ISSN: 2350-0328
International Journal of Advanced Research in Science, Engineering and Technology
Vol. 6, Issue 11 , November 2019

Perspective Drilling Methods, Non-Technological Holes in Polymeric Composite Materials

SH.N.Fayzimatov, B.N.Fayzimatov, Yu.Yu.Husanov

P.G. Doctor of technical sciences, professor Department of "Mechanical engineering and automation", Fergana Polytechnic Institute, Fergana, Uzbekistan
Candidate of technical sciences, professor Department of "Mechanical engineering", Andijan Machine-Building Institute,Andijan, Uzbekistan
Assistant department of "Mechanical engineering and automation", Fergana Polytechnic Institute, Fergana, Uzbekistan

ABSTRACT: In recent years, the share of polymer composite materials (PCM), which have high physical, mechanical and operational characteristics, has been growing rapidly in industry. Their application allows to obtain products with properties that even traditional materials do not possess.To date, the industry has identified the problem of improving the efficiency of machining by chip removal. During processing, there is a high consumption of the tool due to rapid wear, the operation of processing holes in the PCM and their structural combinations make up a significant part of the complexity of the assembly process and, accordingly, in the total cost of the product. Here are some ways to solve these problems.

KEY WORDS: hole, non-technological, PCM, drilling, materials, combinations, industry

I.INTRODUCTION

In recent years, the share of polymer composite materials (PCM), which have high physical, mechanical and operational characteristics, has been growing rapidly in industry. Their application allows to obtain products with properties that even traditional materials do not possess.

The cost of manufacturing parts, compared with metals, is reduced due to a decrease in the share of machining and an increase in the utilization rate of the material. The mechanical properties of PCM can be adapted for a specific application by changing the location of the reinforcing elements

Composite materials with a polymer matrix based on carbon or carbon fiber are widely used in mechanical engineering. This material is characterized by high strength, elasticity and low density.

To date, the industry has identified the problem of improving the efficiency of machining by chip removal. During processing, there is a high consumption of the tool due to rapid wear, the operation of processing holes in the PCM and their structural combinations make up a significant part of the complexity of the assembly process and, accordingly, in the total cost of the product.

PCM are fundamentally different in structural structure, in the nature of achieving the required mechanical properties and production technology, which significantly complicates the choice of methods for connecting these materials to each other. The connection by the method of mounting fasteners in the machined holes of the products, from the above materials, in most cases is the only possible way to assemble them into the structure.

The analysis of literature data shows that the accuracy of the hole obtained by drilling is affected by the main technological parameters of the process, namely: cutting speed and feed, and a number of additional process parameters: lubrication, cooling, the mechanism of crushing and chip removal. The presence of lubrication and cooling improves the surface quality and accuracy of the holes and allows you to increase the cutting conditions in order to increase productivity. Chip removal, excluding its packing in the hole, also improves surface quality and hole accuracy. The most important, from the point of view of optimizing the process of drilling holes, are the cutting speed and feed, they will be considered as the main factors.

Due to the lack of evidence-based recommendations for choosing a drilling method and cutting modes, the productivity of the cutting process is not high, the durability period of tools, in particular drills, is also quite low. The quality of the hole during drilling, due to delamination at the entrance and exit of the drill, the packaging of the outgoing chips is very poor.

ISSN: 2350-0328
International Journal of Advanced Research in Science, Engineering and Technology
Vol. 6, Issue 11 , November 2019

The most acutely indicated features are manifested in the processing of drilling of non-technological holes in parts made of polymer composite materials (PCM).

The search for ways to increase productivity and improve quality when drilling non-technological holes in RMB, as well as the development of specific evidence-based recommendations on the method and technology of drilling are currently an urgent task.

II. RECOMMENDATIONS

Figure 1 shows the most characteristic types of non-technological types for drilling in PCM and the existing methods for processing recommendations.

Non-technological holes	Recommended Drilling Methods	Non-technological holes	Recommended Drilling Methods

