Analysis of heat release characteristics when working on methanol

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Abstract. Existing and currently being upgraded simplified models of the internal combustion engine workflow have very limited capabilities in terms of describing the fuel combustion process. Gorenje it is known that the most important means of studying the combustion in diesel fuel is the analysis of the indicator diagram for heat release. By analyzing the shape of the indicator chart, you can get information about the process of heat release during fuel combustion. The heat release characteristic is a function of the amount of heat released in the cylinder, from the angle of rotation of the crankshaft or time. The heat release characteristics are expressed in different ways: as a dependency of the absolute amount of heat from the current corner p.c.v., the integrated characteristic or the so-called dependence of heat release rate — differential characteristic. In most cases, the characteristics of relative heat release are used, rather than absolute. Vyatka agricultural Academy continues to study the impact of alcohol consumption in diesel engines when they are fed using a dual fuel supply system. The article presents the effect of methanol consumption on the characteristics of heat release.

Due to the low ability of methanol to self-ignite, it is necessary to initiate its ignition using diesel fuel. The changed geometry of the nozzle holes of the sprayer is necessary in order for methanol to be injected into the burning dt burner. A graphic image of the intersection of the torches is shown in figure 1.

Based on the analysis of indicator charts (figure 2) heat release characteristics were obtained.

For rice.3 shows the effect of using methanol with a dual fuel supply system (DST) on the heat release characteristics in the 2CH 10.5/12.0 diesel cylinder, depending on the load change at the rated speed of the crankshaft. When a diesel engine is running on diesel fuel (DT), the maximum active heat release rate decreases with increasing load from \( \frac{d\chi}{d\phi} \) at \( p_e = 0.127 \) MPa to \( \frac{d\chi}{d\phi} \) at \( p_e = 0.65 \) MPa. The decrease was 65.2 %. At the same time, the active heat release curve corresponding to the maximum combustion pressure decreases with increasing load from 0.78 at \( p_e = 0.127 \) MPa to 0.37 at \( p_e = 0.65 \) MPa when the diesel engine is running on DT. A decline of 52.6 percent [1-10].

The active heat release corresponding to the maximum cycle temperature also decreases with increasing load. Thus, at \( p_e = 0.127 \) MPa, \( \chi_{T_z \text{ max}} = 0.92 \), and when the load increases to \( p_e = 0.65 \) MPa, it decreases in \( \chi_{T_z \text{ max}} = 0.50 \). The decrease was 45.6 % [11-16].

The angle corresponding to the maximum cycle temperature \( \varphi_{T_z \text{ max}} \) at \( p_e = 0.127 \) MPa is 15° p.c.v., and when the load increases to \( p_e = 0.65 \) MPa, it increases to 20° p.c.v. The increase is 5° p.c.v., or 25% [17-25].
Figure 1. Graphic representation of the intersection of DT and methanol torches in a diesel cylinder.

From the curves shown in figure 1, it can be seen that when the 2CH 10.5/12.0 diesel is running on methanol with DST, the heat release characteristics differ slightly from those obtained when the diesel is running on DT. When the diesel engine is running on methanol with DST when the load increases, the maximum active heat release rate with \((d\chi/d\phi)_{\max} = 0.067\) at \(p_e = 0.127\) MPa increases to the value \((d\chi/d\phi)_{\max} = 0.072\) at \(p_e = 0.46\) MPa, and then the maximum heat release rate decreases, and at \(p_e = 0.65\) MPa it reaches the value \((d\chi/d\phi)_{\max} = 0.053\). As a result, the overall decrease was 20.9 %.

The active heat release curve corresponding to the maximum combustion pressure increases with increasing load from 0.50 at \(p_e = 0.127\) MPa to 0.69 at \(p_e = 0.46\) MPa when the diesel engine is running on methanol with DST. The increase was 27.5 %, then there is a decrease in \(\chi_{p,Tz_{\max}}\) to the value of 0.53 [26-35].

