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USED AUTOMOTIVE OIL FILTERS – AN ENVIRONMENTAL HAZARD FROM THE POLISH PERSPECTIVE

Usually motor oil and used oil filter are exchanged simultaneously. Used motor oil contained in the filter presents a menace to the environment, especially for drinking water. In Poland, used oil (as a hazardous waste) is collected and re-refined, but the program does not include filters collection. In the presented paper, an attempt was made to estimate the quantity of used oil remaining annually in used oil filters. The assessment is based on the data obtained from the experiments and statistic data. Legal solutions and technical means of used oil filters collection in the U.S.A. (where every second used filter is recycled) were analysed. The means for solving the problem in Poland were suggested.

1. INTRODUCTION

Generation of wastes is an inseparable consequence of human functioning on the Earth. Especially the group of wastes classified as hazardous ones present a serious risk for the environment.

In Poland, as in many other countries of the world, people realise that these wastes should be systematically collected and utilised or recycled. Used oils (waste oils) are the typical representatives of such wastes – they are generated on a huge scale and significantly threaten the environment.

New Polish law [1] defines waste oils as follows (Art. 3): „... whenever waste oils are mentioned in the act – this means all the lubricating or industrial oils, which are no longer suitable for application, for which they were originally designed, and especially used oils from the internal combustion engines and gear oils, as well lubricating oils, oils for turbines and hydraulic oils”, so the definition applies to oils called until now “used oils”.

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The regulation [2] (implementation status of the act: January 1st, 2002) lists the following wastes in subgroup 13 02 ("waste motor oils, gear oils and lubricating oils"):

13 02 04* Mineral motor oils, gear oils and lubricating oils containing halogen derivative organic compounds.

13 02 05* Mineral motor oils, gear oils and lubricating oils non-containing halogen derivative organic compounds.

13 02 06* Synthetic motor oils, gear oils and lubricating oils.

13 02 07* Easily biodegradable motor oils, gear oils and lubricating oils.

13 02 08* Other motor oils, gear oils and lubricating oils.

All the wastes in this group have got the code numbers marked with asterisk which means "the hazardous waste". Used oil filters always contain some used oil (the amount of oil depends on the filter size and its construction) so they shouldn't be disposed of in landfills or – which is much worse – thrown away in woods, into the streams or ditches by the roads. The reason is obvious – the oil may contaminate drinking water and such pollution is very dangerous. According to American data one dm^3 of used oil has the potential to contaminate up to one million dm^3 of drinking water [3].

At present for the first time in our law the used oil filters have been classified as the hazardous waste. In the regulation [2], the used oil filters get their own code number 16 01 07* and they are qualified as hazardous wastes from the sub-group named "used or unsuitable for the service vehicles".

In the United States (the first country which started collecting and recycling of these wastes), used oil and fuel filters are classified as wastes which are subjected to the detailed federal [4] and state regulations. They are a real menace to the environment although their legal status ("hazardous" or "non-hazardous") is not the same in different states.

2. USED OIL FILTERS IN POLAND – THE SCALE OF PROBLEM

According to the data of Chief Central Statistical Office [5] (updated December 31, 1998) in Poland there were registered:

- 8,891,000 passenger cars,
- 1,563,000 trucks and truck-tractors,
- 1,261,000 ballast and farm tractors,
- 81,000 busses.

If we assume that an oil filter is changed only in passenger cars once a year (it is obviously underestimated) we get annually 9 million used oil filters originated only from passenger cars. To this value we should add the amount of filters changed in busses, trucks and tractors, where the filters are changed more frequently.

Used oil contained in the used oil filter can be assigned to two categories:

- free oil, which does not flow out of the filter when taken apart from the engine because it is blocked by the inner gasket – it can be removed after cutting the filter or puncturing the housing,
- absorbed oil – fixed, immobilised in filtering paper soaked with oil.

2.1. EXPERIMENTAL

To find an average amount of used oil contained in a single used oil filter there were conducted some experiments. Two lots of new and used oil filters were examined to find masses of filter elements and amount of oil contained inside. The used oil filters, which were the subject of the experiments, derived from passenger cars and vans. They were classified according to the position of arrangement into two groups:

- Arranged in random.
- Arranged vertically with the inlets downward which enabled a part of free oil to flow out of the filters. It was found that the new generation filters have got such an inner gasket position that the significant amount of oil can be drained.

In table 1, there are shown masses and mass contributions of single components of the new filters used in passenger cars and in vans. It may be assumed that the average mass of metal parts derived from one filter equals 300 g.

The investigations were performed with the three kinds of filters, which differed significantly in size:

- type I – small filters,
- type II – middle-size filters,
- type III – big filters.

Sizes of the newly tested filters were a bit different from the sizes of used tested filters.

