Three times during the course of the voyage, the test diesels and the reference diesels were torn down for inspection. On the inside surfaces of the cylinder sleeves, the intake and exhaust valves and seats, and the pistons and rings of the diesels operating on WFE, no trace of corrosion could be detected, and there was no scale or any other sort of salt deposit. The carbon deposits on the piston heads and grooves and in the exhaust duct in the diesels operating on the emulsion were considerably less than in the diesels operating on diesel fuel.

Long-term service tests on an 8Ch 24/36 diesel (950 h) and laboratory tests on a 6ChNSP 18/22 diesel (1500 h) on emulsions of the "water-in-engine-fuel" type showed that the engine operation on this type of fuel is stable. No cases were noted of coking of the nozzle openings, hangup of exhaust valves, or other such malfunctions. Inspections of the cylinder-piston group parts showed no traces of corrosion on the inside surfaces of these liners, pistons, rings, or intake valves. The minor pitting of valves and seats that was found could be readily removed by grinding. Carbon on the piston heads, grooves, and exhaust duct in the engines operating on the water-in-fuel emulsion was the same as in the engines operating on diesel fuel. These carbon deposits were looser and easier to remove from the surfaces of the parts in the engine operating on emulsified fuel.

An inspection of the cylinder-piston group parts of the 8Ch 24/36 diesel showed that when it was operated on emulsified engine fuel, the liners in the area of TDC were worn less than in operation on diesel fuel. In the lower part of the liner, the reverse was observed; this can be explained by the corrosive action of sulfur. On the whole, however, the greatest wear of the liners did not exceed the established standards. The wear of the upper rings was approximately the same in the two cases. The lower rings were worn more severely in operation on emulsified engine fuel.

Economic calculations have shown that the advisability of using emulsified fuels will depend on the power of the ship, the number of ships operating on emulsion, and other factors. The use of a "water-in-diesel-fuel" emulsion is economically justified if the saving in specific fuel consumption is at least 3%. In this case, the payout period will range from 0.25 to 2.3 years, depending on the power of the ship. Conversion of marine diesels to operation on "water-in-engine-fuel" emulsion will give still greater savings.

USE OF DISPERSE-FUEL SYSTEMS FOR UTILIZATION
OF COMBUSTIBLE WASTES AND CONSERVATION OF FUEL

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Disperse-fuel systems (DFS) are being used more and more extensively. This growth is explained by a number of factors: the increase in the relative amounts of coal and heavy liquid fuels being used in power generation and industry; the trend toward utilization of wastes from the fuel branches of industry; environmental pollution limits; and the efficiency of combustion of such fuels. The last factor should really be considered as the first and most important, since it is determined by the completeness of combustion of the fuel and the decrease in soot formation and content of incompletely burned products in the stack gas, and hence by the economy of fuel utilization.

The problem of using combustible wastes as fuels can be solved only by converting them to DFSs.

The effectiveness of DFS use is determined by such properties as their stability, viscosity, transportability, etc. Since the basic properties of a DFS depend on the phase ratio, the type and quality of the fuel and other components, the dispersity of the components, the conditions of preparation, and the nature and magnitude of external effects, each fuel system must be studied individually. DFSs are used in thermal power generation, manufacturing and industrial power processes, and transport engines. Since DFSs often have certain advantages over natural fuels, we believe that the use of these fuels, both in terms of number of applications and total usage, will increase continuously.

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In the Soviet Union, the use of DFSs was investigated for the first time by V. F. Kustov and L. L. Khotuntsev in the prewar and war years, in the case of suspensions of coal in heavy fuel oil. Work in this direction was suspended, starting up again in 1957 at the Institute of Fossil Fuels [I]. Today, extensive research and development are being performed on the application of DFSs in a number of industry branches and technologies.

The increasingly severe processing of crude oil to maximize the yield of motor fuels has led to a situation in which the power generation, metallurgy, and other fuel-consuming branches of industry are receiving almost entirely heavy petroleum residues. This situation not only will continue, but will become more pronounced.

In the USSR, the principal fuel used for power generation is residual fuel oil, which according to the currently effective standards may contain up to 5% water. Because of the high solid point of such fuels (about 20°C), the users must heat it to 60-70°C in order to unload it from the transport tanks. The fuel oil is usually heated by means of live steam, so that the total water content in the fuel oil after condensation of steam may be as high as 10% in the summer or 12-15% in the winter. The main difficulty in using water-cut fuel oils is not the mere fact that they contain water, but that the water is distributed non-uniformly throughout the oil, in the form of individual accumulations. When water in this state passes through a nozzle and into the firebox, the combustion process ceases, the firebox is overcooled, and the technological process is disrupted. When atomized oil is ignited to restart the combustion, an explosion may result.

The most logical, simplest, and least costly method for using water-cut fuel oils is the conversion of such oils to a water-in-oil emulsion. In emulsions of this type, the water, in the form of extremely fine droplets (2-16 μm) is uniformly distributed through the entire volume of the fuel oil; in this condition, the water not only does not complicate the furnace process, but, as shown by our studies and earlier studies in other countries, actually promotes more effective combustion of the liquid fuel, reduces soot formation, and reduces the content of nitrogen oxides in the combustion products.

The more effective combustion of the emulsion in comparison with that of the original fuel oil is explained by the phenomenon of "microexplosion" [2]. Because of the large difference between the boiling point of water (100°C) and residual fuel oil (300°C), each droplet of emulsion, in the process of thermal pretreatment, increases in volume under the action of the steam formed within it, after which it breaks up. As a result of the microexplosions (in-stream breakup) of the drops of atomized emulsion, the reaction surface increases very sharply, and the mixing of the fuel with air is improved; this in turn tends to increase the completeness of fuel combustion and reduce the amount of soot formation, even at reduced excess air coefficients (α = 1.03). When burning emulsions with 15-18% water at α = 1.05-1.07, no overconsumption of fuel is observed. This result is also supported by calculations. An increase in the water content of the emulsion leads to a drop in efficiency of the steam generator and overconsumption of fuel. As an example, with a water content of 30%, the overconsumption of fuel oil is about 1%. It has been shown that the phenomenon of microexplosion is characteristic not only of emulsions based on heavy fuels, but also emulsions based on kerosene, diesel fuel, or even gasoline. Further, we have established that it is characteristic for all emulsions, where the disperse phase is not restricted to water, but may be any other low-boiling polar liquid such as methanol or ethanol.

The use of emulsions is effective not only in furnaces, where the greatest part of heavy fuel oil production is consumed, but also in internal combustion engines, both diesel and carburetor engines. When using fuel emulsions with a water content of 10-15%, the advantages we have already mentioned, i.e., lower soot formation and improvement in the gas composition (lower concentrations of carbon monoxide, nitrogen oxides, and hydrocarbons), and 3-5% fuel savings, are added onto improvements in the mechanical indices and condition of the engine components [3]. The use of water–fuel emulsions in internal combustion engines in metropolitan, water, and railroad transport is currently receiving much attention, since the use of such emulsions cannot only resolve ecological problems but can also save fuel; also, such components as methanol and ethanol can be used more successfully.

In recent years, water–fuel oil emulsions with water contents of 10-12% have come into use in metallurgical processes, particularly in blast furnaces, in order to curtail the consumption of expensive coke. It has been established that the emulsion usage can be brought up to 120-150 kg per metric ton of iron, i.e., more than double the amount of water-free fuel oil that can be used, without increasing the amount of soot formation. Here the