Assessment of coke deposits during heating of hydrocarbon fuel under dynamic and static conditions

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A comprehensive assessment of coke deposits during heating of hydrocarbon fuels was carried out. Samples of RT and T-6 jet fuels developed at JSC TANECO were considered as objects of research.

Coke deposits in aggregates of fuel systems of aircraft at temperatures of 150-350 ºC are formed mainly due to the processes of interaction with oxygen. At temperatures of 350-500 ºC, the contribution of thermal decomposition becomes significant. Therefore, the key parameter determined in the experiments was the propensity of the fuel to form deposits in the processes of its thermal oxidation and thermal decomposition.

A dynamic method with a flow-heated reactor was used to study the thermo-oxidative stability of the samples. The main parameter to be determined was the rate of change in the hydraulic resistance of the test reactor (due to the formation of deposits) over time at a constant final temperature of the fuel flowing through it.

To study the process of thermal decomposition of samples, a static method was used, implemented on a manometric installation. In the course of the work, the kinetics of the thermal decomposition process, the final gas release (mol/kg) and the mass of the formed coke (% mass) were determined.

It was found that under the conditions of the absence of an increase in the hydraulic resistance of the test reactor, under dynamic conditions with an operating time of 50 hours, the maximum temperature of the RT fuel application is 200 ºC. For T-6 fuel, this temperature is 330 °C. Thus, in terms of thermal-oxidative stability, expressed in terms of the maximum application temperature, T-6 fuel exceeds RT fuel at the operating time specified in the experiment.

According to the results of studies of the kinetics of thermal decomposition of samples under static conditions at temperatures of 390-460 ºC, it has been experimentally shown that the thermal decomposition of T-6 and RT fuels obeys the first-order reaction equation. The activation energies of the thermal decomposition processes of the considered fuels are close and amount to ~ 256 kJ/mol. The rate constant of thermal decomposition of T-6 fuel under the same experimental conditions is on average 15% lower. This indicates its greater thermal stability in comparison with RT fuel. When the T-6 fuel sample is completely decomposed under experimental conditions, 2.8 times less coke is formed than when the RT fuel sample is decomposed. This indicates a large contribution of condensation processes with the formation of pyrolysis carbon (coke) during thermal degradation of RT fuel compared to T-6 fuel.

The data obtained is planned to be used to optimize the operation of fuel systems of power plants.