EXPERIMENTAL RESEARCH FOR THE PURPOSE OF REGENERATION OF USED INDUSTRIAL OILS AND THEIR REINTRODUCTION TO THE TECHNOLOGICAL FLOW

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The justification for choosing this theme is given by the need to solve a problem that is particularly important for the oil products regeneration industry. Regarding this matter, the theme of the article consists in the development of a new technology that allows the reuse of oil products and greases so that their loss is as small as possible and in parallel to allow the significant reduction of the beneficiaries' expenses by regenerating at least 3 times the oils used for both the cooling of the machine and for the thermo chemical treatments by managing them as efficiently as possible, so that the neutralization is the last solution, but also their transformation into general grease with a high degree of use. This technology applies to different types of industrial oils from, for example, H46 hydraulic oil, T30 transformer oil to various other types of mineral oils, as long as they are stored in a single container. The purpose of this work is researching the possibilities of making a very high yield after the administration and regeneration of industrial oil.

Keywords: industrial oils, waste oils, pollution, regeneration oils

1. Introduction

The most commonly used liquid lubricants are oils. Lubricating oils consist mainly of base oil and additives. The base oils are mineral, vegetable, animal and synthetic in nature. [1,2,3]. An oil classification is given in Fig. 1. Lubricants are characterized by a series of physical-chemical and functional properties, of which the main ones are:

- viscosity;
- oiliness: it is the property of the oil to adhere to the surfaces with which it comes in contact; this causes an oil film to remain on the surfaces of the contacted parts, so that when starting they have a minimum of oiling;
- oil density, which defines the mass of moisture in the volume;
- oxidation stability;

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- inflammability point: it is defined as the minimum temperature mark at which the oil mixture becomes flammable - air vapors;

- combustion point: this is 40-50 ^{0}C above the flammability point;

- freezing point: represents the most volatile temperature at which the oil ceases to flow.

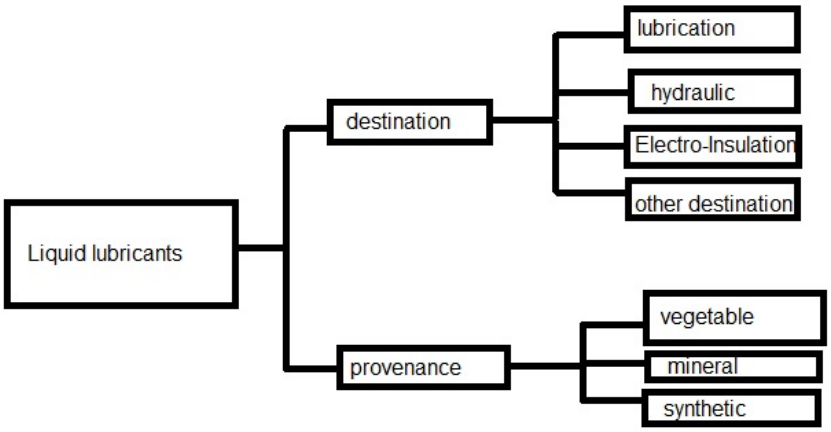


Fig. 1. Classification of liquid lubricants

Soil, water, flora and fauna suffer from waste oils that are accidentally thrown away. The oil that reaches the soil significantly reduces its productivity and, moreover, prevents it from regenerating in order to be fruitful later.

Underwater life is also at risk if it comes into contact with waste oils and used greases, as they form a film on the surface of the water that blocks the absorption of oxygen and the penetration of sunlight. [4,5]

Waste oils and greases are not biodegradable, so they do not disappear, and more than that, in contact with other elements they increase their volume and contaminate both water and soil. [6]

Used oils and greases are harmful to animals or plants. In the case of animals, they have effects similar to those they have on the human body, ie they cause irritation or can even contribute to the appearance of diseases. On the other hand, the vegetation also has problems of survival in contact with the used oils and greases [7.8]. Used industrial oil is an important resource used especially for the manufacture of biofuels, being a viable alternative to specially cultivated plants that occupy large agricultural areas. 900 ml of biodiesel can be obtained from one liter of used industrial oil, and from the secondary product there is a natural soap, good for the human body.

