The American Journal of Interdisciplinary Innovations Research
(ISSN – 2642-7478)
VOLUME 04 ISSUE 03 Pages: 12-16
SJIF IMPACT FACTOR (2020: 5. 498) (2021: 5. 676) (2022: 6. 233)
OCLC – 1091588944 METADATA IF – 7.895
Publisher: The USA Journals

Journal Website: https://theamericanjournals.com/index.php/tajiir

Research Article

THE INFLUENCE OF THE OPERATIONAL PROPERTIES OF THE WORKING FLUID ON THE RELIABILITY OF HYDROMECHANICAL TRANSMISSIONS OF CARS

Submission Date: February 26, 2022, **Accepted Date:** March 16, 2022,
Published Date: March 28, 2022 |
Crossref doi: https://doi.org/10.37547/tajiir/Volume04Issue03-03

Alimova Z. X.
Professor, Tashkent State Transport University, Uzbekistan

Ibragimov K.I.
Associate Professor, Tashkent State Transport University, Uzbekistan

Turakulov B.H.
Senior Lecturer, Tashkent State Transport University, Uzbekistan

ABSTRACT

This article is devoted to the analysis of the influence of the operational properties of the hydraulic transmission fluid on reliability. Based on the analytical review and operational observations made by the authors of the article, it is recommended to introduce high-performance filters for cleaning the working fluid (oil) with a drop-out fineness of no more than 10 microns into the hydraulic system. Also recommended for hot climate conditions is the frequency of oil change, which should be 15-20% lower compared to non-hot climate conditions.

KEYWORDS

Hydromechanical transmission, viscosity, oil oxidation, friction force, additives, boundary layer.

INTRODUCTION

Hydromechanical transmissions are the most heat-stressed unit of all the transmission units of the car.

The average oil temperature in the crankcase of hydromechanical gears should be 80-950C, and in summer in a hot climate with an urban traffic cycle reaches 130-1500C. Such a high oil temperature in hydromechanical transmissions, unlike a manual transmission, is created mainly due to internal friction, in which the oil flow rate in the torque converter reaches 80-100 m/s. In addition, if more power is removed from the engine than is necessary to overcome the resistance to movement, excess power is spent on the internal friction of the oil, which further increases its temperature. High speeds of oil movement in the torque converter lead to its intensive aeration, enhanced oil oxidation.

The main functions of the oil in the hydromechanical gears are: power transmission from the engine to the chassis of the car; lubrication of the components of the gearbox parts; energy transfer to turn on the friction clutches of the hydromechanical gears; cooling of the parts of the components and mechanisms of the unit.

RESEARCH ANALYSIS

During the operation of the pump in the hydraulic system, the oil is heated and intensively mixed with air. This leads to the oxidation of the oil, to an increase in the viscosity of the oil, to the accumulation of oxidation products in it. The oxidation of the oil leads to a change in its viscosity, and the resulting products form sediments and varnish on the surfaces of parts of the hydraulic system. To ensure reliable operation of the torque converter of lubricated parts, the oil must have an optimal viscosity. The temperature dependence of the viscosity of transmission oils is quite heavy. With increasing viscosity, the thickness and resistance to mechanical influences of the oil layer between the rubbing surfaces increases. Also, viscous oil makes it difficult for a cold car to move smoothly and penetrates narrow gaps between friction surfaces more difficult. It is determined that an increase in the viscosity of the oil due to a decrease in its temperature from 900C to 300C leads to a decrease in the efficiency of the torque converter by an average of 5-7%.

Reducing the viscosity of transmission oils is one of the main ways to increase the efficiency of the car. The use of oils with a viscosity at a temperature of 100°C equal to 1.4mm²/s instead of 5.1 mm²/s in hydromechanical transmissions improves the dynamic characteristics of the car by 6-8%, as well as contributes to fuel economy. The highest efficiency of hydraulic transmissions is provided when the oil viscosity is not higher than 4-5 mm² / s at a temperature of 100°C.

The viscosity of the transmission oil is the most important physico-chemical property that affects the friction force F:

$$F = \eta \frac{V \cdot S}{h},$$

where:

V -the relative velocity of the surfaces;

h - the thickness of the lubricant layer;

S - the sliding area.

