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# **TREATMENT OF USED MACHINE AND INDUSTRIAL MINERAL OIL IN REPUBLIC OF SERBIA UNDER THE SANCTIONS**

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## **ABSTRACT**

In this paper we present the only system of collection and recycling of used oil in Serbia, developed by NIS – Refinery, Belgrade. In addition to the discussion about the environmental dangers of used machine oil, we present the advantages of organized collection and its reuse. Our analysis shows steady decline of the collected amount of used oil during the period of economical sanctions. The amount collected by Jugopetrol, NAP and Beopetrol was drastically reduced in 1999 (35%) and 2000 (75%) with respect to 1995 (43%). The Yugoslav Army increased the percentage of collected used oil in the total amount collected from 23% to 33% in 1999 to 53% in 2000. Automechanical services did not participate in the collection of used oil in the last three years. Having all this in mind we might ask ourselves what happened to the used oil that was not collected? We also point out the advantages and disadvantages of the system for collection and recycling in the conditions of ten years of economical sanctions, including old equipment and technology, regulations, price politics and difficult economical conditions. We discuss the reasons for the decline of the collected amount of used oil. The ecological problems of misuse of used oil will only increase, having in mind industrialization and the increase in the number of cars. The solution lies in the introduction of state regulations that will require and reinforce collection and recycling of used oil.

Key words: recycling, used oil, refinery

## **INTRODUCTION: WASTE OILS, THEIR GENERATORS, NOXIOUSNESS AND POTENTIALS**

The industry of waste oil regeneration, of engine oils in particular, is a relatively long lived industry that has rapidly developed in Europe after the Second World War. This was due to the fact that engine and industrial waste oils contain valuable raw materials from which basic oils are obtained by different technologies. Appropriate processes have been deve-

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loped thanks to the fact that 3-5 lit of crude oil are needed to produce one liter of basic oil and that the process derivation from crude oil is very complex and expensive.

Besides the indicated undesired constituents waste oils also contain various mechanical impurities, organic metal compounds and other matter and have to be changed and disposed in appropriate way. Such waste materials represent highly unfriendly wastes for any environmental system. According to Basal's convenient from 1992, and we are the signatory too, on the other hand, waste oils contains a highly valuable and expensive unaltered component - basic oil.

In West Europe, waste oil destruction by burning in subject to gas emission strict regulations of control and air pollution control legislation. Such an action is unjustified because environment pollution goes on and expensive raw materials are irretrievably lost. The only acceptable way to resolve this problem is to regenerate or re-refine waste oils. In this case, priority is given to re-refining procedures which are more efficient in terms of raw material utilization and elimination of noxious by-products /2/ and /3/.

The following mineral oils can be re-refined by the above processes: engine oil /ISO L-E, ISO L-F/, reduction gear oils /ISO L-C/, compressor oils /ISO L-D/, turbine oils ISO /L-T/.

## **RE- REINATION AS THE BEST WAY FOR ECOLOGICAL TREATMENT OF WASTE WATER**

Advantages of the re-refining compared with other kinds of waste oil processing can be listed as follows:

- waste oil is an alternative source of basic oils for lube industry
- re-refining gives a product of the highest added value that can be obtained from waste oil /4/
- re-refing uses less than one-third energy needed to produce new basic oil /5/
- in that way the valuable and irrecoverable resource is preserved.

However, in spite of the listed benefits a new value and a positive economic balance can be created through waste oil re-refing only under the following conditions:

- consideration should be given to waste oil price and costs of its collection that must be as low as possible ;in Italy this problem has been solved by collection cost coverage from the budget available to the consortium of lubricant producers, and formed from the tax of 54 lira per kg of solid lubricator
- re-refiners must be granted certain benefits through legislation /such as abolishing sales tax for products containing re-refines / or lubricator buyers should be forced by certain restrictions to deliver their waste oils to re-refiners,
- the technical level of a re-refinery plant must understand rational energy consumption and their capacity should be above the profitability threshold which is in fact a flexible term depending on technology, legislation and prices of waste oil and energy/13/.