Industrial waste oils and greases not only harm the environment and man, but also their deposition on the walls of the sewage system causes regular clogging, bad odor effects, faster corrosion and has a negative influence on the operation of the treatment plants and leads to blocking and their destruction. The

frequency of cleaning and maintenance of the sewage, pumping, pipes and sewage systems increases five times compared to the normal cycle. This leads to a huge increase in costs to the community. The elimination of these adverse effects is possible if these wastes are collected, treated, filtered and reintroduced into the economic circuit in another form [9,10]. The analysis of the possibilities of regeneration of used industrial oils and their reintroduction into the technological flow is regulated by GD no. 235/2007.

According to GD no. 235/2007, oil producers and importers are obliged to ensure the organization of the waste oil management system, corresponding to the quantities and types of oils placed on the market. [4]. This obligation can be realized individually or through third parties indicated to the central public authorities for environmental protection, by the responsible persons. Thus, between 2010-2013, both the quantities of oils placed on the market and the quantities of waste oils generated have a non-uniform variation, according to Fig. 2 (source: National Agency for Environmental Protection (ANPM)

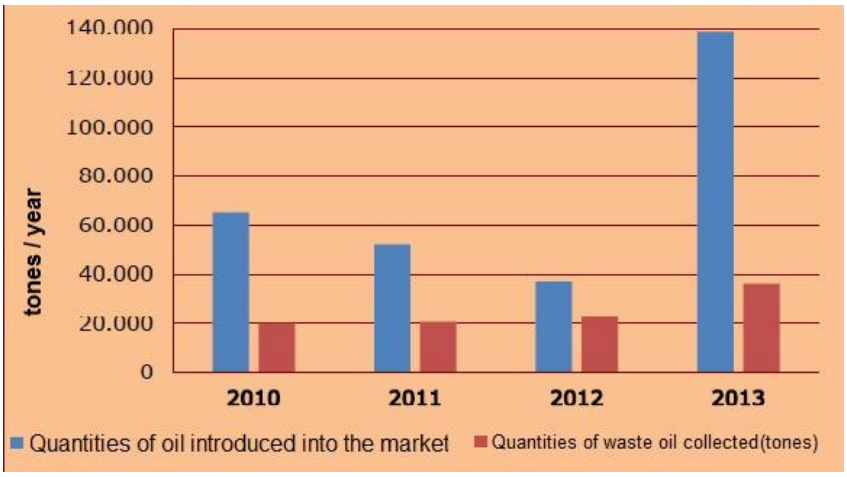


Fig.2. Data on oil quantities in Romania (source: National Agency for Environmental Protection (ANPM)

2. Experimental

The technological equipment for regeneration of waste oils is shown in Fig. 3, having the following constructive components:

Oil inlet: the hole through which the oil enters for recycling;

Filter 1: after entering the enclosure with the help of a pump, the oil circulates through the filter which leads to its cleaning and cleaning, the filter is for removing coarse impurities up to 10 microns in size - pre-filtration operations; Collection vessel after pre-filtration; Heater for raising the temperature of the oil in order to eliminate a quantity of water and decrease the viscosity index of the oil.

Filter 2: After passing through filter 1, the oil enters the filter 2 through the pump to be able to benefit a second time from its filtration. The second filter is designed for cleaning the oil and removing impurities up to 3 microns and collecting the water particles that have passed through the heater; Enclosure for collecting oil after passing through filter 2; Heater for maintaining and raising the oil temperature.

Filter 3: final filtration at a micron in which the urpurity impurities larger than one micron are eliminated, if any, the remaining water molecules; Oil collection chamber coming out of filter 3; Pump for transferring regenerated oil into the machine; Control panel: to start the filtration installation and by default the workflow, it is connected to the electrical installation which starts the circulation pump of the installation. Output of regenerated oil: after the oil has been filtered using the 3 filters, it is pushed out so that the new used oil enters the circuit for filtering and regeneration.

Fig.3 Oil regeneration plant

The flow of obtaining the regenerated industrial oil is summarized in Fig. 4, based on the description of the experimental installation.

