Analysis of Pollution of Automobile Engines Operating in the Hot, High-Dust Zone of Uzbekistan

R.M. Tadjikuziyev
Senior Lecturer, Department of Mechanical Engineering and Automation, Fergana Polytechnic Institute, Fergana, Uzbekistan
E-mail: r.tadjikuzieyv@ferpi.uz

ABSTRACT

This paper presents the results of an experimental and analytical study of the abrasive aggressiveness of dust particles present in fuels and engine oils of automobile engines. Because the wear of parts of the cylinder-piston group is mainly abrasive in nature, the abrasive ability of dust particles of engine fuel pollution was studied. The study found that it depends on the logarithmic-normal distribution of dust particles and the numerical values of their abrasive aggressiveness, which significantly facilitates the development of theoretical issues to reduce the breakdown of engine parts.

Keywords: increasing wear resistance of engine parts, wear of parts, abrasive particles, the durability of engines, air dustiness, atmospheric dust.

Introduction

In any period, the problem of improving the quality of products remained one of the most important tasks. In this regard, increasing the reliability and durability of automobile engines, which provide the national economy with multimillion-dollar savings, occupies one of the first places in the work of engine-building plants and research, as well as educational institutes [1-4]. One of the technical aspects of solving the problem of increasing the durability of products is to substantiate the main direction of design developments that provide, at the lowest cost, the necessary increase in the wear resistance of engine parts and, first of all, parts of the cylinder-piston group [5-7]. Practice shows that the wear resistance of automotive engine parts is influenced by numerous factors for various reasons. It is very important to know and determine the factors that have a decisive influence on the wear of parts.

Materials and methods

The practical experience in the motor building shows that it is possible to achieve high durability of motors only by reducing the abrasive wear of auto tractor engine parts. [1,3]

The reliability of this hypothesis is confirmed by the results of experiments by several researchers [5-9]. It has been established that in modern automobile engines more than half of the wear is caused by abrasive particles, while this type of wear of engine parts is predominant for vehicles operating in various areas of Central Asia. This circumstance indicates that the main reserve for increasing the durability of engines is to reduce the abrasive component of wear by protecting engines from dust particles, improving air, fuel and oil filters, as well as all places where dust can enter the engine. From the foregoing, it follows that a decrease in the wear of car engine parts,

Of particular importance from the point of view of abrasive wear is the dust content of the air, especially in the summer, dry period of the year. Dust content in the air in the Republic of Uzbekistan in summer is on average 1.5-2.0 g/m3, and often during strong winds -17 g/m3. For clarity, it suffices to say that when the dust content of the air is 0.8 .... 1.2 g / m3, visibility is completely lost. Obviously, the operation of machines in such extreme conditions has its own characteristics and increasing their wear resistance and durability requires a specific and original approach to solving the issue.

Thus, the main amount of fuel and air contaminants is atmospheric dust, which causes abrasive wear of parts and failure of the engine power system. Due to the fact that the magnitude of this type of wear is determined by the abrasive ability of dust, of particular interest from the point of view of developing measures to improve durability is the identification of the abrasive properties of atmospheric dust by determining their numerical values. In this regard, we carried out analytical and experimental studies to solve the above problem.

There is a certain correlation between air dustiness and fuel pollution. The higher the dust content of the air, the greater the number of dust contaminants in the fuel, mainly oxides of silicon and aluminium. This shows that the main source of pollution is atmospheric dust [18-23].

The abrasive ability of dust depends primarily on its dispersed and mineralogical compositions, therefore, of theoretical and practical interest is the quantitative assessment of the abrasive ability of road dust, natural air pollutants, fuel and artificial quartz pollutant used in testing fuel, oil and air filters.

Road dust from the surfaces of the cab hood and wings was studied, and deposits from the fuel filters of cars operating in various regions of the Republic of Uzbekistan were used as gasoline contaminants.

