Analysis of the use of methanol with a pilot portion diesel fuel

A N Chuvashev and A I Chuprakov

Federal State Budgetary Educational Institution of Higher Education «Vyatka state agricultural academy», Department of thermal engines, automobiles and tractors, 610017, Kirov, October prospect, 133, Russian Federation

E-mail: aleks_dvs@mail.ru

Abstract. Due to the depletion of oil fuel reserves, the deterioration of the environmental situation in many countries and the global problem of climate warming, there is a need to develop and use alternative, renewable fuels. In Kirov, at the Vyatka state agricultural academy, at the Department of thermal engines, automobiles and tractors, research on the use of alternative fuels has been conducted for many years. The article presents an analysis of the use of alcohol fuel (methanol) with a pilot portion of diesel fuel according to the economic and energy indicators of diesel 2СH 10.5/12.0 depending on the change in the speed of rotation of the crankshaft.

Figure 1 shows that when the power unit is running on oil fuel, with an increase in the speed of rotation, the fuel consumption also increases from 3.6 kg/h at n = 1200 min⁻¹ to 6.3 kg/h at n = 2000 min⁻¹. The increase is 2.7 kg/h, or 42.9%. The graph shows that when the power unit is running on alcohol with the supply of a pilot portion of DT with an increase in the speed of rotation, the total fuel consumption increases from 6.4 kg at n = 1200 min⁻¹ to 10.6 kg at n = 2000 min⁻¹. The increase is 4.2 kg/h, or 39.6% [1-3].

When analyzing the results obtained, it should be noted that when the power unit is running on alcohol with the supply of a pilot portion of DT, the fuel consumption is significantly higher than when the power unit is running on oil fuel. Thus, at n = 1200 min⁻¹, the fuel consumption when operating the power unit on oil fuel is 3.6 kg/h, and when working on alcohol with the supply of a pilot portion of DT – 6.4 kg/h. The increase is 43.7 per cent. At n = 2000 min⁻¹, the consumption of alcohol fuel is also higher than when the power unit is running on oil fuel. If the power unit is running on oil fuel, the fuel consumption is equal to 6.3 kg/h, then at the same speed, and the power unit is running on alcohol with the supply of a pilot portion of DT, the consumption is 10.6 kg/h. The increase is 40.6%.

Figure 2 it is shown that when the power unit is running on oil fuel, the minimum specific effective fuel consumption occurs at n = 1800 min⁻¹ and is $g_\text{e}= 273 \text{ g/(kW\cdot h)}$. When the power unit is running on alcohol with a pilot portion of DT, the minimum total specific effective fuel consumption occurs at n = 1400 min⁻¹ and is $g_{\text{e}\Sigma}= 490 \text{ g/(kW\cdot h)}$.

When analyzing the results obtained, it should be noted that the value of specific fuel consumption when operating a power unit on alcohol with the supply of a pilot portion of DT is higher than when operating a power unit on oil fuel [4-6].

Figure 3 shows that when the power unit is running on oil fuel, the effective efficiency value changes with increasing speed from $\eta_\text{e}= 0.305$ at n = 1200 min⁻¹ to $\eta_\text{e}= 0.29$ at n = 2000 min⁻¹, and the maximum is reached at n = 1400 min⁻¹ and is $\eta_\text{e}= 0.31$. When the power unit is running on alcohol
with the supply of a pilot portion of DT, the effective efficiency value decreases with increasing speed from $\eta_e = 0.34$ at $n = 1200 \text{ min}^{-1}$ to $\eta_e = 0.305$ at $n = 2000 \text{ min}^{-1}$, and the maximum is reached at $n = 1400 \text{ min}^{-1}$ and is $\eta_e = 0.35$. The value of the effective efficiency at $n = 1200 \text{ min}^{-1}$ and the power unit is running on fuel oil is 0.305, and when the power unit is running on alcohol with the supply of a pilot portion of DT - 0.34. The increase was 10.3% [7-9].

Figure 1. Analysis of alcohol consumption with the supply of a pilot portion of DT by fuel consumption: — diesel process; — — — methanol with ignited DT.

Figure 2. Analysis of alcohol consumption with the supply of a pilot portion of DT for specific effective fuel consumption: — diesel process; — — — methanol with DT ignition.
Figure 3. Analysis of alcohol consumption with the supply of a pilot portion of DT for effective work:

- - diesel process; - - - - methanol with ignited DT.

When analyzing the results obtained, it should be noted that when the speed increases to \( n = 2000 \text{ min}^{-1} \), the value for the power unit running on oil fuel is 0.29, and when the power unit is running on alcohol with the supply of a pilot portion of DT \(-0.305\). The increase was 4.9\% [10-13].

