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Recommendations for the Effective Operation of Mercedes-Benz Bus Air Filters in Hot Climatic Conditions

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Abstract. This article is devoted to the regeneration of air filters Mercedes-Benz buses, justified the number of optimal regeneration of clogged air filters. The dynamics of the aerodynamic resistance of air filters is experimentally and theoretically proved, and the second-order polynomials are obtained for the prediction of the change in their resistance by applying the methods of mathematical statistics.

Key words: filter elements, air flow, filter elements, air resistance, cleaning methods, pollution particles, air filter, aerodynamic drag.

Introduction.

By regenerating cardboard filter elements, their original aerodynamic drag cannot be completely restored. However, depending on the method of regeneration, it is possible to significantly reduce the resistance of the filter element close to the original [1].

At the nominal air flow resistance of the new filter element is less than the resistance of the restored at 0.15-0.25 kPa. Moreover, the lower resistance value corresponds to the wet cleaning method, and the higher value-to dry (purge with compressed air at a pressure of 0.3-0.4 MPa) method for cleaning the filter element.

The regularity of changes in air resistance from the operating time of the filter element is nonlinear, i.e. in the form of a parabolic dependence [2]. This dependency can be described as:

$$\Delta P_i = a * L^2 + b * L + c$$

where:
ΔP_i - resistance of the air filter depending on its operating time L, kPa;
a, b - values depending on the complexity of the air filter design;
C - initial filter resistance in kPa.

This means that the parabolic dependence of the change in air resistance passes through the origin. From the requirements of the standard it is known that the initial resistance of the new air filter at the nominal air flow rate consumed by the engine should not exceed 0.08 - 0.12 kPa. The maximum permissible value of the clogged air filter should be 5.0-6.0 kPa. Further increase in the resistance of the air filter will lead to difficult engine start, unstable operation, fuel overruns and other negative consequences.

Research analysis.

We have studied the operating conditions and modes of maintenance of air filters of Mercedes-Benz buses in the conditions of Tashkent [3].

Currently, the filter elements of air filters in bus fleets are replaced with new ones after 75-90 thousand km of run taking into account their real condition. During this time, the bus power supply system is subjected to five or six times the service, respectively.

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Table 1.
Changing the aerodynamic resistance of air filters depending on their operating time.

Number of recoveries	Bus mileage, thousand km	Aerodynamic drag, kPa		Results of external inspection of the filter element
		A clogged filter	Restored filter	
New	0	-	1.20	New condition, meets the requirements of the standard
1	15.0±0.3	4.50	1.40	Normal state
2	30.0±0.3	4.70	1.65	Normal state
3	45.0±0.3	4.85	1.8	Normal state
4	60.0±0.3	5.05	2.05	Traces of violation of the structure of the filter material
5	75.0±0.3	5.6	2.40	Noticeable disruption of the structure of the filter material

For air filter elements, the service is to remove the dust settled on the surface and pores of the filter material under the pressure of 0.3 - 0.4 MPa in special installations.

Table 1 shows the increase in filter resistance during operation every 15 thousand km, which shows that the aerodynamic resistance of the new air filter on the run after the first recovery is reduced from 4.5 to 1.4 kPa.(at nominal air flow rate).

External inspection of the filter element after three times of recovery found that changes or violations on the surface of the filtration material were not observed. It can be assumed that the dust transmission coefficients of the filtration material did not deteriorate.

After the fourth restoration, the external examination revealed traces of violation of the structure of the filtration material, after the fifth restoration, noticeable violations of the structure of the filtration material were found, which allowed moisture to penetrate into the filtration material. After the sixth restoration of the filter element on the surface of the filtration material, it was easy to detect local swelling of the filtration material and changes in the geometric shape of the element due to the prolonged effect of moisture and fatigue.

The average values of the measured resistances of the air filters every 3.0 thousand km of run is given in table 2. The table data shows that the lowest aerodynamic resistance has a new filter: initial resistance 1.03 kPa, the ultimate resistance, i.e. 15.0 thousand km mileage – 5.05 kPa.

Table 2
Change in the aerodynamic drag of the air filter depending on the mileage of the bus and the number of regenerations

The mileage of buses, after which resistance was measured, thousand km.	The value of the aerodynamic drag from the number of regenerations, kPa					
	New filter element	1	2	3	4	5
0	1.03	1.15	1.20	1.32	1.5	1.65
3.0	1.50	1.70	1.85	1.85	2.05	2.35
6.0	2.2	2.50	2.50	2.55	2,70	3.05
9.0	30	3.30	3.40	3.20	3.40	3.70
12.0	4.05	4.15	4.35	4.20	4.50	4.70
15.0	5.05	5.15	5.20	5.33	5.40	5.62

The table shows that each regeneration increases both the initial and final resistance of the air filter. For example, the initial resistance of a new filter after five times regeneration increases from 1.03 to 1.65 kPa (by 60%).