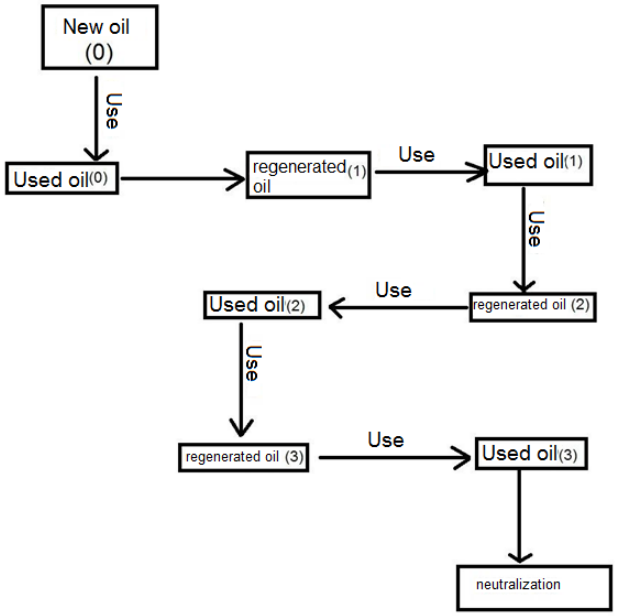


Fig. 4. Implementation diagram of the used industrial oil

The technological solution described in Fig. 4, has been applied concretely, to one of the big economic agents in the field of steel production.

Analysis of experimental data

This analysis is composed of the microscopic analysis of the three categories of oils: new oil, purchased from suppliers, used oil and regenerated oil.

1. the new H46 hydraulic oil, purchased from suppliers, has the following main physical and chemical properties (Fig. 5)

In this image you can see a sample of a new oil. Certain impurities can also be seen in the case of a new oil.

2. The used H46 oil has the following main physical and chemical properties (Fig. 6). In this image you can see a sample under the microscope of a hydraulic oil type H46 that had more than 8000 operating hours in operation.

It was to be neutralized (removal of the used product).

As noted, in the case of used oil the amount of medium (15 µm) and large (30 µm) impurities is significantly higher than the new oil.

3. The regenerated H46 oil has the following main physical and chemical properties (Fig. 7). The microscope test is taken from a regenerated oil sample using the technological equipment that is the subject of the present article.

In the image above you can see the microscopic examination of an oil sample after regeneration. All physical and chemical properties are the same as the new unused oil.

RESULTS			
MEASUREMENT PARAMETERS	NORMA	Results	
Particles larger than 5µm / ml	(ISO 4406)	1242	-
Particles larger than 15µm / ml	(ISO 4406)	33	-
Particles larger than 30µm / ml	(ISO 4406)	13	-
ISO CODE - impurities	17/12		
Particles	Metal: 80%, Silicone : 20%.		
Viscosity at 40°C	46.8		
Viscosity at 100°C	7.5		
IV	120.6		
Water			
Condition	ALLOWED		

MICROPHOTOGRAPHY

Zoom: 350x

DIAGNOSTIC

The oil has physical properties allowed

Fig. 5. H46 new oil quality certificate

RESULTS			
MEASUREMENT PARAMETERS	NORMA	Results	
Particles larger than 5µm / ml	(ISO 4406)	1076	-
Particles larger than 15µm / ml	(ISO 4406)	151	-
Particles larger than 30µm / ml	(ISO 4406)	48	-
ISO CODE - impurities	17/14		
Particles	Metal: 80%, Silicone : 20%.		
Viscosity at 40°C	46.9		
Viscosity at 100°C	7.5		
IV	120.3		
Water			
Condition	Alarm		

