Effect of methanol use in the engine on the workflow

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Abstract. In the Vyatka GSHA for a number of years, research has been conducted on the conversion of internal combustion engines to work on methanol. The purpose of our research is to improve the efficiency and environmental friendliness of the 2CH 10.5/12.0 diesel engine when working on methanol using a dual-fuel feed system (DST) and the use of a multi-jet nozzle for feeding a portion of diesel fuel (DT) by improving the mixing, combustion and heat generation processes. The implementation of a method for using methanol by feeding it directly into the combustion chamber and igniting it from the igniting part of the DT provided for the installation of two fuel systems, including two high-pressure fuel pumps of type 2UTNM and two injectors for each cylinder. At the same time, an additional hole was drilled in the head, located in the same vertical plane as the standard nozzle, to install the nozzle that feeds the DT.

Studies have shown that the best results in fuel consumption are obtained when the incendiary part of DT and methanol are simultaneously supplied. The value of the incendiary part of the DT when working on methanol with DST was determined by reducing the supply of DT before ignition, after which it increased slightly until stable diesel operation was achieved. In the future, the cyclic supply of fuel for ignition was fixed and remained constant, and the load mode was changed only by changing the supply of methanol [1-3].

For Gorenje process research in the diesel engine 2CH 10.5/12.0 when working on methanol with DST in accordance with the purpose, objectives of the research and the test method were conducted in the rated frequency mode at \( n = 1800 \text{ min}^{-1} \) with a maximum torque at a frequency of \( n = 1400 \text{ min}^{-1} \). The indicator diagrams were taken at the optimal installation of the UHT, with a constant cyclic supply of DT and a cyclic supply of methanol, which ensures that the value of the average effective pressure is maintained at the level at which the experimental diesel was indicated [4-8].

For figure 1 shows the indicator diagrams of the experimental diesel 2CH 10.5/12.0 when working on DT and when working on methanol with DST with a frequency of \( n = 1800 \text{ min}^{-1} \) and \( \rho_0 = 0.585 \text{ MPa} \). The results of processing indicator diagrams show a slight increase in the maximum gorenje pressure \( p_{\text{z max}} \). So, for an experienced diesel engine, the range value \( p_{\text{z max}} = 6.97 \text{ MPa} \), and when working on a methanol diesel with DST, this value increases to \( p_{\text{z max}} = 7.09 \text{ MPa} \). Accordingly, the maximum "hardness" of the Gorenje process \( (dp/d\phi)_{\text{max}} \) is 0.490 MPa/deg for experimental diesel, and when working on methanol with DST - 0.290 MPa/deg. At the same time, it should be noted that the combustion process when working on a methanol diesel with DST is slightly shifted towards the expansion line. Gorenje for an experimental diesel engine, the maximum cyclic pressure \( p_{\text{z max}} \) is reached at an angle of \( \phi = 7.0^\circ \) after TDC, then when the diesel engine is running on methanol with DST at \( \phi = 10.1^\circ \) after TDC [9-13].
Figure 1. Effect of the use of methanol with DST on the indicator charts of diesel 2CH 10.5/12.0 at n = 1800 min\(^{-1}\): - - diesel process, - - - - methanol with ignited DT.

From the results of processing the indicator diagram, it can be seen that the heat release characteristics (Fig.2) and the average temperature of the gases in the cylinder (Fig.3, 4) changes when the diesel engine is running on methanol with DST. At a frequency of n = 1800 min\(^{-1}\) and \(p_e = 0.585\) MPa, the maximum average cycle temperature for an experimental diesel engine is 1920 K and is observed at an angle of \(\varphi = 18.5^\circ\) after TDC, when working on methanol with DST, the value of \(T_{\text{max}} = 1960\) K is reached at an angle of \(\varphi = 21^\circ\) after TDC [14-18].

