TOTACHI®: Cleaning up our filter game.

In today's automotive world; OEMs, trade associations and consumers alike are placing utmost importance on the environmental impact of modern automobile engines.

One of the key contributors to maximizing engine efficiency, and minimizing pollution to the environment is the protection of engine parts against abrasive wear. The number one cause of engine failures that require an overhaul is abrasion damage, caused by foreign particles in an engine under operation. Due to the importance placed on engine efficiency, modern automotive engines are designed with extremely close tolerances, increasing the friction load, and thus; increasing the sensitivity of the engine to micron-sized abrasive particles. The result? Increased importance on the durability and reliability of the oil filtration system to ensure a long, stable engine life.

In order to further develop TOTACHI® Automotive Filters, the product development team recently sent filter samples to the Central Automobile and Engine Institute (NAMI), to implement comparative filter testing in an independent research facility.

The technological development of TOTACHI® Automotive Filters is reliant on working with various scientific bodies around the world who lead their field in research and development, such as the NAMI Institute of the Russian Federation. Outlined below is an overview of the findings from the NAMI study on TOTACHI® Automotive Filters.

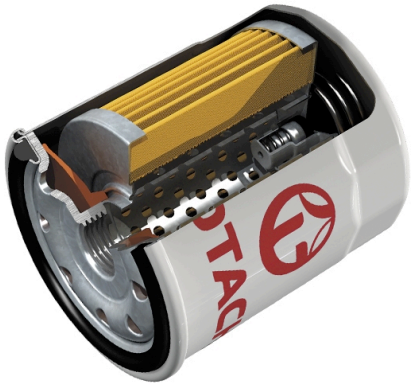
The level of contamination in a used engine oil has several key contributors: quality of fuel, quality of oil, engine design, and engine application. There are also many factors that contribute to contamination of engine oil, such as oxidation, incomplete combustion, foreign particles, engine residuals. Contaminants can be categorized into two major groups: *organic*, and *inorganic*.

The majority of *organic contaminants* consist of byproducts of incomplete combustion, thermal decomposition, oxidation, as well as polymerization of oil, fuel, water and sulfur compounds. Modern engine lubricants contain detergent and dispersant additives that aim to prevent contaminants adhering to each other, resulting in particles no larger than two microns. Organic contaminants have no significant effect on the friction couples or abrasive wear of the engine.

Inorganic contaminants include dust particles, worn out ash additive particles, engine wear particles and process contaminants. These contaminants lead to abrasive wear, and can have significantly detrimental effects of the longevity of the engine.

Automotive filters are assigned the role of removing contaminants (both organic and inorganic) from the engine oil.

The design of an engine oil filter consists of a filter element, and anti-drain back / bypass valves. These elements can be arranged either in steel case (screw-on filter – TOTACHI® TC series), or separately in the engine (element filter – TOTACHI® TO series).



All the design elements of an oil filter play a crucial role in the successful filtration of lubricant.

The anti-drain back valve usually has the form of a rubber membrane adjacent to the inner side of the can type filter cover. The membrane covers the holes where the contaminated oil gets through to the filter and protects against the back flow after the engine stops. The anti-drain back valve reduces the duration time of the dry or semi-dry friction between the working parts of the engine because by preventing the oil flowing towards the oil pump it speeds up the oil stream getting to the working elements during the start of the engine, especially after a long stop. The application of the valve is conditioned by the position in which the filter has been screwed to the engine.

The by-pass valve is always installed in the oil system with full-flow filter (installed in series in the system). Usually it is built in the filter itself, however there are constructions where this valve is placed in the engine body. Regardless of the place where it is installed, its only function is to clear the oil flow when the flow resistance is too high and there is a risk of insufficient lubrication of working parts. It is considered though that lubricating and cooling with contaminated oil is less damaging than the lack of lubrication which may lead even to the engine stopping. There are basically two reasons why oil flow resistance in the filter opens the by-pass valve. The first one is high density which happens in winter at low temperature. While starting the car after a long stop (i.e going to work in the morning), cold and thick oil gets to the filtration partition and runs through it in a difficult way. The pressure increase makes the by-pass valve open. The second reason for the by-pass valve opening is the filter medium wear. When the filter is excessively contaminated, its filter

medium is clogged with pollutants. In this case the by-pass valve might be open all the time. To avoid such situations, it is required to change filters and oil in accordance with the car manufacturer's recommendations.

