THE DEVICE FOR MECHANICAL FILTRATION OF PETROLEUM PRODUCTS

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ABSTRACT

The aim of this study was to try out fuel and oil filtration in combination with different types of nanotextiles. The filtration was carried out on a special testing device, which included innovative heads of three sizes: 20mm, 50 mm and 100 mm. The first, smallest head was used for filtration of liquids with lower level of impurities, such as gasoline and diesel. The largest head was used for lubricating oils and other kinds of oily liquids. Medium size was designed for polluted water. Each head is equipped with new quick and easy to use system for mounting samples in order to avoid damaging the nanotextile structure. Special filter methodology was designed for these experiments. Individual samples were then sent to an external laboratory for tribotechnical analysis. Detailed analysis of the results will follow as the next step of this research project.

Key words: filter, filtration device, nanofibrous

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INTRODUCTION

Nowadays, more and more machines and equipment are used that require prescribed purity of technical fluids for their work. Fuels and lubricants are the most important ones among these liquids. Mechanical work of the machines, their maintenance and refilling of liquids cause impurities in the hydraulic circuit, which have a considerable damaging effect to all the important elements. Thus, filters are inserted into the circuits to minimize the amount of impurities throughout the period of use (Bilyi *et al,* 2000). However, current environmental trends require extending the change intervals of fluids and filters. This approach makes the risk of failure even higher, because the amount of impurities does not only depend on the quality of liquids, but also on a good function and proper selection of the filtering materials (Farahani *et al,* 2011). For these and many other reasons we are constantly looking for materials that would be able to preserve their excellent properties (flow rate, mechanical strength, high porosity, etc.) in the long run and at he same time would allow very fine filtration. Future properties and behaviour of the filter cannot be unambiguously predicted and thus each unknown material must be properly tested and analyzed at the beginning. (Barhate *et al,* 2007). Our experiments focused on testing various types of nanotextiles are held on a special device that simulates actual operating conditions.

MATERIAL AND METHODS

The aim of this test was to try filters of different sizes for filtration of various types of liquids. Two different fuels (N95 and E85) and two types of filters (traditional and nanomaterial) were chosen for the experiment. The capture of particles by individual filters was measured and analysed.

The special equipment for the testing consists of a stainless steel pressure tank with capacity of about two liters, mounted on a stand. The tank has an inlet and outlet valves, the upper lid, a pressure gauge up to 10 bars, an air filter and an air regulator. The device has three different sized heads into which the nanofilters are inserted.

Before starting the test it was necessary to wash any possible dirt from the tank. This was done using perchlorethylene. Then the tested substance was poured into the reservoir device and the upper lid was closed. The next step was the preparation of nanotextile samples. They were cut out or coined with a stamp from the nanotextile bulk. The smallest head was used mainly for substances with lower pollution level like gasoline and diesel fuel. The samples were successively inserted into the head of the device and the filtering process was started.

The filtration procedure works according to the following model: the pressed air from the compressor enters the upper part of the device through the air filter. The air is regulated to the desired pressure, usually in the range of 1 - 3.5 bars, sometimes even 6 bars. The compressed air goes through a pipeline into the tank where it exerts pressure on the fluid. The fluid escapes outside through the head containing a nanofilter.

Tested liquids escaped from the filter heads were captured in plastic test tubes. Each experiment was repeated three times for each sample.

RESULT AND DISCUSSION

The test was focused on the amount of particles in the fluid. The particles are so small that they can not be seen to the naked human eye. Special device was needed to determine exactly the size and number of particles. The samples were analysed on LNF-C (Laser-Net Fines-C). This method is called "Method for coding the level of contamination" by solid particles and is subject to the standard of CSN ISO, (No 4406, 2006). After this process the samples were evaluated and their purity before and after filtration was compared. The average values before and after filtration using a traditional paper filter and a nanofilter M334 are given below (see Fig. 1.)

Tab. 1. The average number of particles in sizes >4, >6 and >14 [μm], resp.

