

**Name of the topic of the project:** Improving the quality of restoration of agricultural machinery parts by developing repair composite mixtures based on polymers, minerals and nano-additives.

**Actuality:** The state program for the development of the agro-industrial complex of the Republic of Kazakhstan for 2017-2021 provided for an increase in the provision of agricultural machinery at times, as well as technical modernization of the agro-industrial complex with the use of innovative resource-saving technologies. In the conditions of economic crisis, rural producers cannot ensure constant purchases of equipment at the level of demand. Problems of high level of wear and tear of agricultural machinery, lack of development of the service system, low efficiency of work on restoration of agricultural machinery parts are the most important during seasonal work. Improving the efficiency of repair and restoration of agricultural machinery parts is possible by well-known methods using effective composite materials: polymers, ceramics and nanodispersions.

Repair composite materials based on polymers, minerals containing nanoparticles are currently in high demand. Scientific research and practical work in this area are very relevant. The use of the proposed compositions of repair mixtures based on the study of physical and chemical properties will reduce the labor intensity and cost of work in the restoration of various parts of machinery and equipment. In accordance with the innovation policy of Kazakhstan, the state program for the development of the agro-industrial complex of the Republic of Kazakhstan for 2017-2021, the use of new materials will improve the repair and restoration of worn-out parts of equipment.

**Goal of the project:** Development of new compositions of repair composite mixtures based on polymers, minerals with nano-additives with improved characteristics for the restoration of machine parts.

**Expected results:**

As a result of the use of new materials and technologies, it is possible to increase the service life of parts of agricultural machines, reduce the period of repair work. The results of the project have prospects for opening new enterprises using the demanded high-tech technologies. The proposed composite materials should ensure the efficiency of repair and restoration of agricultural machinery parts, reduce the costs of small and medium-sized business producers, in the context of the economic crisis, for the purchase of new equipment. The use of new materials will improve the repair and restoration services for worn-out equipment parts. In the environmental aspect, the application of the results obtained will reduce the anthropogenic impact of industrial waste on the environment through their disposal.

Based on the research results, at least 2 (two) articles and (or) reviews will be published in peer-reviewed scientific journals in the scientific direction of the project, indexed in the Science Citation Index Expanded of the Web of Science database and (or) having a CiteScore percentile in the Scopus database of at least 35 (thirty five), 2 (two) articles or reviews in a peer-reviewed foreign or domestic publication, recommended by the Committee for Control in the Field of Education and Science, 2 articles at international conferences of foreign countries with the

publication of abstracts, and a patent will be obtained in the Kazakhstan patent office.

Upon completion of the project, there will be:

- developed new composite materials based on silicates and industrial waste for the restoration of agricultural machinery parts;
- the scientific and technical foundations for obtaining new composite materials based on silicates and industrial waste for the restoration of agricultural machinery parts have been developed.

**Members of the research group:**

Kokayeva G.A. – project manager, candidate of technical sciences, specialty 05.16.02 – Metallurgy of ferrous, non-ferrous and rare metals, associate professor of the Department "Technological machines and equipment" of S. Seifullin KATU. Research area: composite and powder materials, coatings, materials science, powder metallurgy, non-ferrous metals metallurgy. Hirsch Index – 3. Link to the profile of the scientometric database Scopus:

<https://www.scopus.com/authid/detail.uri?authorId=57203342166>

Nurlankyzy Zh. - chief researcher, master of technical sciences, senior lecturer of the department "Standardization, metrology and certification" of S.Seifullin KATU, specialist in the field of quality management of products and processes of the construction industry, accreditation of certification laboratories, testing of building materials. Research area: minimization of risks in construction, consequences of risks in construction, quality control and safety of building materials. [Hirsch Index](#) – 1. Link to the profile of the scientometric database Scopus: <https://www.scopus.com/authid/detail.uri?authorId=57195913629>

Serekpayeva M.A. – senior researcher, master of technical sciences in the field of standardization, doctoral student of the Department "Standardization, metrology and certification" of S. Seifullin KATU. Research area: recycling and use of industrial wastes, protective coatings, standardization of new materials. Link to the profile of the scientometric database Scopus: <https://www.scopus.com/authid/detail.uri?authorId=57779484600>

Ibzhanova A.A. – senior researcher, master of technical sciences in the field of standardization, senior lecturer of the Department "Standardization, metrology and certification" of S. Seifullin KATU. Research area: product quality and safety, standardization, recycling and use of industrial wastes. Link to the profile of the scientometric database Scopus: <https://www.scopus.com/authid/detail.uri?authorId=57780174100>

Kardybay S. – senior researcher, master of technical sciences, assistant of the Department "Technological machines and equipment" of S. Seifullin KATU, specialist in the field of structural materials and agricultural machinery. Research area: agricultural machinery and technological equipment.

