead of high-quality regulation, allows its fuel efficiency to be improved by 12–17% [8].

In 1981, the GM Company for Cadillac Eldorado V-8-6-4 cars began mass production of engines with such regulation. The engine could work with the shutdown of two or four cylinders. In 1998, Daimler-Chrysler resumed cylinder shut-off technology. It was named "Active Cylinder Control" (ACC) on the V8 and V12 engines of Mercedes-Benz cars (Fig. 1). The engines were switched off, respectively, 4 or 6 cylinders. Since 2005, Honda has been implementing a row shutdown (3 cylinders) on a V6 gasoline engine. Then for the first time the system was called "Variable Cylinder Management" [4] (Fig. 2).

When this method is implemented at low load conditions, both valve operation (leave them closed) and fuel injection systems are deactivated. For engines with spark ignition,

ISSN: 2581-4230, Website: journalnx.com, June 18th & 19th, 2020

naturally, the ignition system is also deactivated. Thanks to the closed valves, the disconnected cylinder turns into an "air spring" [10]. This reduces the mechanical losses associated with pumping strokes.

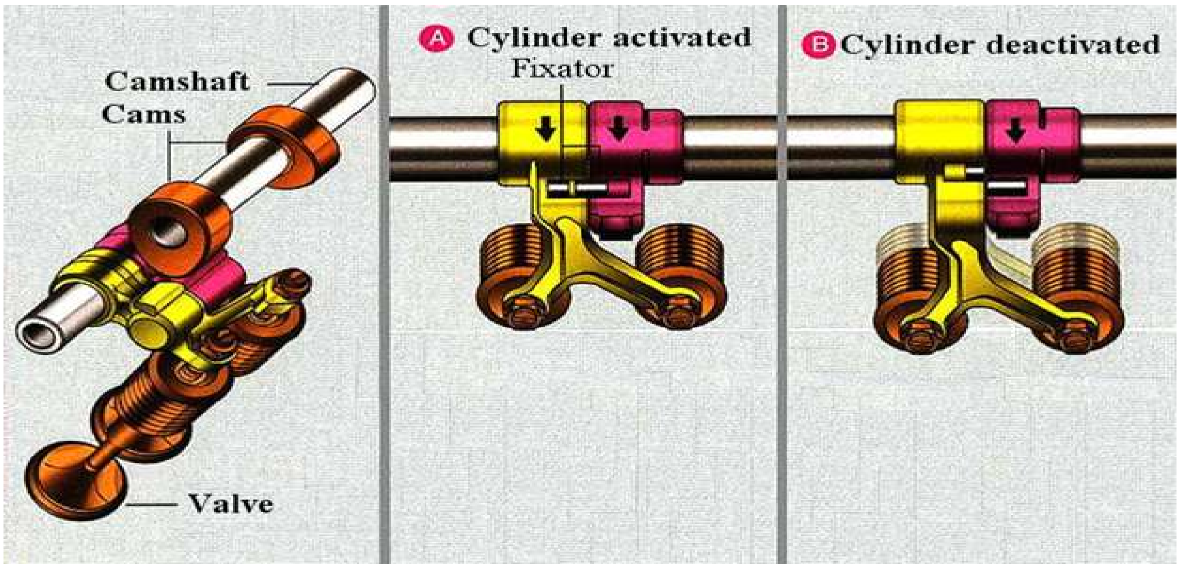

Fig 1. "Active Cylinder Control" (ACC) system of engine by Mercedes-Benz.

Fig 2. "Variable Cylinder Management" (VCM) system of engine by Honda.

The method of turning off the cylinders can reduce fuel consumption by up to 25–40%, depending on the operating mode and method of shutdown [5, 9]. At the same time, harmful emissions, primarily greenhouse gases (CO_2, etc.) are also reduced.

According to the control method, it is possible to turn off - turn on the same group of cylinders, alternate groups of disconnected - turn on cylinders, turn off - turn on individual cylinders and their alternation, as well as turning it off-turning it on individual cycles in part or in all cylinders. All this is possible both without changing the phases of gas exchange, and with their change.

The method of mechanical shutdown of cylinders with stopping of the pistons by shutting off part of the crankshaft or one of, for example, two shafts is just beginning to develop [4]. The most common method of shutting off the fuel supply without changing the phases of gas exchange.

In [70], it is noted that simply turning off the cylinders leads to an abrupt change in the engine performance, and as a result of excessive vibration, the car “jerks”, that is, the loss of such a quality as driving comfort. To eliminate this drawback, it is proposed to regulate the engine mode not by turning off the cylinders, but by skipping individual fuel supplies (in [11] - “turning off individual cycles”). In addition, at low load and idle modes, it is proposed to reduce the actual compression ratio in both disconnected and active cylinders. This reduces mechanical loss as well as heat loss to the cooling system during the compression stroke. The compression ratio is reduced by leaving the intake valve closed during the suction stroke [10].

It should be noted that in [10] it is recommended that when the cylinder is turned off, both the intake and exhaust valves be left closed. But it is important at what point to leave them closed. Currently, there are actually three options for starting shutdown (deactivation) of gas distribution valves:

1 - before the release beat;

2 - after completion of the intake stroke;

3 - after completion of the release beat.