If the viscosity is excessively high, the friction forces in the liquid can lead to a violation of the filling of the working chambers of the pump and cavitation occurs, which reduces the flow of liquid. When the thickness of the lubricant layer is less than 0.1 microns, boundary friction occurs on the surface of the conjugate bodies.

The presence of a boundary layer helps to reduce the friction force in comparison with friction without a lubricant by 2-10 times and reduces the wear of the

The American Journal of Interdisciplinary Innovations Research
(ISSN – 2642-7478)
VOLUME 04 ISSUE 03 Pages: 12-16
SJIF IMPACT FACTOR (2020: 5. 498) (2021: 5. 676) (2022: 6. 233)
OCLC – 1091588944 METADATA IF – 7.895
Publisher: The USA Journals

mating surfaces by hundreds of times. The coefficient of boundary friction is in the range of 0,08-0,15.

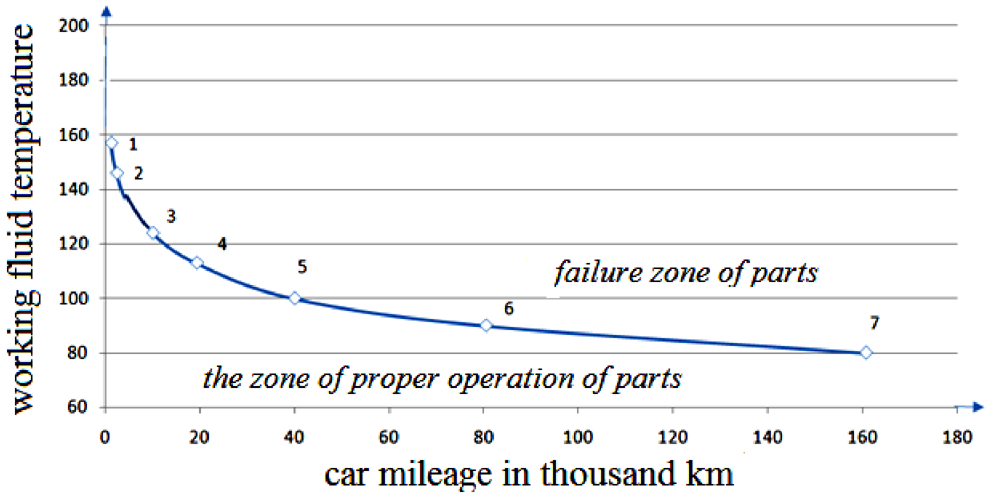
During operation, processes such as wear of rubbing surfaces and oxidative processes occur in hydromechanical transmissions. The antioxidant resistance of the oil ensures reliable and long-lasting operation of the hydromechanical gears. Oxidation of oil, in addition to its general contamination and an increase in the content of acidic products, leads to disruption of the normal operation of friction discs. In boundary lubrication, special additives are important – additives containing organic compounds of sulfur, phosphorus, chlorine or a combination of them. Additives allow artificially increasing the chemical activity of the boundary film. They help to increase the coefficient of friction and prevent slipping of rubbing surfaces. As such additives, organic acids and their derivatives are used – lauric acid and its mixture with monoolein phosphate, magnesium stearates (Mg), calcium (Ca) and zinc (Zn), barium sulfonate (Ba). The concentration of additives is from 0.1 to 3%.

Oils with an additive can be adsorbed on a metal surface, forming a boundary film. The strength of the film is affected by the presence of active molecules in it, their quality and quantity. The lubricant molecules are oriented perpendicular to the solid surface, the boundary bar in this case can be represented as a pile. When there is a mutual movement of the friction surfaces, the molecules seem to bend in opposite directions. Molecules of surfactants are sorbed on the active centers of the surface, which separates a pair of contacting surfaces and significantly reduces friction. It takes some time to restore the orientation of the molecules to their initial position.

The ability of the working fluid to maintain physicochemical properties for a given time within acceptable limits is called property stability. Stability is characterized by the antioxidant capacity and uniformity of the working fluid, which are dependent on each other. During long-term operation, as a result of the reaction of oil hydrocarbons with air oxygen, resinous insoluble fractions appear in the working fluid, which form varnish-like precipitates and films on the surfaces of parts and slot seals, resulting in a complete failure of the hydraulic drive.