Figure 2. Effect of using methanol with DST on the rate of diesel heat release 2CH 10.5/12.0 at n = 1800 min\(^{-1}\): - - diesel process, - - - - methanol with ignited DT.
Analyzing the graphs of heat release, we can conclude that initially the rate of heat release as a result of exothermic oxidation reactions is low and the rate of heat release prevails. Therefore, the resulting heat release rate is negative up to a certain point. In the future, the rate of heat release as a result of exothermic reactions begins to exceed the rate of heat flow, and the resulting rate of heat release becomes positive.

Figure 3. Effect of using methanol with DST on the rate of diesel heat release 2CH 10.5/12.0 at n = 1400 min⁻¹: - - diesel process, - - - methanol with ignited DT.

At the same time, when working on methanol with DST, it is characterized by an increase in the rate of heat release and a shift in the maximum speed to the right of the TDC. If for an experimental diesel the maximum heat release rate (dχ/dϕ)max = 0.050 is observed in TDC, then for a diesel powered by methanol with the value DST (dχ/dϕ)max = 0.059 and is achieved at an angle ϕ = 9° in TDC. From the graph of heat release χ, χi and active heat release and the dynamics of heat consumption, it can be seen that the value of active heat release χi = 0.425, corresponding to the maximum combustion pressure pmax, for an experimental diesel is reached at an angle ϕ = 7.0° after TDC. When the diesel runs on methanol with DST at this angular value ϕ, the value χi is already 0.52 of the total heat release, i.e. the rate of heat release increases more intensively. At an angle ϕ = 10.1° after TDC in accordance

Figure 4. Effect of the use of methanol with DST on the average temperature of gases in the diesel cylinder 2CH 10.5/12.0 at n = 1800 min⁻¹: - - diesel process, - - - - methanol with ignited DT.
with \( p_{\text{max}} \), the active heat release \( \chi \) reaches a value of 0.60 [19-23].

In the second phase of heat release at an angle of \( \varphi = 18.5^\circ \) after TDC, corresponding to the maximum average cycle temperature \( T_{\text{max}} \) for the experimental diesel, \( \chi = 0.57 \). When the diesel engine is running on methanol with DST, the maximum average temperature is already reached at an angle of \( \varphi = 21^\circ \) after TDC, and the value of active heat release is \( \chi = 0.79 \), i.e. the heat release in this case is more active.

This is also confirmed by the fact that the rate of heat release when operating a diesel engine on methanol with DST is higher than that of an experienced diesel engine, starting from the angle \( \varphi = 2^\circ \) after TDC.

Gorenje graph shows that as the combustion process progresses, the amount of active heat release increases, and if there was no heat transfer to the walls and the combustion was complete, then at some point, corresponding to the completion of combustion and recombination of dissociated molecules, the amount of active heat release \( \chi \) would be 100 %. But due to the presence of heat transfer, as well as some incompleteness of combustion of the working charge in the cylinder, in particular in the wall layers, the active heat release curve is located below. At a certain point, it reaches a maximum corresponding to the equality of the rates of heat release and heat removal, after which the value of active heat release \( \chi \) begins to decrease due to the fact that heat transfer prevails. At the same time, when working on a methanol diesel with dust, the maximum is higher than when working on a DT diesel.

Thus, when using methanol as a motor fuel using DST, the maximum «rigidity» of the combustion process is reduced, while heat generation in the second phase is more active, i.e. an increase in the percentage of fuel burnout leads to a decrease in the share of heat loss during this period. Gorenje This causes an increase in the active heat release coefficient, which determines a more efficient use of heat in the diesel cylinder during the initial combustion period of the main part of the fuel. It should also be noted that the intensity of heat release during rapid gorenje, which determines the value of the maximum «stiffness» \( (dp/d\varphi)_{\text{max}} \), depends on the mass rate of fuel burn-out. Since the process of fuel ignition in diesel is multi-stage, the mass rate of fuel burnout is determined by the concentration of active products-promoters that initiate ignition, and the volume of vaporized fuel [24-25].

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