The active heat release curve corresponding to \(T_{z_{\max}}\) increases slightly with increasing load. Thus, when \(p_e = 0.127\) MPa, the value xi, \(\chi_{i,Tz_{max}} = 0.72\), and when the load increases to \(p_e = 0.46\) MPa xi, \(\chi_{i,Tz_{max}} = 0.83\). The increase was 8.9 %. Then the value of xi, \(\chi_{i,Tz_{max}}\) decreases to 0.77 [36-45].

The angle corresponding to the maximum cycle temperature \(\varphi_{Tz_{max}}\) at \(p_e = 0.127\) MPa is 13º after TDC, and when the load increases to \(p_e = 0.65\) MPa, it increases to 23.5º after TDC the increase is 44.7 % [46-50].

Analyzing the changes in the values of the fuel characteristics of the diesel 2CH 10.5/12.0 depending on the change in the load at the speed \(n = 1800\) min\(^{-1}\) and the optimal installation angles, we can note the following. The maximum speed of active heat release when running a diesel engine on methanol with DST at low loads is less than when running a diesel engine on DT. Thus, at \(p_e = 0.127\) MPa, the maximum rate of active heat release is reduced from \((d\chi/d\phi)_{\max} = 0.115\) when working with diesel on DT to \((d\chi/d\phi)_{\max} = 0.067\) when working with methanol diesel on DST. The decrease was 41.7 %.
Figure 2. 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.

Figure 3. Effect of the use of methanol with DST on the heat release characteristics in the diesel cylinder 2CH 10.5/12.0 depending on the load change at n = 1800 min⁻¹: — - diesel process; - - - - methanol with ignited DT.
As the load increases, the maximum rate of active heat generation decreases. So, for $p_c = 0.65$ MPa, the value $(d\chi/d\phi)_{max} = 0.040$ when working with diesel on DT, and when working with methanol on DST $(d\chi/d\phi)_{max} = 0.053$. The increase was 24.5%.

The values of active heat release at the maximum combustion temperature at low loads at $p_c = 0.127$ MPa are 0.72 – when operating a diesel engine on methanol with DST and 0.92-when operating a diesel engine on DT. When the load increases to $p_c = 0.65$ MPa, the value of active heat release at the maximum average cycle temperature in the diesel cylinder increases in comparison with the experimental diesel and is $\chi_{i,Tz} = 0.50$ when the diesel is running on DT and $\chi_{i,Tz} = 0.77$ when the diesel is running on methanol with DST. This increase was 35.1 percent [51-60].

The value of active heat release corresponding to the maximum combustion pressure in the diesel cylinder, at low loads when working on methanol with DST is lower than when working on DT. So, for $p_c = 0.127$ MPa, the value is $\chi_{i,Pz} = 0.78$ when working with diesel on DT and $\chi_{i,Pz} = 0.50$ when working with diesel on methanol with DST. The decrease was 34.8 %. When the load increases to $p_c = 0.65$ MPa, the value of active heat release at the maximum cycle pressure in the diesel cylinder increases in comparison with the experimental diesel and is $\chi_{i,Pz} = 0.53$ when the diesel is running on DT and $\chi_{i,Pz} = 0.37$ when the diesel is running on methanol with DST. The increase was 30.2 %.

The angle corresponding to the maximum cycle temperature at $p_c = 0.127$ MPa is equal to 15° after TDC, when the diesel is running on DT, and 13° after TDC, when the diesel is running on methanol with DST. The increase was 20° p.c.v., or 13.3%. When the load increases to $p_c = 0.65$ MPa, the value of the angle corresponding to the maximum cycle temperature when operating a diesel engine on DT is 20° p.c.v., and when operating a diesel engine on methanol with DST, the angle value is 23.5° p.c.v. The increase is 3.5° C, or 14.9% [61-65].

Thus, when using methanol as a motor fuel with its ignition using a pilot portion of diesel fuel, the heat release indicators do not deteriorate, and the combustion process itself proceeds more "gently".

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