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THE NEW TECHNOLOGY OF LIQUIDATION OF TRANSPORT ACCIDENTS INVOLVING OIL PRODUCTS

Summary. In order to eliminate the environmental aftermaths of transport accidents with oil products the cycle of laboratory researches and field tests on the study of factors affecting the processes of migration of oil products in different types of soils was conducted. Comparison of convergence of the data on migration of oil products obtained in the laboratory conditions and field tests with the results of mathematical simulation of filtration processes in the same conditions is performed.

In the process of development of recommendations on application of sorbents for cleaning up of soils from oil products a wide spectrum of industrial wastes and natural materials was investigated, the optimization of cleaning processes is conducted.

The kinetics of cleaning up of soils from light oil products by means of thermoconvection is studied. The estimation of degree of renewal of the cleaned soils is executed by the biological testing.

НОВАЯ ТЕХНОЛОГИЯ ЛИКВИДАЦИИ АВАРИЙНЫХ РАЗЛИВОВ НЕФТЕПРОДУКТОВ

Аннотация. С целью ликвидации экологических последствий транспортных аварий с нефтепродуктами был проведен цикл лабораторных исследований и полевых испытаний по изучению факторов влияющих на процессы миграции нефтепродуктов в различных типах грунтов. Произведено сравнение сходимости данных по миграции нефтепродуктов, полученных в лабораторных условиях и при полевых испытаниях с результатами математического моделирования процессов фильтрации при тех же условиях.

В процессе разработки рекомендаций по применению сорбентов для очистки грунтов от нефтепродуктов был исследован широкий спектр отходов производств и природных материалов, проведена оптимизация процессов очистки.

Изучена кинетика очистки грунтов от легких нефтепродуктов путем термоконвекции. Оценка степени восстановления очищенных грунтов выполнена путем биологического тестирования.

The environmental aftermaths of accidents occurring during transportations of dangerous freights are one of the most large-scale and important problems of transport ecology (Fig. 1). During such accidents the salvo emissions of great amounts of toxic substances having a serious danger for people and the environment takes place [1, 2].

The statistics shows that despite considerable efforts in prevention of transport accidents they continue to take place. For example, even according to incomplete data of the Organization for Railways Cooperation a few tens of large-scale railway accidents per year take place in these countries, and the average losses of dangerous freights are about 130 tons per accident. This is related to difficulties of predicting natural calamities, for example, earthquakes, hurricanes, floods and so on, with unavoidable faults of personnel, with unsatisfactory conditions of the rolling stock and track, especially in countries with the transition economy (Ukraine is one of them), with natural striving for increasing traffic speeds and a number of other causes. During last year's local military operations and terrorist acts become added to these causes.

