WEB OF SCIENTIST: INTERNATIONAL SCIENTIFIC RESEARCH JOURNAL
ISSN: 2776-0979 (Volume 2, Issue 12, Dec., 2021)

INVESTIGATION OF HEAT LOAD PARAMETERS OF FRICTION PAIRS OF VEHICLE BRAKING SYSTEMS

Azimov Sadriddin Zhurakulovich
Senior Lecturer Tashkent State Transport University, Tashkent, Uzbekistan

Valieva Dilmira Shavkatovna
Assistant Tashkent State Transport University, Tashkent, Uzbekistan

Qo’chqorov Lochinbek Axmadjonovich
Assistant Tashkent State Transport University, Tashkent, Uzbekistan

Abstract
This article reveals the features of the technical operation of vehicles in a hot climate. Means and methods for assessing and thermal loading of brake mechanisms are proposed.

Keywords: vehicles, temperature, design, operation.

Introduction
In recent years, the fleet of vehicles capable of developing high speeds has been continuously increasing. The improvement in the quality of the road network has led to an increase in the average traffic speed on the roads. At the same time, there is an increasing intensity and density of traffic, especially on urban routes.
These factors increase the likelihood of emergencies on the road, therefore, the issue of improving traffic safety, in particular, ensuring the braking properties of vehicles, becomes especially relevant.
To successfully solve the set tasks, the industry produces a large number of machines, but their designs in most cases are not adapted to operating conditions in hot climates. In this regard, it is of interest to assess the operating conditions of machines in a hot dry climate zone.
It is known that the potential operational properties of vehicles are realized in specific operating conditions, and knowledge of the factors of operating conditions and the degree of their influence on the characteristics of vehicles allows purposeful control of the quality indicators of machines in the process of its design and operation.
The more the design of the machine is adapted to the complex of operating conditions for which it is intended, the more efficient it is.

Let us consider the influence of individual factors of hot climate conditions, in particular, the combination of high temperature and high dust content of the air on materials, equipment and technical and economic indicators of vehicles. In conditions of high temperatures and dusty ambient air, machine units are exposed to intense heating (up to 60-90°) and clogging with dust (2-4 g / m ^{3}). At the same time, in the cabin at noon, the air temperature at the seat level reaches 50-60° C.

With high-speed processes of friction and wear in brake mechanisms, such factors as a change in the kinematic viscosity of the surface layers of materials, a change in the conditions of heat transfer from rapidly moving heated elements of friction pairs to the environment become essential.

This approach to the problem of optimizing the power and thermal loading of brakes makes it possible to effectively control the deformations of the brake drum rim, vibrations of the brake drum and pads, as well as the surface temperatures of the friction pairs of brakes, while varying their structural, thermophysical and strength parameters: the design schemes of the rims and the loading of their violations surfaces, intensity of heat exchange and vibrations of brake drums and pads, heat removal from their working surfaces, depending on the heat release process.

The proposed approach is quite universal, since it is based on the analysis of the laws governing the processes characteristic of the brake mechanisms used.

The following formulas can be used to assess the power and thermal loading of the braking mechanisms.

By force load: deformation of brake drums

$$W_1 = \varphi_1(\sum К_{Мо} : Н_о : П_{Мо} : Т_{Но}); \quad (1.1)$$

$$W^1 = \varphi_2(W_1 : \sum К_{Мδ} : Нб : П_{Мδ} : Т_{Мδ}); \quad (1.2)$$

where $\sum К_{Мо}$, $\sum К_{Мδ}$ – a set of design parameters of the cylindrical rim of the brake drum, pads and mechanisms;

$Н_о$, $Н_δ$ – loads acting on the cylindrical rim of the brake drum and pads;

$П_{Мо}$, $П_{Мδ}$ – parameters of the cylindrical rim of the brake drum;

$Т_{Мδ}$, $Т_{Но}$ – parameters characterizing thermal changes in the cylindrical rim of the brake drum.

When braking devices are in operation, their friction pairs are subject to wear with varying intensity. So, metal elements, working surfaces of the brake drum rim and treadmills of the tire wear on average 8-13 times slower than friction linings working with it in pair. To compensate for the resulting gap between the brake friction pairs, mechanical and automatic gap adjusters used in braking devices are provided.

To study the cooling and heating of bodies, and representing a special form of unsteady heat transfer, it is necessary to distinguish between the following stages of heat loading of friction pairs of brakes.

