УДК 621.432.4

Slynko G.[1], Sukhonos R.[2]
[1] Doctor of Technical Science, professor NU «Zaporizhzhia Polytechnic»
[2] senior teacher NU «Zaporizhzhia Polytechnic»

METHODS FOR IMPROVING 2-STROKE INTERNAL COMBUSTION ENGINES

Two-stroke internal combustion engines (ICE) successfully competed with 4-stroke ICE for a long time, as they have 1.3...2 times higher liter capacity. However, the use of 2-stroke engines these days is hindered by higher fuel consumption and worse environmental performance (mainly hydrocarbon emissions). And both of these factors are caused by the peculiarities of the work process of 2-stroke internal combustion engines [1].

There are several promising directions for increasing the efficiency and environmental friendliness of 2-stroke internal combustion engines.

1) Emissions of hydrocarbons in the exhaust gases can be reduced by directing part of the exhaust gases containing a certain quantity of unburned fuel back to the cylinder. This can be implemented in two ways. First, using resonance phenomena in the exhaust system. In the simplest design, the exhaust system of a 2-stroke engine is a double truncated cone, in which, due to the resonance effect of pulsating exhaust gases, part of these gases returns to the combustion chamber [2]. Adjusting the size of the elements of the exhaust system allows to make this process effective in a wide range of engine revolutions.

The second method – recirculation of part of the exhaust gases – is implemented through an additional recirculation channel that connects the exhaust channel with the crank chamber. When this recirculation channel is opened, which is carried out by changing the position of the piston, part of the exhaust gases flows to the crank chamber, and then enters the cylinder again.

The use of these measures allows to reduce the specific consumption of fuel up to 10...12 % [1].

2) One of the most effective and at the same time the most expensive solutions – direct fuel injection into the cylinder at a time precisely calculated by the electronic control unit taking into account the real engine temperature, throttle position, crankshaft rotation angle, atmospheric pressure [3]. Direct injection allows to feed finely atomized fuel into compressed air at a time when the intake channel is already closed by the piston. The main disadvantage of direct injection systems is their increased cost due to the complexity of the design.

A simpler system is distributed injection, in which fuel is injected into the blow-by or into the intake inlet. In such systems, the fuel pressure is reduced (usually about 0.3 MPa), but the number of engine parts is still approximately the same as in direct injection systems. Compared to carburetor engines, intake resistance is reduced, and due to finer atomization of fuel, the composition of the air-fuel mixture approaches stoichiometry, a faster change in the composition of the mixture during transient modes is ensured, and cold start-up is facilitated [1].

3) Currently, the most promising way to improve the economic and environmental properties of 2-stroke ICE is the organization of layer-by-layer introduction of fresh charge. At the beginning of scavenging, air (or a very lean

fuel-air mixture) first enters the cylinder, and only then a fuel-air mixture of the required (or enriched) mixture is supplied. Layer-by-layer mixture formation is carried out by most engine manufacturers using injection systems [3]. In Husqvarna X-Torq, and Stihl 2-MIX engines, air and the ready fuel-air mixture are supplied to the cylinder through different channels. In these engines, the purge air does not come into contact with gasoline and engine oil before entering the cylinder, which ensures a reduction of hydrocarbon emissions by up to 75 %. And accurate and timely cut-off of the flows of exhaust gases, air, fuel-air mixture by the piston ensures an improvement in the effective performance of the engine by up to 20 % [1].

REFERENCES

1. Слинько, Г. І. Аналіз напрямків покращення економічності та екологічності 2-тактних двигунів внутрішнього згорання [Текст] / Г. І. Слинько, Р. Ф. Сухонос, В. В. Слинько // Інноваційні аспекти розвитку автомобільного транспорту України : Міжнарод. наук.-практ. конф., 16-18 травня 2023 р. : Тези доповідей. – Кам'янське : ДДТУ, 2023. – С. 123–125.

2. Слинько, Г. І. Дослідження впливу резонансного наддуву бензинового двотактного двигуна на його ефективні і екологічні характеристики [Текст] / Г. І. Слинько, В. П. Лук’яненко // Тиждень науки – 2015 : зб. тез доп. наук.-практ. конф. викладачів, науковців, молодих учених, асп.ів, студентів ЗНТУ. В 5 т. Т. 1. – Запоріжжя : ЗНТУ, 2015. – С. 210.

3. Корогодський В. А. Наукові основи перспективних робочих процесів двигунів з іскровим запалюванням при внутрішньому сумішоутворенні : дис. … д-ра техн. наук : 05.05.03 / Корогодський Володимир Анатолійович. – Харків, 2018. – 499 с.