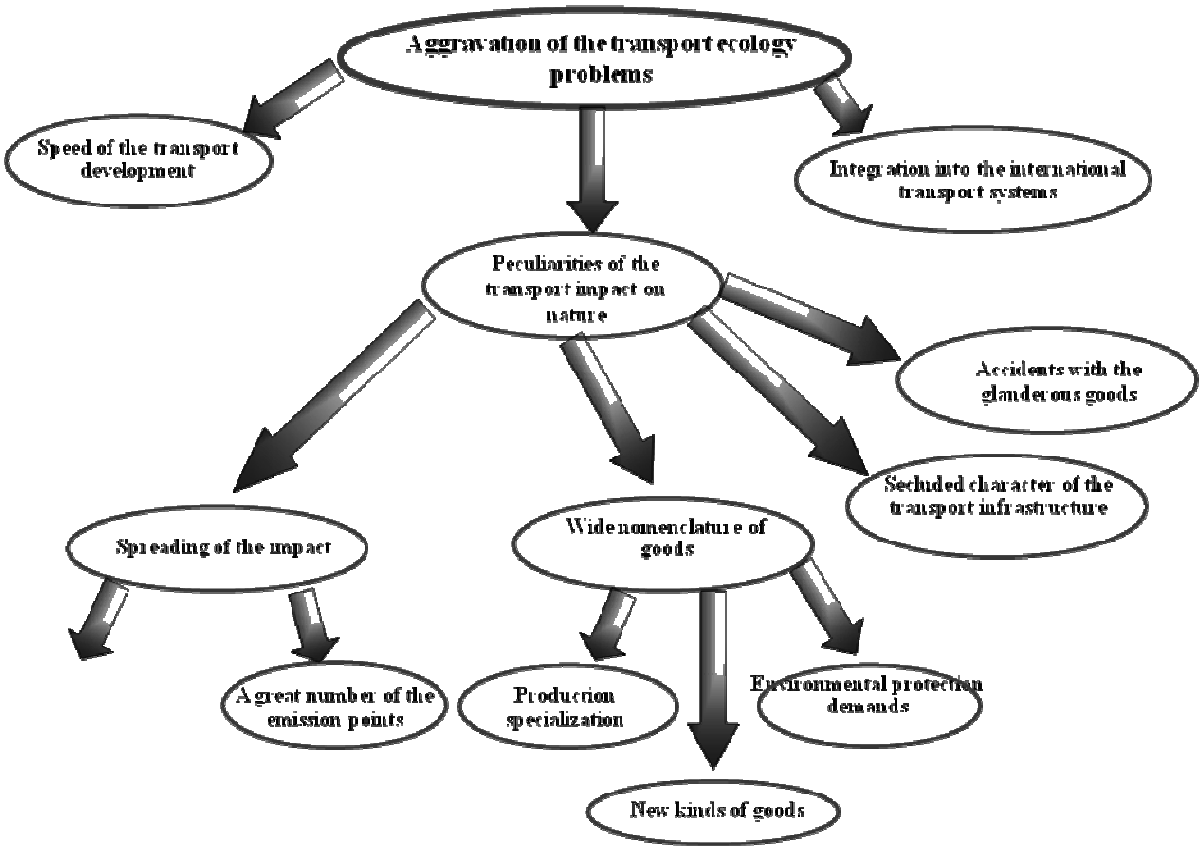

Fig. 1. Aggravation of the transport ecology problems
Рис. 1. Обострение проблем транспортной экологии

Oil products are one of most widespread freights transported by railways in Europe. Ukraine is a transit country and together with great quantity of domestic consumers the number of consignees of this kind of products in the West grows, and as a result the stream of Russian trains in the direction Europe-Asia grows too. However the number of accidents with such freights has a tendency to growth.

It is also worth taking into account that in the result of mass spills of oil products during accidents the considerable amounts of expensive energy materials become lost and thus the related technologies that include their utilization should be recognized as energy- and resource-saving ones.

First of all, it was needed to clarify what is the rate of filtration of spilled oil products through soils and what factors have the greatest effect on these processes [3]. The influence of the following factors has been studied by us for the process of filtration of oil products through soils: temperature of surrounding and soil, dispersion, humidity, compactness and chemical composition of soils.

On the base of data obtained the mathematic simulation with the purpose of further prediction of oil products behavior in soils with non-destructed structure was performed [4, 5].

The direct development of elimination measures in two basic directions differing by the character of run of emission, spreading of oil products and, accordingly, by the features of approach to their conduction was the next stage of performance of this work.

The attention was accented on:

elimination of the environmental aftermaths of accidents during transportation of *heavy* oil products; elimination of the environmental aftermaths of accidents during transportation of *light* oil products. The basic principle of elimination of spills of light oil products is as follows:

Blowing of light fractions by air warmed-up to the optimum temperatures (convection) with the parallel regeneration of oil product → Pumping-in of enzymes and biopreparations-oil destructors for deep final cleaning up of soil.

The basic principle of elimination of spills of heavy oil products is the generally recognized scheme:

Localization of place of spill → Pumping-out of liquid phase of oil product → Filling up of accident scene by absorbers → Collecting of exhausted absorbers and cutting-off of oil-contaminated soil → Ordering of collected absorber and cut-off soil to utilization → Treatment of accident scene by enzymes and biopreparations-oil destructors for deep final cleaning up of soil.

Thus an orientation on the use of industrial wastes and some natural materials as sorbents-absorbers is a central conception of the technology.

In doing so, the central conception of technology is the orientation on using of wastes of metallurgic, construction, woodworking enterprises, steam electric stations and some natural materials as sorbents-absorbers. To be able to recommend one or another material we have also studied the influence of main physical factors (temperature, humidity, granulometric and chemical compositions).On the base of results obtained the recommendations on their application under various parameters of the environment have been developed. And the radically new sorbent on the base of wastes of pulp-and-paper industry and wastes of housing-and-communal services is also proposed.

During the consideration of problems of utilization of materials saturated with oil products we start from the following ideas: if the utilization of benzine can be done in a few ways (for example, by means of skimming of light fractions) then for a variant of diesel fuel the method of thermal oxidation looks more simple and rational. In order to solve the question of expediency of burning any sorbents saturated with oil products and to calculate the related equipment we have to determine their heating power and ash content. We carried out research on determination of combustion heat and ash content of absorption products of diesel fuel by the proposed sorbents. Experiments were fulfilled by a calorimetric method according to standards. The table 1 contains the values of combustion heats and ash percentage of sorbents (Q_{ab} - absorbent and Z_{ab}.) and also their mixture with diesel fuel obtained in calculation ($Q_{mix.t}$ and Z_T) and experiment ($Q_{mix\ ab}$).

On the basis of results obtained, in order to forecast expected effects we have drawn the correlation dependence of heating power.

It shows the correlation between combustion heat and absorption capacity of the studied sorbents in relation to diesel fuel (Fig. 2). For most cases we can see a satisfactory correlation which is close to a linear one that testifies the dominating contribution of absorbed oil products into combustion heat. Adobe brick, wood chips and coarse saw dust are exceptions for which the effect of combustion heat of the sorbent itself is more.

The development of prevention measures, including the signalization system on an emergency situation that took place, has become a final stage of creation of the technology for elimination of transport accidents with oil products. The results obtained have provided the basis of technology for elimination of environmental aftermaths of transport accidents with oil products. The offered technology has passed the successful tests at Prydniprovs'ka Railways and has become a part of the “Recommendations R003” of the Commission on Transport Policy, Ecology and Combined Transportation of the Organization for Railways Cooperation.