The countable disperse composition of contaminants was determined on a PMS instrument manufactured by Millipore (USA) by automatic counting of pollutant particles under a microscope. The calculation error does not exceed 2.7%.

When determining the dispersed composition of pollutants for the preparation of samples, a sample of dust and sediments was taken from the filters weighing 10 mg and distributed in 100 ml of gasoline. To exclude large conglomerates, the flask with the sample was placed in an ultra disperse. 1 ml of the suspension was taken from the dispersed sample, diluted with 14 ml of gasoline, and filtered through a Millipore membrane filter. The filter with settled particles was dried and clarified with a solution with equal proportions of hexane and dichloroethane. For the convenience of comparing the research results, the specific surface of pollutants on the PSH-2 surf was also determined in accordance with GOST 8002-94.

The mineralogical composition of pollutants was determined by gross analysis based on the fusion of primary and secondary minerals of the soil, connected by crystal lattices with the help of sulfate and carbonic salts of sodium and potassium at a temperature of 1273-1473K. The resulting alkaline salts of silicic acid were dissolved in hydrochloric acid and the content of quartz minerals, and then other elements, was determined by weight. The abrasive ability of pollutants was studied on the UAS-2 installation designed to determine the abrasive properties of micro powders in accordance with the SEV 206-75 standard. The UAS-2 unit is a bench-top grinder with a horizontal faceplate for grinding metal samples with loose abrasive powders in an oil suspension. Disc rotation frequency, i.e. faceplates, made of steel ШХ15 with hardness HRC 60, is equal to 1.67 s-1. Cast iron SCh 21-40 with hardness HB 310-340 was used as a test sample in the form of a rectangular prism with a base of 10 X10 mm. Simultaneously, three samples are tested, fixed at an equal distance from each other on the holder block, which reciprocates along the faceplate movement surface at a frequency of two strokes per second. The samples are pressed against the surface of the faceplate with a weight of 2 kg. Abrasive powders, together with oil, are introduced onto the surface between the faceplate and the samples. Test duration 30 min. The abrasive ability of dust was determined by the result of two parallel experiments. Cast iron SCh 21-40 with hardness HB 310-340 was used as a test sample in the form of a rectangular prism with a base of 10 X10 mm. Simultaneously, three samples are tested, fixed at an equal distance from each other on the holder block, which reciprocates along the faceplate movement surface at a frequency of two strokes per second. The samples are pressed against the surface of the faceplate with a weight of 2 kg. Abrasive powders, together with oil, are introduced onto the surface between the faceplate and the samples. Test duration 30 min. The abrasive ability of dust was determined by the result of two parallel experiments. Cast iron SCh 21-40 with hardness HB 310-340 was used as a test sample in the form of a rectangular prism with a base of 10 X10 mm. Simultaneously, three samples are tested, fixed at an equal distance from each other on the holder block, which reciprocates along the faceplate movement surface at a frequency of two strokes per second. The samples are pressed against the surface of the faceplate with a weight of 2 kg. Abrasive powders, together with oil, are introduced onto the surface between the faceplate and the samples. Test duration 30 min. The abrasive ability of dust was determined by the result of two parallel experiments. The samples are pressed against the surface of the faceplate with a weight of 2 kg. Abrasive powders, together with oil, are introduced onto the surface between the faceplate and the samples. Test duration 30 min. The abrasive ability of dust was determined by the result of two parallel experiments. The samples are pressed against the surface of the faceplate with a weight of 2 kg. Abrasive powders, together with oil, are introduced onto the surface between the faceplate and the samples. Test duration 30 min. The abrasive ability of dust was determined by the result of two parallel experiments.

A study of the dispersed compositions of natural road dust and contaminants from vehicle fuel tanks showed that they all have a log-normal distribution (LNR) of particle sizes, so each of them is fully characterized by two parameters: the average logarithm of the particle sizes lgβ, and the logarithm of the standard deviation lgβ, defined by the relation lgβ =1/tgα where tga is the angle between the straight line characterizing the particle size distribution and the abscissa axis in logarithmic normal coordinates. The results of the countable disperse analysis of aerosols showed that they are satisfactorily approximated by a log-normal distribution.

