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RESOURCE-EFFICIENT AND ENERGY-EFFICIENT CHANGES IN WASTE OILS MANAGEMENT¹

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ZASOBOOSZCZĘDNE I ENERGOEFEKTYWNE ZMIANY W ZARZĄDZANIU ODPADAMI OLEJOWYMI¹

Abstract: Contemporary problems of waste oils management in Ukraine are considered in the paper. Based on European Union countries' experience the innovation approach to solve the waste oils management problem is supposed. Reforming of the oil products recycling branch in Ukraine has to be based on the concept concerning absolute domination of processed oils regeneration that will provide increase of regions and country environmental and economic security. General scheme of organizational and economic mechanism to control waste oils recycling branch development at macro-level developed in the paper. In order to organize producing process, authors suggest to create regional complexes, located by principle of the territorial integrity in regions where waste oils are collected, optimization of their transporting routes, and producing capacities of waste management facilities. Each of these complexes has to include structures, specialized on some stage in waste oils recycling that will make the processing mobile, flexible and able to achieve maximal economic results.

Keywords: waste oils management, waste oils, waste oils system, organizational and economic mechanism, risk, environmental and economic security.

Streszczenie: W artykule rozpatrywane są współczesne problemy zarządzania olejami odpadowymi na Ukrainie. Sugerowane jest podejście innowacyjne do rozwiązywania problemu zarządzania odpadami na podstawie doświadczeń krajów Unii Europejskiej. Reforma branży recyklingu produktów naftowych na Ukrainie musi opierać się na koncepcji absolutnej dominacji regeneracji olejów przetworzonych, która zapewni wzrost regionów i bezpieczeństwo gospodarcze kraju i środowiska. W artykule opracowano ogólny schemat mechanizmu organizacyjnego i gospodarczego w celu kontroli rozwoju filtra ropy naftowej na poziomie makroekonomicznym. Aby zorganizować proces produkcyjny, autorzy sugerują stworzenie regionalnych kompleksów zlokalizowanych na zasadzie integralności terytorialnej regionów zbierania odpadów ropy naftowej, optymalizacji ich tras transportowych i zdolności produkcyjnej przedsiębiorstw przetwórczych. Każdy z tych kompleksów musi obejmować struktury specjalizujące się w pewnym etapie recyklingu ropy naftowej, które sprawią, że przetwarzanie stanie się mobilne, elastyczne i może osiągnąć maksymalne wyniki ekonomiczne.

Słowa kluczowe: zarządzanie olejami odpadowymi, oleje odpadowe, system olejów odpadowych, mechanizm organizacyjny i ekonomiczny, ryzyko, bezpieczeństwo środowiskowe i gospodarcze.

Introduction

Needs for energy resources which are growing every year, sharpen the existing economic and ecological problems in the country. It concerns mainly the oil waste recycling branch. On the one hand, there is heavy raw deficit that put at threat energy independence of Ukraine.

Ukraine, given to develop scientific-research topic № 53.15.01-01.15/17.GF "Methodology of forming mechanism of national economics innovative development based on alternative energy".

On the other hand, as a result of production scale-up, based on traditional approaches, oil wastes are accumulated in the environment. One of the main efficient ways to solve these problems is to enhance activity concerning collecting and raw recycling, based on using of dangerous substances regeneration technologies, which conform to the standards.

The object of the article is to develop scientific and applied bases to form resource-efficient and energy-efficient waste oils management system in Ukraine.

Waste oils management: experience of EU countries and Ukraine

The conducted research showed that today amounts of waste oils producing is about 2 million tons in Ukraine: 29% – are processed oil products (POP): engine oil (EOP) and industrial processed oil (IPO), mixture of processed waste oils (MPO), and 71% – oil mud (OMW). Market demand for oils in Ukraine trends to increase oil production and processing amounts². According to prognosticated calculations amounts of the waste oils production, which conform classification group EOP, will annually grow to 15–17%. Prognosticated annual amounts of oil wastes growing, which conform classification group IPO, MPO and OMW considering changes in producing sphere will be 4–6% and 3–5% respectively. Prognostication of oil wastes consumption and production, which conform group EOP, by regions is shown in fig. 1.

Figure 1. Prognostication of oil materials consumption and waste oils producing amounts for 2015-2020, thousand ton/year

Rysunek 1. Prognozowanie zużycia materiałów ropopochodnych i odpadów ropy w latach 2015-2020, tys. ton rocznie



Source: own study and *The general information about the process KTI RELUB (technical suggestion)*, Zoetermeer: Kinetiks Technology International B.V. 2007, 12 p.