Figure 4 shows that when the power unit is running on oil fuel, the exhaust gas temperature also increases with increasing rotation speed. So, at \( n = 1200 \text{ min}^{-1} \) \( t_g = 485^\circ\text{C} \), and when the speed increases to \( n = 2000 \text{ min}^{-1} \) \( t_g = 615^\circ\text{C} \). This increase is 130\%, or 21\%. When the power unit is running on alcohol with the supply of a pilot portion of DT at \( n = 1200 \text{ min}^{-1} \) value of \( t_g = 365^\circ\text{C} \), and when the speed increases to \( n = 2000 \text{ min}^{-1} \) \( t_g = 520^\circ\text{C} \). The increase was already 155\%, or 29.8\%.

When analyzing the results obtained, it should be noted that the exhaust gas temperature when the power unit is running on alcohol with the supply of a pilot portion of DT in the entire range of rotation frequency changes is less than when the power unit is running on oil fuel. So at \( n = 1200 \text{ min}^{-1} \), the value of \( t_g = 485^\circ\text{C} \) when the power unit is running on oil fuel, and when the power unit is running on alcohol with the supply of a pilot portion of DT \(-t_g = 365^\circ\text{C} \). The decrease was 24.7\%. If the speed of rotation is further increased to \( n = 2000 \text{ min}^{-1} \), the value of \( t_g = 615^\circ\text{C} \) when the power unit is running on oil fuel and \( t_g = 520^\circ\text{C} \) when the power unit is running on alcohol with the supply of a pilot portion of DT. The decrease was 95\%, or 15.4\%.

Figure 5 shows that when the power unit is running on oil fuel, the air consumption is 58 kg/h at \( n = 1200 \text{ min}^{-1} \) and increases to 125 kg/h at \( n = 2000 \text{ min}^{-1} \). The growth was 53.6 percent. When the power unit is running on alcohol with the supply of a pilot portion of DT, the air consumption at \( n = 1200 \text{ min}^{-1} \) is 66 kg/h and increases to 126.5 kg/h at \( n = 2000 \text{ min}^{-1} \).

When analyzing the results obtained, it should be noted that the air consumption at \( n = 1200 \text{ min}^{-1} \) when operating the power unit on oil fuel is 58 kg/h, and when operating the power unit on alcohol with a pilot portion of DT \(-66 \text{ kg/h} \), an increase of 12\%. With a further increase in speed to \( n = 2000 \text{ min}^{-1} \), the air consumption for a serial diesel engine is 125 kg/h, and when the power unit is running on alcohol with the supply of a pilot portion of DT \(-126.5 \text{ kg/h} \) [14-16].

Figure 6 shows that the coefficient of excess air when the power unit is running on oil fuel decreases with increasing speed. The coefficient of excess air when the power unit is running on alcohol with the supply of a pilot portion of DT also decreases with increasing speed [17-20].

Figure 4. Analysis of alcohol consumption with the supply of a pilot portion of DT by exhaust gas temperature:

- - diesel process; - - - - methanol with ignited DT.
Figure 5. Analysis of alcohol consumption with the supply of a pilot portion of DT by air consumption: — diesel process; - - - - methanol with ignited DT.

Figure 6. Influence of alcohol consumption with the delivery of a pilot portion of DT about the excess air coefficient: — diesel process; - - - - methanol with ignited DT.

Figure 7 shows that when the power unit is running on oil fuel, the fill factor is 0.81 at $n = 1200 \text{ min}^{-1}$, and at $n = 2000 \text{ min}^{-1}$ it is already equal to 0.825, while the maximum is reached at $n = 1800 \text{ min}^{-1}$ and is 0.875. When the power unit is running on alcohol with the supply of a pilot portion of DT, the fill factor at $n = 1200 \text{ min}^{-1}$ is 0.84, and when the speed increases to $n = 2000 \text{ min}^{-1}$ - 0.825, while at $n = 1800 \text{ min}^{-1}$ it reaches a maximum of 0.86 [21-23].

Figure 7. Analysis of alcohol consumption with the supply of a pilot portion of DT about the filling coefficient: — diesel process; - - - - methanol with ignited DT.

When analyzing the results obtained, it should be noted that the filling coefficient at $n = 1200 \text{ min}^{-1}$ and the power unit is running on fuel oil is 0.81, and when the power unit is running on alcohol with a pilot portion DT $\eta_p = 0.84$. The increase was 3.6 %. At $n = 1800 \text{ min}^{-1}$, the filling coefficient for a serial diesel is 0.875, and when the power unit is running on alcohol with a pilot portion DT $\eta_v = 0.86$. At $n = 2000 \text{ min}^{-1}$, the filling coefficient remains the same and is 0.825 [24-25].

Thus, the use of methanol as an alternative fuel with the supply of a pilot portion of diesel fuel
through a multi-jet nozzle allows you to maintain the energy performance of the serial engine and provide fuel oil savings by replacing it with an alternative one.

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