Table 1

Material composition of new filters

Components of the filter	Mass and mass contribution of the single filter element					
	Type I		Type II		Type III	
	(g)	(%)	(g)	(%)	(g)	(%)
Housing + metal elements	152	72.4	335	73.6	485	75.2
Dry cartridge	50	23.8	110	24.2	145	22.5
Gaskets (internal + external)	8	3.8	10	2.2	15	2.3
Total	210	100	455	100	645	100

In table 2, there is shown the material composition of used filters, i.e. masses of the filter elements and their mass contributions and mass of used oil contained in the filter, the so-called "free oil". These results were obtained for the filters which were stored in any position (freely, packed at random).

Table 2

Material composition of used filters

Components of the filter	Mass and mass contribution of the single filter element					
	Type I		Type II		Type III	
	(g)	(%)	(g)	(%)	(g)	(%)
Housing + metal elements	170	44.8	320	43.8	515	54.2
Cartridge + fixed oil	90	23.7	230	31.5	225	23.7
Gaskets (internal + external)	10	2.6	10	1.4	15	1.6
Used oil, the so-called free oil	110	28.9	170	23.9	195	20.5
Total	380	100	730	100	950	100

As it can be found in table 2 the average content of used oil in the investigated types of filters equals about 160 g apiece. In this estimation, the amount of used oil which flew out of the filters during their dismantling and storage in random places is not taken into account.

New models of trucks have got oil filters of the new construction – during the oil exchange only the cartridge is exchanged, the housing remains for the multiple application. In this type of filters, the whole quantity of motor used oil is collected during the oil and cartridge exchange.

According to the information obtained also new models of passenger cars with the engines of new generation will be equipped with oil filters with exchangeable cartridges. It is planned for the nearest 2–3 years, first in such cars as: BMW. Opel Astra and Opel Vectra. For the new type of filters (with exchangeable cartridges) the filtering part with the fixed used oil (immobilised, sorbed inside) still remains a problem.

To find the sorptive capacity of the used filtering cartridge the quantitative investigation has been performed. Three different types of new (non-used) filters were tested. The masses of their dry cartridges were as follows:

- little cartridge (type A) – 50 g,
- middle-size cartridge (type B) – 110 g,
- big cartridge (type C) – 335 g.

The filter cartridges were immersed in used motor oil for 72 hours and they were weighted twice – after 24 and 72 hours of soaking. The results are presented in table 3.

Table 3

Oil fixed in the oil filter cartridges

Cartridge	Filter mass [g]			
	Dry	Wet after 24 h	Wet after 72 h	Mass of the fixed oil
A	50	85	85	35
B	110	190	200	90
C	335	510	515	180

Analysis of the experimental result obtained leads to the conclusions presented below.

2.2. DISCUSSION

If the amount of used oil filters is assumed to be 9 million per year the following materials can be recycled:

- steel – 2700 Mg/year,
- free used oil – collected for the regeneration – 1440 Mg/year.

The remaining materials, i.e.

- used oil fixed in the cartridges – 900 Mg/year,
- gaskets contaminated with oil,

should be properly disposed – maybe that thoroughly selected and strictly controlled system of burning would solve the problem.

Currently in Poland any system for collecting and disposing used oil filters does not exist. The single efforts to collect them were mainly made by RAN companies (with the share of Rafineria Nafty Jedlicze S.A.) and by the individual scrap metal collectors. Their attempts are a good opportunity to attract attention of the proper environment protection services to the scale and importance of the problem.

The other problem, although of minor importance, is collection and disposal or utilisation of used fuel filters, but this topic is not the subject of our considerations.

3. METHODS OF SOLVING THE PROBLEM IN THE U.S.A. AND IN THE OTHER COUNTRIES

The United States of America are the world leader in collecting and recycling used oil filters. About 420 million of new filters are sold annually in the United States. According to the data given by FMC Brent Hazelett in 2000, currently 50% of them are recycled [6]. So impressive effect was achieved during only 10 years of the action. It seems that the way of performing the operation of collecting and disposal is worth analysing.

A lot of organisations being involved in different ways in the problem joined their actions, starting from the filters manufacturers association (established in 1971 the Filters Manufacturers Council (FMC) in 1997 included 25 companies) through the U.S. Environmental Protection Agency (EPA), to the firms engaged in recycling, public institutions and media.

FMC initially developed to monitor regulatory and technological advances that affect the industry expanded its activities – it represented the industry in the deliberations of the U.S. EPA of whether used oil and used oil filters should be considered “hazardous waste” under the federal environmental laws. Thanks to this cooperation the used oil filters have got precisely formulated regulations, but they have never been listed as hazardous wastes under federal law.

