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NANOFIBER FILTERS FOR PURIFYING MOTOR OIL

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Abstract: The article analyzes modern designs of automotive oil filters and develops proposals for increasing their operational efficiency and reducing harmful environmental impact. The study highlights the possibilities of using nanofibre filters.
Key words: car, engine, engine oil, oil filter, filter element, nanotechnology, modular system, sensor, efficiency.

The oil filter is an essential component of the internal combustion engine (ICE) lubrication system. It removes pollutants from the engine oil (carbon particles, metal wear particles, and dust entering the engine oil from the air), prevents wear of internal combustion engine parts, helps cool the engine, and extends the viscosity period of the oil. Modern filters are full-flow, meaning they clean the entire oil flow, or have partial-flow cleaning capabilities**.**

Oil filters are distinguished by their operating principle: mechanical, magnetic, centrifugal, gravity-driven, by design: full-flow, partial-flow, combined, and by the type of filter element: mesh, paper, or felt. Their primary purpose is to remove pollutants from the engine oil to protect the engine. The following methods are used to purify motor oil.

By cleaning method: Mechanical: Most commonly, they use paper, synthetic, felt materials, or wire mesh materials to physically retain particles.

Magnetic**:** They attract and hold metal particles using magnetic fields, often used in gearboxes.

Centrifugal force is strong: They purify the oil using centrifugal force, separating impurities from the oil by centrifugal force and holding it in a special lid.

Currently, new filters are being developed to improve the quality indicators of motor oil purification. Below is information about one such filter, the nanofiber filter.

Nano-fiber filter element.

Nanotechnology involves controlling matter almost at the atomic level. Nanotechnology is used in industrial enterprises, particularly in automotive internal combustion engines, to perform high-efficiency filtration of air and motor oils. A layer of nanofiber is produced using electrospin, resulting in very thin, long, and elastic fibers with a diameter of 0.2–0.3 microns. Then, filter layers are prepared from these fibers. The nanofibers form strong, fine-mesh shells on the surface of the filter element. These meshes trap dust, various particles, and pollutants on the filter surface.

Nano-fiber oil cleaning element. This is a modern type of filter element for internal combustion engines (ICE) designed to purify oil more efficiently than traditional materials such as paper or cellulose. These filters can better protect the engine by capturing the smallest pollutant particles.

Nanofiber filters have the following advantages: A distinctive feature of nanofibers is their highly developed surface area and porosity, which makes them highly effective in filtration

processes. The nanofibers were manufactured using NanoSpider technology on the NS LAB 500 S system (ELMARCO, Czech Republic).

High efficiency: Nanofibers capture even the smallest pollutant particles that traditional filters would allow to pass through.

Longer filter lifespan. Due to their structure and materials, nanofibre filters can retain their properties for a long time. Due to the effective nanoscale layer and surface filtering properties, nanoscale layer filters last much longer than traditional filter elements. Longer service life means fewer purchases of filters, leading to significant savings in the long run. Furthermore, a longer service life of the filter reduces the frequency of vehicle failure.

Reduces friction and wear of engine parts. It prevents the formation of pollutants and sediment in the engine. Extends the oil change interval.

Improved protection: Fine filtration reduces engine wear by trapping abrasive particles and extends the engine's service life.

They work as follows: Filtering: An oil filter is a part of the engine lubrication system through which all oil passes. During this process, nanofibre filters capture carbon, carbon, and other pollutants.

Rotary valve: The filter has a rotary valve that opens when the pressure increases, ensuring oil flows into the engine even if the filter is clogged.

Nanofiber filters differ from standard filters in that they consist of:

Material: Traditional filters are made of paper, cardboard, or felt. Nanofiber filters instead use specialized nanofiber materials.

Pore capacity: Nanofiber materials have smaller pores, allowing them to retain smaller pollutants.

Cost: Nanofiber filters can be more expensive than traditional filters.

Filters based on nanofibers allow for the blocking of micron and submicron particles. These filters are used for heavy-duty trucks and passenger cars that require maximum engine protection.

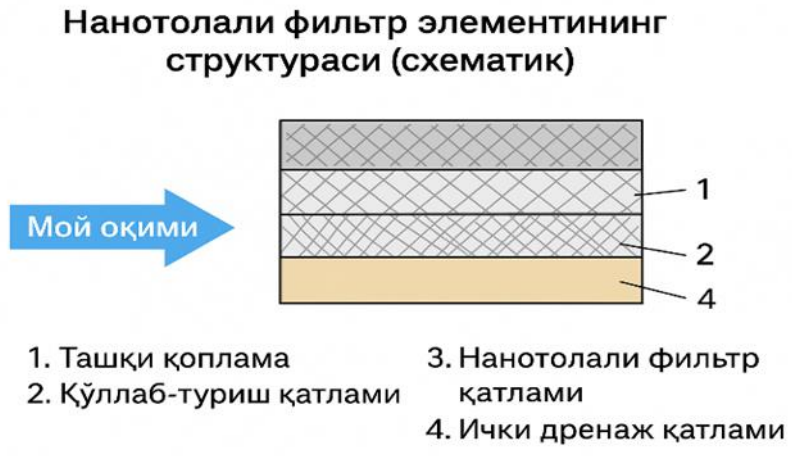

Figure 1. Structure of the nanofiber filter element (schematic)

Experimental results. The filters mentioned above underwent comparative testing in laboratory conditions, and the results obtained are presented in the table below.

Table 1

Filter performance comparison

Filter type	Particle blocking rate (%)	Operating cycle (hours)	Oil pressure (bar)
Traditional filter	82	400	3.1.
Nanofilm filter	97	610	3.0
Touch modular filter	96	640	3.0

Conclusion. Nanofibrous materials increased filter efficiency by 18-25%.

Nanoparticles capture even the smallest pollutant particles that traditional filters would allow to pass through. Thanks to their structure and materials, nanofiber filters retain their properties for a long time. Nanofiber filters have reduced the impact of waste on the ecosystem by 30%. These results indicate the possibility of using new oil filters in the automotive industry.

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