Table 1

Calculated and experimental data of combustion heat and ash value of materials by saturated oil products

Sorbent	W, %	Q_{ab}, Kj/kg	$Q_{mix.t}$, Kj/kg	$Q_{mix\ ab}$, Kj/kg	Z_{ab}, Kj/kg	Z_T, %
Claydite	31,4	264±10	13370	11090±120	30,3	29,3
Kaolinite	8,5	-647±14	2920	2310±21	61,5	63,7
Foamed concrete	16,2	674±16	7370	6190±64	32,8	31,4
Aerated concrete	19,6	791±13	8870	7450±89	31,5	30,2
Pumice	65,3	1164±20	23870	23090±365	23,7	24,2
Adobe brike	9,1	8562±64	11610	10950±115	29,8	27,9
Metallurgical slag	19,2	0,07±0,005	8060	6670±78	75,2	71,5
Coke slag	22,7	87,3±3	9600	7960±105	67,1	69,1
Wood chips	36,1	9479±92	21200	18600±456	1,2	1,2
Coarse saw dust	76,3	9240±88	34200	31000±802	0,7	0,7
Sand	16,5	-0,18±0,04	6900	5730±66	82,7	78,6
Slurry sand	26,4	16,4±0,8	11100	9190±82	63,9	60,6

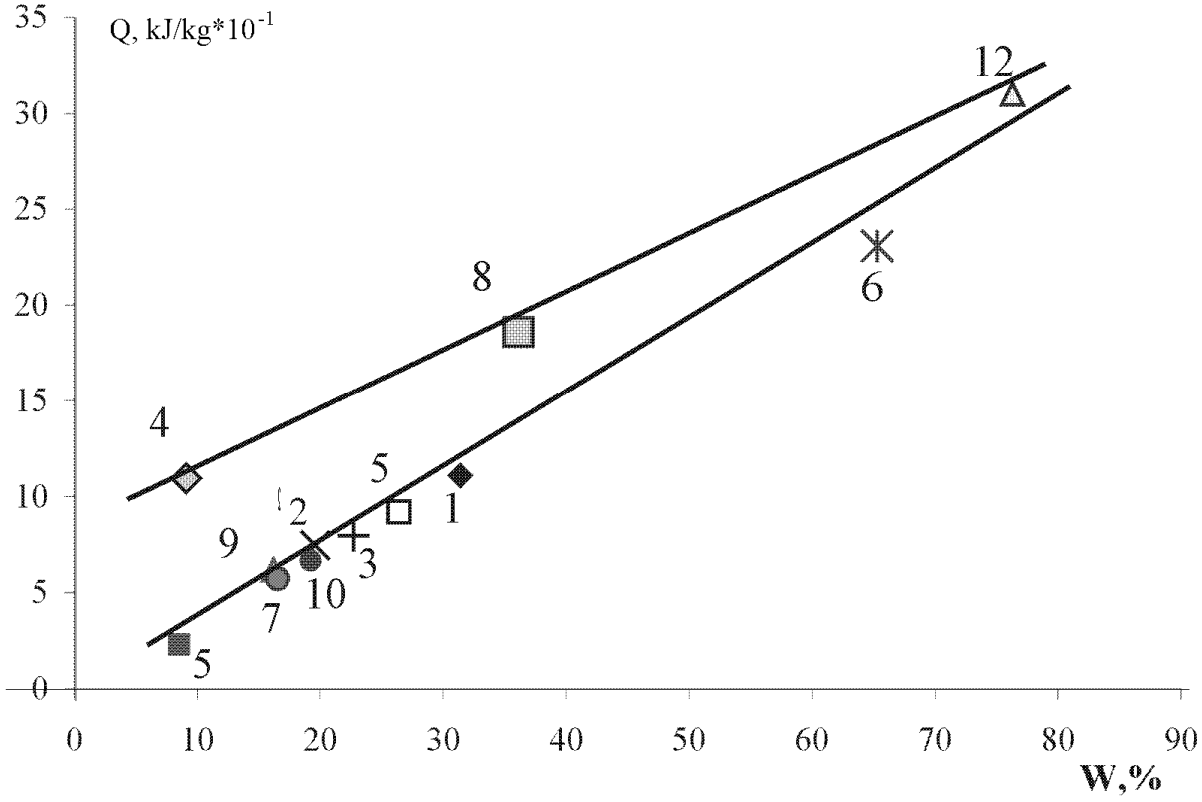

Fig. 2. Correlation graph of combustion heat vs. extent of absorption
Рис. 2. Корреляционная зависимость теплоты сгорания от степени поглощения

Both methods present possibilities for further re-use of extracted petroleum or oil-containing products. The author provides recommendations on the application of various absorbents, specifies

their expenditures, and suggests plausible ways for the utilization of the by-products from absorption and the use of soils contaminated with fuel oils. The efficiency of the suggested technology has been proved by its introduction into practice that resulted in a number of favorable ecological, economic and social effects.

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