## **FINANCIAL BENIFITS**

The group of the most developed countries of Europe differently observe collection of waste oils from financial side, but one is the common:the state with its policy stimulates

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the collector and companies in collection waste oils and re-refining. These are some examples of the most developed countries:

In Great Britain, there is not any tax on the product price and nor the other financial addition during the collection and re-refining waste oils. Cut-throat competition of mainly small collectors caused low prices. In France, costs of collection includes parafiscal taxes on original collection and re-refining base oils. In Germany storekeepers /service and garage/ pays to transporters for collecting and transport waste oils. In this country, legislators enforce the policy law as tax on waste oils as fuels, or specially tax free for products of re-refining waste oils, or intending to raise value waste oils by company for re-refining, which is uses as energent. In Italy "Consortium of delivery obligations waste oils" pay to transporters for every transported used oils kilo. It sales used oils giving priority re-refining through the economic re-refining price. The costs of collecting don't include in income that is realize through selling waste oils, but compensate by Consortium with taxes on all sold lubricants. Taxes on re-refining oils are allowed reduce for 50%/7/.

### **SITUATION IN YUGOSLAVIA**

According to the expert analysis of 1980 /energy crisis/ the purchase price of waste oil should not be below that of fuel oil /high quantities of waste oils are used instead of fuel oil. If tax privileges are taken into account and waste oils are purchased at fuel oil price, then financial benefits may be achieved only if collected quantities exceed 7500 tons a year. Another analysis shows that collection of waste oils in the absence of any tax privileges, and waste oil purchase at fuel oil price give negative effects in the whole capacity range of processing and collection.

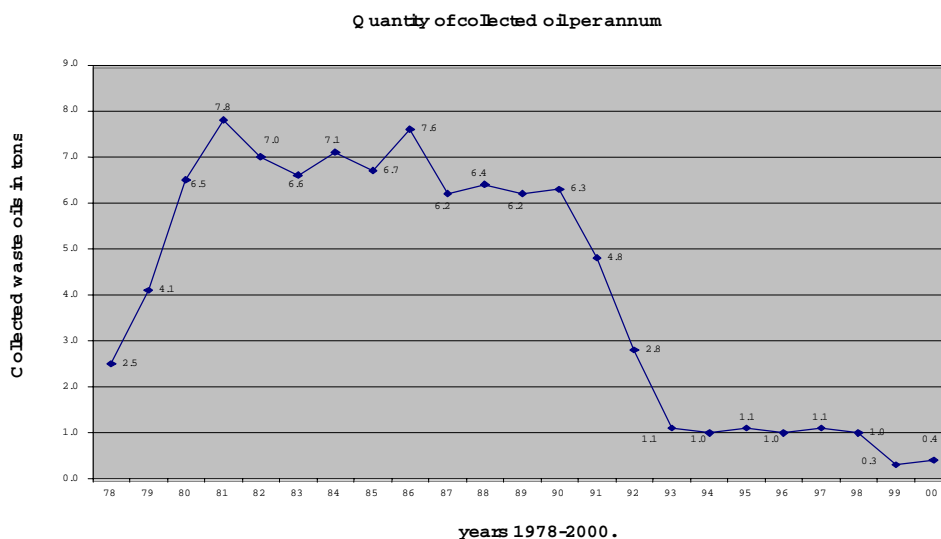
The latest analysis by RNB in 1996. shows that waste oils re-refining is profitable when 20 000 tons a year are processed, the profit being 9.85% from the total revenues. The profitability threshold lies at the level of 14 251 tons processed a year under market conditions, without tax privileges.