The problem of legal qualification was not simple; used motor oil – the component which creates the environmental risk – had never been listed as hazardous under federal law. But there are discrepancies between federal and state laws. There are 3 states, however, which have classified used oil as a hazardous waste (California, Massachusetts and Rhode Island).

The Resource Conservation and Recovery Act (RCRA) states that plants where waste is generated are obliged to determine, if their wastes are hazardous. This determination is made in one of two ways: either the waste is listed as hazardous or its producer should make the determination based either on his knowledge of the waste or on testing. The name of the test to be performed is the Toxic Characteristics Leaching Procedure.

On May 20, 1992 the EPA decided that non-terne plated used oil filters (the term explained below), which have been gravity hot-drained, need not to be tested and they are automatically considered to be non-hazardous. These conditions need some explanation. The term *terne* means an alloy of lead and tin. Based on TCLP testing data this material is considered as hazardous. Terne-plated oil filters (used only in some heavy-duty applications) contained it. Now, thanks to the EPA–FMC co-operation, all FMC members eliminated terne from their products no later than January 1, 1993. So practically the first condition is no longer valid.

The procedure of hot draining accepted by EPA can be realised in different ways. These methods include:

- puncturing of the filter dome and hot-draining (puncturing is necessary, because the shape of gasket causes that without this action part of oil will remain in the interior of housing),
- hot-draining and crushing,
- dismantling and hot-draining,
- any other equivalent hot-draining method.

The length of time necessary for draining is not specified, though the tests proved that draining for 12 hours at the temperature above 15.5 °C is sufficient to remove almost completely the used oil.

At the very least, in order to enjoy this exemption from testing, no used oil should immediately leak or drip from a used filter, which is picked up. The exemption does not include non-oil filters (coolant, etc.) that are still subject to the RCRA determinations.

It is worth paying attention to the educational action. As the effect of the co-operation of different organisations there were created:

- Toll-free hotline for the used oil filters generators (companies, where the used oil filters are generated as the result of their activity, for example, transport bases).

- A page in Internet, where in the Used Filter Management Database [7] essential information concerning laws and regulations in different states may be obtained. Besides it contains names and addresses of the companies providing services within the range of transport, processing and recycling of the filters.

- Booklets, pamphlets, leaflets and brochures designed for different groups of addressees. They may be taken directly from Internet or got free by post [8]–[14].

- Materials for propagating the action for the teachers – on the EPA Internet homepage [15] even little children learn through attractive educational games (entitled *Recycle City*) about the necessity of used oil filters collecting and recycling.

Technical means for the action have been created – there was organised the whole net of companies involved in collecting, dismantling, crushing, processing and recycling the used oil filters. Numerous items of scientific literature concern different technical problems – the review of American patents from the period of 1971–2000 includes dozens of solutions. Generally they may be divided into the following groups:

- apparatus for utilisation of the filters with the use of various devices for dismantling and/or crushing of the filters with the simultaneous oil removing,

- devices for draining oil from the filter,

- auxiliary devices for the environmentally safe exchange of oil made by the do-it-yourself methods and devices for collecting of the used oil and oil filter and transporting them to the collection centre in the containers protecting against spillage,

- different devices – for instance designed for filter washing with the use of water and surfactants.

The situation in Europe is much worse than in the U.S.A. We tried to find the information about the used filters recycling in CONCAWE, the oil companies' European organisation for environment, health and safety. CONCAWE was established in 1963 in The Hague, and in 1990 its Secretariat was moved to Brussels. They are engaged in used oil recycling but the project does not include used oil filters [16]. The similar situation develops in the other countries, in Poland is the same.

4. SUGGESTIONS OF SOLUTIONS IN POLAND

Based on the gathered information we propose to take the following actions to organise collection and recycling of used oil filters in Poland:

1. Changes of the law and regulations. Thanks to the new law the first step towards collecting and recycling of the used oil filters has been done as they have been classified as the hazardous ones. At present the precise regulations concerning their handling do not exist. It should be clearly determined who is obliged to collect and utilize these wastes.

Some questions appear:

What role should the companies generating wastes on a big scale – transport basis, service stations, municipal transport services etc., play in this recycling?

How to create a motivation for the individual car user who changes oil himself (the so-called: do-it-yourselfer) to carry the used oil filter to the collection centre?

It is quite obvious that creating technical means for filters recycling must follow the legal activity.

2. Collecting system. A clear-cut question arises – who should collect the used oil filters? At present the most promising and economically attractive option is to take advantage of existing net of basis built by the refineries for the used oils collection. For example, the refinery RN Jedlicze possesses such a net consisting of 14 base covering the whole area of Poland. These bases should be equipped with the apparatus for dismantling and/or crushing filters with the simultaneous removal of oil.

