

The title of the project topic is: IRN №AP09562082 «Creation of impact-toothed hammers for intensive crushing of feed from animal waste»

Relevance: the use of animal waste is essential in increasing feed production. At the same time, grinding is the most important process in the production of feed. An essential and urgent issue of grinding is the provision of grinding processes for animal waste with new and intensive equipment that contributes to the production of high-quality feed products with improved technical and economic indicators. As is known in hammer crushers, the predominant grinding method is the method of grinding by hammer blows, but here it is also possible to observe splitting in the process of hammer blows, especially if all the impact surfaces of the hammers are provided with teeth, which significantly intensifies the formation of cracks and cracks in the raw material being crushed. Therefore, the creation of an intensive technology for crushing animal waste, aimed at forage purposes, is an urgent topic for scientific research.

Purpose: design and implementation of impact-toothed hammers for intensive grinding of particles of feed meal from animal waste.

Expected results: prototypes of impact-toothed hammers for intensive crushing of feed from animal waste will be designed and introduced. It is expected to establish up to 3-5 main factors influencing the intensive grinding process of animal feed, which will allow developing the optimal design of impact elements for intensive grinding of animal feed. It is expected to develop a mathematical model of cracking in animal waste during intensive grinding with impact-toothed hammers, which will allow rationalizing the operation of the crusher. As a result of the implementation of this project, the results of applied scientific research in the field of technical sciences will be published in at least 1 (one) article published, accepted for publication or submitted to a peer-reviewed scientific publication included in the Science Citation Index Expanded or Social Science Citation Index on the Web of Science and (or) having a CiteScore percentile in the Scopus database of at least thirty-five (35) (it is mandatory that the first author and / or author for correspondence will be the project leader and / or a member of the research group). Research results will be published in scientific journals recommended by the Committee for Quality Assurance in Education and Science (CQAESXON). The textbook "Impact elements of crushers" will be published in a foreign publishing house, the monograph "Intensive grinding by impact of particles of fodder bone meal". Technical solutions obtained as part of the project will be protected by the title of protection of the Republic of Kazakhstan, the Eurasian Patent Office. Scientific, technical, design documentation will be developed in accordance with the requirements of a unified system of technological and design documentation, current standards and regulatory documents for the serial production and implementation of the developed hammers. To disseminate the results of the work among potential users, the community of scientists and the general public, the results of the project will be reported at conferences, seminars, forums, and published in publications.

Results achieved: prototypes of impact-toothed hammers for intensive crushing of feed from animal waste were designed and tested. There is an act of implementation. The main factors affecting the intensive grinding process of animal feed have been established, in particular, the presence of passive zones on the working elements of crushers, insufficient working surfaces of hammers, the duration of cracking in splitting particles of animal feed, the design of the working surface of the hammer, the presence of teeth and the angle of the tooth profile on the working surfaces of the hammer. A mathematical model of cracking in animal waste during intensive grinding with impact-toothed hammers is developed, in particular, a mathematical description of the impact of sharp-pointed hammer teeth on crushed food particles of animal origin is presented using the theorem on changing the momentum, F. Kick's hypothesis. It was revealed that as a result of the impact of a sharp-pointed hammer tooth on the crushed material, an instantaneous crack formation occurs, while the shape of the crack repeats the shape of the tooth. The force from the side of the tooth cheek to the element is decomposed into a vertical component F_B , creating a crack plane and into a horizontal component, pushing apart the divided halves of the element in directions perpendicular to the fracture plane. The normal pressure on the cheek of the tooth H_3 and the friction force F_g give the total reaction force R . As a result, the dependences of the expanding force on the angle of the tooth tip are obtained for various coefficients of friction $\eta = 0.8-0.2$. The optimal angles of a pointed tooth are determined in the range $\alpha = 30-50^\circ$, for which there will be the greatest variation. The results of applied scientific research have been submitted for publication in a peer-reviewed scientific publication included in the Science Citation Index Expanded or Social Science Citation Index in the Web of Science database and (or) having a CiteScore percentile in the Scopus database of at least 35 (thirty-five). Research results are published in scientific journals recommended by Committee for quality assurance in education and science. Published an electronic textbook "Impact elements of crushers" from the publishing house Buk (Kazan, Russia) with the receipt of ISBN 978-5-00118-800-1. A monograph "Intensive crushing by impact of fodder bone meal particles" was published with ISBN 978-601-257-342-8 and the decision of the Academic Council of KazATU named after Seifullina (a scientific publication equated to the list of publications recommended by Committee for Quality Assurance in Education and Science of the Ministry of Education and Science of the Republic of Kazakhstan). The technical solutions obtained as part of the project are protected by the title of protection of the Republic of Kazakhstan. An application is filed with the Eurasian Patent Office. Scientific and technical documentation has been developed in the form of a report on the conduct of patent information research on the project topic. Design documentation has been developed in accordance with the requirements of a unified system of technological and design documentation, current standards and regulatory documents for the serial production and implementation of the developed hammers.