### **ORGANIZED WASTE OIL COLLECTION IN THE TERRITORY OF YUGOSLAVIA**

Serious efforts to construct equipment for systematic collection of waste oils in Serbia have been made by Belgrade Oil Refinery. Specifically, on the premises of large consumers RNB has constructed installation to receive and handle waste oils, i.e. oil stations. There were 250 points for waste oil collection in the territory of former Yugoslavia. Presently the number is reduced to 141. Waste oils collected in the yards of large consumers, collection centers and some minor sources are transported in tank trucks /5-20 t/ or in lorries /180 kg barrels/ to RNB. The following oils are collected : engine, hydraulic, circulation, reducing gear, compressor and turbine. Emulsion oils, oils for heat and mechanical treatment of metals and fuel oil are not collected. The Belgrade Oil Refinery performs a laboratory analysis for each shipment of waste oils in order to determine oil quality and water content. In addition to oil stations, waste oil is collected from other sources /collection centers, storage's, car repair shops, public and internal petrol stations/. Waste oils in barrels and in bulk are purchased from direct holders at the price of 5.50 din per kg, free loaded on truck/fig. 1/.

RNB, as shown on fig. 1. collected most waste oils in 1981. /7865 t/ and 1986./7638 t/.Over the last years,1992 .to 2000., a drop in the collected quantities of the waste oils is evident. Reasons are numerous and are in the first place:

- Abolished tax privileges for waste oil processing plants /1991.Law on Temporary Measures on Product and Services Sales Tax - Off. Gazette No.4,18.01.1991./,
- Insufficiently defined legislation in the field of waste oils collection
- Price policy
- Current system or organized collection, transport and storage of waste oils in the new situation/the loss of 110 oil stations in the territory of the former Yugoslavia and of large quantities of waste oils, too/.



**Fig. 1 Collected waste oils from 1978 - 2000 in tons**

Further analysis may show that the single organized method of collection is the existing system of oil stations in RNB's possession and that other sources/car repair shops, industrial tanks, public and internal petrol stations, waste collecting firms/ collect waste oils periodically and at random. A conclusion may be drawn from Table 1 and the percentage of collected waste oils that there are good chances for organized collection in the firms that collect waste and in other sources:public and internal stations, car repairs shop. According to date before 1994 we can see that the sum of waste oils was 26,46% and don't correspond to its own purpose. In 1995 /1086 t/, Jugopetrol Beopetrol and Naftagas promet collected 43%/ JP=39,5%, BP and NAP =3,5%/ and 34% by transportation company, FAM, services, mines and others /Table 2./ Car-services includes 1,5% in relation to 370t of others and transport company -22%, FAM with 28% of 370 t. Army of Yugoslavia 1086t with 23%. In the last three years /1999-312 t, 2000-412 t, 2001-193 t/ with May /Table 1/

**Table 1. Quantities of collected waste oils depends of collected source in 1995**

Collected source	Quantity in t	%
JP,NAP,BP	430	43
Army of Yu	244	23
Others /ATP,FAM,GSP/ service, mines/	370	34

it shows considerable fall of collected waste oils as from eightieth years, before disintegration Yugoslavia and sanctions.

Analysis of years 1999 and 2000, we see that the percent of collected waste oils by JP, NAP and Beopetrol is fallen down /1999-35%, 2000-7,5% in regarding to 1995-43%/ /Table 2./

Army of Yu increased from 23 to 33% in 1999 and on 53% in 2000 in all sum of collected waste oils. It noticed increasing of TENT-Obrenovac with 15%.Car-sercices didn't collect waste oils in the last three years.

**Fig.2 Percent of collected waste oils**

Years	1995	1999	2000
JP,NAP,BP	43	35	7,5
Army of Yu	23	34	53
Others	34	66	46

According to ZIT data, most customers change oil by themselves /47%/ and the least of them /3%/ change it at petrol stations and it is quite clear that by good organization, legislation and marketing, the number changing oil at petrol stations could rise as well as the quantity of collected waste oils.