The advantage of the first case is the high temperature and gas pressure, which is associated with the thermal efficiency of the engine, with maintaining a rational thermal

ISSN: 2581-4230, Website: journalnx.com, June 18th & 19th, 2020

state. In the second case, pressure and temperature are low and are related to environmental parameters. Charge leaks and heat dissipation through the cylinder walls determine low pressure and temperature in the cylinder. For a long time, an engine with a variable displacement is understood to mean an engine that can be controlled by changing the volumes that pass through the pistons of the working cylinders. A decrease in the active working volume of the engine leads to an increase in its efficiency, since the load on the working cylinders increases, which leads to an increase in the indicator efficiency, in accordance with the adjustment characteristic ($\eta_i = f(\alpha)$) [12]. In addition, with a change in the phases of gas exchange, the mechanical engine efficiency (η_m) increases. All this leads to a decrease in specific effective fuel consumption (g_e). This method has found effective application in the development and creation of hybrid powertrains [2, 13], designed to solve the problems of operational efficiency, toxicity of emissions, as well as reducing greenhouse gas emissions of CO_2.

In [3], the opinion is expressed that in order to increase efficiency and reduce the toxicity of car emissions in modern urban traffic, it is necessary to reduce the installed engine power by at least two times. This is recommended in order to combine the engine operating conditions in a city with the zone of least fuel consumption, determined by the universal characteristics of the engines. This idea was subsequently reflected in the use of multi-parameter characteristics to assess the possibility of increasing the efficiency of ICEs by changing the engine’s displacement [5, 14].

In [8], it was noted that solutions began to be developed in which a part of the pistons (at top dead center – TDC) stopped without stopping the rotation of the crankshaft. The basic principle of the solution is the use of a telescopic connecting rod. A rigid connection with a piston and a crankshaft forms a system for filling cavities with an incompressible fluid (oil). In other cases, the use of several shafts, etc. is required. Such solutions are under development. In Russia, studies on the regulation of engine displacement were started in 1984-1985 years on the US auto range. The studied samples were a modular powertrain (MPT), consisting of two engines connected in series by a clutch [3]. Tests have shown the

ISSN: 2581-4230, Website: journalnx.com, June 18th & 19th, 2020

possibility of reducing fuel consumption during the European driving cycle by 26% due to changes in the working volume of the powertrain.

The shutdown of the cylinders or cycles is achieved in most cases by stopping the supply of fuel and air to the disconnected cylinders. But a long shutdown of the same cylinders was not so effective, given the increase in wear, the reduction in the thermal state of deactivated cylinders, and as a result, an increase in mechanical losses, etc. Therefore, there were developments to turn off individual cycles (engine control by skipping flashes, discrete control).

An analysis of studies of the application of the method on gasoline ICEs showed that in order to increase the efficiency of cylinder shutdown methods, it is necessary to limit switching repeatability, introduce hysteresis (delay) into the switching control system, and provide a mechanism for storing the value effective engine torque (M_e) before and after switching.

Bibliography

1 Регулирование дизеля методом изменения его рабочего объёма / Н. Н. Патрахальцев [и др.] // Тракторы и сельхозмашины. 2012. № 1. С. 19-22.

2 Кутенёв В. Ф. Перспективы совершенствования ДВС // Двигатель. 2005. № 6 (42).

3 Кутенёв В.Ф. Пути повышения топливной экономичности автомобильных двигателей на режимах частичных нагрузок // Исследование, конструирование и расчёт тепловых двигателей внутреннего сгорания: Сб. науч. тр. НАМИ. 1988. С. 7-19.

4 Балабин В.Н. Регулирование транспортных двигателей отключением части цилиндров. Монография. М.: ГОУ «Учебно - методический центр по образованию на ж. д. транспорте». 2007. 143 с.

5 Корнев Б. А. Возможности повышения экономичности режимов малых нагрузок автотракторного дизеля типа Д-260 (6Ч11/12,5) изменением его рабочего объёма: дисс. … канд. техн. наук. Москва. 2013. 140 с.

6 Виноградов Л.В., Горбунов В.В., Патрахальцев Н.Н. Работа дизеля на режимах частичных нагрузок: Учеб. пособие. М.: Изд-во РУДН. 2000. 88 с.: ил.

ISSN: 2581-4230, Website: journalnx.com, June 18th & 19th, 2020

7 Суркин В.И., Федосеев С.Ю., Петелин А.А. Анализ изменения механических потерь дизеля тракторно - транспортного агрегата при отключении части цилиндров // Достижения науки и техники АПК. 2012. № 2. С. 80-82.

8 Тер-Мкртичьян, Г.Г. Двигатель с количественным бездроссельным регулированием мощности. // Автомобильная промышленность. 2014. № 3. С. 4-11.

9 Мельник И.С. Регулирование тракторных дизелей изменением их рабочих объёмов: автореферат дисс. … канд. техн. наук. Москва. 2013. 17 с.

10 Peters G.F. A Cylinder deactivation on 4 cylinder engines. A torsional vibration analysis. DCT 2007. 11. February 15, 2007. P. 10-15, 39.

11 Andres Valderrama Romero, Nikolay Patrakhaltsev. Aumento de la efi-ciencia de los motores diesel automotrices mediante la desconexion de cilindros y ciclos // COBEM-CIDIM/95. 1995. Lima. Peru.

12 Двигатели внутреннего сгорания. В 3 кн. Кн. 1. Теория рабочих процессов: Учебник для вузов / В.Н. Луканин [и др.]. Под ред. В.Н. Луканина. 2-е изд, перераб. и доп. М.: Высшая школа. 2005. 479 с. ил.

13 Грабовский А.А., Максяшев И.А. Экономичные и экологичные варианты формирования крутящего момента в силовых установках комбинированных (гибридных) схем. // Автомобильная промышленность. 2014. № 1. С. 8-14.

14 74. Toyoaki Fukui. Mitsubishi Orion. MD. A new Variable Displacement Engine / Toyoaki Fukui, Tatsuro Nakagami, Hiroyasu Endo // SAE Techn. Pap. Ser. - 1983. № 831007. 9 p.