The first stage, in which the law of temperature variation with time is exponential and short-term thermal equilibrium takes place (the range of steady-state temperatures is 50-250°C).

Second stage. Constant temperature heating at all points of the drum (250-450°C).

The third stage, which is characterized by an intense change in temperature (heating temperature - 450°C and above).

Let us determine the critical steady-state temperature of the metal brake element.

The average value of temperatures exceeding the permissible value at a minimum temperature gradient along the thickness of the rim or tire of the brake drum. The value (t_{Hy}) is characterized by the thermal equilibrium of the working surface of the linings and the metal element over the thickness of the open brake.

Heating and cooling of the brake drum is described by the differential Fourier thermal conductivity equation.

$$\frac{\partial T_2}{\partial t} = \alpha_{o\delta}\left(\frac{d^2T_2}{dX^2} + \frac{d^2T_2}{dY^2} + \frac{d^2T_2}{dZ^2}\right) \qquad (1.3)$$

as well as the initial $T_2 = f(x, y, z, t)$ and boundary

$$\alpha_1 (T_B - T_{B1}) = -\lambda_B \frac{dT_1}{dz} \qquad (1.4)$$ conditions,

where $T_2 = f(x, y, z, t)$ – is the instantaneous temperature of the point of the brake drum rim, given by the current coefficients x, y, z and time (t) K.

$\alpha_{o\delta}$ – coefficient of thermal diffusivity of the material of the metal element of the brake m^2/s,

T_{B1} – ambient temperature, K.

The general integral of the Fourier equation for the case T_{B1} = const can be represented by an infinite series, the terms of which are exponential rapidly decreasing functions of time.

$$T_\delta = T_N - T_B = A_1{}^1U_1e^{-m_1{}^r} + A_2{}^1U_2e^{-m_2{}^r} + A_3{}^1U_3e^{-m_3{}^r} \qquad (1.5),$$

where $T_\delta = T_t - T_B$ – excess temperature of the drum rim over the environment;

$A_1{}^1\ A_2{}^1 A_3{}^1$ – constants determined from the condition of the drum rim over the environment; the initial moment of time (t = 0). The functions of the coordinates of the points $U_1U_2U_3$ of the system that characterize the spatial distribution of temperature.

ISSN: 2776-0979 (Volume 2, Issue 12, Dec., 2021)

$m_1 m_2 m_3$- constant positive increasing numbers, characterize the rate of the process and depend on the conditions of heat transfer (α) physical properties of the drum rim ($\lambda_\delta \alpha_{o\delta} \gamma$) from the shape ($F^1$) of the mass ($m_{o\delta,\delta}$) and its dimensions.

In general $m_T = \psi \frac{F}{m_{o\delta,\delta}} \frac{\alpha_1}{c}$ (1.6),

where ψ is the criterion of temperature unevenness at t_1- exceeding a certain value of t. Due to the rapid convergence of the terms of the series, the sum differs little from the first term and therefore we can take $T_\delta = A_1{}^1 U_1 e^{-m_1{}^r}$, where $z_1 > t$

Differentiating Equation 1.6 with respect to time, we obtain

$$\frac{dT_\delta}{dt} = -m_T A_1{}^1 U_1 e^{-m_1 t} \quad (1.7)$$

It follows from equations (1.3) and (1.5) that $\frac{dT_\delta}{dt} = -m_1 T_\delta$

The number $m_t = -\frac{1}{T_\delta}\frac{dT_\delta}{dt}$ characterizes the rate of cooling, because it represents the change in time of the relative temperature (excess over the environment) for any point, the rate of its change.

Taking the logarithm of equation 1.7, $\ln T_\delta = -m_T t + \ln A_1{}^1 U_1 = -m_T t + C_1$ (1.8) whence it follows that at T_{BT}=const the natural logarithm of excess temperature over the environment will change as a function of time along a straight line with different the slope of the first and third stages of the process.

The heat load of the tire or rim of the brake drum changes in the indicated stages at different rates. $\ln T_{\delta 1}$, $\ln T_{\delta 2}$, $\ln T_{\delta 3}$, $\ln T_{\delta 4}$- are the natural logarithm values, in which $T_{\delta 1} = 323К$, $T_{\delta 2} = 523К$, $T_{\delta 3} = 673К$ и $T_{\delta 4} = 773К$.