² *Proposal (Budget offer) for a used oil re-refining plant. Meinken Engineering* (patent Nos. DE 3023374 C 2, DE 420 588 4/5, DE 39 16 732), Haltern 2007, 33 p.

Studies on waste oils handling in Ukraine show that about 80% POP are illegally emptied into environment and are burnt, 20% – are partially processed. At the same time there is another situation in Europe, where only 25% of processed oils, 25% – are regenerated, 49% – used as fuel and 1% – destructed (table 1). Such statistics underlines the necessity to reform the oil wastes recycling branch considering the existing experience of such activity in USSR (fig. 2)³.

Table 1. Indexes to use POP in European countries

Tabela 1. Indeksy używania przetworzonych produktów naftowych w krajach europejskich

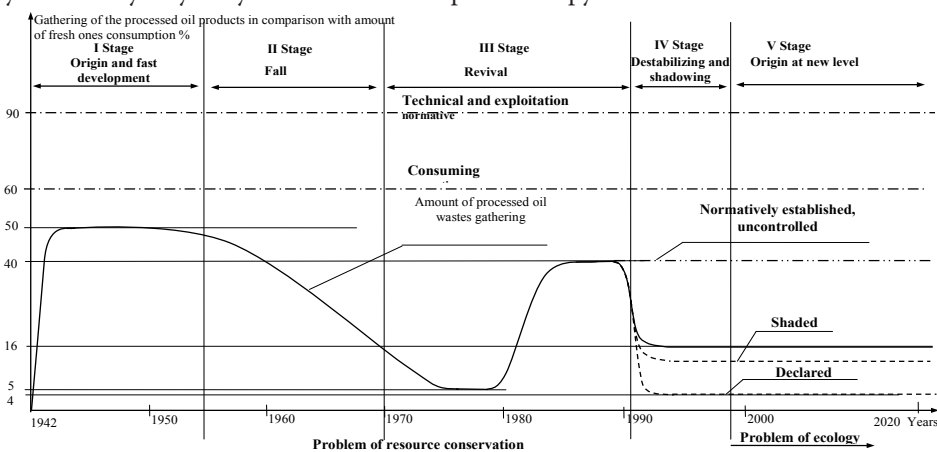
Country	Number of recycle facilities, unit	Productivity of the acting facilities, thousand ton/year	Part of POP, which are collected, %	among them:		
					are regenerated, %	Are used as petrol, %
Germany	6	280	87		55	30
Sweden	...	...	82		...	...
Italy	6	239	...		55	18
Belgium	2	45	42		50	25
France	1	110	...		28	54
Spain	8	190	...		16	...
Holland	...	...	71		...	...
Ireland	...	...	35		...	...

Note: ... – there is no data

Source: own study based on *State Statistics Service of Ukraine* [Electronic resource] – Access mode: <http://www.ukrstat.gov.ua/>

Figure 2. Life cycle of the waste oils recycling gathering system

Rysunek 2. Cykl życia systemu zbierania odpadów z ropy



Source: own study based on *State Statistics Service of Ukraine* [Electronic resource] – Access mode: <http://www.ukrstat.gov.ua/> and *The general information about the process KTI RELUB* (technical suggestion), Zoetermeer: Kinetiks Technology International B.V. 2007, 12 p.

³ *The general information about the process KTI RELUB* (technical suggestion), Zoetermeer: Kinetiks Technology International B.V. 2007, 12 p.

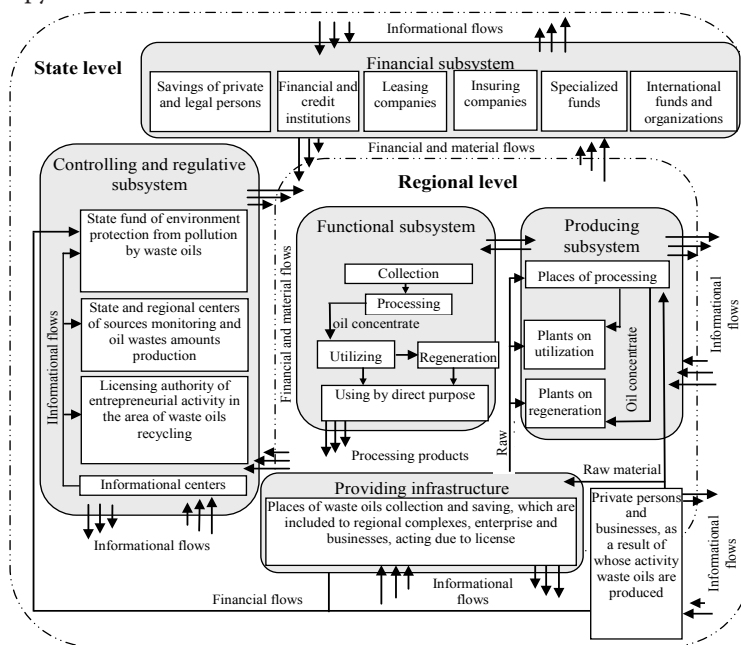
1. The ways of reforming the waste oils system in Ukraine

