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IMPROVING THE PROCESS OF PROCESSING HOLES WITH DRILLS

One of the urgent problems of mechanical engineering is the processing of holes, which are subject to high requirements for the accuracy of size, shape and location. Most often, hole processing is carried out with the help of rod measuring tools. This is due to their following advantages: relatively high productivity, low costs for pre-production. The quality of the machined holes is determined mainly by the accuracy of the cutting tools, machines and accessories used.

The drilling process with existing drills takes place under severe cutting conditions. The magnitude of the front angle on the transverse edge is very unfavorable. For standard spiral drills, the front angle γ on the transverse edge is up to minus 57–60. In view of this, on the transverse edge, instead of cutting, there is a crumpling, squeezing and scraping of metal.

When drilling holes with existing drills, the transverse edge of the drill perceives up to 80 % of the axial force, i.e. the resistance to axial feed is created by the contact area of the transverse edge with the workpiece.

The specified working conditions of the transverse edge significantly worsen the processing conditions and the quality of the treated hole. To eliminate the transverse edge, a new design of a spiral drill is proposed – a two-vertex spiral drill without a transverse edge, preliminary patent of the Republic of Kazakhstan № 19559. The elimination of the transverse edge on the drill allows you to dramatically reduce the heating and wear of the drill during the cutting process, increase the durability of the drills.

The analysis of the results shows that the accuracy of the diametrical dimensions of the holes after processing with two-vertex spiral drills increased by 1, 2 quality compared with spiral drills; roughness decreased by 1, 2 classes.

Keywords: spiral drill, jumper, sharpening, durability, accuracy, productivity

Introduction

Hole processing can be performed in various ways. But most often it is performed with the help of measuring tools, since this method has high productivity, low requirements for the accuracy of machine tools – the accuracy of the machined holes mainly depends on the accuracy of the machine, the tool and the equipment used, and there is no need for highly qualified workers [1–5].

The most common method of obtaining holes in a solid material is drilling, holes are obtained with low accuracy. More accurate holes are obtained when processing with countersinks and reamers. In this case, the accuracy of the holes is ensured by better centering of the tool, increased accuracy and rigidity of the tool and easier working conditions of each blade.

Comparison of working conditions of tools during drilling, countersinking and deployment:

– drilling, number of teeth z=2, quality H11...H13, roughness Ra 10...20 μ;

– countersinking, number of teeth z = 3–6, quality H9...H11, roughness Ra 2,5...10 μ;

– deployment, number of teeth z = 4–12, quality H6...H9, roughness Ra 1.25...2.5 μ.

When drilling holes, the following main types of defects occur: rough surface of the drilled hole; the diameter of the drilled hole exceeds the specified one; displacement of the axis of the hole; misalignment of the axis of the hole [6–9].

The cutting edges of the drill must be straight, of the same length and must be positioned at equal angles to the drill axis. If these conditions are not met, the drill leads away during operation, and the hole drilled by it turns out to be larger than the diameter of the drill. In addition, the removal process is influenced by the anisotropy of the properties of the processed material, the beating of the cutting edges.

The bridge (transverse edge) accounts for up to 60 % of the axial force and up to 15 % of the torque. The length of the transverse edge is equal to the diameter of the core. The transverse edge of the spiral drill, instead of the cutting process, performs scraping, crumpling and squeezing, the front angle is $\gamma \leq -57°$. All this worsens the working conditions of the drill.

The performance of the drill is negatively affected by the stressful working conditions of the peripheral (external) part of the cutting edges, which leads to increased wear. To improve the cutting conditions, increase the productivity and durability of drills, several forms of sharpening are recommended, depending on the material being processed, which allow to some extent to reduce the design disadvantages of spiral drills noted above. Sharpening is performed on the back surface [4, 10].

Materials and methods

Recommended forms of sharpening drills, depending on their diameter and the material being processed: normal (N), normal with sharpening of the transverse edge or jumper (NP), normal with sharpening of the transverse edge or jumper and ribbon (NPL), double with sharpening of the transverse edge or jumper (DP), double with sharpening of the transverse edge or jumper and ribbons (DPL).

Sharpening the transverse edge and ribbons of drills in known ways does not solve the problem. Therefore, this issue is open for further solutions with the development of new designs of cutting tools.

In order to eliminate the disadvantages of hole processing with standard drills, a number of drill designs have been developed and designed. The design of the new drills is aimed at improving the processing accuracy (size accuracy, surface roughness), durability, as well as cutting conditions [4, 9, 10].

