ANNOTATION

of the dissertation work of Gabit Maksutovich Bazenov on the topic "Study of accuracy and increase of productivity of waterjet processing" for the degree of Doctor of Philosophy (PhD) in the specialty 8D07101 - Mechanical Engineering.

Relevance of the study. Currently, small-scale production, and sometimes single-piece production, prevails in the industry. In order to reduce production costs and expand production capabilities, equipment is being modernized and advanced technologies for the production of parts are being introduced. In single-piece production, the manufacture of stamped and cast blanks is not cost-effective due to the high cost of manufacturing technological equipment. Therefore, blanks are increasingly used by cutting out parts of approximate contours from thick sheet plates. One of the most modern and promising methods of cutting and obtaining finished parts is the method of waterjet processing (waterjet cutting).

Waterjet machining is a relevant and important production method, providing precision and quality of machining, a wide range of material processing, minimal impact on the material, no impact on the environment, automation and robotics with the development of new technologies. Currently, small-scale production, and sometimes single-piece production, prevails in the industry. In order to reduce production costs, as well as expand production capabilities, equipment is being modernized, as well as the introduction of advanced technologies for the production of parts. In single-piece production, the manufacture of stamped and cast blanks is not cost-effective, due to the high cost of manufacturing technological equipment. Therefore, blanks are increasingly used by cutting out parts from thick sheet plates with approximate contours. One of the most modern and promising methods of cutting and obtaining finished parts is the method of waterjet machining (waterjet cutting). Waterjet machining is a relevant and important production method, providing precision and quality of machining, a wide range of material processing, minimal impact on the material, no impact on the environment, automation and robotics with the development of new technologies.

The aim of the work is to increase the productivity of the waterjet machining process by optimizing the machining modes.

The idea of the work is that the increase in productivity and energy efficiency of waterjet machines is achieved by substantiating rational technological and geometric parameters and optimal cutting modes.

The main objectives of the study:

- analysis and substantiation of the field of application of waterjet machining;
- theoretical studies of the waterjet machining process;
- theoretical and experimental studies of the formation of cut surface roughness depending on the technological parameters;
- development of recommendations for the selection of rational machining modes depending on the operating conditions, ensuring the best surface quality and increased productivity with a technical and economic justification.

Scientific provisions submitted for defense:

1. Improving the quality of the cut and roughness to Ra 1.6 μm due to optimization of the process parameters, namely increasing the speed to 30,000 mm / min, which increases the efficiency of the equipment and reduces material and energy consumption by 20-30%;

2. The influence of technological factors (feed; cutting depth, consumption of abrasive material; thickness of the processed material) on the roughness of the processed surface are obtained on the basis of experimental studies;

3. Recommendations by optimizing the modes of waterjet processing for practical application, based on technical and economic calculations, which help to reduce production costs and increase the profitability of the processes.

Scientific novelty of the work:

1. Empirical dependencies of the influence of processing modes on the quality of cutting and roughness of the processed surface were obtained and it was found that with an increase in feed and depth, the surface roughness increases by 1.6 times, and with an increase in the consumption of abrasive material, the surface roughness increases by 1.5 times;

2. For the first time, the influence of technological factors (feed; cutting depth, consumption of abrasive material; thickness of the processed material) on the roughness of the processed surface was established;

3. Technical and economic indicators for optimizing processing modes were established, which will reduce production costs and increase the profitability of the waterjet processing process.

Implementation of research results

1) The research results were accepted for implementation in REDCUBE LLP, Almaty, and Hydrojet LLC, Moscow, for practical implementation in the development of technological processes for the manufacture of parts (Implementation Act);

2) The main provisions and recommendations have been implemented in the educational process of Bauman Moscow State Technical University and Toraigyrov University. The dissertation materials have been included in the lectures on the subject "Rocket and Space Engineering Technologies", "Processing of Non-Metallic Materials" read for students of groups SM-1, MT-2 and SM-12, and in 2022, a teaching aid for students of technical specialties (for internal use in the department) "Waterjet Cutting of Materials" was implemented at the SM-12 Department of Rocket and Space Engineering Technologies, which includes individual results of this dissertation research. (Implementation Act).

The dissertation research materials at Toraigyrov University have been included in lectures and practical classes on the subjects: "Innovative Technologies in Mechanical Engineering", "Modern Aspects of Mechanical Engineering Development", "Advanced Methods of Materials Processing" under the educational program of doctoral studies 8D07101 - Mechanical Engineering. (Implementation Act).

Practical value of the work

As a result of the testing, the operating modes of the process equipment were selected that ensure accuracy and increase the productivity of the work performed.

As a result of the testing, it was found that the proposed process parameters provide minimal heat generation and accurate cutting of complex-shaped materials; no thermal impact on the material and no melting or burning, as well as increased productivity of the work performed.

Positive conclusions were made about the practical significance, economic efficiency and prospects of implementing the optimization technique and the feasibility of using waterjet cutting technology.

The proposed process parameters: jet speed, abrasive grain size, jet angle, distance from the nozzle to the workpiece significantly increase the speed to 30,000 mm/min and the quality of cutting material with an edge roughness of up to Ra=1.6 μm.

From an economic point of view, material and energy consumption is reduced by 20–30%.

