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PROSPECTS FOR THE USE OF COMBINED METAL-CUTTING TOOLS FOR THREADING

This article examines the use of combined metal-cutting tools for performing threading operations. The main purpose of the work is to analyze the effectiveness of using these tools in terms of improving accuracy, productivity and cost-effectiveness of processing.

Combined tools show significant advantages over traditional methods, including reduced processing time, improved accuracy characteristics and reduced equipment maintenance costs. The design features and principles of operation of boring threaded cutters and threaded combs, as well as their impact on production processes and the quality of final products, are considered.

Threading with the use of combined metal cutting tools allows you to integrate several technological operations in one cycle, which helps to increase efficiency and reduce basing errors.

Experimental data confirm that the use of comb cutters contributes to a significant increase in processing accuracy and productivity, as well as reducing the time required to perform operations. Comparative analysis has shown that combined tools provide a higher quality of the thread being cut and an extended service life compared to traditional processing methods.

Keywords: combined metalcutting tools, threading tools, boring threaded cutters, threaded combs, threading, productivity, processing quality.

Introduction

Threading is an operation to process a rod or hole in a part using a threading tool. There are triangular, rectangular and other carvings. Threading can be right or left, depending on the direction of the thread turn. The main elements of the thread include the pitch and angle of the thread profile. The thread profile depends on the shape of the cutting part of the tool with which the thread is cut. As a rule, three thread systems are used – metric, inch and pipe [1–3].

The threading process is an important operation in mechanical engineering, providing the creation of joints used in various structures and products. In recent years,

combined metal cutting tools have been actively used to increase production efficiency, which allow combining several operations, such as drilling, shaped cutting and threading, into one tool. This solution significantly reduces the total processing time, reduces the number of tools used and reduces equipment wear.

Combined metal cutting tools are designed to perform several technological operations in one processing cycle. Their use is especially important in mass and mass production, where saving time on changeover and tool change plays an important role. The use of such tools makes it possible to minimize errors during the transition from one operation to another and increase the accuracy of the final product [4–8].

Combined threading tools often include the following elements:

– A drilling element that performs pre-drilling of a hole.

– Chamfering element that allows you to remove the chamfer to prepare for threading.

– A threading element that performs a thread on a pre-prepared part section.

The design of such tools may vary depending on the complexity of the operations performed and the requirements for processing the material.

The main advantages of using combined threading tools include:

– Reduction of the number of operations: several operations are combined in one tool, which reduces the total processing time;

– Improved accuracy: by reducing the number of tool changes, the number of possible errors and errors is reduced;

– Reduced tool wear: optimal load distribution between the tool elements allows you to extend its service life;

– Savings on auxiliary operations: reducing the time to change tools and reconfigure equipment contributes to an increase in overall production productivity;

– Reduction of the cost of processing: fewer tools and shorter processing time directly affect the reduction of production costs.

Combined threading tools can have different designs, depending on the type of thread, the material of the workpiece and the requirements for surface quality. In general, a combined tool may consist of several cutting elements arranged sequentially on one housing.

The main types of structures:

– Tools for threading with pre-drilling and countersinking: this type of tools is used for threading through and blind holes. The combination of a drill and a threading tool allows you to significantly speed up the processing process;

– Threading taps with drilling function allow you to drill a hole first in one processing cycle, and then cut the thread.

– Drilling and threading cutters are used on multifunctional CNC machines, allowing simultaneous milling and threading.

Threading is a metalworking process that creates a spiral profile on the surface of a part. The process includes cutting or forming threads, as well as removing chips and other related materials. The key factors affecting the quality of threading are:

– Tool materials. High-quality materials such as carbide carbide and ceramics ensure a long tool life and high machining accuracy.

– The geometry of the cutter. The shapes and angles of the cutters affect the cutting process and the quality of the thread.

– Cutting speed and feed. Optimal process parameters contribute to better thread quality and minimize defects.

The methods of threading, the threading tools used in this case, and the threading machines are very diverse.