To reduce the axial force during drilling, the transverse edge is cut through with a special double sharpening, but it remains on the drill in a modified form, with smaller front angles (a front angle $\gamma = 0$ is created on each of the two halves of the transverse edge). Such drills have proven themselves well in the processing of cast iron. An increase in the durability of the drill is achieved by using sharpeners for Klemm, Menzel, Dreez, Feldstein, Glushchenko, which provide for sharpening the transverse edge to 0.1 – 0.2 mm.

To reduce uneven loading on the working part, drills with curved cutting edges are used, which can have either a radius profile or a radius profile associated with a rectilinear section. Due to the complexity of sharpening such drills, the curved edge is sometimes replaced by a broken one, consisting of two sections with an angle at the apex of 116–120 °, and an additional cutting edge at the periphery at an angle, in a section 0.2 of the drill diameter.

To facilitate chip removal, reduce heat generation in the cutting area and increase the durability of the drill on its front or back surface, chip-separating grooves are made. The execution of chip-separating grooves on the front surface is more labor-intensive, however, in this case, their periodic restoration is not required during the operation of the drill [4, 11, 12].

For drills equipped with a hard alloy, designs with a special sharpening were developed: a non-standard drill of the KMG design, a drill of the N.A. Shevchenko design, a drill of the N.K. Klebanov design. Thus, their experimental studies have shown, from the point of view of productivity, reduction of axial force on the transverse edge and wear of the drill, the best results are provided by continuous drills with a radial arrangement of the main cutting edges along their entire length or on part of the length of the edges adjacent to the center of the drill.

However, on these drills, the transverse edge is not eliminated, but remains in a slightly modified form. The forces acting on the transverse edge are not fully eliminated, the front angle on the transverse edge decreases, but still remains negative. The specified working conditions of the transverse edge significantly worsen the processing conditions and the quality of the treated hole. To exclude a transverse edge, a new design of a spiral drill is proposed – a two-vertex spiral drill without a transverse edge, preliminary patent of the Republic of Kazakhstan No. 19559 [13]. The elimination of the transverse edge on the drill allows you to dramatically reduce the heating and wear of the drill during the cutting process, increase the durability of the drills.

Results and discussions

A two-vertex spiral drill without a transverse edge has design features (elements) that coincide with the features of an analog: a shank, a neck, two spiral grooves for chip removal, working (calibration and cutting) parts, the diameter of the core, a ribbon on the calibration part – and the signs that distinguish it from its analogue: a cut of the drill tip made on a half-diameter section in the axial part with an angle (the vertex of which is directed to the shank) equal to the angle at the top (the well-known angle range at the top of the drill is 30–150 °) with the formation of two vertices and two external (on the periphery of the drill) and two internal (on the section of the vertex cut) of the main cutting edges, separated by a groove cut between them, shifted relative to the axis of the drill so that one of its walls is located on the axis in the axial plane of the drill and cuts off the resulting internal hollow, preventing cutting.

In addition, there is a part of the opposite cutting edge that is shorter than the cutting edge reaching the groove wall and the axis; one wall of the groove is thus aligned with the longitudinal axis of the drill, i.e. located in the axial plane; both drill vertices are located on the same line perpendicular to the drill axis, at a distance of a quarter of the diameter, and in one axial plane. drill planes; the internal main cutting edges are located in the same axial plane of the drill; the specified design of the axial cutting part of the drill eliminates the transverse edge, which is inherent in all types of existing drills and is the cause of unfavorable cutting conditions.

The drill has, in addition to the calibration, one smoothing (guiding) ribbon on the back of each pen at the back of the head; the claimed drill, like all drills, has two versions for right and left cutting.

The proposed design of the cutting part creates favorable conditions for the operation of the drill under the conditions of mechanical and thermal stress: when the angle at the top is 120° for drilling steel and cast iron (the total range of angles at the top for processing different materials is 30–150°), the angle between the outer cutting edges is 120°; the angles between the outer and inner cutting edges and the end walls of the groove cutting the transverse edge are 120°, which is about twice as large as when cutting the transverse edge of a traditional drill adopted as an analogue, and creates better conditions for heat dissipation; with other values of the angle at the top, these ratios are slightly different.