Innovative process activating in this branch using dangerous substance technologies, which conform the world standards, will lead to decrease of ecodestructive load on the environment and will provide native commodity producers with oil resources of high quality. Modern technologies, which are practically without wastes (concerning carbonic fraction) allow to receive standard second-generation oil products. They are not inferior by quality level to fresh ones received in the process of primary processing from base oil (more details see⁴). Thus, reforming of the oil products recycling branch in Ukraine has to be based on the concept concerning absolute domination of processed oils regeneration that will provide increase of regions and country environmental and economic security.

General scheme of organizational and economic mechanism to control oil wastes recycling branch development at macro-level is suggested in fig. 3, where one can see interconnection between controlling and regulating, financing, functional and producing subsystems at different levels. Their role to provide ecological and economic processes, assisting the achievement of economy sustainable development, is determined.

Figure 3. Organizational and economic mechanism to control waste oils recycling branch development

Rysunek 3. Mechanizm organizacyjno-ekonomiczny kontroli rozwoju branży recyklingu odpadów ropy



Source: own study.

⁴ Ibidem.

Today most Ukrainian regions have proper business organizations, which can provide collection, saving and transporting of oil wastes. In order to organize producing process, authors suggest to create regional complexes, located by principle of the territorial integrity in regions where waste oils are collected, optimization of their transporting routes, and producing capacities of waste management facilities. Each of these complexes has to include structures, specialized on some stage in waste oils recycling (more details see⁵) that will make the processing mobile, flexible and able to achieve maximal economic results:

1) enterprise on POP and OMW processing in order to receive waste oils from licensing collectors and businesses, their identification, processing, sorting on raw material of group EOP, IPO, MPO, shipment of the oil concentrate for further utilization and regeneration;

2) plant for utilization of the OMW. It is designated to extract OMW from oil mud basins, defecators and other types of oil mud containers, which belong to businesses; distinction from OMW through oil concentrate, conformed requirements of State standard 21046-86 for MPO group; utilization of the oil concentrate and MPO to standard light motor fuels and bitumen; shipment of the produced and sorted oil products to their final consumers;

3) plant on POP regeneration, designated to distinguish oil concentrated from POP, its quality bringing to raw groups EOP, IPO by State standard 21046-86; oil concentrate regenerations to standard basic or sorting oils; shipment of the produced basic and sorting oils to their final consumers.

The power of each complex depends on technologies and basic lines on waste oils processing. On the bases of leading specialists' expert estimations, market analysis of recycling modern technologies investigator, producers and suppliers of the main technological tool, expertise of the most effective active world objects on waste oils recycling, it is decided that there are two optimal variants for Ukraine: technology RELUB (company «KTI», Holland) and B.MEINKEN (Germany), with capacity 12 thousand ton/year. Raw balance, which is necessary to provide producing process, and ready production is shown in table 2.

⁵ Ibidem.

Table 2. Annual exploitation features
Tabela 2. Roczne cechy eksploatacyjne

Factors	Measuring units	Annual amount of processing	
		B.MEINKEN ¹	RELUB
Productivity	Thousand ton/year	12	50
Production costs			
Raw (processed oil)	t	12000	50000
Stove oil	t	1496	
Natural gas	Thousand Nm ³ /year		725
Electrical energy	mW/year	2000	4900
Water	m ³ /year	25600	
Filtrating paper	m ² /year	24000	
Activated decolorizing earth	t/year	368	
Additional materials and chemical substances	USD/year	5000	200000
Production yield			
Basic oil SAE 15/30	t/year	7500	37500
Basic oil SAE 5/30	t/year	960	
Stove oil	t/year	2592	
Liquid building bitumen	t/year	790	4500
Hydrotreated gas oil	t/year		4500
Production wastes			
Processed decolorizing earth	t/year	560	–
Waste water	m ³ /year	24000	–

¹ This table shows exploitation features of the production, with capacity 12 thousand t/year. The company also takes orders to produce and install equipment with capacity 24 thousand t/year, cost of which is 15-20% greater in comparison with equipment with 12 thousand t/year.