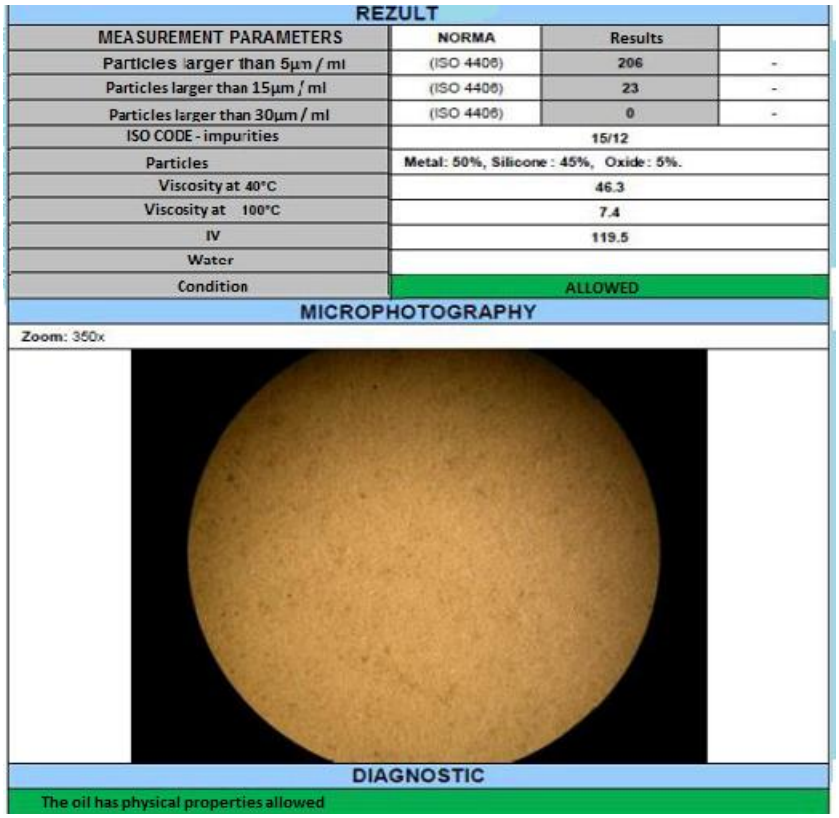
MICROPHOTOGRAPHY

Zoom: 350x

DIAGNOSTIC

The oil has physical properties in alarm values due to the quantity of particles

Fig. 6. H46 old oil quality certificate



REZULT			
MEASUREMENT PARAMETERS	NORMA	Results	
Particles larger than 5µm / ml	(ISO 4406)	206	-
Particles larger than 15µm / ml	(ISO 4406)	23	-
Particles larger than 30µm / ml	(ISO 4406)	0	-
ISO CODE - impurities	15/12		
Particles	Metal: 50%, Silicone : 45%, Oxide : 5%.		
Viscosity at 40°C	46.3		
Viscosity at 100°C	7.4		
IV	119.5		
Water			
Condition	ALLOWED		

MICROPHOTOGRAPHY

Zoom: 350x

DIAGNOSTIC

The oil has physical properties allowed

Fig. 7. H46 regenerated oil quality certificate

In the image above you can see the microscopic examination of an oil sample after regeneration. All physical and chemical properties are the same as the new unused oil.

Analysis of the profitability of the presented technology

The calculation of the economic efficiency in the regeneration of the hydraulic oil, with a case study for Tenaris Calarași led to the following result:

The price of one liter of new oil is 6 lei

The price of one liter H46 of regenerated oil is 2.5 lei

New oil price for purchase

15000 x 6 = 90000 lei

Cost of regenerated oil

15000 x 2.5 = 37500 lei

The economy achieved for the 15000 liters of regenerated oil

90000 - 37500 = 52500 lei

This oil can be regenerated 3 times.

Thus: If the 15000 liters of H46 oil would regenerate 3 times the price would be

37500 X 3 = 112500 lei

If it did not regenerate it would be 15000 x 6 x 3 = 270000 lei

The achieved economy would be:

270000 - 112500 = 157500 lei

Also these 15000 liters of oil resulting after the 3rd regeneration, which could be transformed into greases:

The price of one kg of grease purchased from the market is 4.60 euros (1 euro = 4.8 lei)

4.6 Euro / kg x 4.8 RON / Euro = 22.08 lei / kg. new grease

The same type of grease with a drop point of 140oC made from waste oil that can no longer be regenerated

1 kg of grease from used oil = 9 lei

Economy achieved at 1 kg. grease 22.08 - 9 = 13.08 lei

13.08 x 15000 = 196200 lei

The economic efficiency registered at the Electric Otelaria where 15000 liters of H46 oil were regenerated, oil that had to be neutralized, given to the collector and replaced with new oil and according to the ones presented in Fig. 8, a total economy of 353700 lei was made up of:

157500 lei from oil regeneration;

196,200 lei from the transformation of the oil used in the lubrication.

