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EFFECTS OF ADDITIVES ON THE WORKING PROPERTIES OF FURNACE HEAVY FUEL OILS

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A multifunctional additive is proposed for use with low-grade heavy fuel oil. There is a discussion of its effects on the working properties. The additive tends to increase the mechanical and economic and otherwise ecological parameters in heavy fuel oil use.

Thermal power stations (TPS) account for 67% of energy sources [1]. Power stations and boilers that use low-grade heavy fuel oil (mazut) encounter problems associated with high-temperature corrosion because the fuel contains vanadium, and also low-temperature sulfuric acid corrosion due to the presence of sulfur. Also, the burning of this mazut produces oxides of nitrogen, sulfur, and carbon, as well as soot, benz-α-pyrene, and other toxic substances, which pass along with the flue gases into the atmosphere. The reason for this lies in the chemical composition of the mazut.

A simple and effective method of improving the quality of mazut is to use multifunctional additives that improve the anticorrosion, depressor, antioxidant, and certain other properties. The additives are used to bind the

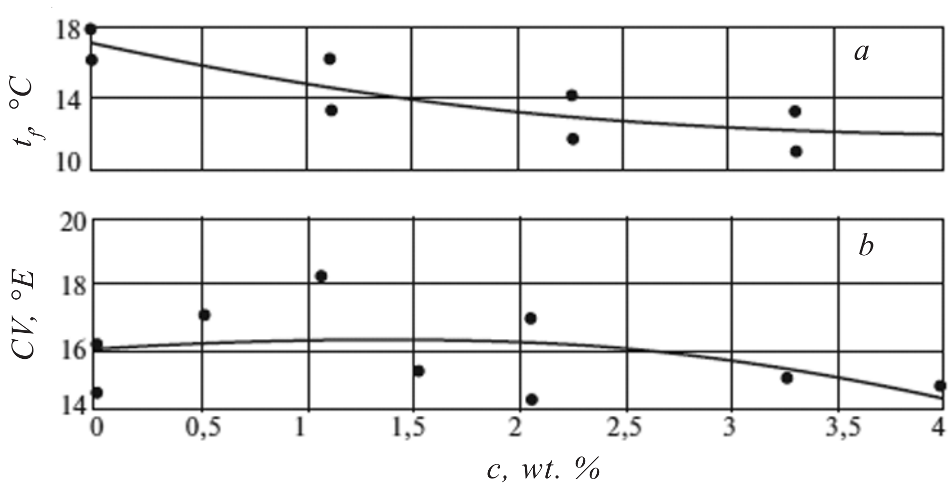

Fig. 1. Dependence of the temperature t_f (*a*) and the conditional viscosity CV at 80°C (*b*) of M100 heavy fuel oil on the additive concentration *c*.

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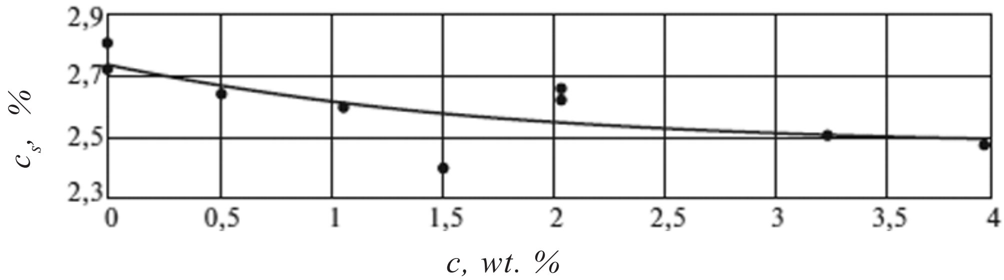

Fig. 2. Dependence of the content c_s of sulfur in M100 oil on additive concentration *c*.