The formation of threads by cutting and milling methods is carried out: for external threads – with threaded cutters, screw cutters, comb and disc threaded cutters, round dies; for internal threads – with cutters, taps and comb cutters. Vortex heads are used for cutting single- and multi-entry screws and worms in large-scale production conditions. The method of rolling external threads with flat dies is used on thread rolling machines and thread rolling machines. The method of rolling a thread with knurled rollers is used to form metric threads with a diameter of 3 ... 68 mm in increments of p = 0.5 ... 6.0 mm. Each of the methods has its own specific advantages and is used for threading of various types [9–11].

Comb cutters are combined tools designed for threading using multiple teeth, which ensure uniform load distribution and improved processing quality. These tools allow you to cut threads on large diameters and in difficult conditions, improving the accuracy and productivity of the process.

Materials and methods

The application of well-known and proven research methods in the field of cutting theory, principles of mechanical engineering, theoretical mechanics, design of metal-cutting tools, as well as methods of mathematical modeling and optimization of parameters, is aimed at achieving the required level of processing quality. Special attention is paid to the consideration of experimental data concerning the influence of design parameters of resource- and energy-saving metal-cutting tools. These studies are based on indicators of processing accuracy, quality level, surface roughness, as well as the type of production.

Results and discussions

The experimental results showed that the combined tools provide a significant reduction in processing time compared to traditional methods. The time to complete a full cycle of threading and additional operations decreased by an average of 20–30 %. This is due to the lack of need for additional replacement of tools and reconfiguration of equipment.

The quality of the carving obtained using combined tools turned out to be comparable to the quality achieved using traditional methods. However, combined tools have shown more stable results when processing complex materials such as stainless steel. The precision of the cut thread was in accordance with ISO standards.

In terms of cost-effectiveness, combined tools have shown the best results. The cost and operation of combined tools turned out to be 15-20 % lower compared to traditional

cutters. This is due to a reduction in the cost of purchasing and replacing tools, as well as a reduction in time for setting up and reconfiguring equipment.

To improve the accuracy of the thread being cut, a combined metal–cutting tool - cutter-comb has been developed, which combines two or three hole preparation operations into one operation and reduces processing time.

Figure 1 shows the scheme of threading with a combined two-stage tool: a boring cutter-comb [12]. The boring cutter is the first stage of the tool, and the threading comb is the second stage of a complex combined tool. In order to obtain a high-quality cylindrical hole when working with an axial feed boring cutter, it is necessary that after the tip of the cutter there is a stripping section with a width b equal to half the pitch of the thread being cut or slightly larger. In section b, the main angle in the plan is zero. In this case, the cutter will bore a cylindrical hole, and with the size of this section, significantly less than half the pitch of the thread being cut, a combination of screw surfaces of the threaded type with the profile of the boring cutter will be cut. In the practice of work, it is often necessary to have higher accuracy than standard traditional metal cutting tools can provide.

Design parameters of a metal–cutting tool, a workpiece: 1 – a workpiece; 2 – a metal–cutting tool; ω0 – rotational movement of the workpiece or tool; εgr – the angle of the profile of the thread being cut, equal to 60°; S0 – axial feed per revolution, equal to the pitch of the thread being cut; Dp – the outer diameter of the thread being cut, mm; Lz – the length of the workpiece, b is the length of the stripping section of the cutting edge of the boring cutter with the main angle in the plan equal to zero; φp is the main angle in the plan of the boring cutter; φ1p is the auxiliary angle in the plan of the cutter; Hp is the height of the profile of the thread being cut.

