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OPTIMAL COMBINATION OF ADDITIVES FOR TURBINE OILS

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The production of gas from fields yielding large amounts of hydrogen sulfide has created an acute need for reliable protection of gas production and transmission equipment against corrosion and corrosive–mechanical wear. In this connection it has become necessary to develop lubricating oils that maintain a high level of tribotechnical and protective properties when operating in contact with corrosive media that contain hydrogen sulfide.

Gas pumping units of the centrifugal type are commonly lubricated with turbine oils Tp-22 and Tp-22s, which contain additive packages. The antiwear and anticorrosion properties of these oils are inadequate in this sort of service, where they are repeatedly saturated with corrosive impurities, primarily hydrogen sulfide.

Thus far, no oil suitable for service under these conditions have been developed, since no apparatus or procedures are available for evaluating the antiwear and anticorrosion properties of oil saturated with hydrogen sulfide and other corrosive impurities. At the I. M. Gubkin State Academy of Oil and Gas, in cooperation with the Ufa Petroleum Institute, apparatus and procedures have been developed for evaluating the lubricity of oils and other petroleum products in contact with hydrogen sulfide [1].

It has been shown by means of this method that corrosive–mechanical wear can be reduced significantly by means of antiwear additives in the oil [2]. In addition to these additives, however, the oil must also contain effective inhibitors of hydrogen sulfide corrosion. The combination of such inhibitors with antiwear additives may have a synergistic effect as a consequence of intermolecular interaction, or they may have a negative "antagonistic" effect.

The work reported here was aimed at selecting effective combinations of additives to improve the lubricity and anticorrosion properties of oils operating in the presence of hydrogen sulfide and an electrolyte, containing all components in optimal ratios.

Turbine oil Tp-22s was used as the base stock in our experiments. The antiwear properties of this oil were evaluated on the basis of the linear wear of an St3 [mild] steel rod. It had been established previously that the best protection can be obtained by the use of nitrogen-containing inhibitors with an amino group in the molecule (IFKhANGAZ-1, D-4, D-5, IKIPG), or derivatives of pyridine (I-25-D) and benzotriazole (Betol-1), at concentrations of 0.05-0.1% by weight. Of these inhibitors, we selected for investigation in the present work the IFKhANGAZ-1, D-5, and Betol-1.

The IFKhANGAZ-1 (dialkylaminopropionitrile) is a light-brown liquid with a characteristic odor with good solubility in hydrocarbons and only limited solubility in water. The D-5 inhibitor (a mixture of 5-25% aniline, 14-30% pyridine, and 55-70% picoline by weight) is a light-brown liquid, soluble in both water and hydrocarbons. The Betol-1 (1-diethylaminomethylbenzotriazole) is a viscous, dark-brown liquid that is soluble in hydrocarbon oils. The main physicochemical characteristics of these inhibitors are listed in Table 1.

As the antiwear agent we selected the molybdenum-containing additive MSP, as the most effective additive for oils containing hydrogen sulfide and an electrolyte. Previous data had indicated that its optimal concentration was 0.05% by weight. The tests were performed in an MT-2M unit [1]. In Fig. 1 we illustrate the influence of the inhibitors (0.1% by weight) and the MSP additive (0.05% by weight) on the antiwear properties of Tp-22s turbine oil in a medium of hydrogen sulfide and electrolyte.

The inhibitors IFKhANGAZ-1, D-5, and Betol-1 give some improvement of the oil lubricity, reducing the amount of corrosive–mechanical wear. The MSP additive is highly effective under these same conditions. In Fig. 2 we present results from tests on Tp-22s oil with each of the inhibitors in combination with MSP (total concentration 0.1% by weight). It will be seen that the combinations with IFKhANGAZ-1 or D-5, regardless of the ratio of components, reduce the amount of metal wear in comparison with the effects of the individual additives.

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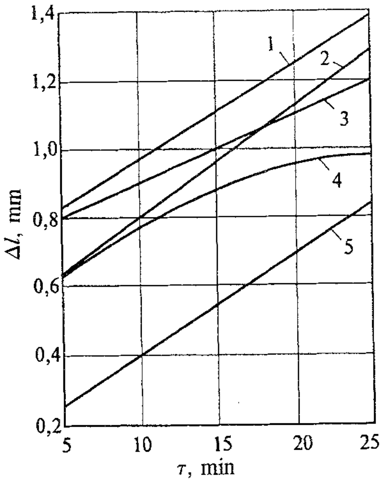

Fig. 1. Linear wear Δl of rod as a function of test time τ on Tp-22s oil in the presence of hydrogen sulfide and electrolyte (5%): 1) without additive; 2,3,4) with 0.1% inhibitor – IFKhANGAZ-1, Betol-1, and D-5, respectively; 5) with 0.05% MSP additive.

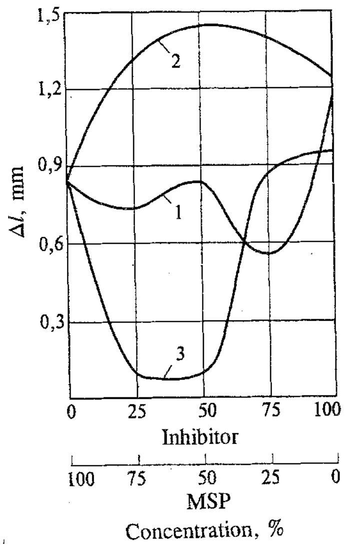

Fig. 2. Linear wear Δl of rod as a function of composition of additive package in TP-22s oil: 1) IFKhANGAZ-1 + MSP; 2) Betol-1 + MSP; 3) D-5 + MSP.

The combination of MSP and IFKhANGAZ-1 gives the best results at a 3:1 or 1:3 ratio; the combination of MSP and D-5 gives the best results at ratios from 1:3 to 1:1. In both of these cases we are observing synergism (curves 1 and 3). The polar molecules of the additives in the presence of hydrogen sulfide apparently form associates (micelles) at the interface between the oil and metal, with good protective properties.

We can assume that the associates include polar molecules that are present in the commercial Tp-22s oil (antioxidants, antifoam additives, and others), and also hydrogen sulfide molecules. In view of the extremely complex composition of the associates, the optimal ratios that we have found for the combination of MSP and the inhibitor IFKhANGAZ-1 or D-5 may have to be corrected if a different type of turbine oil or a different additive package is used.

TABLE 1

Inhibitor	Density at 20°C, kg/m^3	Viscosity at 20°C, mm^2/sec	Temperature, °C		Solvent
			flash point	solid point	
IFKhANGAZ-1	856	13,1	148	−42	None
D-5	1009	1,5	65	−40	"
Betol-1	814,5	14,1	197	−16,5	Methanol

Thus, in order to improve the lubricity of Tp-22s oil and extend the service life of the components of oil systems in gas compressors, it is recommended that a combination of the additive MSP with the inhibitor IFKhANGAZ-1 or D-5 should be used with the optimal component ratios that we have found.

REFERENCES

1. V. G. Spirkin, Sh. K. Gil'mutdinov, and É. A. Akhmetshin, *Khim. Tekhnol. Topl. Masel*, No. 6, 31-32 (1993).
2. V. G. Spirkin, Sh. K. Gil'mutdinov, A. A. Bocharov, et al., *Neftepererab. Neftekhim.*, No. 4 (1994).