Heat release indicators when working on methanol

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Abstract. To study the features of the combustion process in a 2СH 10.5/12.0 diesel engine when working on methanol with a portion of diesel fuel in accordance with the purpose, research objectives and methodology, tests were conducted at the nominal speed mode at a speed of n = 1800 min⁻¹ and at the maximum torque mode at n = 1400 min⁻¹. Indicator diagrams were taken at the optimal setting of the fuel injection angle, with a constant cyclic supply of diesel fuel 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 shown. Based on the results of processing indicator diagrams, heat release graphs were constructed, the analysis of which is presented in this article.

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 a change in the heat release characteristics of a 2CH 10.5/12.0 diesel engine from a change in load when running on diesel fuel (DT) and methanol with a dual fuel supply system (DST) at the speed corresponding to the maximum torque. When the diesel engine is running on DT, the maximum speed of active heat release decreases with increasing load from (dχ/dφ)max = 0,106 at pе = 0.127 MPa to (dχ/dφ)max = 0,042 at pе = 0.635 MPa. The decrease was 60.4 %. At the same time, the active heat release curve corresponding to the maximum combustion pressure also decreases when the load increases from 0.73 at pе = 0.127 MPa to 0.39 at pе = 0.635 MPa when the diesel engine is running on DT. The decrease was 46.6 %.

The active heat release corresponding to the maximum cycle temperature also decreases with increasing load. Thus, when pе = 0.127 MPa, the value χi,Tz max = 0,88, and when the load increases to pе = 0.635 MPa, it decreases to χi,Tz max = 0.53. The decrease was 39.8 %.

The angle corresponding to the maximum cycle temperature φTz max at pе = 0.127 MPa is 11° after TDC, and when the load increases to pе = 0.635 MPa, it increases to 17° after TDC. The increase is 6° TDC, or 35.3%.

From the curves shown in figure 2, it can also be seen that when a diesel engine is running on methanol with DST, the heat release characteristics differ slightly from those of an experimental diesel. When the diesel engine is running on methanol with DST, when the load increases, the maximum active heat release rate decreases from (dχ/dφ)max = 0.069 at pе = 0.127 MPa to (dχ/dφ)max = 0.058 at pе = 0.635
MPa. The decrease was 15.9 %.

Figure 1. Graphic representation of the intersection of DT and methanol torches in a diesel cylinder.

At the same time, the active heat release curve corresponding to the maximum pressure increases with increasing load from 0.45 at $p_e = 0.127$ MPa to 0.68 at $p_e = 0.46$ MPa when working with diesel methanol with DST. The increase was 33.8 %. Then the active heat release corresponding to the maximum gorenje pressure decreases to the value $\chi_\text{p,max} = 0.58$. This reduction was 14.7 percent.

Figure 2. Effect of the use of methanol with DST on the indicator charts of diesel 2CH 10.5/12.0 at $n = 1400$ 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 = 1400 min\(^{-1}\); — - diesel process; - - - - methanol with ignited DT.

The active heat release curve corresponding to the maximum temperature when operating a diesel engine on methanol with DST increases with increasing load from 0.65 at \(p_e = 0.127\) MPa to 0.83 at \(p_e = 0.46\) MPa. The increase was 21.7 %. Then the active heat release corresponding to the maximum cycle temperature decreases to the value \(\chi_{i,Tz,max} = 0.79\). The decrease was 3.7 %.

The angle corresponding to the maximum cycle temperature \(\phi_{Tz,max}\) at \(p_e = 0.127\) MPa is 13° after TDC, and when the load increases to \(p_e = 0.635\) MPa increases to 19° after TDC the decrease is 31.6 %.

Analyzing the changes in the values of indicators of the heat release process depending on the load at a speed of \(n = 1400\) min\(^{-1}\) and the optimal installation of UVVT, 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 decreases from \((d\chi/d\phi)_{max} = 0.106\) when working on DT to \((d\chi/d\phi)_{max} = 0.069\) when working on methanol with DST. The decrease was 34.9 %. As the load increases, the maximum rate of active heat generation increases. Thus, for \(p_e = 0.635\) MPa, the value \((d\chi/d\phi)_{max} = 0.042\) when working with diesel on DT, and when working with methanol on DST \((d\chi/d\phi)_{max} = 0.058\). This increase was 27.6 percent.

The active heat release corresponding to the maximum combustion temperature at low loads, at \(p_e = 0.127\) MPa, is equal to 0.88 - when operating a diesel engine on DT and 0.65 - when operating a diesel engine on methanol with DST. The decrease was 26.1 %. When the load increases to \(p_e = 0.635\) MPa, the value of \(\chi_{i,Tz,max}\) in comparison with the experimental diesel increases and is \(\chi_{i,Tz,max} = 0.53\) for DT and \(\chi_{i,Tz,max} = 0.79\) when the diesel is running on methanol with DST. The increase was 32.9 %. The active heat release value corresponding to the maximum gorenje pressure at low loads is lower when working on methanol with DST than when working on DT. So, for \(p_e = 0.127\) MPa, the value of \(\chi_{i,Pz,max} = 0.73\) when working with diesel on DT and \(\chi_{i,Pz,max} = 0.45\) when working with diesel on methanol with DST. The decrease was 38.4 %.
The angle corresponding to the maximum cycle temperature at $p_v = 0.127$ MPa is equal to 11° after VT, when the diesel is running on DT, and 13° after TDC, when the diesel is running on methanol with DST. When the load increases to $p_v = 0.635$ MPa, the angle corresponding to the maximum cycle temperature is 17° after TDC when the diesel engine is running on DT, and when the diesel engine is running on methanol with DST 19° after TDC, the increase is 2° pca.

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

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