However, despite all of the above, the main indicator limiting the durability and serviceability of the hydraulic drive remains the temperature of the working fluid. The proof of the above is the following graphical dependence of the transmission resource on the temperature of the working fluid and the mileage of the car.

The American Journal of Interdisciplinary Innovations Research
(ISSN – 2642-7478)
VOLUME 04 ISSUE 03 Pages: 12-16
SJIF IMPACT FACTOR (2020: 5. 498) (2021: 5. 676) (2022: 6. 233)
OCLC – 1091588944 METADATA IF – 7.895
Publisher: The USA Journals



Dependence of the life of hydromechanical transmissions on the temperature of the working fluid

Note:

1- oil seals and couplings are charred, the liquid polymerizes, becomes black and with a burning smell (1200 km, 157°C);
2- couplings slip, the box "slips"; (2400 km, 147°C);
3- oil seals, seals harden and lose their properties, liquid leakage is possible (10000 km,127°C);
4- formation of varnish deposits on automatic transmission parts (20000km, 115°C);
5- the appearance of periodic jerks and jerks (40000km, 105°C);
6- service life at the permissible operating temperature (80000km, 90°C);
7- service life at normal operating temperature (160,000 km, 80°C).

Contamination of the working fluid can occur during refueling of the hydraulic system, during repair of hydraulic equipment, through the breather of hydraulic tanks, as well as during wear of the rubbing surfaces of hydraulic units. Increased contamination of the working fluid inevitably leads to premature wear of hydraulic equipment and, as a result, significantly reduces the working life of the hydraulic system.

The main way to combat contamination of the working fluid is its filtration, for which the hydraulic system is necessarily supplied with full-flow filters, and the breather of hydraulic tanks - air filters. Up to a certain level, these contaminants do not have a noticeable effect on the operation of the hydraulic system, but as they accumulate, they can cause an emergency failure of the hydraulic system, since the presence of these contaminants in the working fluid leads to obliteration of throttles and slot seals. Therefore, it is necessary to strictly observe the frequency of changing the working fluid.

Our observations on the operation of passenger cars in Uzbekistan show that the timing of the oil change of gearboxes is 80-60 thousand km. Such a noticeable reduction in the timing of gear oil change compared to the manufacturers' recommendations is due to the high ambient temperature and increased dustiness.

CONCLUSIONS

Based on the performed analytical review and our operational observations, the following conclusions can be drawn:

- It is necessary to introduce highly efficient hydraulic filters with a cleaning fineness of no more than 10 microns into the hydraulic system;
- In the conditions of real operation of vehicles with a hydro-mechanical transmission, it is necessary to take into account high speeds of the working fluid, high loads (mountain conditions) and elevated ambient temperature, especially in hot climates, which ultimately lead to a reduction in the service life of the working fluid and the resource of the hydro-mechanical transmissions themselves.

REFERENCES

1. Kirichenko N. B. Automotive maintenance materials. Textbook for secondary vocational education - M.: publishing house "Academy", 2012.
2. Danilov V. F. and others. Oils, lubricants and special fluids. Study guide-Elabuga: publishing house of the K (P) FU branch. 2013. - 216 p.
3. Investigation of the thermooxidative stability of fluids for stepped hydro-mechanical and continuously variable gearboxes. Proceedings of Gubkin Russian State University of Oil and Gas No. 3 (276) 2014.
4. Dzherikhov V.B Automotive operational materials. Textbook. St. Petersburg: SPGASU, 2009. –256 p.
5. Alimova Zebo Khamidullaevna, Sobirova Dilorom Kobulovna, & Yuldasheva Gulnora Buranovna. (2021). Improve The Physico - Chemical Properties Of Hydraulic Oils Way Of Introduction Of Additives. *The American Journal of Engineering and Technology*, 3(12), 1–5.
6. Alimova, Z. K., Makhamajanov, M., Akhmatjanovich, I., & Magdiev, K. I. (2021). Research Of Anti-Corrosion Properties Of Engine Oils When The Engine Is Running. *The American Journal of Agriculture and Biomedical Engineering*, 3(11), 28-33.
7. Alimova, Z. X., Kholikova, N. A., Kholova, S. O., & Karimova, K. G. (2021, October). Influence of the antioxidant properties of lubricants on the wear of agricultural machinery parts. In *IOP Conference Series: Earth and Environmental Science* (Vol. 868, No. 1, p. 012037). IOP Publishing.