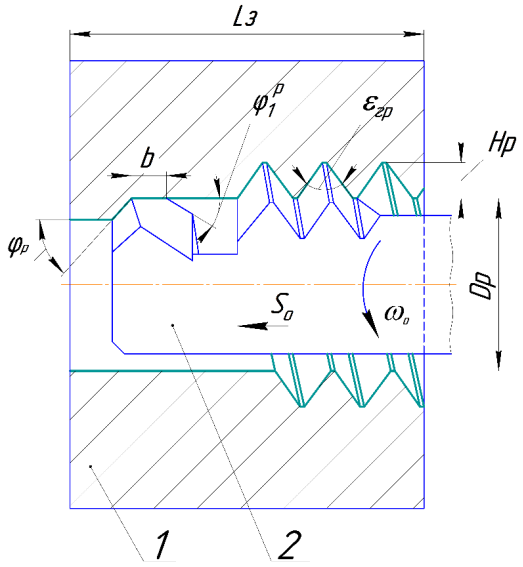

Figure 1 – Diagram of internal threading with a combined tool with a comb cutter

Figure 2 shows a diagram characterizing the method of cutting an internal thread with a boring tool-comb with a preceding boring hole with a boring tool [12] with a section of the cutting edge width b with a main angle in terms of φ = 0 and with a guide between the cutter and the comb. The addition of a guide rail turned a two-stage tool into a three-stage one. The guide allows you to increase the accuracy of the thread being cut, because it reduces or prevents the tool from beating relative to the hole of the workpiece. Thus, with the help of a guide, the multifunctional first and third stages of the combined tool are better centered relative to the axis, which increases the accuracy of the thread being cut.

The design and geometric parameters of the tool and the workpiece in Figure 2: Dp – the outer diameter of the guide, mm; Hp – the length of the guide.

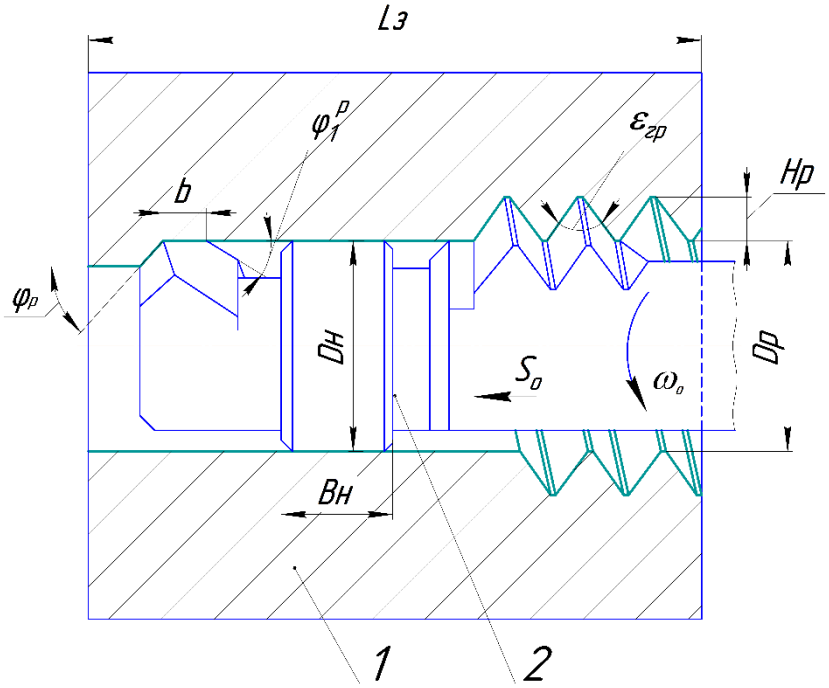

Figure 2 – Chart of internal threading with a combined tool with a comb cutter with a guide

High-precision threading schemes with more productive combined metal-cutting tools in Figures 1 and 2 can be implemented provided that the boring cutter used in them is changed so that at higher axial feeds equal to the pitch of the thread being cut, not an ordinary cutter of the type of an ordinary turning pass-through will be used, but a cutter with a stripping section, on in which the auxiliary angle in the plan is zero in the area from the top to the size of 4...5 axial feeds. When this condition is met, the boring cutter with a stripping section on the auxiliary cutting edge in the diagrams shown in Figures 1 and 2 increases the accuracy of the drilled hole before threading.