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At the same time, the final resistance increases from 5.05 to 5.62 kPa (approximately 12%) after five times regeneration.

These data indicate the need to limit the number of regenerations of air filter elements in the operation of buses in terms of aerodynamic drag, cleaning efficiency, dust capacity, mechanical properties and others.

The average data of table 2 are processed by the least square method and formulas for predicting the aerodynamic resistance of the air filter depending on its operating time and the number of regenerations are obtained.

With the help of the obtained formulas it is possible to calculate the aerodynamic resistance of the new (R0) or regenerated (R_1,R_2,R_3,R_4,R_5) filters. The dynamics of changes in the resistance of the air filter and the resulting formulas are shown in Fig.1.;2.; 3.

$$\Delta P = 0.008 * L^2 + 0.1514 * L + 1.0068$$

The following formulas are obtained for regenerated filters:

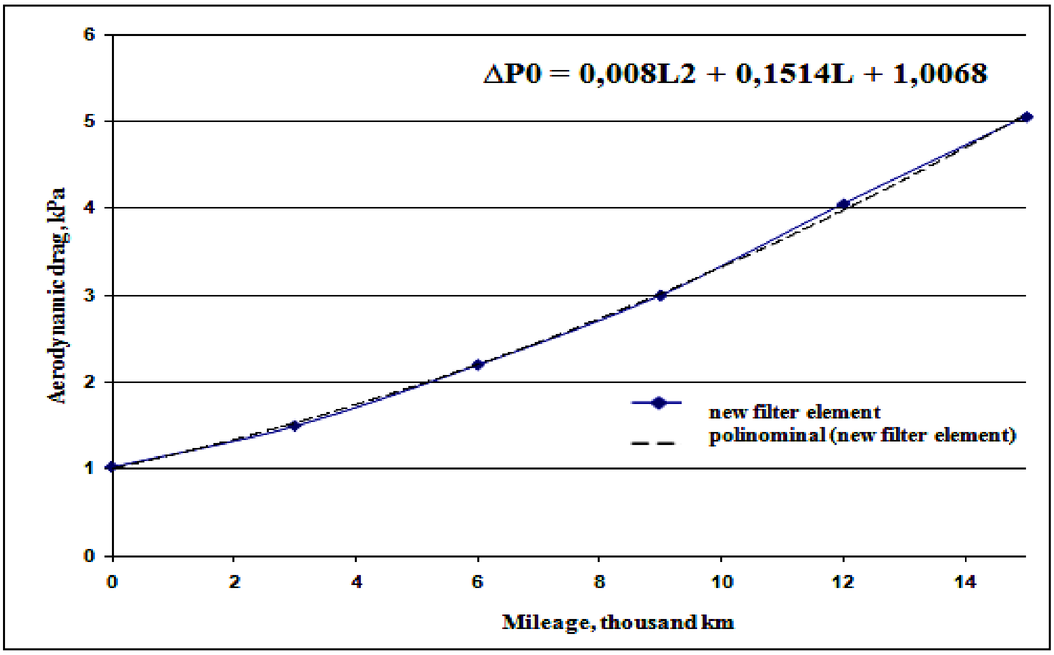
$$R_1: \Delta P = 0.0044 * L^2 + 0.074 * L - 0.9071;$$
$$R_2: \Delta P = 0.0044 * L^2 + 0.0569 * L - 1.0357;$$
$$R_3: \Delta P = 0.0083 * L^2 - 0.6107 * L + 11.95;$$
$$R_4: \Delta P = 0.007 * L^2 - 0.6885 * L + 17.455;$$
$$R_5: \Delta P = 0.0046 * L^2 - 0.4906 * L + 12.806;$$

R_1 ,R_2, R_3, R_4, R_5-filter element after the first, second, third, fourth and fifth regeneration.

The error did not exceed 1.0%, more precisely R_2 =0.9983, when describing the aerodynamic drag by the least squares method.

The obtained formulas can be used to predict the state of air filter elements depending on the operating time, as well as to determine the required amount of filter elements stock for a certain period of time of operation of buses.