The quality of an oil filter is determined by three key parameters:

- **Filtration capacity**
- **Completeness of filtration**
- **Dust capacity**

Filtration capacity:

The filtration capacity of an oil filter measures the ability of a filter to remove particles at the micron size. Some filter companies advertise capacity of 5 microns, however, filtering particles under 20 microns can cause significant hydraulic resistance to filtration, as these particles will clog the filter extremely quickly. The most dangerous contaminants in oil are particles that are sized 30-45 microns, leading to significant abrasive wear if left unfiltered. With this in mind, the most effective filter should have a capacity to remove contaminants from 25-30 microns and above. A lower capacity will lead to filter clogging, whilst a higher capacity will result in damaging contaminants being unfiltered.

Completeness of filtration:

Completeness of filtration is correlated with the filtration capacity, and gives an indication of the percentage of dust / particles that can be captured by the filter.

Dust capacity:

Dust capacity is determined by the amount of dust / contaminants that the filter is able to hold, while maintaining moderate hydraulic resistance. The dust capacity defines the lifespan of the filter, and the replacement interval. The accumulation of contaminants in the filter element will result in gradual clogging, and an increase in the hydraulic resistance of the filter. As the hydraulic resistance begins to increase, the filter loses its ability to filter the oil, the oil pressure in the filter rises and the bypass valve opens to relieve the pressure.

Given that filter manufacturers use similar filter materials that are defined by similar characteristics, the dust capacity of a filter is highly dependent on the weight and surface area of the filter medium. A higher specific gravity of filter material, and a greater surface area results in a greater dust capacity value, and therefore a longer service life. Leading

filter manufacturers use folding technologies to effectively achieve larger surface areas of the filtration paper.

As mentioned earlier, the NAMI institute implemented comparative testing of several samples from 3 different OEMs manufacturers, with the results presented below. The testing was conducted using filters from MANN-HUMMEL GmbH, Germany, a globally recognized filter manufacturer, an original Toyota Motor Corp filter, and a filter manufactured by TOTACHI INDUSTRIAL CO., LTD.

Test no. 1: Comparative test of a spin-on oil filter – Toyota OEM filter, and the cross-referenced alternative for MANN-HUMMEL and TOTACHI:

- **TC-1030 (TOTACHI Industrial Co Ltd, Japan);**
- **W68/3 (MANN-HUMMEL GmbH, Germany);**
- **90915-YZZJ1 (original Toyota Motor Corp).**

The official test transcript is available online:
http://totachi.com/images/catalog/Packaging/nami_test_results_1.pdf

The results of the comparative testing demonstrate that the TOTACHI TC-1030 filter sample has a filtration capacity of 28 microns, a value of 62% in regards to completeness of filtration, with 0.018 MPa maintenance of hydraulic resistance – these results are similar to that of the Toyota and MANN-HUMMEL filters. Given the test data, the NAMI Institute has given testimonial that the service life of the TC-1030 exceeds 15 000km, exceeding the requirements for replacement intervals of leading OEMs (including Toyota).

Test no. 2: The following analog samples of ECO series filters were compared:

- **TO-1190 (TOTACHI Industrial Co Ltd, Japan);**
- **HU 6006z (MANN-HUMMEL GmbH, Germany);**
- **04152-37010 (original Toyota Motor Corp).**

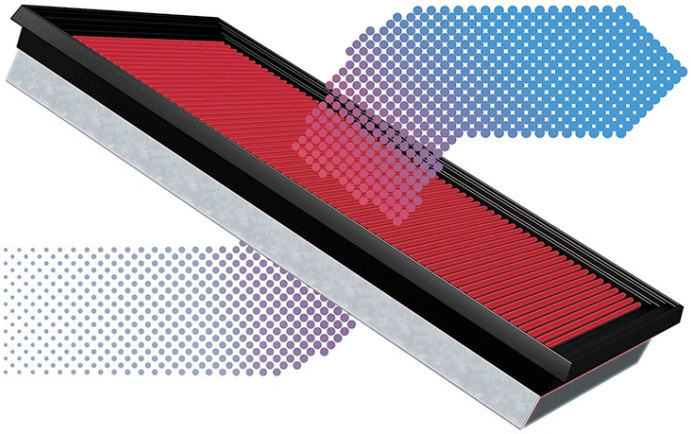
The official test transcript is available online:
http://totachi.com/images/catalog/Packaging/nami_test_results_2.pdf

