Functional-Cost Analysis of Waste Mineral Oil Regeneration Methods

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Abstract – The main methods of used mineral motor oils regeneration are considered - namely physical, chemical and physico-chemical methods. Functional and cost analysis of the used mineral motor oils regeneration methods was carried out with the help of industry experts. The functional-value analysis consists of the paired comparisons method and involves the process of ranking selected characteristics according to the importance degree (validity). For this, each character is assigned a definite index. As a result of the conducted functional-cost analysis, the suitability of using technologies of vacuum distillation and hydrocracking of used oils in the processes of regeneration of used oils was established.

Keywords – functional-value analysis, used oil, oil regeneration, oil hydrocracking, coagulation.

Introduction

Currently, the vast majority of lubricants are imported into Ukraine from abroad, which makes it dependent as their consumption grows over the years. Motor oils derived from petroleum or synthetic are characterized by a wide range of applications, including lubrication, heat and power transfer, engine parts protection, cleaning of components, etc. Such oils become contaminated and/or degraded depending on the application and operating environment, so they must be disposed of, resulting in used motor oils. Used oils are classified as hazardous waste and belong to subgroups Y8 and Y9 of the Basel Convention [1].

In Ukraine, used oils (UO) are mostly burned, which is irrational both from economic and ecological points of view. However, submitting them for secondary processing is more appropriate for obtaining components of base oils or lubricants of different uses.

At the same time, with the annual increase in the consumption of commercial oils in the world, the amount of UO also increases, which leads to their further accumulation, which negatively affects the environment and creates the problem of their rational disposal. The primary "producers" of UO in Ukraine are industry (28%), transport (38%), agriculture (23%) and construction (11%) [1]. Today, secondary raw materials recycling is primarily a concern for the environment and future generations!

To regenerate UO, it is necessary to change their physical and chemical properties, bringing them as close as possible to the base oil components' properties. To achieve the goal, it is necessary to:

– remove mechanical impurities from used oil - water, dust, additives decomposition products;

– to separate light hydrocarbons from oil - the remains of unburned fuel;

– change the group hydrocarbon composition of UO, bringing it as close as possible to the original oil composition of the corresponding brand;

– to improve the UO viscosity-temperature properties;

– to correct the UO low-temperature properties; to reduce the UO acid number.

If the tasks are fulfilled, the base oil component will be obtained, which can be used in commercial oil manufacturing or other industries. To fulfill the task, first of all, it is necessary to carry out a detailed analysis of well-known oil regeneration methods and to study the possibility of new methods usage.

To choose the optimal technology for UO regeneration, it is expedient to use functional-cost analysis (FCA) of known UO regeneration technologies, which makes it possible to formulate the basis of ranking at the same time and has a fairly simple mathematical calculation apparatus [1]. To perform an expert evaluation of the UO regeneration technologies, industry experts were involved, which made it possible to conduct a functional and cost analysis based on their estimation.

The analysis of the UO regeneration methods using the FCA method showed that the vacuum distillation technology received the highest integral rating, and the hydrocracking technology received a slightly lower rating.

The UO hydrocracking process is well-studied and used in global practice. Well-known industrial processes for the UO regeneration by IFP and the companies UOP, Snamprogetti, and Mainken make it possible to obtain high-quality base oils and use them in commercial oil production. However, according to its technical and economic indicators, this process requires high capital investments, and problems arise with the production and use of hydrogen. It is economically beneficial in the case of large UO processing volumes (at least 50-60 thousand tons/year).

Conclusions

For the first time, independent experts have made a functional and cost analysis of known used oils regeneration methods. It was established that according to the functional-cost analysis evaluation results, the vacuum distillation technology received the highest integral evaluation.

The obtained FCA results provide initial information for selecting the optimal technology for the used oils regeneration and can also be used for the development of the used oils regeneration complex technologies.

References

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