BIO Web of Conferences **141**, 03014 (2024) https://doi.org/10.1051/bioconf/202414103014
AGRICULTURAL SCIENCE 2024

Research on the treatment of oil-polluted wastewater with olive oil production waste

Maya Abdullayeva[1*] and *Zuleykha* Mammadova[1]

[1]Azerbaijan State University of Oil and Industry, 20, Azadlig Avenue, AZ1010, Baku, Azerbaijan

Abstract. Despite the development and use of waste-free technological processes in the oil refining industry, the modernization of oil production enterprises, the improvement of the processes of storage and transportation of oil products, the pollution of water bodies and lands with oil products is quite high. The scientific significance of the work lies in the justification of the possibility of obtaining oil-absorbing sorbents from olive peel and the determination of the dependence of the specific capacity of the sorbent on the initial oil content in water and the amount of the sorbent. The olive groves of "Absheron Olive Garden" LLC are the result of the successful implementation of the concept of the development of the non-oil sector and agriculture in our country, and they are used in the treatment of waste water. The practical importance of the work lies in the development of the production method of oil absorbent sorbents and the development of proposals for the creation of territorial ecological-technological complexes.

1 Introduction

The increase in oil production, the increase in the volume of its transportation, processing and use leads to an increase in the risk of pollution of the environment, especially water bodies. Oil and oil products flow into water bodies with the waste water of industrial enterprises, during accidents in deposits, especially in the shelf zone of the seas, during transportation by sea. The range of estimates of the annual intake of oil and oil products into the hydrosphere varies from 2.4 to 24 million tons. According to the IMO, the annual supply of oil to the World Ocean is 2.4 million tons: of this, 1.5 million tons are from coastal (and near-shore) sources; 0.2 million tons as a result of moving the atmosphere from land; 0.2 million tons by natural seepage; 0.1 million tons in offshore oil fields; 0.4 million tons during sea transportation, including: 0.2 million tons from tanker accidents and 0.1 million tons from accidents of other sea vessels, including 0.1 million tons from unknown sources. The volume of annual pollution of the World Ocean is 6-11 million tons it is estimated that 35% of it comes from sea transport (washing water, docking, seepage, loading and unloading, etc.), 13% comes. from industrial drains; 1.5% - offshore oil production; 32% - river flow; 10% - from the atmosphere; about 10% are natural sources [1].

In the aquatic environment, oil is in the form of films, aggregates and emulsions. Films are observed mainly along oil transportation routes, shipping areas, river mouths and coasts of industrialized countries: Atlantic - 24%, India - 14%, Pacific - 10%. The average pollution

* Corresponding author: mayaabdullayeva@hotmail.com

of the Atlantic is estimated at 35-46 thousand tons. In the northern parts of the Pacific Ocean, 7 thousand tons are estimated.

The North Atlantic is the most polluted with oil aggregates (15-20 thousand tons). Its oil pollution in the emulsified state is estimated at 0.05-0.01 mg/l [2].

Oil pollution of the natural environment causes severe reactions in all components of ecosystems. When it enters the hydrosphere, its chemical, physical and microbiological properties undergo profound, often irreversible changes. This situation makes the development of methods to prevent these consequences one of the urgent tasks facing scientists and engineers.

Prevention of environmental pollution with oil products as a result of discharges or emergency spills, as well as elimination of the consequences of pollution, is a complex scientific and technical problem of multifaceted nature. One of the directions of research conducted within the framework of this problem is the development of new types of sorbents that are effective and relatively cheap according to their properties from existing raw materials. These criteria include brown coal, coke, peat, moss, straw, paper, wool, ground corn husks, rice husks, wood waste, etc. Natural carbon-containing sorbents made from organic materials are the answer. Despite the fact that a large number of different sorbents are currently being produced, the development of oil-absorbing sorbents that can use local agricultural waste as raw materials is an urgent issue [3].

2 Methods and materials

Oil absorbing sorbents are hydrophobic and highly porous materials with high adsorption properties for oil and oil products. The ability of the sorbent to absorb pollutants in excess of its mass is due to their developed sorption surface and large pore volume. The movement of sorbents used to absorb oil and oil products from aqueous solutions is based on the capillary absorption process, which is one of the manifestations of capillary phenomena caused by the effect of interphase surface tensions at the interface of immiscible media.

