Abstract

Abstract to the dissertation on the topic: «Development of technologies for the utilization of plant waste in a closed-loop economy».

Relevance of the research topic

The formation of a circular economy (CLE) is included among the internationally accepted goals of sustainable development and national development goals of the Russian Federation. In Russia, the CLE is being formed within the framework of the National Project "Environmental Well-Being" and the tasks solved within the CLE include: increasing the amount of waste involved in economic circulation as secondary raw materials or secondary resources, as well as reducing the amount of non-recyclable waste, which will ultimately lead to minimizing the negative impact on the environment and improving the ecological state.

By Decree of the President of the Russian Federation dated 07.05.2024 № 309 «On the national development goals of the Russian Federation for the period up to 2030 and for the perspective up to 2036» ensuring environmental well-being is included in the list of national goals. To do this, it is necessary to form a secondary circulation of industrial, construction waste, housing and communal services and agricultural waste through the implementation of federal projects and industry programs; by 2030, the level of use of secondary resources and raw materials from waste in economic sectors should reach 30%.

Currently, at least 64.3 million tons of large-tonnage plant waste (food production) is annually placed in landfills, leading to the alienation of a significant amount of land, pollution of soils, water bodies and atmospheric air.

According to open data from Rosprirodnadzor, in 2023 (form 2 TP (waste)), 6,5 million tons of beet pulp waste were generated during sugar beet processing and sugar production, of which ~80% was sent for disposal. Malt (brewer's) grains are the main large-tonnage organic waste of the brewing industry, and in 2023, more than 1 million tons of brewer's grains waste were generated, of which only 11% was sent for disposal. Since many manufacturers classify hydrolytic lignin as a by-product, there is no information on the volumes of formation and utilization (form 2 TP (waste)). Currently, its use level is very low, and lignin is mainly used as energy fuel at the hydrolysis plants themselves, and the remains are placed in waste heaps.

The relevance of recycling stale large-tonnage plant waste - brewers' grains, hydrolytic lignin, beet pulp - is determined by both their negative impact on the environment when placed in landfills and the current lack of recycling technologies that are both environmentally and economically effective.

At the same time, large-tonnage industrial waste includes oil-contaminated soils, of which 1.156 million tons were generated in 2023, no more than 50% were disposed of and neutralized, and most of the waste, including that generated in previous years, remains in landfills. For example, the accumulated mass of oil-contaminated waste at Rosekoil LLC facilities is ~25 million tons.

The simultaneous utilization of plant and industrial waste (oil-contaminated soils) with the production of in-demand products is an example of a technology that complies with the principles of the CLE.

The aim of the study is to develop resource-saving technical solutions aimed at the utilization of large-tonnage plant waste, such as brewer's grain (BG), hydrolytic lignin (HL), beet pulp (BP), by using them as secondary material resources and obtaining in-demand products (using carbonized sorbents and Technoground as an example).

To achieve the set goal, it is necessary to solve the following tasks:

1. To develop a technology for the utilization of plant waste BG, HL, BP with the production of sorbents.

2. To determine the main physical and chemical characteristics of the obtained sorbents (carbonates and activators).

3. To evaluate the efficiency of using the obtained sorbents (carbonates and activators) in the treatment of industrial wastewater.

4. To develop a technology for the utilization of plant waste BG, HL, BP when using them as structurants in the bioremediation of oil-contaminated soils.

5. To evaluate the possibility of secondary pollution of environmental objects with substances washed out of the waste.

Scientific novelty:

Scientific novelty lies in the substantiation of the resource potential of large-tonnage stale plant waste (BG, HL, BP) as secondary material resources in a circular economy.

The theoretical significance of the work is determined by the fact that:

1. It is proven that large-tonnage plant waste (BG, HL, BP) (including stale) can be used as raw material for obtaining sorbents.

2. It is substantiated that the obtained sorbent-carbonizates can be effectively used in the treatment of wastewater containing organic compounds.

3. It is confirmed that large-tonnage plant waste (BG, HL, BP) are effective structurants in bioremediation of oil-contaminated soils without introducing secondary pollution.

The practical significance of the work is determined by the fact that:

1. A technology for the utilization of sugar beet pulp to obtain a sorbent-carbonizate has been developed, protected by patent RU 2821395 C1 «Method for obtaining a sorbent from granulated sugar beet pulp».

2. A technology for the utilization of stale hydrolytic lignin waste during bioremediation of oil-contaminated soils has been developed, protected by patent RU 2814273 C1 «Method for rendering harmless oil-contaminated soils».

3. The «Technological regulations for the production of reclaimed techno-soil (RPS) from oil-contaminated soils» and the Technical conditions for the resulting product "Reclaimed techno-soil (RPS) from oil-contaminated waste» have been developed. The technology has been implemented at the industrial site of Rosekoil LLC (Orenburg Region).

4. The obtained results and developed technologies formed the basis for:

– programs for the transition to a circular economy, envisaged by the passport of the Federal project «Circular economy Economy» and reflecting the regional policy on the construction of a circular economy and the involvement of secondary resources and raw materials in economic circulation in the Orenburg and Kirov regions;

– a draft of a new passport of the industry program «Use of secondary resources, secondary raw materials from waste in agriculture for 2022-2030», previously approved by the Government of the Russian Federation on 29.12.2022 № 16133p-P11.

The provisions submitted for defense:

1. Technology of utilization of plant waste - BG, HL, BP with obtaining sorbent-carbonizates.

2. The obtained sorbent-carbonizates are macroporous sorbents with a surface area of 0,83-3,22 m^2/g, micropore volume of 0,00005-0,0003 cm^3/g.

3. The obtained sorbent-activator is a macroporous sorbent with a surface area of 280 m^2/g, micropore volume of 0,0315 cm^3/g.

4. The efficiency of purification of wastewater containing organic pollutants, using sorbent-carbonizates from plant waste BG, HL, BP is comparable to industrial activated carbons (BAU-A, AG-3).

5. Technology for utilization of stale waste HL of during bioremediation of oil-contaminated soils with obtaining a useful product - Technoground.

6. Prevention of negative impact on the environment in the form of secondary pollution during bioremediation of oil-contaminated soils using stale waste of HL.