

THE CONCEPT OF TECHNICAL STATE CONTROL OF VEHICLE BRAKING SYSTEM WITH ABS IN OPERATING PROCESS

КОНЦЕПЦИЯ КОНТРОЛЯ ТЕХНИЧЕСКОГО СОСТОЯНИЯ ТОРМОЗНОЙ СИСТЕМЫ АВТОМОБИЛЯ С АБС В ПРОЦЕССЕ ЭКСПЛУАТАЦИИ

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Abstract: Possibilities of diagnosing of a technical condition of brake system of the car with ABS while in service are considered. The concept of sharing of onboard means and stands for diagnosing is presented.

KEYWORDS: VEHICLE, ANTIBLOCK SYSTEM (ABS), DIAGNOSTICS, BENCH.

Automobile active safety is defined not only by its technical equipment, but also by serviceability of its elements technical state in operating process. It is thus obvious that a lot of things depend on effective work of brake system of the vehicle. Number of automobiles equipped by anti-lock braking systems (ABS) exceeded 80% for the ones released in Europe. However, a lot of things are still unclear with the ideas of technical state control of vehicle brake system with ABS. We will try to sort the problem out. First of all it is absence of traditional serviceability signals of brake system for the driver. If a vehicle is skidding these signals are often the traces left on asphalt surface by slowed-down wheels which testify, first, about efficiency of functioning of the brake drive (the brake moment on wheels exceeded (or not) greatest possible in these conditions the brake torque on tractive contact). The quantity of the last is defined on the known formula:

$$M_{\max} = R_z \varphi_{\max} r_d, [1]$$

if: R_z – normal loading on a wheel, r_d – the dynamic radius of a wheel, φ_{\max} – the maximum size of coefficient of traction at optimal wheel spin.

Secondly, by the traces left while skidding it is possible to judge indirectly about unevenness of operation of brake gears (u. o. b. g.) . The essential traces discrepancy is incentive motive for maintenance of brakes or bench preliminary treatment of the vehicle.

If a vehicle is provided with ABS brake system skidding traces absence on the road surface is regarded in two ways. It can testify effective work of ABS or insufficient efficiency of operating of the brake drive units and its general inability to provide the quantity of the maximum moment on traction that enables braking a wheel in subcritical skidding area $\varphi(S)$ - charts.

However, even in the first case not everything is so obvious. The matter is that while ABS is operating it is almost impossible for the driver to estimate degree of use of the maximum coefficient of traction and its compliance to standard requirements basing only on his feelings.

It is known that technical state control of an operating vehicle is carried out regularly during annual maintenance or a planned one after a certain mileage. At the same time malfunction of vehicle brake system units, especially ABS, involves serious consequences. So, according to European countries traffic police sudden failure of ABS caused more serious road accidents' consequences than while skidding.

Producers equip ABS with self-control system which carries out testing serviceability of electric chains and signal level. So, break of a power-supply circuit of the modulator or the sensor will immediately lead to shutdown of ABS and giving a warning signal to the driver.

It is thus obvious that this system doesn't settle possible malfunctions of its units. Besides malfunctions listed above it is possible to add, for example, such ones as change of the modulator channels section owing to their contamination, a delay at valves operation, an angular pliability of a stator of the ABS sensor, weakening of springs pulling together brake shoes, etc. In cases of all listed above failures ABS system of self-diagnostics doesn't give a signal of malfunction.

The listed facts dictate an urgent need to improve onboard diagnostic tools of the brake system elements' technical state to make them become capable to provide, at least as at a first approximation, objective information for the driver about a condition of brake system as a whole and quality of carried out operating process during the inter-control period of operation. At this stage diagnosis has to be carried out first of all in parameters of efficiency and give the general "integrated" assessment, thereby, filling for the driver absence of objective visual criteria of skidding traces. Therefore, brake dynamism based on implemented slowdown has to be the basis for such onboard diagnostic tools.

Further development of means of onboard diagnostics is seen in creating intellectual systems constructed on the basis of developed structural and investigative schemes. As an example in figure 1 the example of the structural and investigative scheme developed for the pneumatic drive of brakes with ABS is presented. Such approach will allow seeing codes of estimated malfunctions or failures of system elements. At the same time, it is necessary to remember that in actual practice operation braking process proceeds at an essential deviation of characteristics of external conditions, in particular, fluctuations of coefficient of traction both in longitudinal and cross directions that will affect diagnosis accuracy.

The last circumstance causes need of monitoring technical state of braking system units under the fixed and reproduced external conditions that is reached at bench preliminary treatment.

Existing benches at which diagnosis of a car with ABS is possible can be divided into two large groups: the roller power and drum inertial. We do not mention benches of areal type considering necessity of providing rather high speed of movement. The benches of the first group provide the greatest possible traction of the tire with a roller surface due to its longitudinal corrugation. The main objective thus is testing efficiency of brake gears functioning and the system as a whole on the basis of assessment of the implemented braking torques.