Additionally the companies collecting scrap metal should be engaged in used oil filters collecting or the emptied (hot-drained and pressed) filters should be taken directly from the basis net to the steelworks to be processed.

3. Educational action. After changing the regulations the educational action should be taken, especially in service stations, transport basis, communication companies in towns etc., later for the individual car users which change the oil themselves.

5. CONCLUSIONS

According to cautious and underestimated assessment based on the experimental results 3600 Mg/year of used oil remaining in the used oil filters present essential environment hazard in our country – especially waters are in danger.

Used oil filters should be collected and recycled. Their classification by the new Polish law as the hazardous wastes is an important step taken to collect them. The actions organising the collection and recycling in administrative and technical respects should be the next stage. Such an action will not only eliminate or reduce the danger of environment's pollution by the hydrocarbons, but also will provide valuable recycleable materials – used oil and steel scrap (up to 2700 Mg/year).

Educational action taken in the society is extremely important. The aim of this publication is to make the society aware of the scale of a menace to the environment by used oil filters and to suggest the potential counteractions against this danger in our country.

The presented suggestions, of course, do not solve the problem; the subject still remains urgent. Our proposals are only the result of collecting information about the subject and performing the preliminary experimental investigations within the range of researches made in Tadeusz Kościuszko Cracow University of Technology. The example of the U.S.A., where every second used oil filter is collected and recycled, is worth following.

REFERENCES

- [1] Ustawa z dnia 27 kwietnia 2001 o odpadach (Dz. U. Nr 62, poz. 628).
- [2] Załącznik do Rozporządzenia Ministra Środowiska z dnia 27 września 2001 w sprawie katalogu odpadów (Dz. U. Nr 112, poz. 1206).
- [3] *How to Change Your Own Motor Oil and Oil Filters*, URL: www.epa.gov/grtlakes/seahome/housewaste/src/oil.htm.
- [4] 40 CFR Part 279 – Standards for the Management of Used Oil, URL: <http://www.epa.gov/epaoswer/hazwaste/state/cfr/97cfr279.pdf>.
- [5] GUS Rocznik statystyczny Rzeczypospolitej Polskiej 1999. Rok LIX, Zakład Wydawnictw Statystycznych, Warszawa, 1999.
- [6] *Recycling Rate for Used Oil Filters*, URL: <http://www.filtercouncil.org/news/May2000.html>.
- [7] Used Filter Management Database, URL: <http://www.filtercouncil.org/regs/index.html>.
- [8] *Used Motor Oil Collection & Recycling. Frequently Asked Questions*, URL: http://www.api.org/pasp/recycleoil/usedoil_fraqs.htm.
- [9] *Keep Used Oil Filters in Step. Proper Hot Draining. Steps to recycle*, URL: <http://www.filtercouncil.org.envinfo/educational/recsteps.html>.
- [10] *Recycling Used Oil Filters at the Shop*, URL: <http://www.filtercouncil.org.envinfo/educational/recshop.html>.
- [11] *Recycling Used Oil Filters at Home*, URL: <http://www.filtercouncil.org.envinfo/educational/rechome.html>.
- [12] *Collecting Used Oil for Recycling/Reuse. Tips for Consumers Who Change Their Motor Oil & Oil Filters*, US EPA 530-F-94-008, March 1994, URL: http://www.epa.gov/epaoswer/non-hw/recycle/recy_oil.pdf.
- [13] *Managing Used Oil: Advice for Small Businesses*, EPA 530-F-96-004, November 1996, URL: <http://www.epa.gov/epaoswer/hazwaste/usedoil/usedoil.htm>.
- [14] *How to Choose a Filter Management Service*, URL: <http://www.filtercouncil.org.envinfo/educational/choose.html>.
- [15] EPA homepage, URL: <http://www.epa.gov>.
- [16] CONCAWE, URL: <http://www.concawe.be>.

ZUŻYTE SAMOCHODOWE FILTRY OLEJOWE –
ZAGROŻENIE ŚRODOWISKA Z POLSKIEJ PERSPEKTYWY

Podczas wymiany oleju w samochodzie jest wymieniany także filtr olejowy. Zawarty w nim przepracowany olej stanowi zagrożenie dla środowiska naturalnego, w szczególności dla wody pitnej. Olej przepracowany jako odpad niebezpieczny podlega w Polsce zbiórce i powtórnej rafinacji. Program zbiórki nie obejmuje jednak filtrów. Na podstawie danych statystycznych i danych z przeprowadzonych eksperymentów podjęto próbę oszacowania ilości oleju przepracowanego, pozostającego rocznie w zużytych filtrach. Przeanalizowano rozwiązania prawne i techniczne zbiórki zużytych filtrów olejowych w USA, gdzie co drugi filtr poddaje się recyklingowi. Zaproponowano sposób rozwiązania problemu w Polsce.