Changing the initial and final aerodynamic resistance of air filters in the direction of increasing, in turn, will lead to a decrease in their life.



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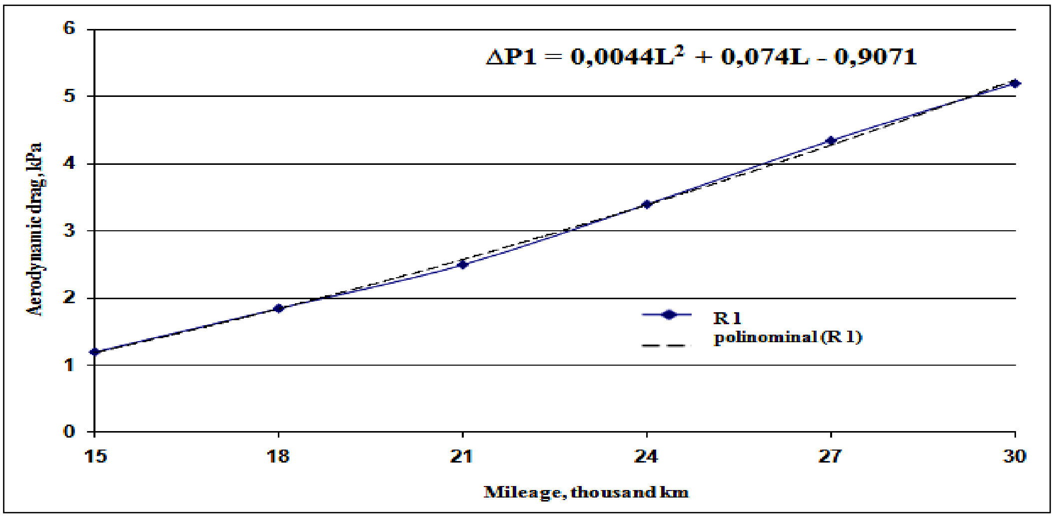


Figure 1. Aerodynamic resistance of new (R_0) and regenerated (R_1) filters.

Based on the data obtained in the conditions of operation of buses and observations of the state of air filter elements (especially for physical and mechanical indicators, such as the geometric shape, the presence of shrinkage of the element and the state of the filter material, violations of the structure, etc.), we offer three or four times the regeneration of the filter element.

