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Acid tars: environmental problem or secondary resources?

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Abstract. The study analyzes the most important areas of processing acid tars, a specific type of non-permanent composition waste, the main source of which are the processes of oil refining and storage. Among the complex of substances included in the composition of acid tars are very aggressive components of high hazard classes, which creates risks of secondary pollution of natural environments when the storage tank is overflowing or loses its integrity. Despite more than 100 years of development history, sufficiently effective technologies for their processing have not been proposed to date. For Russia, the problem is very relevant: several storage facilities for this type of waste are included in the register of objects of accumulated environmental damage and are subject to prompt environmental rehabilitation. As a solution to the problem, it is proposed to apply an approach consistent with the principles of green economy: neutralization of acid tars using waste from other industries, such as the food industry or agriculture. The result of neutralization is a decrease in the degree of hazard of waste for the environment, "mutual neutralization" of waste of various origins and the prospect of obtaining material suitable for economic use. In addition to the actual technological solution for waste neutralization, it is proposed to systematize information on existing technologies in this area — to create an information and reference system. Which will allow organizing information on developments and will facilitate the selection of optimal solutions for each storage facility, taking into account the individual characteristics of the stored waste and the availability of technological solutions from the standpoint of the best available technologies (economic, environmental, technological availability and efficiency).

Keywords: acid tars, neutralization, technology, waste, green economy

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Кислые гудроны: экологическая проблема или вторичное сырье?

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Аннотация. Проанализированы важнейшие направления переработки кислых гудронов — специфического вида отходов непостоянного состава, главным источником которого являются процессы переработки и хранения нефти. Среди комплекса веществ, входящих в состав кислых гудронов, — весьма агрессивные компоненты высоких классов опасности, что создает риски вторичных загрязнений природных сред при переполнении накопителя или утрате им целостности. Несмотря на более чем 100-летнюю историю разработок, до настоящего времени не предложено достаточно эффективных технологий их переработки. Для России проблема весьма актуальна: несколько накопителей этого вида отходов включены в реестр объектов накопленного экологического вреда и подлежат скорейшей экологической реабилитации. В качестве решения проблемы предложено применить подход, соответствующий принципам зеленой экономики: нейтрализации кислых гудронов с применением отходов других отраслей, например пищевой промышленности или сельского хозяйства. Результат нейтрализации — снижение степени опасности отходов для окружающей среды, «взаимная нейтрализация» отходов различного происхождения и перспектива получения материала, пригодного для хозяйственного использования. Дополнительно к собственно технологическому решению по нейтрализации отходов предлагается систематизация сведений о существующих технологиях по данному направлению — создание информационно-справочной системы, которая позволит упорядочить сведения о разработках и будет способствовать выбору оптимальных решений для каждого накопителя с учетом индивидуальных особенностей хранимых отходов и доступности технологических решений с позиций наилучших доступных технологий (экономическая, экологическая, технологическая доступность и эффективность).

Ключевые слова: кислые гудроны, нейтрализация, технология, отходы, зеленая экономика

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Introduction

Acid tar is one of the most common types of petroleum waste. In their chemical composition — a wide range of chemical compounds, including substances of high hazard classes. It is the complexity of these wastes that becomes the most difficult obstacle to their recycling.

According to modern estimates, today the enterprises of Russia and CIS have accumulated more than one and a half million tons of acid tars. Most of these wastes are identified in the Nizhny Novgorod and Yaroslavl regions, Bashkortostan and several other regions where work with hydrocarbon raw materials is actively carried out. Some of the acid tars storage facilities, which have been used for many decades, are classified as objects of accumulated environmental damage: four such facilities are included in the state register (GRONVOS — State Register of Objects of Accumulated Damege to the Environment), although there are actually much more.

The ecological danger of accumulation of acid tars is related to the possibility of their penetration into the components of the environment: into the soil by overflowing outside the storage or because of the destruction of the storage tanks insulation; in underground water; also, possible evaporation of stored substances.

The composition of acid tars in storage facilities is unstable (can change when changing weather conditions: storage in the open air) and very different. The stored material can be divided into layers with high concentrations of certain components. Thus, gradually precipitate viscous substances, polymerization products of unsaturated coal-hydrogen, aromatic compounds, acid containing compounds (including sulfuric acid — up to 70%). Detailed analysis of the chemical composition of acid tars makes it possible to evaluate them as waste of II class of danger, which requires the organization of their treatment with increased precautions.

Due to the fact that the problems of acid tars have been known for many years, a wide range of approaches to their management has now been proposed, but each storage is unique in its own way (formed from waste products of different composition of petroleum feedstocks; existed in specific local conditions), which ultimately requires the selection of specialized technologies individually in each case.

Materials and methods

The study was based on the results of surveys on the state of the environment in the oil-producing regions of Russia and the world, as well as on patent databases with information on developments for the disposal of acid tars.

It should be noted that the oldest developments in this field appeared several decades ago. Thus, one of the first domestic patents [5] was granted in 1925. Development involves the production of asphalt from acid tar by treating it with hot air.

In general, proposals for the disposal of acid tar are as follows:

– acid regeneration;

– production of bitumen;

– production of surface active substances;

– neutralization of acid tars by the application of alkaline agents and thus, stabilization of the mixture.

In total, several dozen technological plants have been developed, some of which show good efficiency [1-3]. However, universal technologies suitable for processing any kind of acid tars do not exist due to the great diversity of their composition.

Results

Review of existing methods for the disposal of acid tar waste and detailed analysis of their composition suggests a method based on the stabilization of acid tar by mixing them with other high-alkaline wastes: vegetable waste, agro-industrial waste (such as sugar production waste).

In general, the methods of neutralization and stabilization of acid tars are quite actively used in foreign practice. In particular, the study [8] considered the possibility of using to stabilize portland cement and high-carbon fly ash. The resulting product of acid tar treatment is proposed to be used as controlled low-strength materials for levelling and filling landfills. In several other studies, the stabilization efficiency of the composition of wastes treated in this way is high enough to significantly reduce leaching from cured waste hazardous chemical compounds (such as polyarenes) [6,7,9].

As already pointed out, each storage of acid tars is unique: it was formed from specific wastes, it exists under specific local conditions (meteorological, climatic, engineering and geological). There is therefore an urgent need to identify optimal technologies for the treatment of such wastes. And the requirements of green economy principles imply that the result of such works should be either the production of new materials (suitable for economic use) or the possibility of eliminating several types of waste when they are mixed. Both conditions can be met, as the practice discussed above shows. However, the creation of specialized

information (expert) systems that would include environmental impact catalogues and registers of optimal (most efficient) technologies for the disposal of acid tars can be a significant benefit in optimizing work.

Conclusions

Analysis of the problem of accumulation of acidic tars shows that its complexity of solution is due to complex, heterogeneous and variable composition of this type of waste.

The individuality of each storage facility requires individual solutions for the disposal of these wastes or their neutralization in order to avoid contamination of environmental components (especially soil, groundwater and surface water).

With a large variety of proposed technological solutions and methods for the disposal of acid tars, some technologies may be insufficiently efficient precisely due to the underestimation of specific waste. However, with the right choice of technologies it is possible to obtain valuable products (including VOC, regenerated acids, bitumen). In this case, the acidic compounds should be considered as potentially secondary mineral resources, although they are quite problematic because of their toxic components.

Neutralization technologies have fewer ecological constraints and are green economy-friendly, ensuring to fix the problems of waste accumulation in several industries at once by using waste to neutralize acid tars.

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