

Chapter 1

Introduction

The leading research centers and companies of the world engaged in designing and manufacture of the modern high-tech goods are actively solving the problems connected with vibroacoustics in mechanical and dissipative systems, which include also tribological objects intended for various mobile, aerospace vehicles, complex domestic appliances and other aims [1]. Elevated interest to this sphere of investigations is related in part with the ecological aspect since generated by the mechanical systems noise is treated by the UN European Economic Commission as an important ecological parameter [2–4].

Abatement of undesirable noise and vibration generated by the rubbing and vibrating solid bodies is especially acute in transport due to the presence of the nonstationary friction joints in mobile vehicles.

The nonstationary friction joints are characterized by varying in time friction characteristics, load, velocity, temperature and properties of the rubbing materials. The friction process is considered to be nonstationary if at least one of above-named parameters significant for the friction contact is varying. The braking systems and friction clutches can be related to the most widespread joints of nonstationary friction. Their operation is often associated with elevated noise and vibration levels. These phenomena impair safety, reliability and serviceability of machines, worsening their quality and competitiveness.

Vibroacoustic activity of the friction units in brakes and friction clutches leads, from the one hand, to acoustic and vibration discomfort of the machine user and from the other to lowered durability of just as separate parts, so the integral machine. What is more, this problem is difficult to predict [5–7]. While the papers on this topic are abundant in quantity, the design and experimental methods promoting comfort and competitiveness of above products by meeting the existing norms and standards are lagging behind.

It is interesting that the expenses on the experimental and theoretical studies of noise and vibration have made up these years directly or obliquely about 50 % of the total budget of the basic companies engaged in developing friction materials (FM) and braking systems [8]. The problems with vibration and noise are decided

Table 1.1 Criteria for selecting friction pairs

Estimated parameter		Criterion	Unit	Grade points
Friction coefficient	Run-in	Deviation of μ from μ_{av}	–	8
	Mean level	Deviation of μ_{av} from μ_n	%	7
	Mean level stability	Difference between μ_{av} and μ_{min} or μ_{max}	%	9
	Heat-induced reduction	Deviation of μ from μ_{av}	%	6
	Sensitivity to pressure	Deviation of μ from μ_{av}	%	7
	Sensitivity to temperature	Deviation of μ from μ_{av}	%	8
	Sensitivity to velocity	Deviation of μ from μ_{av}	%	7
Noise	Bench tests	Noise level	dBA	8
	Ride tests	Noise level	dBA	7
Vibration	Vibration cold/hot	Vibration level	dB/1 m/s	8
	DTV-induced vibration	Disc thickness variation	μm	9
Wear	Lining	Lining wear	mm/GJ	7
	Disc	Disc wear	mm/GJ	8
Physical properties of lining material	Compressibility cold	Lining thickness variation	μm	7
	Compressibility hot	Lining thickness variation	μm	5
	Thermal conductivity	Heat conductivity factor	Wt/(m • K)	4
	Swelling	Variation in dimensions	μm	6
	Shear strength	Maximal force	N	6
Ecological safety of lining material	Lead	Content	mass%	4
	Cadmium	Content	mass%	2
	Carcinogenic fibers	Content	mass%	7
	Other	Content	mass%	7
Wear debris	Build-up on disc and lining surface	Subjective estimate	–	8

very often by the end of the design stage or even after its termination when preparing for the production startup. This is connected with extra-costs on design debugging in attempting to abate noise and vibration. Therefore, taking into account the repair costs and related expenses, the manufacturers make efforts to create the brake systems with improved vibroacoustic characteristics already on the design stage.

There exist the procedures of preselecting frictional parts for such units as automotive brake blocks. Different criteria for selecting tribopairs for brakes are presented in Table 1.1. These criteria are used by the world-known car manufacturers in agreement with the national and international rules and legal documents like SAE, ISO, DIN, EN, JASO, Euro Spec and other. Their effect on the car quality is estimated using a ten-point scale [8]. It is evident from the table that noise and vibration are significant criteria for the car quality determination procedure.

The reduction of noise and vibration in the brake and transmission systems is attained mainly through varying structure of the joint, e.g., by refining geometry of the tribopair, or by involving new elements, like damping ones, or other.

It should be noted that very poor information is presented in scientific literature on the effect of composition and structure of the rubbing bodies on the noise and vibration level of the total system. It is very actual today to study the possible ways of abating vibroacoustic activity of tribojoints by optimizing structure and composition of friction materials based on the novel trends in tribology and materials science [9].

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