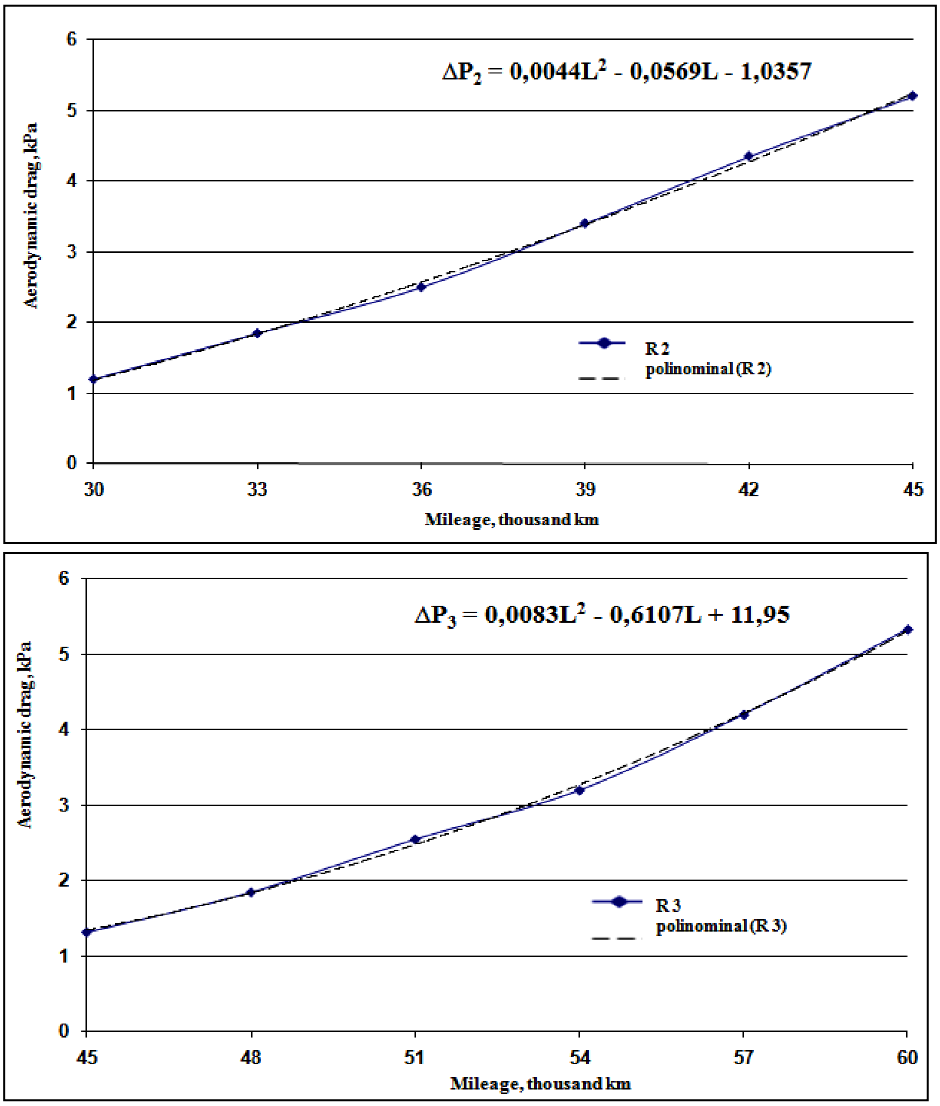
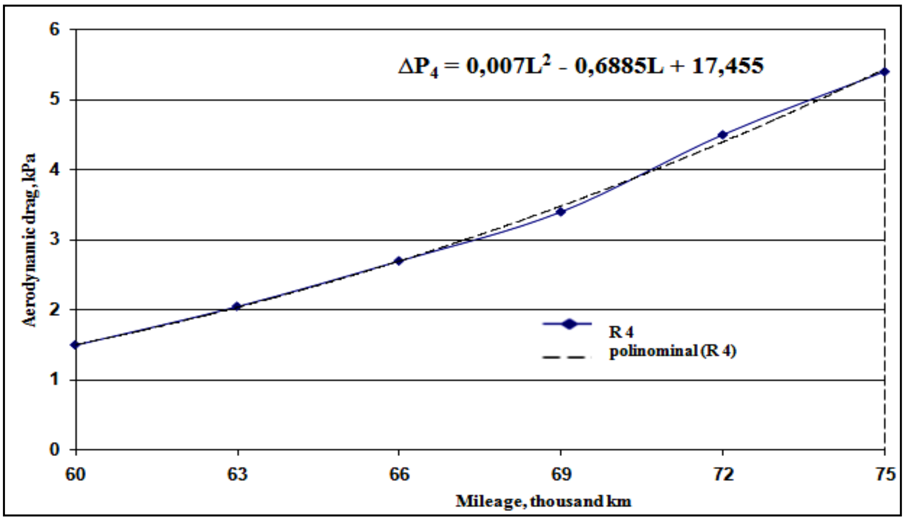


Figure 2. Aerodynamic resistance of filters after the second (R_2) and third (R_3)regeneration.

Based on the results of the operational tests and the description of their polynomials of the 2nd degree, it is possible to give recommendations on the permissible number of regenerations, dynamics of changes in the aerodynamic resistance of filter elements. Three or four times regeneration of filter elements in the conditions of bus fleets is offered.



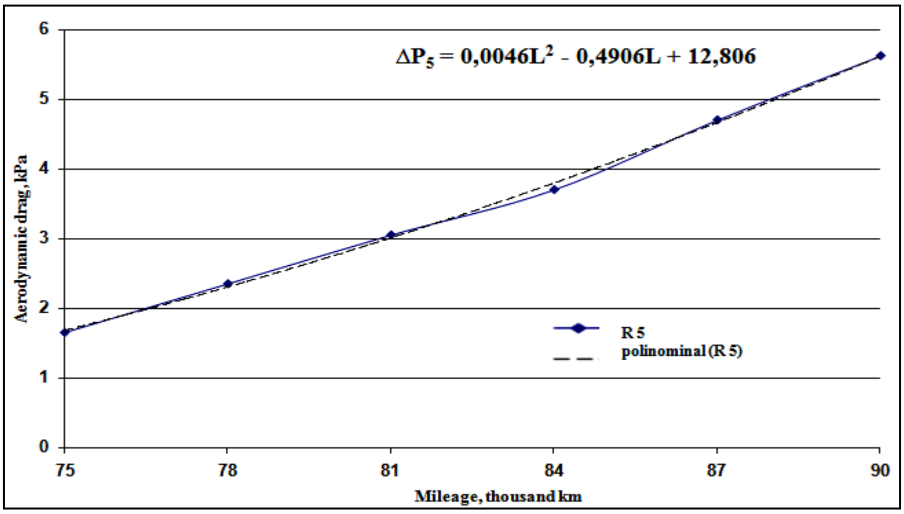


Figure 3. Aerodynamic resistance of filters after the fourth (R_4) and fifth (R_5) regeneration.