Konkanov M.D. – researcher, PhD, head of the Department of metrological support and testing of RSE "KazStandart" specialist in the field of building materials. Research area: technology of cements and concretes. Hirsch Index – 1. Link to the profile of the scientometric database Scopus: <https://www.scopus.com/authid/detail.uri?authorId=57203338476>

Aldabergenova S.S. – junior researcher, PhD, senior lecturer of the Department "Standardization, metrology and certification" of S. Seifullin KATU. Research area: product quality and safety, standardization of new materials. Hirsch Index – 1. Link to the profile of the scientometric database Scopus: <https://www.scopus.com/authid/detail.uri?authorId=57190729374>

**The results obtained:**

The paper defines the organizational and technical principles of the system for restoring parts, analyzes the applied and innovative methods for restoring parts of agricultural machinery, and conducts an analytical review.

Defects were assessed and risks analyzed during the operation of agricultural machinery using statistical methods of product quality management, an analytical review was carried out and defects-risks that may arise during the restoration of agricultural machinery parts were identified.

The risks were identified, the analysis of mechanical and physico-chemical processes determining the causes of defects was carried out. The properties of materials are investigated and the dependence of the properties of materials is revealed. Theoretical and practical prerequisites for the development of compositions of repair composite materials are determined, a theoretical review is carried out.

The properties of structural epoxy resins most in demand on the market are investigated: the amount of chlorine, the degree of abrasion by abrasives, resistance to temperature influences, chemical resistance, data on the study of polymer compositions based on epoxy resin ED-20 with additives of silica are obtained.

The properties of anaerobic sealants have been studied: resistance to temperature changes, chemical resistance, and data on tests of the materials used have been obtained.

Based on the results of the research, 1 article was published in a peer-reviewed domestic publication recommended by the Committee for Control in the Field of Education and Science.

1. Serekpayeva M.A., Kokayeva G.A., Niyazbekova R.K., Kardymbai S. «Investigation of the properties of composite materials based on epoxy resins with microsilica additives», Complex Use of Mineral Resources. 2021, Volume 3, Issue 318, pp.63-70. <https://doi.org/10.31643/2021/6445.29>

In the second year of work, work was carried out to optimize the compositions of composite materials based on polymers, fly ash, silica and fibrous fillers. The modes for obtaining optimal compositions are investigated in order to obtain optimal compositions. The composition and properties of fillers for composite materials are investigated. The granulometric composition of fillers was studied using a laser particle analyzer and scanning electron microscopy. Composite materials based on ED-20 epoxy resin with additives of microspheres and microsilicon have been developed: the phase and granulometric composition of raw materials have been determined, the thermophysical, physico-mechanical properties of composite materials have been determined.

The phase composition and granulometric properties of raw materials have been studied. The phase and elemental compositions were determined on a PANalytical X-ray fluorescence spectrometer, model Axios Max(Rh 2.4kW). The structure and particle sizes of fine fillers were determined using a Mastersizer 3000 laser particle size analyzer with a Hydro MV attachment (120 ml) using water as a dispersion medium.

Data on the study of particle sizes of micro- and nanodispersions of fly ash, microsilica using the state standard of dispersed parameters of aerosols, suspensions and powdered materials and the mass concentration unit of particles in aerodisperse media were obtained. Images were taken from an electron microscope.

The phase composition of the mineral filler silica fume has been studied. The geometry of microsilica fibers has been studied.

Samples of composite materials based on epoxy resin ED-20 with different percentage content of microsilica additives, CHP ash microspheres have been developed. PEPA hardener was used to cure the epoxy resin. The samples were made by molding.

The thermophysical properties of composite materials are determined. The effect of the introduction of fillers on the heat resistance according to Martens (GOST 21341-214) on the RT-01 device was studied. The heat resistance of composite materials with different contents of microsphere fillers and silica fume has been determined.

The physical and mechanical properties (breaking stress in tension - GOST 11262-80, modulus of elasticity in tension and bending - GOST 9550-81, breaking stress in compression - GOST 4648-71) of epoxy composites containing microsilica and microspheres as a filler have been determined.

The impact strength of composite materials on the KMM-M (GOST 4647-2015) pendulum impact tester was determined.

The microhardness of the surface of composite materials has been determined.

Based on the results of the research, 1 article was published in the collection of the international conference of far-abroad countries and 1 thesis in the collection of the international conference. 2 articles were submitted to peer-reviewed scientific publications in the scientific direction of the project, indexed in the Science Citation Index Expanded of the Web of Science database and (or) having a CiteScore percentile in the Scopus database of at least 35 (thirty-five). The results of the study were discussed at the 26th International Congress of Chemical and Process Engineering CHISA 2022 in Prague, Czech Republic.

1. Serekpaeva M.A., Niyazbekova R.K., Ibzhanova A.A., Kokayeva G.A. Estimation of defects in agricultural machinery using statistical methods of product quality control. Materiály XVIII Mezinárodní vědecko - praktická conference "Zprávy vědecké ideje", Volume 3. Praha. Publishing House "Education and Science", 2022, - P. 87-92.

2. Serekpaeva M.A., Ibzhanova A.A. Analysis of methods of restoration of agricultural machinery parts and corrosion protection. Materials of the

international scientific and practical conference "Seifullin readings - 18: "Youth and science – a look into the future", 2022. - Vol.I, Part II. - P. 302-305