N95				
Samples/Size of particles	**> 4 [μm]**	**> 6 [μm]**	**> 14 [μm]**	**Total particles**
Raw sample (gas station)	1837	394	35	2266
Traditional filter	1272	241	10	1523
M334	577	172	7	756
E85				
Raw sample (gas station)	1539	531	48	2118
Traditional filter	825	226	17	1067
M334	520	143	15	678

As shown in Fig. 1, non-filtered gasoline N95 contained 1837 particles having particle size ≤ 4 µm and the filtration using traditional filter was able to lower the amount of particles by 565 pcs per 1 ml. However, the filtration using the membrane M334 achieved to remove total 1260 contaminating particles. In other cases the course of filtration was similar and the filter M334 was able to catch the highest amount of particles.

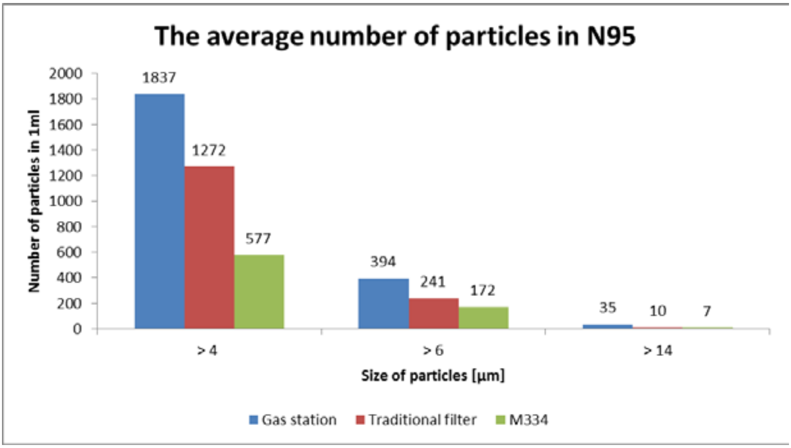

Fig. 1. The average number of particles in N95

Fig. 2 shows the amount of impurities per one ml of bioethanol E85. The number 1539 pcs of particles represents the amount of impurities before filtration having particle size ≤ 4 μm. In this case the decrease to almost one half of particles occurred during traditional filtration, i.e. to 825 particles. The filter M334 was able to reduce the content of impurities to 520 particles.

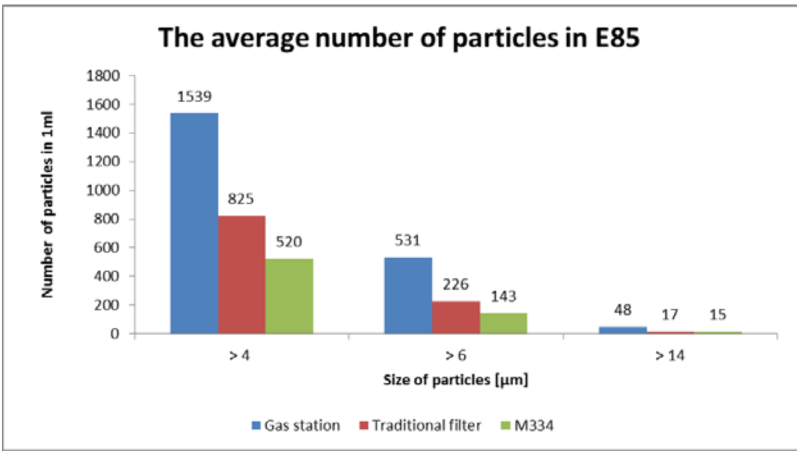

Fig. 2. The average number of particles in E85

CONCLUSIONS

The experiment proved that the impurities were present in each of tested fuels. Non-filtered gasoline N95 contained most impurities in the size range 4-14 μm; there was total amount of 2 266 particles per 1 ml volume. All filtrations decreased original amount of particles, the results differed according to the filter material used. Common traditional filter is able to reduce the content of impurities up to one half in some cases. New filtration nanomaterial was able to reduce the content of impurities up to one third of original impurity particles in overall scale. Next step of this research will be the test of filtration of various types of diesel engine fuels and the comparison of results. Possible occurrence of problems with higher viscosity or larger content of impurities is expected here. This test simulated real conditions and the results will used for further studies.

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