

ANNOTATION

Dissertation on «Synthesis and physicochemical studies of new sorbents from rice and oil waste for wastewater treatment» for the degree of Doctor of Philosophy (PhD) on educational program 8D05301 – «Chemistry»
Diyarova Banu Maralbekkyzy

Research topic: Synthesis and physicochemical studies of new sorbents from rice and oil wastes for wastewater treatment.

Aim of the research: obtaining and research of new carbon sorbents for wastewater treatment by co-carbonization and co-thermolysis of rice straw, husk and oil wastes.

Research objectives:

- To obtain biochar (carbon fertilizer) and new carbon sorbents from rice straw and husk;
- obtaining new carbon sorbents by co-thermolysis of rice straw and husk and oil wastes;
- studying the properties and structure of new carbon sorbents obtained under optimal conditions on the basis of chemical and physicochemical analysis methods;
- analytical work on wastewater treatment from pollution by new carbon sorbents.

Research methods:

Theoretical: literature review on the use of sorbents in nature and methods of preparation of sorbents from different biomasses.

empirical: scanning electron microscopy, transmission electron microscopy, Raman spectroscopy, infrared spectroscopy, high-performance scanning electron microscopy with X-ray analyzer (EDS).

The main statements put forward for defense (proved scientific hypotheses and other conclusions constituting novelty):

- the scheme of processing of rice straw, husk and oil waste and reuse of secondary products was created;
- biochar was obtained from rice straw and husks;
- porous carbon materials were obtained from rice straw and husk;
- porous carbon materials were obtained by joint thermolysis of rice straw and husk and petroleum waste;
- granular porous carbon materials were obtained by adding binder to rice straw, husk and oil waste;
- properties and structure of the obtained sorbents were studied by methods of chemical and physicochemical analysis;
- works on wastewater treatment from pollution by new adsorbents were carried out;

Justification of novelty and significance of the obtained results and compliance with the directions of scientific development or state programs:

1. For the first time biochar (coal fertilizer) was obtained from rice straw and husks. Physicochemical properties of biochar were studied;

2. Thermolysis of new carbon sorbents from rice straw and husk was carried out. It was proved that the physicochemical characteristics of the new carbon sorbents obtained from rice straw and husk were as good as the quality of porous carbon sorbents obtained from agricultural wastes;

3. Joint thermolysis of rice husk, straw and oil sludge was carried out. According to the results of the research it was proved that the new carbon sorbent obtained by joint thermolysis of rice straw and oil sludge in the ratio of 9:1 corresponds to the effective sorption and other parameters recommended for activated carbon.

4. The optimal mass ratio of rice husk:oil sludge:starch = 9:1:2 by adding binder to rice husk:oil sludge:starch to obtain granular activated carbon was determined for the first time. It is proved that physicochemical characteristics of the adsorbent obtained under optimal conditions correspond to the activated carbon of BAU-MF grade;

5. The specific surface area of the new carbon sorbents is measured in a surface porosity analyzer "Model: 3H-2000PS1", the elemental composition was investigated by high-performance scanning electron microscopy with X-ray analyzer (EDS) JSM - 6490LA-JEOL that facilitates control and analysis by EDS, scanning electron microscopy, transmission electron microscopy and Raman spectroscopy;

6. Works on purification of sewage and collector-drainage water from contaminants formed on rice fields from the biological station of Kyzylorda city were carried out with new adsorbents. After treatment it was proved that chemical indices of total mineralization, Fe^{3+} , SO_4^{2+} , Ca^{2+} , Al^{3+} , Mn^{2+} , NO_3^- ions correspond to the limit norm.

Description of the doctoral student's contribution to the preparation of each edition (the share of the dissertation author is indicated as a percentage of the total text):

The main results of the dissertation research were published in 17 editions, including: 3 articles in international scientific journals included in the Scopus scientometric database (Egyptian Journal of Chemistry Q3 37%, Journal of Composites Science Q2 63%, Bulgarian Chemical Communications Q4 15%):

1. Production of activated carbon granulated by treatment of rice husk and straw with an oil sludge using polyvinyl acetate as a binder. Egyptian Journal of Chemistry. - 2023. - 66(13). pp. 1871 - 1878. (Co-authors Appazov N., Bazarbaev B., Djiyembaev B., Lygina O., Tapalova A., doctoral student share 80%)

2. Lithium-Containing Sorbents Based on Rice Waste for High-Temperature Carbon Dioxide. Capture. Journal of Composites Science. – 2024. - 8(9). – pp.376 (Co-authors Ergazieva G., Mambetova M., Makaeva R., Appazov N., share of doctoral student 30%)

3. Obtaining granular activated carbon using a binder gelatin in the joint processing of rice and oil waste. Bulgarian Chemical Communications. – 2022. – 54(B1). - pp. 9-12. (Co-authors Appazov N., Bazarbayev B., Dzhiembaev B., Lygina O., doctoral student share 75%).

5 articles published in publications recommended by the Committee for Quality Assurance in Science and Higher Education of the Ministry of Education and Science of the Republic of Kazakhstan:

1. Processing of rice wastes into activated carbon. Chemical Journal of Kazakhstan – 2018. - № 4(64). - 259-263 pp. (Co-authors Bainazarova S.R., Lygina O., Shuragazyeva A.T., Tapalova A.S., Zhusupova L.A., Appazov N.O., doctoral student share 65 %).