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List of publications and patents published within the framework of this project: (with links to them):

1 Iskakov R.M., Isenov S.S., Zaichko G.A. Article "System analysis of impact-splitting grinding in a hammer mill". Publishing house of the Karaganda Technical University, republican journal "Proceedings of the University", No. 3 (84) 2021. - pp. 54-60 (scientific publication recommended by Committee for Quality Assurance in Education and Science of the Ministry of Education and Science of the Republic of Kazakhstan). <http://tu.kstu.kz/archive/issue/89>

2 Iskakov R.M. Utility model "Toothed-comb hammer of a hammer mill". RK patent for utility model No. 6469. NIIS MJ RK, publ. 01.10.2021 <https://gosreestr.kazpatent.kz/Utilitymodel/Details?docNumber=345573>

3 Iskakov R.M. Useful model "Toothed rod hammer of a hammer mill". RK patent for utility model No. 6470. NIIS MJ RK, publ. 01.10.2021 <https://gosreestr.kazpatent.kz/Utilitymodel/Details?docNumber=345572>

4 Iskakov R.M. Copyright certificate No. 17405 dated 05/12/2021, issued by the National Institute of Intellectual Property of the Ministry of Justice of the Republic of Kazakhstan. The work of science "Mechanicaly Ordister". <https://copyright.kazpatent.kz/>

5 Iskakov R.M. Copyright certificate No. 18490 dated 06/08/2021, issued by the National Institute of Intellectual Property of the Ministry of Justice of the Republic of Kazakhstan. The work of science "Machines and equipment for the preparation of feed". <https://copyright.kazpatent.kz/>

6 Iskakov, R.M., Isenov, S.S., Nukeshev, S., Kaspakov, E., Mamyrbayeva, I. and Ukenova A. Development and Justification of the Working Bodies of a Hammer Crusher for Intensive Grinding of Bone Feed Meal. Agriculture (Manuscript ID: agriculture-1454731). Status - filed on October 24, 2021 (scientific publication with percentile 63 (sixty three) according to CiteScore in the Scopus database.

7 Iskakov R.M., Isenov S.S., Zaichko G.A. Application to the Eurasian Patent Office, reg. KZ2021 / 048 dated September 16, 2021 for the grant of a patent for the invention "Hammer for crushing and grinding".

8 Iskakov R.M. Intensive impact grinding of fodder bone meal particles. Monograph. - Nur-Sultan: KazATU named after S. Seifullina, 2021 .-- 160 p. ISBN 978-601-257-342-8 (scientific publication, equated to the list of publications recommended by Committee for Quality Assurance in Education and Science of the Ministry of Education and Science of the Republic of Kazakhstan).

9 Iskakov R.M., Zaichko G.A., Isenov S.S. Impact elements of crushers. Study guide. - Kazan: Buk, 2021 .-- 154 p. ISBN 978-5-00118-800-1.

10 Iskakov R.M., Isenov S.S., Zaichko G.A. Article "Development of shock-toothed hammers based on the analysis of theoretical studies of cracking." Publishing house of the Karaganda Technical University, republican journal "Proceedings of the University". Status - filed on 07.10.2021 (scientific publication recommended by Committee for Quality Assurance in Education and Science of the Ministry of Education and Science of the Republic of Kazakhstan, status - awaiting publication).

11 Iskakov R.M. Utility model "Device for crushing". RK patent for utility model No. 6519. NIIS MJ RK, publ. 10/15/2021 <https://gosreestr.kazpatent.kz/Utilitymodel/Details?docNumber=345571>

12 Iskakov R.M., Isenov S.S., Zaichko G.A. Utility model patent "Impact-toothed hammer for grinding" according to application No. 6706. NIIS MJ RK, publ. 11/26/2021 <https://gosreestr.kazpatent.kz/Utilitymodel/Details?docNumber=347892>

13 Iskakov R.M., Mamyrbayeva I.K., Gulyarenko A.A., Silaev M.Yu., Gusev A.S. The article is accepted for publication in Scopus. Research of Impact-toothed Hammers for Grinding Feed Meal of Animal Origin // RUSSIAN ENGINEERING RESEARCH, followed by placement in the citation database (39 percentile).

Information for potential users: the target consumers of the manufactured shock-toothed hammers are meat and poultry processing enterprises, farms and livestock farms, feed preparation shops, which will use hammers to process non-waste raw materials of animal origin and receive income from the production of feed from animal waste.

Additional information: a high social, economic, environmental, scientific and technical, multiplier and technological effect will be obtained.