Therefore testing the braking system of the car with ABS at such benches is possible only at implementing additional devices (often controlled by a computer), allowing to provide change of a relative wheel slip concerning a roller or the last relatively a drive gear.

During testing quality of functioning of ABS in vitro the important circumstance is the greatest possible reconstruction of real conditions of interaction of the tire with a road surface. The last is reached, on the one hand, by distribution of normal loadings adequate to real process in a spot piece of contact, and on the second hand by a reconstruction of coefficient of traction. The first condition causes at least an one and a half-multiple ratio of diameters of a chassis dynamometer and a car wheel, and the second causes implementing drum cleaning system in a contact piece spot from products of tire wear (for example by means of adding kaolin powder into a spot of contact piece as it is implemented at the bench for tire wear testing on the Volzhsk Tire Plant), and also adding liquid for imitation of a wet surface on cement sectors of a drum, etc.

All the items mentioned above significantly complicate the design of the bench and increase its dimensions, transferring it into the category of the research ones that limits use of such benches in service centres, workshops and MTE. The widespread roller power

brake bench has rollers with longitudinal corrugation made for ensuring the maximum traction with the tire. Practically it excludes opportunity to reproduce road conditions for tire traction close to the reality. However, in the power bench this point is not required as the main objective is the assessment of the greatest possible implementation of braking torques on wheels, and also distinctions of brake forces regarding their compliance to admissible values according to the standards. Due to the relative compactness and rather low cost this type of benches gained the greatest distribution in service centres, workshops and MTE.

At the first glance such design does not allow carrying out diagnosing the braking system of the car with ABS. However, possible way out can be diagnosing with implementing a special set point adjuster of modes which imitates signals of the sensor of angular speed of a wheel or the commands given by the logical block on the ABS modulator. At imitation of the sensor's signals of a wheel angular speed on an input of the ABS logical block the sinusoidal signal of variable frequency from the generator is given. At a certain value of frequency the ABS logical block has to form a controlling signal on the modulator for a wheel brake release that is reflected in the stand oscillogram.

When testing modulator on its inputs (solenoid coils) the test controlling signal "braking – cut-off – brake release - a cut-off" is given that will be reflected in the measure of the produced braking torque. In the both cases, if the driver presses out the brake pedal completely and the rollers of the bench are rotating simultaneously, on the received oscillogram it is possible to track the value of valves operation delay and rates of change of braking torques at braking and brake release.

From all the described above it is possible to draw the following conclusions:

- taking into account features of functioning braking system of the vehicle with ABS diagnosing has to be made in a complex: as means of onboard preliminary treatment during the intercontrol period, so at power roller benches equipped with a set point adjuster of modes at state technical inspection ;
- implementing ABS demands further development of onboard means of diagnosing on the basis of development of new methods of diagnosing with use of multilevel structural and investigative schemes, first of all in efficiency parameters;
- it is expedient to carry out profound unit-by-unit preliminary treatment in bench conditions, with the greatest possible exception of random factors influencing the process. For widely spread

implementing the process of diagnosing in practice maintenance of cars with ABS is expedient to use the widespread approbated bench equipment of a domestic production with rather small cost and outline dimensions, for example, the power roller benches produced by ZAO "GARO-Trade", at their corresponding development [2].

- it is expedient to conduct completion of power roller benches in the direction of creation of special set adjuster of the modes allowing use of standard bench construction to estimate time of delay of the modulator operation, rates of change of braking torques, thresholds of setup of the ABS logical block, etc.

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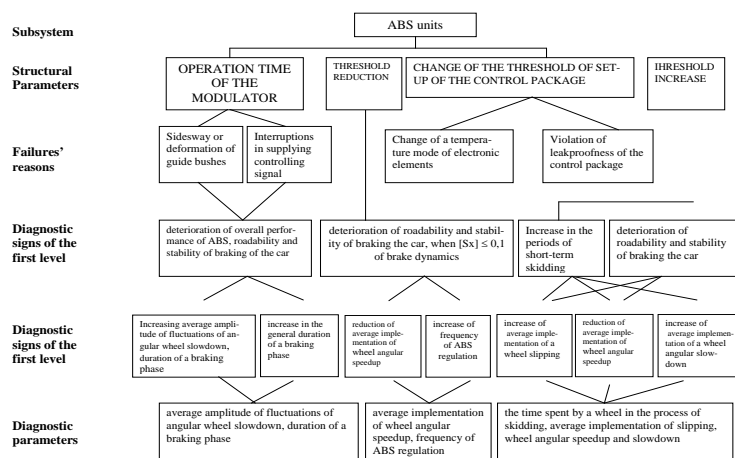


Figure 1. Structurally–investigative scheme for diagnosing the ABS elements of the car with the pneumatic braking system.