Technology of utilization of liquid wastes generated during the preparation of main oil pipelines to transport diesel fuel with produce cheap steam or warm heat carrier

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Abstract. The existing technology of cleaning internal surfaces of oil pipelines from oil residues and solid sediments leads to the formation of a large volume of liquid hydrocarbons contaminated with mechanical particles and various resins. Currently, in the oil industry, mobile steam generator plants of PPU 1600/100 are used to steal sections of oil pipelines. The standard nozzle burner used in the PPU 1600/100 does not allow to burn effectively liquid waste similar to contaminated liquid hydrocarbons formed during the cleaning of the inner walls of the main oil pipelines. The article presents the results of operation of steam generator sets of PPU 1600/100 with a nozzle-free burner device VGU-1.

The increase in demand for petroleum products on the domestic market and competitiveness on foreign trading floors contributed to the construction and commissioning in some regions of the Russian Federation of a number of large oil refineries. The increase in the output of automotive fuels implies an increase in the volume of transportation of petroleum products. The most effective means of delivering oil and oil products from the producer to the consumer is the main pipeline transport. Despite the existing network of oil product pipelines, the difficulties in ensuring the throughput of existing oil product pipelines arise more often [1].

The optimal solution to the problem of ensuring the volume of transportation of petroleum products is the transfer of the main oil pipelines to the main oil product pipelines.

The need to transfer part of the oil pipelines for transportation of commercial petroleum products is due to a number of reasons [2]. The technology of transfer provides for the cleaning of the internal surface of oil pipelines from oil residues and asphalt and resin forming substances by a chemical method. For these purposes, special solvents are widely used, effectively removing oil residues and solid deposits from internal surfaces. In research [1] results of practical works on realization of this purification technology are given. The results of the control of the quality of the passed inspection lot of diesel fuel on the cleaned section of the pipeline show the effectiveness of the proposed purification technology.

The technology of cleaning the inner surface of the oil pipeline from oil residues and solid sediments by dissolving them in a special solvent, as well as the need to use a control lot of passed fuel, leads to the formation of a large volume of liquid hydrocarbons contaminated with mechanical particles and various resins. Of course, these fluids require disposal. Reuse is possible after regeneration. The regeneration of used solvent and diesel fuel is financially expensive [3]. A large part of the costs are for transportation of liquid waste to oil refineries by rail or road. These costs can be reduced if a part of the waste is used as a source of thermal energy to produce steam or a hot heat carrier. In addition, according
to the proposed technology, cleaning of the inner part of the body of linear valves is carried out by steaming with disassembly [2]. Currently, in the oil industry, for the production of steam, mobile steam generator plants of PPU 1600/100 are widely used, in which the working fuel is diesel commercial fuel. The nozzle burner used in PPU 1600/100 does not allow to burn effectively liquid waste similar to contaminated liquid hydrocarbons formed during the cleaning of the inner walls of main oil pipelines.

There are several reasons for this:

1. Mechanical particles contained in liquid waste often cause contamination of the calibrated holes of the nozzle block, thereby violating the process of spraying the hydrocarbon liquid. Removal of solid particles from the liquid fraction requires the use of special technologies.

2. The high content of resinous compounds leads to the coking of the injector, leading its operation disrupted.

3. The fuel supply system of the PPU 1600/100 does not provide for controlling the pressure of the liquid fuel in front of the injector. The power of the burner is regulated by the alternate connection of three injectors located on the nozzle block. Regular nozzles are designed for diesel fuel and the use of other flammable liquids with a different viscosity is not provided.

4. The standard ignition system does not ensure the safe ignition of flammable liquids with a low flash point.

Because of the above-mentioned disadvantages, it is not possible to use energy-intensive liquid combustible wastes as a fuel in steam generators with standard burners. Another combustion principle is needed, according to which the fuel must be converted to the steam-gas state without spraying through the nozzle. The burner device, in which this principle is implemented, was developed by the specialists of the Department of Power Plants and Jet Engines of the Kazan National Research Technical University named after A.N. Tupolev. The essence of the work of the burner device is that the transformation of the liquid fraction into a steam-gas phase (sputtering, evaporation, thermal decomposition) takes place in a vortex flow. Moreover, the flow is interrupted in an orderly manner, creating a pulsation of the gas-air flow with a certain frequency. The supply of combustible liquid to the vortex zone is not carried out through a calibrated wound (nozzle), but through a tube having a diameter dozen times larger than the diameter of the nozzle. According to this principle, it is equally effective to burn both commercial fuels and tarred liquid combustible waste without fine cleaning [4].

At present, 72 modernized mobile steam generators with a nozzle-free burner unit VGU-1, developed under patent No. 2508501, are successfully operating in the Tatspetstransport MC.

Figure 1 shows the structural diagrams of a steam boiler with a nozzle burner block and a nozzle-free burner unit.

From Fig. 1 it can be seen that during spraying, the torch of the flame is elongated and the flame reaches the cold walls of the heat exchanger. From the theory of combustion, it is known that during the "freezing" of products of thermal decomposition of hydrocarbon combustibles, combustion processes are violated.

The upgraded mobile steam generator set was operated on a wide range of liquid combustible materials, such as waste from the petrochemical industry, petroleum products, low-grade furnace fuel.

![Diagram of a steam boiler](image_url)
It was found that the concentration of harmful substances in gas emissions, such as oxides of nitrogen, carbon monoxide, unburned hydrocarbons are within acceptable limits. A comparative analysis of the content of harmful emissions in combustion products of diesel fuel shows that their concentrations during operation of the PPU in the nominal (nozzle) burner block are significantly worse than when the PPU is operating at the nozzle-free burner unit.

PPU 1600/100 with a certain periodicity is subject to routine maintenance. One of the types of work is the inspection and verification of the condition of the coil. Fig. 2 shows photographs of some sections of the coil heat exchanger during operation of the PPU on the nozzle burner block. Traces of carbon formation are clearly visible on them.

![Image](image1.jpg)

Fig. 2. Sections of coil heat exchanger

To the causes of poor fuel combustion and carbon formation when using a standard burner should be included: a long spray torch; heterogeneity of the spray of the centrifugal nozzle; coking nozzles; poor mixing of evaporation products with air in the combustion zone; narrow range of power regulation.

It is noted that the use of the nozzle-free burner assembly avoids carbon formation on the walls of the heat exchanger. This is facilitated by the technological features of fuel combustion in VGU-1: the fuel enters the cavity of the coil heat exchanger in a gasified form, which rapidly burns in an oxidizing environment (created by supplying secondary air).

In work [4] economic indicators obtained during the operation of the PPU 1600/100 with the modernized burner device VGU-1 are given. Waste fuel was used as fuel.

Polluted solvent, diesel fuel and their mixtures formed during the purification of the main oil pipelines are physicochemically close to the fuel waste. Based on this, it can be concluded that these flammable liquids are a promising fuel for PJSC Transneft. Burning these wastes can reduce significantly the energy resources expended in the maintenance of main pipelines.

References

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