The shape of the contact of the friction linings with the drum is influenced not only by the braking mode of the vehicle, but also by the change in their heat load. The thermal effect on the drum rim (not lower than 100 ° C and more) causes its thermal deformation, which, due to the low efficiency of free cooling, lasts for a longer period of time than mechanical ones.

If the temperature of the working surface of the drum is higher than the temperature of the linings, then the linings are adjacent to the drum in the middle (sinusoidal law of distribution of loads). The equalization of the surface temperatures of the linings and the drum falls mainly in the middle of the braking process (long-term and single loading mode) and contributes to the adhesion of the friction pairs of friction.

Thus, the given data on the heat load of the working parts of the brakes of vehicles make it possible to establish the influence of the geometric (diameter, thickness and width of the brake drum rim, the setting gap between the friction pairs of the coefficient of mutual overlap of interacting pairs) and thermophysical coefficients of thermal diffusivity and thermal conductivity of the materials of the drum rim and friction lining, parameters and their surface temperatures and accumulate a priori information on heat generation control.

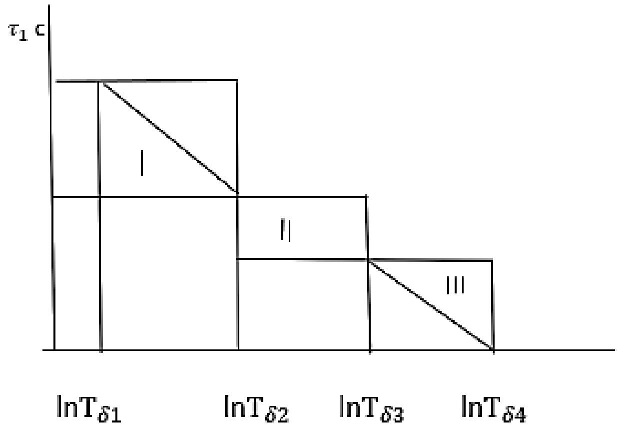

Fig 1. Dependence of the heating or cooling time of the brake drum rim on the value of the natural logarithm of the excess temperature over the environment.

Conclusion

Thus, based on theoretical studies, the data on the heat load of the working parts of vehicle brakes allow us to establish the influence of geometric (diameter, thickness and width of the rim of the brake drum, the installation gap between the friction pairs of the coefficient of mutual overlap of interacting pairs) and thermophysical coefficients of thermal conductivity and thermal conductivity of the materials of the drum rim and friction lining, the parameters of their surface temperatures and accumulate a priori information on heat management. The proposed new design of vehicle brakes with the possibility of its resistance is a compress between the comfort and safety of vehicles

References

1. Бухарин Н.А. Тормозные Системы Автомобилей 1950 Г. 291 С.
2. Вершигора В.А., Зельцер В.И., Пятков К. Б. Автомобили Ваз 1974 Г. 367 С.
3. Гапоян Д.Т, Илиев П. Автомобильные Электродинамические Тормоза-Замедлители Тормоза-Замедлители. М., Ниинавтопором, 1972 95 С.

WEB OF SCIENTIST: INTERNATIONAL SCIENTIFIC RESEARCH JOURNAL
ISSN: 2776-0979 (Volume 2, Issue 12, Dec., 2021

4. Тен, Э. Б., & Тоиров, О. Т. (2020). Оптимизация Литиковой Системы Для Отливки «Рама Боковая» С Помощью Компьютерного Моделирования. In Прогрессивные Литейные Технологии (Pp. 57-63).
5. Toirov, O., & Tursunov, N. (2021, June). Development of Production Technology of Rolling Stock Cast Parts. In E3s Web Of Conferences (Vol. 264, P. 05013). Edp Sciences.
6. Ziyamukhamedova, U., Miradullayeva, G., Rakhmatov, E., Nafasov, J., & Inogamova, M. (2021). Development of The Composition of a Composite Material Based On Thermoreactive Binder Ed-20. Chemistry And Chemical Engineering, 2021(3), 6.
7. Nurkulov, F., Ziyamukhamedova, U., Rakhmatov, E., & Nafasov, J. (2021). Slowing Down the Corrosion of Metal Structures Using Polymeric Materials. In E3s Web Of Conferences (Vol. 264, P. 02055). Edp Sciences.