Source: own study based on *Naftogas of Ukraine. Tendencies, priorities, perspectives*, Oil and gas 2008, № 5, P. 2–5 and V.Yu. Shkola, *Prognostication of the ecological innovations life cycle in the system of projects management*, Marketing. Management. Innovations: (monograph edited by Dr of Economics, Prof. S.M. Illyashenko), Sumy: LLC “TH «Papyrus»” 2010, P. 412–425.

2. Estimation of the innovation projects

Investigation of the market showed that market necessity level in re-refined oils is over 70% that proves their ability to be accepted by the market. Demand dynamics analysis for oil materials allows to conclude the following: considering the most probable consumers' behavior (staged acceptance of new production at the market) will be realized at the stage of recycling production entering the market – mostly by businesses-producers of the oil materials, in the form of oil base. It will provide fast payoff of the capital investments.

Previous ecological and economic analysis showed by all projects that waste oils processing systems provide to control pollution level, made by harmful substances owing to process selectivity (table 3). Besides, there are no harmful co-products during the recycling process: low-boiling hydrocarbons, consisting of chlorine, are used as fuel to produce technological heat and are burnt in special stoves; distillation residues are concentrated in sticky bitumen product; solid wastes do not have harmful substances; water run-offs are moved into the purification system. Absence of the harmful impact by technological process proves the reasonability to implement projects from positions of the regional ecological security.

Table 3. Scheme of the pollution separation in different sections in the recycling process¹
Tabela 3. Schemat oddzielenia zanieczyszczeń w różnych sekcjach procesu recyklingu¹

Substances	Dehydration	Steam of the gasoils	Oils distillation	Purification	Final result of extraction
Detergents / emulgators	–	+	++	0	+++
Organometals	–	±	+++	0	+++
Organohalogens	++	++	±	+++	+++
Nitrogen-organics	+	++	+	+++	+++
Oxygen-organics		+	±	+++	+++
Sulfur-organics	±	±	+	+++	+++
Phosphorus-organics	–	+	+++	0	+++
High-molecular polymers	–	–	+++	0	+++
Metals	–	–	+++	0	+++
Asphaltenes	+	+	+++	0	+++

¹Estimation of the harmful substances extraction level: «+++» – excellent; «++» – good; «+» – satisfactory; «±» – unsatisfactory; «–» – separation is absent; «0» – the component is totally extracted.

Source: own study.

Authors of projects conduct business-analysis, based on ecoinnovations life cycle prognostication. Since in Ukraine activity on waste oils recycling and the product, produced as a result of such activity, is common eco-friendly innovation⁶, each of its life cycle stages duration, is defined by expert method where some event is given probable assessment to occur.

⁶ V.Yu. Shkola, *Economic and organizational bases of the oil wastes recycling branch formation and development*, Problems of the innovative ecologically oriented entrepreneurship management (monograph edited by O.V. Prokopenko), Sumy: PTH "University book" 2007; P. 485–505.

According to prognosticating estimations, the expected duration of the innovative cycle in the suggested project is 24 months. Considering high level of the re-refined oil market potential in Ukraine (over 350 000 t per year) and probable amount of their sales (over 150 000 t per year), prognosticating assessments of the STP development and moral aging speed of this innovation, re-refined oil market life cycle expected duration is 13–33 years.

Risks analysis, which can appear while creating regional complex on waste oils processing, is shown in the table 4.