The results of the comparative testing demonstrate that the TOTACHI TO-1190 filter sample has a filtration capacity of 30 microns, a value of 59% in regards to completeness of filtration, with 0.012 MPa maintenance of hydraulic resistance – these results are

similar to that of the Toyota and MANN-HUMMEL filters. However, the results of the dust capacity testing indicate that the TO-1190 has a similar relative density and filter screen surface area of the OEM sample, resulting in a apples-for-apples service life, which exceeds the parameters of the second competitor's sample by 65%.

The significance of a quality air filter:

There is a common misconception among mechanics and consumers alike that the quality of an oil filter is significantly more important than the quality of an air filter. Unfiltered air, even in the slightest doses, increases the abrasion speed in the cylinder-piston group by almost 10 times. Therefore, selection of a proper oil filter is of significant importance to the longevity of the engine, and cost saving with a low quality oil filter is not advised.



Air composition and quality widely vary across the world, and depend on environmental conditions – soil, dust, road conditions, traffic, construction – the list goes on. The abrasive properties of dust depend on the mineralogical composition, as well as the percentage of quartz and corundum in dust. These elements are extremely hard, and are capable of significant damage / wear to engine parts. Quartz is prevalent across the world, and is considerable harder than most metals that are used in the manufacturing of automotive engines, therefore the air filter plays a crucial role in filtering quartz particles from the air intake. The air filter needs to effectively protect the engine against direct intake of abrasive particles and road dust.

The quality of an air filter is defined by its dust capacity. From a technical standpoint, the average dust capacity of an air filter in an automotive vehicle should not exceed 1%. However, the global standard sees many manufacturers of air filters base their standards on 3%, which for Totachi, is an unacceptable rating.

As mentioned earlier, the NAMI institute implemented comparative testing of several samples from 3 different OEMs manufacturers, with the results presented below.

Test no. 3: Comparative test of an air filter – Toyota OEM filter, and the cross-referenced alternative for MANN-HUMMEL and TOTACHI:

- **TA-1343 (TOTACHI Industrial Co Ltd, Japan);**
- **C 24 005 (MANN-HUMMEL GmbH, Germany);**
- **17801-00060 (original Toyota Motor Corp).**

The official test transcript is available online:
http://totachi.com/images/catalog/Packaging/nami_test_results_3.pdf

The results have demonstrated that Totachi's TA-1343 air filter sample has a dust capacity within the 1% range.

Based on the test results, the Totachi air filter meet the standards for OEM parts, with performance characteristics that exceed durability standards and and replacement intervals.

Mr. Sasaki Eyshi, Chief Operating Officer of TOTACHI INDUSTRIAL CO., LTD offered some insights into the test results:

"Specialists from TOTACHI INDUSTRIAL CO., LTD work closely with the leading filter research laboratories that perform a wide range of special testing for exact and detailed definition of their properties. All filters, developed and introduced by Totachi, passed a series of laboratory tests that measures the performance characteristics. Given the results, users can be confident that Totachi filters fulfill the OEM requirements, and exceed the industry standards for considerations of a high quality filter. "

TF-Technology (Targeted Filtration Technology) is Totachi's filter technology that conforms to the specifications and requirements of OEMs, resulting in automotive filters that meet or even exceed the quality of original OEM parts. One of the key factors of TF-Technology is the selection of a specific type; and structure, of filtering paper, allowing Totachi to regulate the porous structure of the filter element to obtain the required physical and mechanical properties of the filtration material. Totachi's TF-Technology impregnates the filtration medium with additional synthetic fibers, which aids to improve the quality of filtration, and guarantees the set performance characteristics that are adapted for each vehicle type.

Totachi filters are not just automotive products... they are a part of our philosophy of giving the consumer peace-of-mind in using our wide range of products for all their servicing needs. The principle of constant perfection, "TOSAN" is adapted in all our manufacturing processes, with consistent innovation and technological advancements in our filter range, backed by independent testing. Totachi's manufacturing program provides a wide range of filters for all modern vehicles – oil, element, air, cabin and automatic transmission filters. Contact the business development team, or the regional authorized distributor for more information.