2. Получение активированного угля со-термолизом рисовой соломы и нефтешлама. Chemical journal of Kazakhstan АО Ordena trudovogo krasnogo znamenі «Institut khimicheskikh nauk» imeni A.B. Bekturova. – 2019.- № 4(68). 46-51 сс. (Co-authors Appazov N.O., Bazarbaev B.M., Lygina O.S., Shurgazieva A.T., Akylbekov N.I., the share of doctoral students 60%).

3. Получение активированного угля со-термолизом рисовой шелухи и нефтешлама. Chemical journal of Kazakhstan АО Ordena trudovogo krasnogo znamenі «Institut khimicheskikh nauk» imeni A.B. Bekturova. -2019. - № 4(68) pp. 77-83. (Co-authors N.O. Appazov, R.A. Turmanov, R.U. Zhapparbergenov, O.S. Lygina, A.T. Shurgazieva, N.I. Akylbekov, share of doctoral students 65%)

4. Получение качественного сорбента из отходов риса и нефтешлама. Oil and Gaz. - 2020 г. - № 3-4 (117-118). – pp.169-179. (Co-authors Appazov N. O., Bazarbaev B. M., Akylbekov N. I., Zhapparbergenov R. U., Kanzhar S. A., share of doctoral student 75%). U., Kanzhar S. A., the share of doctoral students 75%).

5. Күріш қалдығымен мұнайшламын бірге өңдеуде ұнды қосу арқылы түйіршіктелген белсендірілген көмір алу. News Of the Academy of sciences of the republic of Kazakhstan. JSC «D.V. Sokolsky institute of fuel, catalysis and electrochemistry» Chemistry and technology - 2022.- №3(452). – pp.17-25 . (Co-authors Appazov N., Bazarbaev B., Dzhiembaev B., Lygina O., share of doctoral student 80%).

Published 3 articles in domestic scientific journals:

1. Obtaining biochar from rice husk and straw. News of The National Academy of Sciences of The Republic of Kazakhstan, Series Chemistry and Technology. – 2021.- 1(445). – pp.66 – 74 (Co-authors Appazov N. O., Bazarbayev B. M., Assylbekkyzy T., Kanzhar S. A., Magaiya S., Zhapparbergenov R.U., Akylbekov N.I., Duisembekov B.A. share of doctoral student 85 %)

2. Күріш қалдығымен мұнай шламын бірге өңдеуде байланыстырушы крахмал негізінде брикеттелген белсендірілген көмір алу. News of The National Academy of Sciences of The Republic of Kazakhstan, Series Chemistry and Technology. – 2021. - №3(447). pp.6-12. (Co-authors Appazov N.O., Bazarbaev B.M., Asylbekkyzy T., Djiyembaev B.J. share of doctoral student 80%)

3. Күріш сабаны мен мұнай шламын қосып өңдеу арқылы түйіршіктелген көмір адсорбентін алу. Oil and Gaz. - 2021.- №1(121). – pp.108-117. (Co-authors Appazov N.O., Bazarbaev B.M., Asylbekkyzy T., Kanzhar S.A., share of doctoral student 85 %,).

2 articles in the proceedings of international scientific and practical conferences, including foreign and near abroad:

1. Техногендік шикізат пен табиғи көміртекті материалды біріктіріп өңдеу арқылы қатты кеуекті сорбент алу. «Ғылыми шығармашылық зерттеулер тәжірибесі және басым бағыттары» Әбу Насыр әл-Фарабидің 1150 жылдығына арналған XXII республикалық студенттер мен жас ғалымдардың ғылыми конференция жинағы. Қызылорда. - 2020.- 95-96 бб. (Co-authors Bazarbaev B.M., Zhapparbergenov R.U., Appazov N.O., Akylbekov N.I., Kanzhar S.A., the share of doctoral student 60%).

2. Комплексная переработка рисовых отходов с нефтешламом. «Теоретические и прикладные аспекты естественнонаучного образования» Материалы Всероссийской научно-практической конференции, посвященной 90-летию Чувашского государственного педагогического университета им. И. Я. Яковлева. – Чебоксары. – 2020. - 3-11ст. (Co-authors Akylbekov N.I., Appazov N.O., Bazarbaev B.M., Shuragazieva A.T., Kanzhar S.A., Zhapparbergenov R.U., the share of doctoral students 60%).

4 patents for utility model of the Republic of Kazakhstan were obtained:

1. Method of obtaining activated carbon from oil sludge of rice husk. Patent for utility model. No. 3821 dated November 2, 2018.

2. Method for obtaining activated carbon from rice straw and oil sludge. Patent for utility model. dated July 29, 2019 No. 4435.

3. Method for obtaining biochar from rice straw and husk. Patent for utility model. dated November 11, 2021 No. 5759.

4. Method for obtaining granulated activated carbon from rice waste and oil sludge. Patent for useful model. From November 11, 2022 № 7696.

Structure and scope of the work. The thesis consists of standard sections: normative references, notations and abbreviations, introduction, literature review, experimental part, experimental results and their discussion, list of used literature and appendix.