Obtaining a porous structure of sorbents is carried out: either by forming material from powders using various binders; either by creating open channels in the raw material by removing from it the pore volume of moisture and volatile and partially amorphous inclusions, or (when creating foamed polymers from synthetic resins) using pore formers (gas formers); or (when preparing pinhooks) by introducing hollow carbon microspheres from pitch, phenolic, oxide and epoxy resins, casein, cellulose, polyesters, etc. into thermoreactive resins [4].

Testing of carbonization regimes for agricultural waste was conducted using a batch plant. Rice and buckwheat hulls were selected as starting raw materials. To optimize processing modes and develop industrial facilities for the production of sorbents, studies were conducted on the physico-chemical properties of raw materials and manufactured products. Derivatographic studies of the raw material revealed a typological analogy with wood chips used for the production of activated carbons and allowed to create optimal processing modes for one or another modification of the sorbent in plasma, plasma-thermal and thermal devices. The components of the mineral component of the sorbents were determined by the spectrophotometric method. Structural changes during the production of sorbents were studied using IR spectroscopy. As a result of electronic studies of the microstructure, the cellular structure of sorbents obtained from rice husks and buckwheat husks was revealed (the sorbents from this type of raw materials are called PC (powdered charcoal) and GS (granulated sorbent), respectively). Studies have shown that the resulting sorbents differ in nature: in the case of PC, the mineral component is silica compounds, and in GS, calcium compounds [5].

The characteristics of the surface and porous structure of the produced sorbent samples were determined by the adsorption method for the sorption of benzene vapor (C6H6). It was possible to obtain mesoporous sorbents that can be used to clean the hydrosphere from oil and oil products at a carbonization temperature not exceeding 400°C.

The purpose of his work is the development of sorbents from olive oil production wastes to combat oil pollution of the hydrosphere [6].

• analysis of modern methods and means of prevention of the consequences of pollution of water bodies with oil products;

• substantiating the possibilities of purchasing oil absorbing sorbents from agricultural waste;

• development of sorbent production technology;

• study of sorbent properties;

The main idea of the work is that the thermal treatment of crushed plant waste (olive pomace) is used to obtain an oil-absorbing sorbent, the lyophilic properties and open porosity of the source material are increased as a result of partial combustion of its organic component.

• the advantages of floating sorbents have been determined and restrictions on the value of minimum closed porosity have been obtained for sorbents whose material density is higher than the density of water;

• for the first time, oil-absorbing sorbents were obtained from olive oil production waste;

• the dependence of the characteristics of the sorbents on the processing modes of the raw materials was obtained, which made it possible to optimize them [7].

Prototypes of sorbents are obtained from plant waste on the basis of periodic and continuous plasma devices designed for thermal treatment of raw materials under various conditions: vacuum, atmospheric pressure, argon, nitrogen or air.

In addition to laboratory facilities, facilities for the production of sorbents have been developed and brought to the industrial version, as well as the technological parameters of the plant have been optimized for the conversion of agricultural waste into effective, inexpensive, environmentally friendly sorption materials. The operation of the facilities is based on the thermal treatment of mass organic waste with combustion products of organic fuels, which leads to the formation of high porosity of the material as a result of partial combustion and extraction of the organic component of the source material. due to its surface, it has high lyophilic properties compared to petroleum products [8].

Residual particles are used as an absorbent during the production of olive groves located in Azerbaijan. "Absheron Olive Garden" Limited Liability Company (LLC) is located in Zira settlement, Khazar district, Baku city. In addition to modern olive groves located on an area of 700 hectares, the enterprise combines the largest and most modern olive oil and table olive products processing plant in our country, as well as in the region as a whole (Figure 1).

Fig. 1. Olive Oil Production Complex Performance Indicators (Absheron Olive Garden).

Every year, 2/3 of the entire olive harvest is used to make olive oil. During the production of oil, 70% of the raw material ends up as waste. Considering that in recent years the olive harvest has not fallen below 35 thousand tons per year, it can be concluded that the amount of production waste each year was at least 16 thousand tons. The sorbent produced from such a quantity of waste (assuming that the yield of finished sorbent from the initial raw material will be 30-50%) will be quite sufficient not only for the needs of the domestic market, but also for export to other countries. The production of sorbents from this raw material solves another important problem. For many years, hundreds of thousands of tons of this waste turned into mountains of garbage occupying large areas [9].

The development of the devices was based on their environmental safety and efficiency requirements. The economics of the sorbent production process was based on the use of cheap fuel (fuel oil) and organic agricultural olive waste as raw materials, which are an additional source of energy due to the generation of heat during processing. Special technological methods were also used to minimize heat losses to the environment:

• movement of organic fuel raw materials and combustion products in the opposite direction.