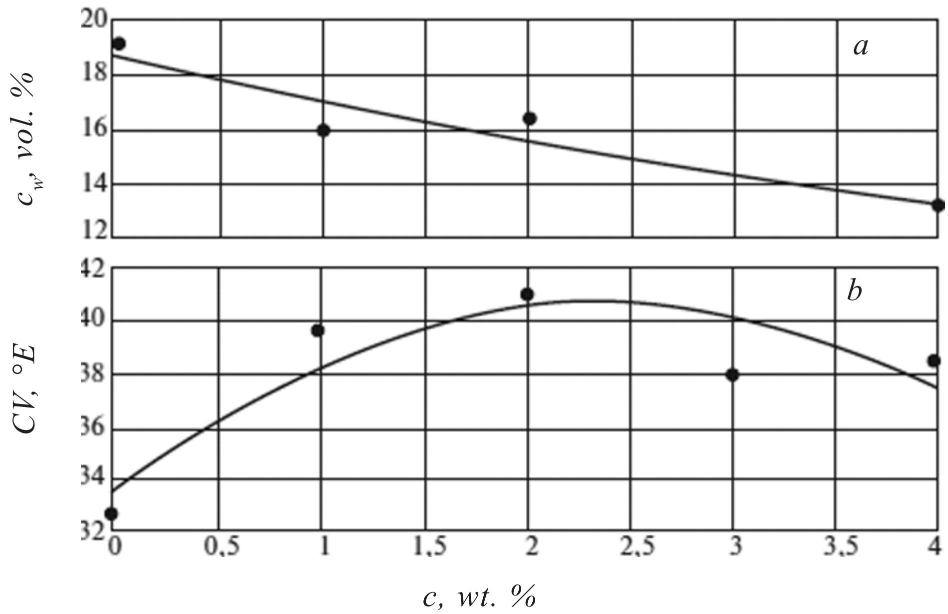

Fig. 3. Dependence of water content c_w in WME (*a*) and conditional viscosity CV of the latter at t = 80°C (*b*) in relation to additive concentration *c*.

corrosive agents (vanadium and sulfur) present in the mazut or formed on combustion, which are converted to noncorrosive form and do not give deposits [2].

Additives based on magnesium, calcium, and manganese are used to prevent vanadium and sulfuric-acid corrosion. Various multifunctional additives have been developed [3]. They are particularly widely used in the USA and Western Europe. The additives may also be individual compounds, polymers, and compositions of these, as well as the wastes from certain processes.

Our proposed multifunctional additive is a waste from thermal power and chemical processes. It has been tested in heavy fuel oils of M100 grade. The best concentration is 1-2%, and at that level it dissolves readily in the fuel oil and water at temperatures up to 40°C.

Copper-plate tests in accordance with GOST 6321-92 in M100 fuel oil have shown that the reduction in corrosiveness is provided at concentrations of 1-4.5 wt.%. However, that additive at a concentration of 1-2 wt.% depresses the freezing temperature by 5-7° and reduces the nominal viscosity of the fuel oil by 10-15% (parts *a* and *b* of Fig. 1) [4].

This additive reduces the generation of one of the most hazardous corrosive agents formed on burning