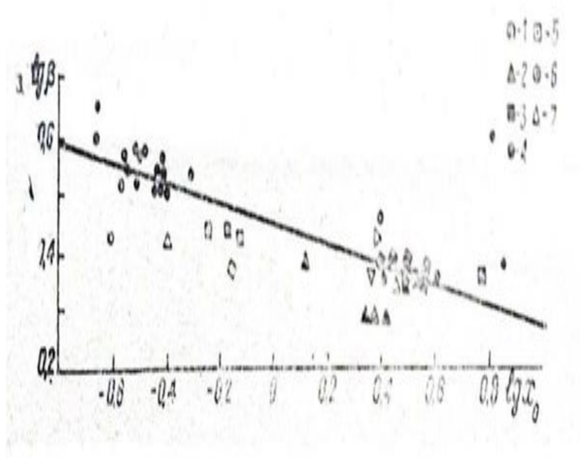

Figure 1. Dependence of the average logarithm of particles lgx on the standard deviation lgfi in aerosols according to various data

From the obtained values of the parameters of the logarithmically normal distribution, plotted on the graph (Fig. 1), one can see a clear correlation dependence of the average logarithm of the particle size on the standard deviation with a correlation coefficient equal to 0.863. Using the least-squares method, a linear equation for this dependence is found:

$$tg\beta=0,4426-0,1647\ lgx_0 \qquad (1)$$

Thus, the distribution of atmospheric dust particles, as well as liquid pollution, can be unambiguously determined by the value lgx0 or x0, which provides a basis for classifying the dispersed compositions of various dust and allows them to be compared, and also greatly facilitates the development of theoretical issues of abrasive wear. The mineralogical composition of the pollutants was estimated from the content of quartz and alumina. The content of alumina in the studied dust did not exceed 19%; therefore, their values are not given.

Quantities of quartz in dust and sediments from filters are close, and depending on the soil structure and sampling area, their content varies from 36.2 to 65%. The content of quartz in the artificial quartz pollutant is 98%.

Table 1. Relative abrasive ability of road dust

Sampling sources	Specific surface cm^2 /g	Quartz content, %	Relative abrasive ability
Quartz used in bench	5900	98	one
Deposits from car fuel filters			
Bukhara region	6560	54	0.53
Khorezm	7100	fifty	0.46
Andijan	6250	36.2	0.48
road dust			
Bukhara region	5460	65	0.58
Khorezm	6030	53.4	0.53
Tashkent	6150	53.4	0.49
Namangan	6420	50.5	0.49
Andijan	6750	47.9	0.45

The abrasive ability of pollutants was determined by the ratio of the mass of ground metal to the mass of dust used for this:

$$A = \frac{q1 - q2}{G} \frac{mg, metall}{g, abrasiv} \quad (2)$$

Where q1 and q2-mass of the sample, respectively, before and after testing, mg; G - sample of abrasive dust, mg. With an increase in the content of quartz in natural dust, their abrasive ability increases. Deposits from fuel filters have a slightly lower abrasive capacity compared to road dust from the same areas, which is apparently due to changes in the dispersed and mineralogical composition of sediments. All-natural contaminants have 1.7-5 times less abrasive ability than artificial quartz contaminants.

Conclusion

Thus, the research results allow us to draw the following conclusions: the disperse composition of particles of various aerosols can be approximated by a single, logarithmic-normal distribution law, between the parameters of which there is a linear dependence, which greatly facilitates the development of theoretical issues of reducing abrasive wear of engine parts. The disperse composition of dusts is uniquely characterized by the logarithm of particle sizes. Estimation of the disperse composition of dusts by the average logarithm of particle sizes can significantly simplify the processing and analysis of filter test results.

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