Methodology and research methods

The methodology of theoretical, mathematical analysis and methods of reliability theory and processing of statistical and experimental research data in laboratory conditions were used.

Theoretical studies were conducted using the basic provisions of cutting theory, theory of materials mechanics, flow dynamics and abrasive cutting processes. When conducting experimental studies, methods of experiment planning, mathematical statistics and parameter optimization theory were used.

Processing of experimental results and necessary calculations were carried out using the EXCEL computer program for plotting graphs of mathematical dependencies and approximating experimental data.

The personal contribution of the applicant consists of analyzing and summarizing the results of the studies performed, formulating the goal and objectives of the studies; developing empirical dependencies of the effect of processing modes on the roughness of the resulting surfaces; conducting, processing and analyzing the results; developing recommendations.

Processing of research results

Experimental studies were conducted:

1) based on the laboratory of the Moscow State Technical University named after N.E. Bauman and OOO "Gidrodzhet" in Moscow. In the experiments, we used waterjet cutting units manufactured by MultiCam WaterJet Systems, as well as Flow Mach 3 1313b with multiplier-type pump systems manufactured by KMT.

2) The experimental data were processed in accordance with the methods of experiment planning, mathematical statistics and parameter optimization theory. The experimental results were processed and the necessary calculations were performed using a computer program for plotting empirical dependencies and approximating experimental data. To obtain a quantitative assessment of the influence of technological factors of waterjet cutting on the studied parameters, mathematical and computer modeling was used based on a two-factor experiment.

3) Based on the processing and analysis of the experimental data, the following results were obtained: - The values of the coefficients reflecting the influence of each technological parameter on the quality of processing were determined; - Proven, tested the hypothesis and significance of the regression model, which will allow more accurate control of the waterjet machining process and optimize the process parameters to achieve the best results.

Testing of the work. The main provisions and scientific results were discussed at international scientific and technical conferences:

1) Базенов Г.М., Итыбаева Г.Т., Касенов А.Ж., Янюшкин А.С. Гидроабразивная технология резки листового стекла / СТИН. Ежемесячный научно-технический журнал – 2022 - №8 - С. 17-21;

2) Itybayeva G.T, Bazenov G.M., Kasenov A.Zh., Yanushkin A.S., Abishev K.K. Processing of flat glass / ВЕСТНИК ЕНУ имени Л.Н. Гумилева. Серия технические науки и технологии. 2022 - № 1(138) - С. 34-43 (КОКСОН МОН РК), ISSN: 2616-7263;

3) Bazenov G.M. On the issue of the use of waterjet treatment in modern mechanical engineering / НАУКА И ТЕХНИКА КАЗАХСТАНА. ISSN 2788-8770. № 2, 2021, С. 39-47;

4) Bazenov G.M., Itybayeva G.T., Kussainov R.B., Galinovskiy A.L., Mussina Zh.K. Stress-deformable state Of glass during waterjet cutting / НАУКА И ТЕХНИКА КАЗАХСТАНА. ISSN 2788-8770. № 3, 2023, С. 93-101;

5) Базенов Г.М., Итыбаева Г.Т., Мусина Ж. К., Деревягин С.И., Галиновский А.Л. Экспериментальные исследования процесса Гидроабразивной резки / НАУКА И ТЕХНИКА КАЗАХСТАНА. ISSN 2788-8770. № 4, 2023, С. 24-40.

1 article in international peer-reviewed journals with a non-zero impact factor and indexed in the Scopus database (percentile at least 38):

1) Bazenov G.M., Itybayeva G.T, Kasenov A.Zh., Yanushkin A.S. Water-Jet Cutting of Glass Sheet // Russian Engineering Research, 2022, Vol. 42, No. 10, pp. 1045–1048.

Domestic and international scientific and practical conferences:

1) Базенов Г.М., Итыбаева Г.Т. Анализ эффективности гидроабразивной обработки материалов // МАТЕРИАЛЫ МЕЖДУНАРОДНОЙ НАУЧНО-ТЕХНИЧЕСКОЙ КОНФЕРЕНЦИИ «I юбилейные чтения Бойко Ф. К.», посвященной 100-летию Бойко Ф. К том 2, 2020, стр 319-324;

Базенов Г.М., Итыбаева Г.Т., Баидильдин Н. Материалдарды гидроабразивті кесумен өндеу технологиясы / МАТЕРИАЛЫ МЕЖДУНАРОДНОЙ НАУЧНОЙ КОНФЕРЕНЦИИ «XXIV САТПАЕВСКИЕ ЧТЕНИЯ», ПОСВЯЩЕННОЙ 125-ЛЕТИЮ АКАДЕМИКА КАНЫША САТПАЕВА, том 13, секция 14, 2024, стр 86-93.

Publications. Based on the dissertation materials, 8 scientific papers were published, including 5 in publications recommended by the Committee for Quality Assurance in Education and Science of the Ministry of the Republic of Kazakhstan,

1 article in publications included in the international Scopus database and 2 in the materials of international conferences and Toraigyrov University.

Based on the dissertation materials, 1 article was published in publications reviewed by the international abstract databases Scopus and Web of Science, 5 articles in journals included in the list of publications recommended by the Control Committee of the Ministry of Science of the Republic of Kazakhstan, 2 reports at international conferences.