• creation of a designed interface to ensure efficient heat transfer between the streams of raw materials and combustion products.

• thermal insulation of the side surface of the furnace.

The technological requirements for the design of the devices were as follows:

• provision of temperature in the range of 400 - 700 ° C in the transition zone of raw materials to the final product;

• ensuring that the raw materials remain in the oven for 10-30 minutes [10].

The starting raw material was an olive processing product resulting from the first pressing of dried and ground fruits. It contained (6-9)% oil, (25-55)% water and pulp (42-54)% seeds, peel (10-11)% and pulp (21-33)% solids. The olive press is scattered in fractions of 5-7 cm; then the starting materials were subjected to heat treatment in a muffle furnace at a temperature of (150-450)°C with an interval of 50°C.

Thermal treatment of materials at temperatures of 150°C, 200°C, 250°C was for 1 hour, and at temperatures of 350°C and 450°C for 15 minutes. The temperature and time parameters for the processing of materials were taken close to the optimal values for the production of sorbents. In order to better prepare the sorption properties of the selected herbal materials, it was accepted to increase the processing time of the materials up to 1 hour. (Figure 2) [11].

Fig. 2. Conversion of residues into a sorbent during olive production.

The productivity of sorbent after heat treatment (residual mass of weighed materials) and visual assessment of sorption properties of obtained sorbents were determined. The product obtained as a result of temperature treatment is a dry, crushed mass of brown color, similar to tea leaves (0.3-0.5 cm) in size [12].

One of the main criteria for assessing the sorption properties of a sorbent are sorption isotherms, which describe the dynamic equilibrium between the concentration of the pollutant in the sorbent (specific absorption of oil by the sorbent) and its content in the solution. Despite the fact that the shapes of the sorption curves may differ significantly for different sorbents, their main feature is that an increase in the waste content in water leads to an increase in the amount of absorbed waste up to a certain limit, after which the concentration of the substance in the solution does not change the sorption value [13].

3 Conclusion

It was determined that the residual pollution of the purified water surface with oil products decreases exponentially with the increase of the amount of sorbent and increases proportionally with the increase of the initial pollution. The effectiveness (sorption capacity and rate of absorption of oil products) of oil-absorbing sorbents is mainly determined by their open pore volume, pore size, lyophilicity in relation to oil products and lyophobicity in relation to water.

Features of the use of sorbents for cleaning the water surface (advantages of floating sorbents) impose restrictions on the true density of the sorbent material, which can be significantly expanded by controlling the ratio between the closed and sorption porosity of the sorbent.

References

1. I. Gafarov, *Sorbent production development from agricultural production waste for hydrosphere purification from oil products* (Symposium «Environmental Technologies For F Healthier World», Las Vegas, USA, 2016)
2. N.S. Chikina, A.V. Mukhamedshin, L.A. Zenitova, Environmental protection in the oil and gas complex **10**, 31-36 (2018)
3. M.Y. Abdullaeva, Kh.A. Aliyeva, Norwegian journal of development of the International Science, 71-72 (2023)
4. R.Kh. Nizamov, *Purification of oil-contaminated waters with sorption materials based on waste from felt production: diss. candidate of technical sciences* (Kazan, 2011)
5. V.D. Katin, Oil refining and petrochemistry **2**, 45–48 (2015)
6. M.N. Chong, B. Jin, C.W.K. Chow, C. Saint, Water Res **44**, 2997–3027 (2010)
7. V.V. Burenin, Oil refining and petrochemistry **12**, 39–47 (2018)
8. V. M. Kuznetsova, A. V. Ovsyankina, Young scientist **32 (166)**, 4-9 (2017) URL: https://moluch.ru/archive/166/45361/ (date of access: 12.08.2024)
9. https://aog.az/about
10. I. Gafarov, *Sorbent production development from agricultural waste. - The International Exhibition and Conference for Environmental Technology for the Middle East* (Riyadh, Kingdom of Saudi Arabia, 2017)
11. C.C. de Almeida, P.R.F. da Costa, M.J. de Macedo Melo, E.V. dos Santos, C.A. Martínez-Huitle, J. Mex. Chem. Soc. **58**, 276–286 (2014)
12. A.L. Ahmad, S. Sumathi, B.H. Hameed, Water Res. **39**, 2483–2494 (2015)
13. B. De Felice, G. Pontecorvo, M. Carfagna, Acta Biotechnol. **17**, 231–239 (2014)