The formulas in the form of a second-order polynomial for the calculation of aerodynamic drag depending on the operating time for both new and restored filters are proposed.

The proposed polynomials can be used to predict the aerodynamic drag of air filters of buses during their operating time or resource.

Conclusions.

It can be seen from these figures that the resistance of air filters varies depending on the mileage in a parabolic dependence, i.e. in a nonlinear dependence: it is known from the literature review that the aerodynamic resistance of cardboard filtration materials varies linearly with the filtration rate.

Changing the initial and final aerodynamic drag of air filters in the direction of increase, in turn, will lead to a decrease in their resource, i.e. dust capacity. Based on the data obtained under bus operating conditions and observations of the condition of air filter elements (especially physical and mechanical parameters such as geometric shape, the presence of shrinkage of the element and the condition of the filter material, structural disorders, etc.), we propose a three-fold regeneration of the filter element,

Based on the results of the operational tests carried out, it is possible to give recommendations on the use of regenerated filter elements for hot climatic operating conditions:

1. For the regeneration of spent cardboard filter elements, it is advisable to use a dry air purification method with a compressed air pressure of no more than 0.5 MPa.

2. Formulas are recommended for calculating aerodynamic drag depending on mileage for both new and refurbished filters.

3. It should be noted that these formulas are derived from hot climatic operating conditions: buses . They can also be used to predict the number of filter elements for a certain period of time of the bus fleet.

Literatures.

1. Rybakov K.V., Ruzaev I.G., Ibragimov K.I., Karpekina T.P. Evaluation of filters. // Machinery in agriculture, No.5, 1980, pp.54-55.
2. 2.Kramarenko G.V., Ibragimov K.I., Karpekina T.P. Investigation of air purification quality and improving the reliability of the pneumatic system of cement trucks.// --Moscow:Niinavtoprom, issue 5, 1981. -pp.23-32.
3. Ibrokhimov K.I., Turakulov B.H., Rakhmatullaev N.N. Efficiency of the restored air filter elements. International scientific and practical conference "Modern materials, equipment and technologies in mechanical engineering" Andijan Engineering Institute, 2016.
4. 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.
5. Alimova Zebo Khamidullaevna, & Sobirova Dilorom Kobulovna. (2022). Development of Technology for the Production of Grease Based on Local and Secondary Raw Materials. *Texas Journal of Engineering and Technology*, *7*, 5–7.
6. Alimova Z. K., Sidikov F. S., & Usmanov I. I. (2021). Improving the stability of lubricants against oxidation. *Science and Education Today,(2 (61))*, 23-25.
7. Khamidullayeva, A. Z., & Narinbaevna, I. M. (2021). Improving the Lubricating Properties of Gear Oils Used in Agricultural Machinery by Adding Additives. *Design Engineering*, 4197-4204.
8. 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.
9. Xamidullayevna, A. Z., & Ahmatjanovich, M. M. I. (2021). Study of Anti-Corrosion Properties of Lubricants and Ways to Improve them. Design Engineering, 3811-3819.
10. Khamidullaevna, A. Z., & Akhmatjanovich, M. M. I. (2021). Environmental Safety in use Flammable Lubricants. Middle European Scientific Bulletin, 19, 83-85.
11. Alimova Z., Makhamajanov M., &Magdiev K.Мировая наука. *Мировая наука Учредители: ООО" Институт управления и социально-экономического развития"*, (11), 7-11.
12. Alimova Zebo Khamidullayevna, & Niyazova Gulhayo Parpiyevna. (2022). Investigation of the operational properties of transmission oils used in vehicles. *The American Journal of Engineering and Technology*, *4*(01), 19–23. https://doi.org/10.37547/tajet/ Volume04 Issue01-03
13. Alimova, Z. X., Ibragimov, K. I., & Turakulov, B. H. (2022). THE INFLUENCE OF THE OPERATIONAL PROPERTIES OF THE WORKING FLUID ON THE RELIABILITY OF HYDROMECHANICAL TRANSMISSIONS OF CARS. *The American Journal of Interdisciplinary Innovations Research*, *4*(03), 12-16.