#### **ADVANTAGES AND DEFICIENCIES OF THE EXISTING WASTE OIL COLLECTION SYSTEM**

RNB invested a good portion of funds to build oil stations on the premises of large customers. Benefits are multiple both for RNB and the customers. Any quantity of fresh oil is available, engine supplies are controlled and the work environment is protected from spill, RNB has a market to sell large oil quantities without a need to buy packing materials

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and pack them. And the most important aspect is that this means solving the problem of waste oil collection, storage and transport of importance for both parties

A problem of waste oils collection at the existing oil stations and other sources lies in the fact that these oil quantities are small, collected over long time periods and periodically transport when their quantity is optimum. Since waste oil are collected and transported from a large number of centers/petrol and oil stations, car repair shop, overhauls /there is no continuous daily transport regime. Therefore the current system of waste oils collection, transport and storage should be revised. Within the framework of macroproject NIS-Environmental protection there have been attempts to resolve this and other problems associated with waste oil collection. The project terms of reference were titled: "Development of a system of collection, transport, storage and processing of used mineral oil on the Republic Serbia". The terms of reference contain ten topics and objectives and such contents that should contribute to finding a solution how to collect waste oils, viewed from environment technical, legislative, economic and legal aspects in the territory of Serbia. RNB and Technological-Mechanical Faculty from Belgrade have created project target of reconstruction the plant for re-refining and new technology for its process. The RNB hasn't got funds in this moment for this investment. One of numerous possibilities for improvement of the current system of waste oil collection dealt in the new terms of reference, maybe of the most importance, is to establish waste oil collection center in the territory of the Republic Serbia.

The number of oil stations in operation in the territory of present Yugoslavia fell from 141 to one half /71/, which made collection of very small quantities of waste oils even more difficult. Serious consideration should be paid to the large potential of the JUGOPETROL network/about 500 public/ and 1400 internal petrol stations /13/ where a well organized campaign and appropriate legislation on waste oil disposal would assist in collecting major quantities of waste oil. Regions /7/ shows that collection centers may be formed so that:

- the available storage capacity in the installations and warehouse of - Jugopetrol - Beograd are used to the utmost
- road and railway transport is used depending on the geographical positions of collection centers
- collection centers are as close as possible to the regions and are producing largest quantities of waste oils.

Thus each collection center would have its subsidiary collection stations to cover municipal areas and regions covering the whole territory of Serbia. It will also be important to meet storage volume requirements and calculate the optimum quantity of waste oils for organized transport. It was also decided in the terms of reference, in addition to measures to improve the current waste oils collection and treatment of those waste oils that cannot be regenerated, to analyze mineral oils consumption, environmental impact of waste oils, legal and political instruments for environment protection, to build the awareness of the environmental impact of waste oils, and to pursue proper waste oil management for the purpose of environmental protection.

#### **Estimated quantities of waste oils that could be collected**

A group of authors in a study/8/ from 1980 determinate the correlation between the quantity of fresh motor oils and used motor oils /waste oils/. That ratio is constant value which when

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multiplied by the oil which is added to motors, give the quantity of waste oils that can be discharged from oil sump. It varies by types of vehicles:

buses -  $K = 0.42$ ; heavy vehicles  $K = 0.42$ ; cars  $K = 0.60$

With these factors  $/K/$  and the number of vehicles  $/n/$  that change oil times a year and oil sump volume  $/q/$ , quantity of waste oil  $/Q/$  can be delved from the original quantity of motor oil. In order to find waste oils quantity in kg a conversion factor is used  $/\gamma = 0.88/$

$$Q = \gamma \cdot n \cdot m \cdot q \text{ /kg/}$$

This means that under the current production plan for engine oils in RNB /20 000 ton/, waste oils quantity would be about

10 000 tons /assuming an average value of  $K = 0.48/$ . That is also the quantity of waste oils that can be re-refined in RNB.

Since in this market there are other engine oil producers and since some unofficial data show that the market is absorbing about 50 000 - 60 000 tons a year of engine oils the potential quantity of waste oils for collection rises. According to date from 1994 the quantity of 59 600 tones represents 26,4% of the whole sum waste oils that settle in SRJ.

