

### Brief information about the project

Name of the project	AP19679428 «Study of the catalytic properties of natural minerals and metallurgical waste for the thermochemical complex processing of degraded plastic into liquid and gaseous hydrocarbon fuels»
Relevance	Plastic waste with a high degree of degradation, contamination, and heterogeneity of composition cannot be processed, is buried, or incinerated, leading to environmental pollution and loss of valuable hydrocarbon raw materials. Catalytic pyrolysis in a bed reactor is proposed to produce condensable hydrocarbon fractions from non-recyclable plastic. The proposed catalysts include modified industrial waste and natural minerals: kaolin, shungite, filtration cake, aluminosilicate filler containing nickel. The characteristics of catalysts and the type and composition of plastics affect the pyrolysis process, mass balance and quality of condensed products. The thermal characteristics of the condensed product of direct pyrolysis are unsatisfactory. The use of catalysts makes it possible to reduce the decomposition temperature of plastics and increase the production and quality of pyrolysis products.
Purpose	<ul style="list-style-type: none"><li>- Intensification of pyrolytic processing of plastic into liquid hydrocarbons;</li><li>- determination of the catalytic properties of shungite, kaolin, and metallurgical waste to intensify the process of pyrolysis of plastic waste;</li><li>- modification of shungite, kaolin, and metallurgical waste to improve their catalytic properties;</li><li>- determination of the characteristics of the resulting liquid hydrocarbons.</li></ul>
Objectives	<ul style="list-style-type: none"><li>- Preparation and characterization of catalysts. Natural minerals and industrial waste, including kaolin, shungite, filtration cake, and aluminosilicate filler containing nickel, will be used as raw materials for the catalysts. The raw materials for the catalysts will be used in their original form, then in calcined form, and modified using iron (III) salts. A total of 16 samples of catalytic materials will be prepared. Characterization of the catalysts will include porosimetric analysis, XRF (XRF, Spectroscan MAX-GV) analysis, and XRD (XRD, D8 ADVANCE "Bruker Elemental GmbH") analysis.</li><li>- Thermogravimetric analysis (TGA) of plastic waste in the presence of catalysts will be used to determine changes in the thermochemical degradation properties of plastics. For TGA, fine granules of plastic waste will be used, including polyethylene (PE), polypropylene (PP), polystyrene (PS), polyethylene terephthalate (PET), and a mixture of plastics simulating plastic collected in Almaty and Astana. The activation energy will be determined in the process</li></ul>

	<ul style="list-style-type: none"> <li>- Pyrolysis of plastic waste without catalysts as a reference. A horizontal tube furnace will be used for pyrolysis; the pyrolysis mode will simulate pyrolysis in a layer reactor. PE, PP, PS, PET, and a mix of plastics will be subjected to pyrolysis. As a result of the experiments, the mass balance will be determined and samples of the liquid fraction (resin and wax) will be obtained and GCMS analysis will be performed.</li> <li>- Pyrolysis of plastics with shungite, calcined shungite, shungite modified using Fe<sup>+3</sup> salts. PE, PP, PS, PET, and a mixture of plastics will be subjected to pyrolysis. Determination of mass balance and samples of the liquid fraction (resin and wax) were obtained and GCMS analysis was performed.</li> <li>- Pyrolysis of plastics with carbonaceous shale, calcined carbonaceous shale, modified carbonaceous shale using iron (III) salts. PE, PP, PS, PET, and a mix of plastics will be subjected to pyrolysis. Mass balance was determined and samples of the liquid fraction (resin and wax) were obtained, characterized, and analyzed by GCMS.</li> <li>- Pyrolysis of plastics with a catalyst made of aluminosilicate filler modified with iron (III) salts. PE, PP, PS, PET, and a mix of plastics will be subjected to pyrolysis. The mass balance was determined and samples of the liquid fraction (resin and wax) were obtained and analyzed by GCMS.</li> </ul>
Expected and achieved results	<p>Work will be completed according to the calendar plan. Articles will be published in peer-reviewed scientific publications indexed in the Science Citation Index Expanded of the Web of Science database and (or) having a percentile ranking according to CiteScore in the Scopus database in accordance with the requirements of the competition documentation.</p> <p>Work on the project has begun</p>
Research team members with their identifiers (Scopus Author ID, Researcher ID, ORCID, if available) and links to relevant profiles	<ol style="list-style-type: none"> <li>1. Project leader - Dosumova B.T., Candidate of Chemical Sciences, Hirsch Index - 3. Scopus author ID: 57210592713. ORCID ID: <a href="https://orcid.org/0000-0003-4126-2907">https://orcid.org/0000-0003-4126-2907</a>, ResearcherID Web of Science: GYZ-0809-2022.</li> <li>2. Project assistant - Nechipurenko S.V., Candidate of Technical Sciences, Associate Professor, Head of the Laboratory of Composite Materials of the Center for Physical and Chemical Methods of Research and Analysis of KazNU named after al-Farabi. H-index 5 (Scopus Author ID: 56195843600, <a href="https://orcid.org/0000-0002-7463-1679">https://orcid.org/0000-0002-7463-1679</a>, Researcher ID Web of Science A-4695-2015).</li> <li>3. SNA of the project - Tokmurzin D.Zh. PhD, Senior researcher, Korea Institute of Energy Research, H-index – 11 (Scopus ID: 55744067900, ORCID ID: 0000-0002-7466-063X, Researcher ID Web of Science AAS-7294-2020).</li> </ol>

	<p>4. NS of the project - Omarova A.S., PhD candidate, researcher in the laboratory “Ecology of the Biosphere”. H-index 3 (Scopus Author ID: 57271406600, <a href="https://orcid.org/0000-0002-3990-1952">https://orcid.org/0000-0002-3990-1952</a>, Researcher ID Web of Science P-5606-2017). Author of over 12 publications (thesis, articles, patents), including those included in the Scopus and Web of Science databases.</p> <p>5. NS of the project - Ibragimova O.P., PhD candidate, researcher at the laboratory “Ecology of the Biosphere”. H-index 4 (Scopus Author ID:57216646818, <a href="https://orcid.org/0000-0001-5868-6648">https://orcid.org/0000-0001-5868-6648</a>, Researcher ID Web of Science O-4098-2017).</p> <p>6. NS of the project - Kayaidarova A.K., KazNU named after al-Farabi, higher education (Politecnico di Torino), Master of Environmental Engineering. H-index 1, Scopus Author ID: 57348966400.</p> <p>7. JRA of the project - Zabara N.A., master's student of KazNU named after al-Farabi.</p>
List of publications with links to them	no
Patents	no