Figure 1 shows the general view of the drill and its elements: angle 2φ – at the apex at the periphery and 2φ′ – the angle whose vertex is directed to the shank; 1 – the working part of the drill with screw chip grooves; ω – the angle of inclination of the spiral (screw) chip groove; 2 – neck; 3 – conical shank with Morse cone; 4 – foot; a – cut thickness; – length of the outer cutting edges with an angle of 2φ at the top; – length of the uncut inner cutting edge with an inverse angle of 2φ at the top; (So – axial feed per turn of the drill) – the length of the cutting edges at the value of half of the axial feed (as with traditional drills); to prevent the removal of the drill axis and the hole due to the asymmetry of the cutting edges on the drill feathers at the chip groove, guide-smoothing ribbons are made.

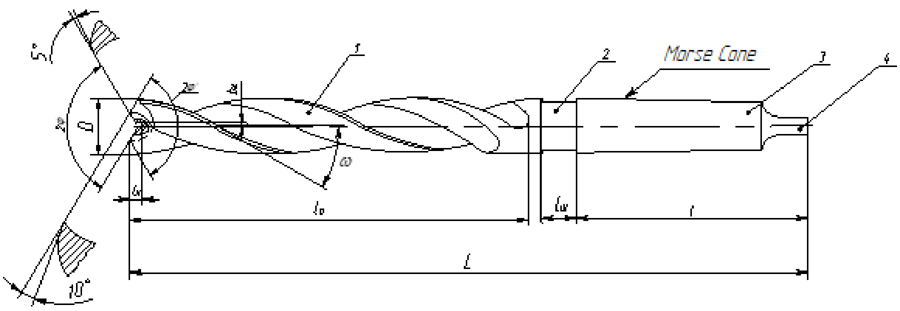

Figure 1 – A two-vertex spiral drill without a transverse edge

A spiral double-top drill without a transverse edge is much more effective than spiral drills with a transverse edge; the proposed drill has optimal favorable cutting conditions and increased drill resistance, the temperature in the cutting zone and drill wear decreases due to the alignment of cutting conditions (mechanical and thermal stresses, constancy of geometric parameters) on different sections of the cutting edges (on all sections of the cutting edges there are positive front and rear corners); as a result, an increase in cutting speed (drill resistance) and an increase in economic efficiency. The recommended dimensions of the cut groove, depending on the diameter of the drill, are shown in table 1.

Table 1 – Dimensions of the cut groove

Drill diameter, D, mm	Groove length, lk, mm	Groove width, bk, mm
up to 10	2–3	0,5–1
10–30	3–4	1–1,5
30–50	4–5	1,5–2
50–80	5–6	2–2,5

Two-vertex spiral drills without a transverse edge were manufactured at the machine-building enterprise of the city of Pavlodar «Format Mach Company» LLP (former tool factory) and tested in the educational and production workshops of the Faculty of Engineering of the NJSC «Toraigyrov University» at the Department of «Mechanical Engineering and Standardization» (Figure 2).

Figure 2 – Designs of double-ended spiral drills without a transverse edge

After processing the holes with spiral and double-vertex spiral drills, the accuracy of the diametrical size of the hole and roughness were investigated. To measure the accuracy of the hole processing, an instrumental horizontal microscope IKG 3 and indicator nutrometers with inserts were used. A profilograph-profilometer mod. 259 was used to measure the roughness of the hole surface.

Results of production tests of samples processed with metal-cutting tools:

1) spiral drills:

– the accuracy of the diametrical dimensions of the holes is 0.21–0.33 mm (12–13 accuracy quality);

– the roughness of the surface of the holes is within Rz=20... 80 microns, which corresponds to grades 3 and 5 of roughness.

2) double-ended spiral drills:

– the accuracy of the diametrical dimensions of the holes is 0.11–0.13 mm (11 accuracy quality);

– the roughness of the surface of the holes is within the range of Ra=2.5 ...10 μ, which corresponds to grades 4 and 6 of roughness.

Conclusions

Thus, the material located within the hole to be processed is completely cut off by the external and radially arranged internal cutting edges of the drill having standard front and rear angles; smoothing ribbons calibrate the hole and finally form its diameter and roughness; since all the cutting edges of the drill have a given normative geometry (front and rear corners), this ensures normal cutting conditions and reduces heating and axial cutting force by eliminating the transverse edge and unfavorable cutting conditions, accompanied by increased friction, heating and wear of the drill; increases the durability of the drill.

The analysis of the results shows that the accuracy of the diametrical dimensions of the holes after processing with two-vertex spiral drills increased by 1, 2 quality compared with spiral drills; roughness decreased by 1, 2 classes.