## **LEGISLATION ON WASTE OIL COLLECTION AND THE EXPERIENCE**

In encourage collection of waste oils in former Yugoslavia, a Law amending the Law on Products and Services Tax was passed in response to requests of work organizations in field, through the then association in the oil sector. This law stipulates that engine oils and other lubricants and greases that are produced with minimum 20% of re-refined basic oil will be exempted from basic sales tax. That was an incentive for the enterprises since increased operating costs were thus covered and there were opportunities for investing into expansion of the existing oil stations and development of waste oils collection system. The promulgation of the Law on temporary measures foe sales tax on products and services /Off. Gazette No.4 of 18.1.1991/ abolished the Law on product and service sales tax and an incentive scheme for waste oils collection, transport and storage. Many times RNB addressed the authorities with proposals for amendment of the current law and revival of tax privileges that would enable profitable collection and processing of waste oils. So far, all much attempts have failed and their consequence have been reflected in the drastic drop of collected waste oils quantity, which is evident in the diagrams and in the suspended operation of the re-refinery plant for used mineral oils.

The 1991 Republic Law on Environment, Art.83 stipulates that rules should be adopted how to handle certain wastes that have the property of waste substances and how to keep records on types and quantities of hazardous substances introduction, use, transport, sales, storage and disposal. Then, in April 1995 a Code was adopted on handling wastes that have the property of dangerous substances in which waste oils are classified, too. The Code stipulates types of records on kinds and quantities of hazardous substances in production, use, transport, sales, storage and disposal. It also foresees waste classification at the place of origin by natural state and monthly reporting to the Ministry of Environment on quantities and types of generated waste oils /10/.

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At the end of May 1996 a Decree on promulgation of the Law on Waste Handling was passed. It stipulates handling of waste substances that may be used as secondary raw materials, method of collection, treatment and storage as well as handling of waste substances that have no value and cannot be used for raw materials recovery. The Law also stipulates measures for environment protection against harmful action of wastes, the way to organize jobs to ensure such protection, as well as fines for non-compliance.

This Law is mentioned because the Rules on handling dangerous substances should be arranged or amended in similar way. Namely, the past experience of RNB indicates that customers are inattentive towards waste oils collection and do not comply with even the minimum of projects. Refining of requirements in the Code. It often happens that the quantities collected at the oil stations built by RNB on the customers' premises end up at some other sites where they are used for some other purpose of which the most dangerous one is burning since then environmentally noxious gases and substances appear.

## CONCLUSION

With the development of automobile industry and increased industrialization all over the world ecological problems caused by irregular handling of waste oils are augmented. They should be first of all solved by adequate national laws that must encourage and force re-refining of waste oils as the single acceptable method of disposal of this dangerous substances. Pursuant to this the state should give certain privileges to re-refining such as sale tax exemption for products containing re-refining and by strict fining of all those that destroy or dispose of waste oils without control. On the other RNB possesses a vast network of oil stations as well as re-refinery for waste mineral oils that according to a present is not any longer an optimum technical and economic solution for treatment of this waste. It should be restructured after the experience of the developed West Europe countries if costs of collection, transport and storage of waste oils are to be lower.

The research and development Sector in RNB has performed a lot of science research to resolve problems in the technology process and has defined new and more efficient processes for re-refining of waste oil. RNB has promoted its work internationally /RANIS/ as a specific promoter for the final implementation of the results in this field. Besides RNB is also an owner of a project of organized collection and treatment of waste oils within the macroproject NIS - Environmental protection.

Oil Refinery to speed up and realize these serious and prospective 10.000 tones of used incentive, so the problem of waste oils should be instigated by the state. The state must be in effect on economic aspects of collection waste oils as we can see on examples in Italy, when the percent of collection waste oils are too low, but 83% of these oils are refined and that is the biggest percent than refined oils in Germany, Great Britain and France. This mineral oils, this being the central capacity of NIS-RNB, plant, would result in saving around 4 millions dollars a years, which sum would be used for purchase of base oils/raw materials for production of new oils/. The effect would be triple:

- saving of hard currency
- providing of new raw materials
- protection of living environment

In that way a life mineral oils/production, ecology, economy/would be closed in accordance with ISO 14000, which would bring benefit to each link in the chain refiner - consumer -



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collector. In that situation, the state should grant credits to Belgrade Oil Refinery to speed up and realize these serious and protective projects. The weakest point in the system is the lack of state effect was reached by introducing specific taxes on lubricants that is 50% smaller than refining oils.

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