Table 4. Types and essence of risks

Tabela 4. Rodzaje i istota ryzyka

Type	Consequences	Cause	Way of risk decrease
1	2	3	4
At the innovative cycle stages			
<i>Excess of costs over planned ones</i>	Profitability level decrease of the regional complex	Changes of economic situation in the country or in the world; increase of design, construction and installation works costs; changes in budget, financial and credit, and taxing systems in Ukraine; economic contractors' (suppliers, master builders') acts	Long-term contracts concluding; punitive sanctions for delinquency; forming of the regional system on agreements insuring; constant monitoring of the political and economic situation in the country and in the world; involving of trustful partners, who have good business reputation
<i>Delay in design, installation and construction and preparatory works</i>	Delay with entering the market; breaking of the early concluded agreements with suppliers of the raw material and enterprises-consumers; degradation of the ecological and economic situation in the region; excess of the mentioned investment budget	Wrong loading of the projectors group; insufficient experience, classification, disagreements in the projectors, constructors' and master builders' work; incorrect constructive and technological documentation; difficulties in coordination between native project and constructive standards and standards of the equipment country-producer; nonconforming technological equipment; actions of the faithful competitors; low labor discipline; delay in delivery of necessary materials and equipment; difficulties in building works (owing to remoteness from transport centers, engineering nets of electric-, heating- and water supply systems)	Establishing of the punitive sanctions, defined by terms in agreements for works performing, for non-fulfillment or undue fulfillment of duties; involvement of trustful partners, who have fine business reputation and enough experience in work in the proper activity sphere; establishment of the clear official duties and hierarchy between workers, involved in the project conduct
<i>Political and legal risks</i>	Increasing of the innovative cycle duration; delay with entering the market; increasing of investment resources amounts; decreasing of the production profitability	Authorities' resisting in the project realization; changes in legislative and normative base, more strict ecological norms accepting; accepting of the new state, regional ecological programs; resource expansion; ecologically oriented people's and public organizations' strikes	Organization of the marketing acts, oriented to inform society, potential consumers and investors about privileges of the re-refined oils and their producing process, expected social ecological and economic effect; constant relations with active publicity and international ecological organizations

Type	Consequences	Cause	Way of risk decrease
1	2	3	4
At the market cycle stages			
<i>Prices risks</i>	Loss of market positions, underpayment of incomes and decrease of the production profitability	errors while forming price and developing price strategies; quick changes of the economic situation in Ukraine and in the world; underestimation of competitors; actions of the economic contractors	Constant investigation of the oil products market and its changes prognostication; in-time informedness providing concerning competitors' acts and intentions; flexible price policy introduction; long-term contracts concluding on re-refined oils sales
<i>Non-delivery of outward raw material, materials and resources</i>	Partial loading of producing capacities, production downturn and regional complex profitability decrease	Absence of the active organizational and economic mechanism to rationalize collection system of the processed oil products at the state and regional levels; insufficient development of the infrastructural provision in the branch; refusal of the potential suppliers of agreements concluding; unexpected difficulties among suppliers; competitors' acts; unacceptable conditions in agreements; tearing up of delivery contract by supplier or its terms changing	Long-term agreements concluding with industrial enterprises on waste oils utilization of POP class and with petroleum refining industry sector for utilization of POP and OMW; constant relations setting with state and local authorities to solve problems on conduct with dangerous waste oils and environment protection; involving of state and local authorities to realize suggested project through project fulfillment within state or regional programs, involving of costs from target or regional funds, budget transfers receive etc; creation of the outgoing materials and raw material insuring; creation of own receiving and keeping points net of the processed oil products; organization of the constant system concerning possible suppliers monitoring; timely investigation of actions to provide functioning of regional complex under conditions of alternative suppliers search

Type	Consequences	Cause	Way of risk decrease
1	2	3	4
<i>Decrease of re-refined oils sales amounts</i>	Worsen of financial state in the complex; increase of the ready production amounts at warehouse; lack of working capital	Underestimation of the marketing activity role, possible errors while forming product, sales and communicative policy; refusal of enterprise-purchaser of realization agreement conditions conduct; change of the consumer demand structure, decrease of necessity in re-refined oils (particularly, owing to irresponsibility of re-refined oils qualitative features by introduced ecological norms; transfer of traditional enterprises-purchasers to manufacture engine, industrial and other oils, produced synthetic instead of the re-regenerated mineral raw material – moral aging of production etc); substitution of regional complex production by competitors' production; absence of the whole information about alternative purchasers and separate market segments; decrease of enterprises-purchasers' paying capacity level; instability of the raw material quality and production output	Involving of independent organizations as agreements guarantees; diversification of production and sales; trustful relations setting with administration of enterprises-purchasers; using of all marketing forms; development of pledge agreements; creation of the agreement insuring regional system; agreements concluding with competitors about impact sphere distinguish; in time following of information about existing and potential consumers, competitors
<i>Income deficiency</i>	Financial state worsening	Those, which mentioned above, and also wrongly determined time of the commercial production development beginning; unsolved producing problems; errors, caused at the stages of innovative cycle; early leave of the market	Creation of own informational and analytical subdivision to store informational base concerning marketing space; prognostication of market performance changes and possible developments of actions at the primary and re-refined oil products market, and also in the secondary resources branch; in time development of actions concerning crisis situations warning etc
<i>Man-made risks</i>	Worsening of ecological space in the country and increase of the environmental payments	Breaking of the management processes by the harmful substances concentration level and failures in the technological processing system; breaks in system of the equipment regular purification. Factors of risk – circumstances of insuperable force; natural disasters; low level of workers' producing culture; financial resources absence to conduct current and capital repair of the equipment; absence of necessary details to repair equipment; equipment deterioration	Constant diagnostics of the technological process and equipment; planning and conducting of scheduled maintenance concerning violations preventing in the technological process