Tenaris Calarasi

Regeneration stage	Nomenclature	Quantity (liters)	Price of new oil (RON)	Total price new oil (RON)	Regenerated oil price (RON)	Total price regenerated oil (RON)	Difference between new oil and used oil (RON)
	Hydraulic Oil (H46)	1	6	6	2.5	2.5	3.5
1	Hydraulic Oil (H46)	15000	6	90000	2.5	37500	52500
2	Hydraulic Oil (H46)	15000	6	90000	2.5	37500	52500
3	Hydraulic Oil (H46)	15000	6	90000	2.5	37500	52500
4	Neutralization / transformation into greases	15000	22.08	331200	9	135000	196200
						Total difference used new oil, regenerated oil + transformation in grease (RON)	353700

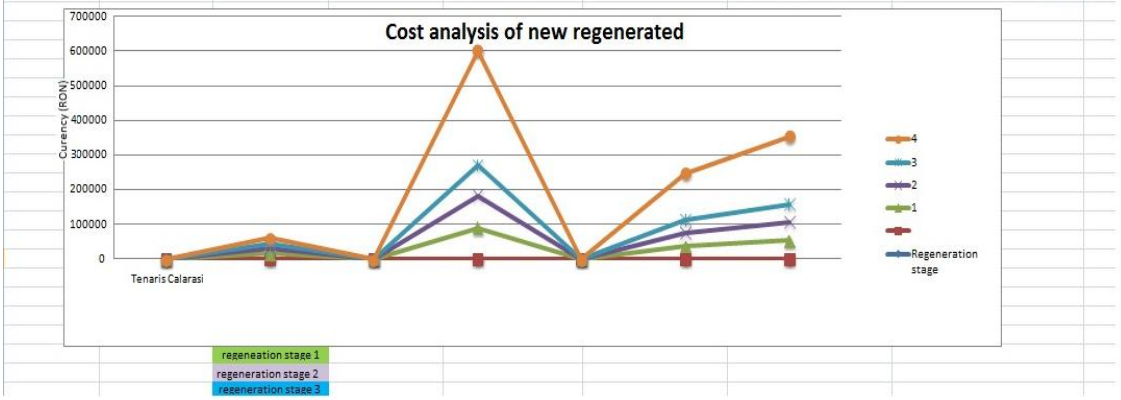


Fig.8 - Tenaris Calarasi economic efficiency diagram

4.Conclusions

In the ones presented above, one can see the efficiency of the applicability of the proposed solution from an economic point of view as well as from the qualitative efficiency that it can have. Both the economic calculations and the experimental determinations were exposed to see the efficiency of the regeneration plant. It can be seen that the degree of purity of an oil is as follows:

- The oil used: according to the picture taken with the help of the microscope you can see the level of impurities and after the laboratory analyzes done it can be observed that this product can only be used and must be neutralized.
- Regenerated oil: according to the picture taken with the help of the microscope it can be seen that there are no impurities and from a technical point of view the product can be used under optimal conditions
- New oil: according to the picture taken with the help of the microscope it can be seen that there are low level impurities and for an unused product, so the more the question of regeneration is posed.

As a conclusion, it can be said that, after using the used oil regeneration plant, it can be seen that, as a result of this process, the oil is (perhaps) of better quality than a new type oil. From the above, we managed to implement the integrated management of industrial lubricants through regeneration. So any industrial processing unit that has in the technological flow industrial oils, greases or industrial emulsions can reduce its costs through regeneration thus protecting nature, practically applying the concepts of Economy Circulare, care involves sharing, reusing, repairing, renovating and recycling existing materials and products as much as possible. Through this innovative concept of integrated management of industrial lubricants can be realized a lasting protection of the environment, saving of resources, economic efficiency.

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