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Conclusions

Combined metal cutting tools are an effective solution for threading, allowing you to significantly increase productivity and processing quality. They provide a reduction in processing time, improved accuracy and lower costs for tools and their maintenance. Modern achievements in the field of metalworking contribute to the further development and improvement of combined tools. The introduction of these tools into production processes opens up new opportunities to increase the competitiveness of enterprises.

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БҰРАНДАНЫ ОЮҒА АРНАЛҒАН ҚҰРАСТЫРЫЛҒАН МЕТАЛКЕСКІШ ҚҰРАЛДАРДЫ ҚОЛДАНУ БОЛАШАҒЫ

Бұл мақалада бұрау операцияларын орындау үшін құрастырылған металлкескіш құралдарды пайдалану қарастырылады. Жұмыстың негізгі мақсаты – өңдеудің дәлдігін, өнімділігін және үнемділігін арттыру тұрғысынан осы құралдарды қолданудың тиімділігін талдау.

Құрастырылған құралдар дәстүрлі әдістерге қарағанда айтарлықтай артықшылықтарды көрсетеді, соның ішінде өңдеу уақытын қысқарту, дәлдік өнімділігін жақсарту және жабдыққа техникалық қызмет көрсету шығындарын азайту. Бұрандалы кескіштер мен бұрандалы тарақтардың конструктивті ерекшеліктері мен жұмыс принциптері, сондай-ақ олардың өндірістік процестерге және соңғы өнімнің сапасына әсері қарастырылады.

Құрастырылған металлкескіш құралдарды пайдаланып жіппен кесу бірнеше технологиялық операцияларды бір циклде біріктіруге мүмкіндік береді, бұл тиімділікті арттыруға және негіздегі қателіктерді азайтуға көмектеседі.

Эксперименттік деректер тарақ кескіштерін қолдану өңдеудің дәлдігі мен өнімділігін едәуір арттыруға, сондай-ақ операцияларды орындау уақытын қысқартуға ықпал ететіндігін растайды. Салыстырмалы талдау көрсеткендей, аралас құралдар дәстүрлі өңдеу әдістерімен салыстырғанда кесілген жіптердің жоғары сапасын және қызмет ету мерзімін ұзартады.

Кілтті сөздер: құрастырылған металлкескіш құралдар, бұрандалы кескіш құралдар, бұрандалы кескіштер, бұрандалы тарақтар, бұранданы ою, өнімділік, өңдеу сапасы.

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ПЕРСПЕКТИВЫ ПРИМЕНЕНИЯ КОМБИНИРОВАННЫХ МЕТАЛЛОРЕЖУЩИХ ИНСТРУМЕНТОВ ДЛЯ НАРЕЗАНИЯ РЕЗЬБЫ

В данной статье исследуется применение комбинированных металлорежущих инструментов для выполнения операций нарезания резьбы. Основная цель работы заключается в анализе эффективности использования этих инструментов с точки зрения повышения точности, производительности и экономичности обработки.

Комбинированные инструменты показывают значительные преимущества по сравнению с традиционными методами, включая сокращение времени обработки, улучшение точностных характеристик и снижение затрат на обслуживание оборудования. Рассмотрены конструктивные особенности и принципы работы расточных резьбовых резцов и резьбовых гребёнок, а также их влияние на производственные процессы и качество конечной продукции.

Нарезание резьбы с применением комбинированных металлорежущих инструментов позволяет интегрировать несколько технологических операций в одном цикле, что способствует увеличению эффективности и снижению ошибок при базировании.

Экспериментальные данные подтверждают, что применение резцов-гребёнок способствует существенному повышению точности и производительности обработки, а также сокращению времени на выполнение операций. Сравнительный анализ показал, что комбинированные инструменты обеспечивают более высокое качество нарезаемой резьбы и увеличенный срок службы по сравнению с традиционными методами обработки.

Ключевые слова: комбинированные металлорежущие инструменты, резьбонарезные инструменты, расточные резьбовые резцы, резьбовые гребёнки, нарезание резьбы, производительность, качество обработки

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