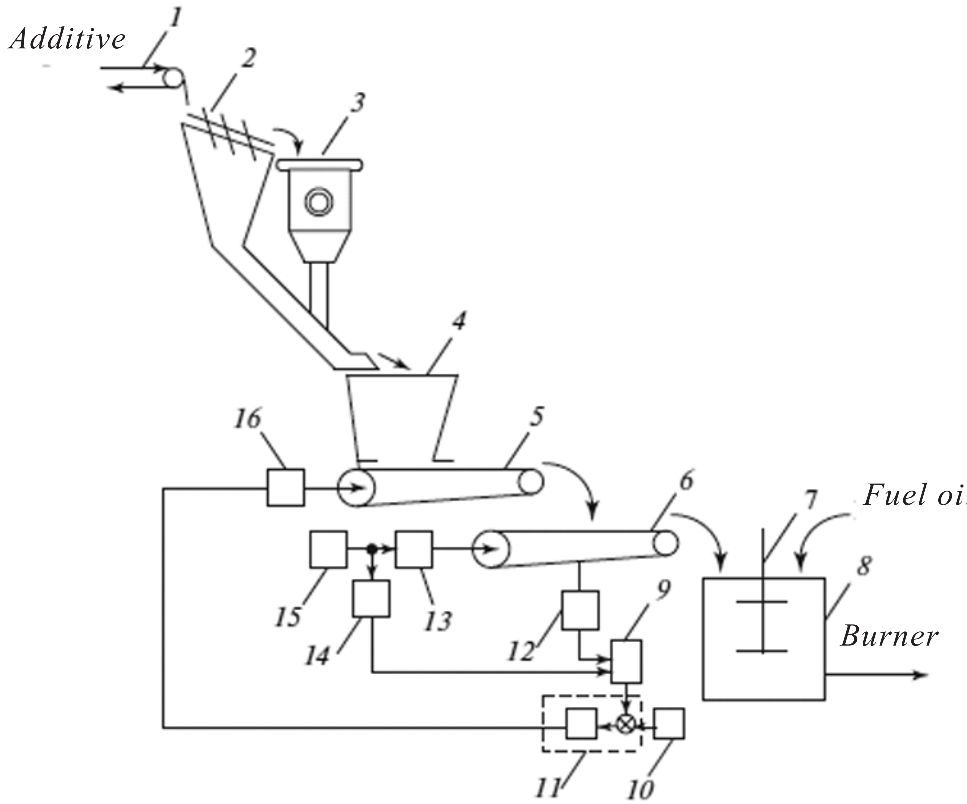

Fig. 4.. Essential scheme for dispensing additive: 1) belt conveyor; 2) grid; 3) crusher; 4) intermediate bunker; 5) feeder; 6) weight-measuring transporter; 7) mixer; 8) mixing apparatus; 9) signal summer; 10) sensor for mass flow of additive; 11) regulator; 12) force-measuring converter; 13) electric motor; 14) frequency converter; 15) voltage source; 16) feeder drive

mazut in steam generators: sulfuric acid, whose vapor condenses on surfaces heated to 330°C and causes vigorous corrosion.

Experiments in accordance with GOST 3877-88 showed that the sulfur content in the fuel oil in the presence of the additive is reduced (Fig. 2), but tests in accordance with GOST 21261-91 have shown that the heat-producing capacity of the heavy fuel oil with the additive at the rate 1-2 wt.% is unaltered.

That additive has been tested in accordance with GOST 2477-65 in a water-mazut emulsion (WME), consisting of 80% M100 oil and 20% distilled water. If the water content in the WME is reduced to 16-17% (Fig. 3*a*), the conditional viscosity is increased by 25-26% (Fig. 3*b*) when this additive at a concentration of 1-2 wt.% is used.

A basic scheme has been devised for dispensing this additive (Fig. 4). The additive is transported on a belt conveyor to a loader, which provides the necessary dispersed composition, which is important, and it then passes to a belt weight dispenser. The dispensed material passes to an exit hole in the bunker to the weight-measuring transporter, whose belt moves with a constant fixed velocity.

The signal from the force converter is proportional to the mass of material on the belt transporter and is passed through the adder to the input of the regulator, where it is compared with the signal from the mass flow sensor. The output signal from the regulator is proportional to the discrepancy between the actual and set levels,

Table 1

Indexes	Boilers	
	GM-50	BK3-75-39GMA
Fuel oil flow at maximum permissible load, ton/h	4.47	5.46
Cost (from actual position for the first half of 2009), rouble/ton		
fuel oil	3500	
additive	5600	
Approximate cost of additive dispensing system with allowance for installation cost, thousand roubles	1668	
Mean annual cost of additive (for 10 kg per ton of oil), thousand roubles/y	2192.8	2678.46
Annual costs in supporting and repairing dispensing device, thousand roubles/y	35	
Saving on fuel costs, thousand roubles/y		
on using additive	1370.5	1674.04
due to reduction in number of shutdowns on account of corrosion of the heating surface, thousand roubles/y	5.9	
from reduction in consumption of electricity for inherent use at TPS	266	
Reduction in production expenses arising from repairs associated with corrosion of the heating surfaces, thousand roubles/y	7302.2	
Working expenses, thousand roubles/y	2227.8	2713.46
Saving from introduction, thousand roubles/y	8942.2	9245.74
Pure return (with tax level α_t = 24%), thousand roubles/y	3835.26	3696.85
Payoff period, months	6	

and it passes to the input of the feed drive and varies the speed of the belt to eliminate the discrepancy [5]. Then the additive passes to the mixing apparatus, which contains turbine mixers [6].

Table 1 gives the preliminary evaluation of the economic performance from using this additive. When the price of heavy fuel oil rises, the performance of using the additive increases, while the return index (RI) takes the value 4 or more for capital costs as determined from RI = 1 + PDR/K_t (where PDR is the pure discount return, while K_t is the investment involved, namely capital investment and costs for introducing equipment for t = 1 year), where the independent variables are the price of fuel oil and the discount standard.

This additive has considerable resources and is readily available and cheap, and it constitutes an effective and promising additive for heavy fuel oil. It provides improvement in the anticorrosion, depressor, and viscosity parameters of heavy fuel oil, and reduces the volumes of polluting discharges to the atmosphere, while lengthening the service life of thermal power plant, and also making it more reliable.

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