Type	Consequences	Cause	Way of risk decrease
1	2	3	4
<i>Additional costs for liquidation of the volatile emissions and emergencies aftereffects</i>	Worsening of the equipment work; insufficient classification of workers; absence of knowledge on peculiarities of the technological processes; workers' insufficient (absent) experience concerning conduct with equipment	Break of labor discipline; possible natural disasters; insufficient equipment reliability	Teaching of workers about work specifics with equipment and their qualification increase; in time repair of equipment; constant diagnostics of the equipment state and purification plants

Source: own study.

While realizing the project, the following scenarios of actions development are possible:

1. *Optimistic*, prognosticated with inflation level 3–5%. During the first year in production level of manufacturing capacities load level is 84%–85%. During the second year regional complex works at full capacity. Starting with the third year besides main activity on waste oils recycling, one plans to introduce complex laboratory service. Owing to incomes, which come from the main and additional activity, it is planned to create own developed infrastructure (centers of the oil wastes acceptance, given by citizens, their keeping, transporting park for transportation of the oil wastes from their creation places (collection) to the plant on processing), that will allow to avoid risk not to get feedstock to provide manufacturing process.

2. *The most probable*, prognosticated with inflation level 6–12%. During the first year of production, it is planned to load the producing capacities for 84%. Starting from the second year regional complex works at full capacity. During the third year besides main activity on waste oils recycling, it is planned to introduce services of the complex laboratory and own infrastructural provision development.

3. *Pessimistic*, prognosticated with inflation level over 12%. During the first year of production it is planned to load the producing capacities for 80%. Starting from the second year the regional complex works at full capacity.

According to our assessments the expected value of the risk level by all prognostication variants has minimal risk that proves efficiency of business-projects on waste oils recycling regional complex creation and reasonability of their introduction. This conclusion is confirmed by enough high factors of their realization efficiency, defined for period 14 years: NPV from 3,02 mln. dol. to 14,87 mln. dol.

($NPV_{m,prob.}=9,80$ mln. dol.), IRR from 29 to 59% ($IRR_{m,prob.}=45\%$), PI from 2,14 to 6,2 ($PI_{m,prob.}=4,4$), PP from 6 to 3,5 years ($PP_{m,prob.}=4,16$ years). Prognosticated annual integral ecological and economic effect from projects realization during life cycle, lasting from 15 to 35 years, is 0,137 mln. dol. per year.

Calculation shows that these projects are highly effective by all actions development scenario (pessimistic, more probable and optimistic). Great internal norm of the projects payoff shows the reasonability to create such complexes in Ukraine, even under conditions of the credit involving.

Conclusions

Activating of the activity concerning waste oils collection and recycling in Ukraine will allow to solve the following tasks: to protect environment from dangerous wastes impact; to provide rational use of oil resources; to keep informational values of the natural systems and natural potential for future generations; to increase the level of ecological security in Ukraine; to increase the life quality of inhabitants; to create additional working places; to provide needs of the native production in basic oils of high quality; to avoid extra costs to liquidate consequences after environment pollution by waste oils; to increase tax revenues to budgets of different levels; to decrease load on the nature protective funds; to provide market with competitive production of the native manufacturing; to decrease prices of oil products owing to their producing on the oil base from re-refined waste oils, prime cost of which is 50% less than basic oil prime cost, produced from raw oil; to increase competitive positions of Ukraine and to avoid dependencies on price hesitations of oil products importers; to increase level of the energetic independence of Ukraine; to assist reorientation of the waste oil flow as secondary resource from black market into real one.

Results of the research allow to affirm that reconstruction in the waste oils recycling and collection is one of the most prior actions to solve energy independence in Ukraine. Innovative process activation in this branch on the basis of waste oils recycling and their regeneration will lead to solve problems concerning decrease of ecodestructive load on the environment and provision of native commodity producers with oil resources of high quality. The received results allow to form continuous control system in the sphere of conducting with waste oils considering social and economic motivation of ecologization in national economy branches.

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