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СОВЕРШЕНСТВОВАНИЕ ПРОЦЕССА ОБРАБОТКИ ОТВЕРСТИЙ СВЁРЛАМИ

Одной из актуальной проблем машиностроения является обработка отверстий, к которым предъявляются высокие требования по точности размера, формы и расположения. Чаще всего обработка отверстий осуществляется с помощью стержневых мерных инструментов. Это объясняется их следующими достоинствами: относительно высокой производительностью, низкими затратами на подготовку производства. Точность обработанных отверстий определяется в основном точностью применяемого режущего инструмента, станков и оснастки.

Процесс сверления существующими свёрлами протекает в тяжелых условиях резания. Очень неблагоприятной является величина переднего угла на поперечной кромке. У стандартных спиральных свёрл передний угол γ на поперечной кромке составляет значение до минус 57 º – 60 º. Ввиду этого на поперечной кромке вместо резания имеет место смятие, выдавливание и скобление металла.

При сверлении отверстий существующими сверлами поперечная кромка сверла воспринимает до 80 % осевой силы, т.е. сопротивление осевой подаче создаётся областью контакта поперечной кромки с заготовкой.

Указанные условия работы поперечной кромки значительно ухудшают условия обработки и качество обработанного отверстия. Для исключения поперечной кромки предложена новая конструкция спирального сверла – двухвершинное спиральное сверло без поперечной кромки, предварительный патент РК № 19559. Устранение поперечной кромки на сверле позволяет резко уменьшить нагревание и износ сверла в процессе резания, повысить стойкость свёрл.

Анализ результатов показывает, что точность диаметральных размеров отверстий после обработки двухвершинными спиральными свёрлами увеличилась на 1, 2 квалитета по сравнению со спиральными сверлами; шероховатость уменьшилась на 1, 2 класса.

Ключевые слова: спиральное сверло, перемычка, подточка, стойкость, точность, производительность.

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БҰРҒЫЛАРМЕН ТЕСІКТЕРДІ ӨҢДЕУ ПРОЦЕСІН ЖЕТІЛДІРУ

Машина жасаудың өзекті мәселелерінің бірі-өлшемнің, пішіннің және орналасудың дәлдігіне жоғары талаптар қойылатын тесіктерді өңдеу. Көбінесе тесіктерді өңдеу өзек өлшеу құралдарының көмегімен жүзеге асырылады. Бұл олардың келесі артықшылықтарына байланысты: салыстырмалы түрде жоғары өнімділік, өндірісті дайындауға кететін шығындардың төмендігі. Өңделген тесіктердің дәлдігі негізінен қолданылатын кескіш құралдың, станоктардың және жабдықтың дәлдігімен анықталады.

Қолданыстағы бұрғылармен бұрғылау процесі ауыр кесу жағдайында жүреді. Көлденең жиектегі алдыңғы бұрыштың мөлшері өте қолайсыз. Стандартты спиральды бұрғыларда көлденең жиектегі γ алдыңғы бұрышы минус 57–60 дейін болады. Осыған байланысты көлденең жиекте кесудің орнына металдың мыжылуы, сығылуы және қыстырылуы орын алады.

Қолданыстағы бұрғылармен тесіктерді бұрғылау кезінде бұрғылаудың көлденең жиегі осьтік күштің 80 % - на дейін қабылдайды, ягни осьтік беріліс кедергісі көлденең жиектің дайындамамен жанасу аймағымен жасалады.

Көлденең жиектің көрсетілген жұмыс жағдайлары өңдеу жағдайларын және өңделген тесіктің сапасын едәуір нашарлатады. Көлденең жиекті болдырмау үшін спиральды бұрғының жаңа конструкциясы – көлденең жиегі жоқ екі ұшты спиральды бұрғы, ҚР №19559 алдын ала патенті ұсынылды. Бұрғылаудағы көлденең жиекті жою кесу процесінде бұрғылаудың қызуы мен тозуын күрт азайтуға, бұрғылардың беріктігін арттыруға мүмкіндік береді.

Нәтижелерді талдау екі ұшты спиральды бұрғылармен өңдеуден кейін тесіктердің диаметрлік өлшемдерінің дәлдігі спиральды бұрғылармен салыстырғанда 1, 2 біліктілікке артқанын көрсетеді; кедір-бұдырлық 1, 2 сыныпқа азайды.

Кілтті сөздер: спиральды бұрғы, далдаша, қайрау, төзімділік, дәлдік, өнімділік.

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66,9 Mb RAM
Шартты баспа табағы 93,80 Таралымы 300 дана. Бағасы келісім бойынша.
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