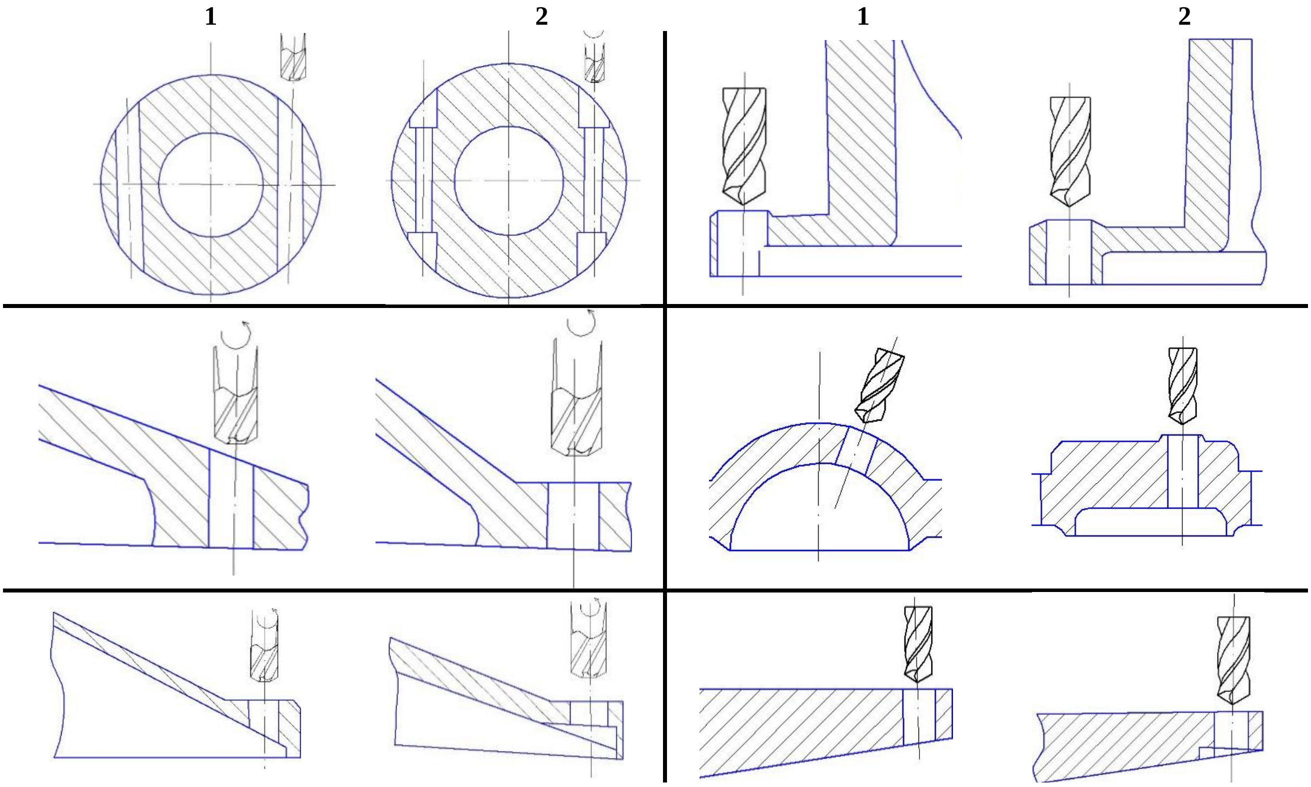


Fig. 1. Types of non-technological holes in parts made from PCM and recommended drilling methods

As can be seen from Fig. 1. the drilling process of non-technological holes is complicated due to the drift of the drill during cutting into the inclined and spherical surfaces of the part, which leads to a bending of the working part of the drill, which contributes to a sharp deterioration in the accuracy and quality of the holes, reducing the tool life.

Diameter errors (size and shape errors) of the hole in the PCM are most clearly manifested at the tool inlet. At the output of the tool, diameter errors are usually less. The reason for this kind of defects is usually an additional removal of material from the walls of the PCM hole at the drilling stage. Chip during the drilling process moves from bottom to top along the chip groove of the drill. Since the PCM polymer matrix has low hardness, the movement of the chips leads to undesirable "indentation and adhesion" of the material to the walls of the hole. Most often, this leads to hole shape errors with reduced quality.

Defects due to the PCM texture arise due to inconsistent chip formation conditions due to the anisotropic structure of the material. The occurrence of tearing of fibers and micro profile defects is a consequence of the action of cutting mechanisms. Defects at the exit of the tool from the hole are the result of the development of the fracture

ISSN: 2350-0328

International Journal of Advanced Research in Science, Engineering and Technology

Vol. 6, Issue 11 , November 2019

process in the area of the top of the drill when it leaves the PCM. The uncut fibers are the remnants of the PCM filler fiber remaining along the edge of the hole from the outlet side of the tool. Their formation is due to the orientation of the filler fibers in this area with respect to the velocity vector of the cutting edge in such a way that the moving cutting edge does not cut them, but crushes them. As a result, the remains of uncut wrinkled fibers are bent over the edge of the hole in the feed direction, and after the end of the cutting process, they partially restore their original shape. Defects at the outlet of the tool are caused by "peeling" of the material due to insufficient interlayer adhesion of the filler layers.

III. METHODOLOGY

With the considered method of drilling non-technological holes, and RMB. The conductor was fixed on the processed sample by means of two quick-detachable hubs. (Fig. 2) Which is the most widely used.

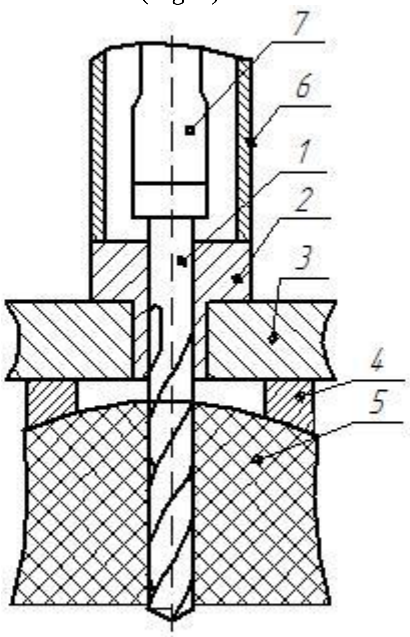


Fig. 2. A method of drilling non-technological holes.

In figure 2. the drill 1 is fixed in the spindle 7. The guide for the drill is the sleeve 2, which is installed in the nozzle 6.As can be seen from fig. 2 at present, for the implementation of the process of drilling of non-technological holes, it is necessary to manufacture special devices, use conductive bushings. Carry out preliminary preparation, perform an additional operation, which, of course, significantly increases the cost of the product.

This problem is most acute when the drill leaves the cutting zone. Since it is impossible to use special devices and the methods discussed above that use when drilling a drill.

In addition, the disadvantages of the known methods of drilling is also the low quality of the machined holes, the presence of chips and loosening of polymer composite materials, especially in the exit zone of the drill, the low resistance of the drill.

We propose a method for drilling non-technological holes according to which, the drill is informed of rotation and axial movement with adjustable feed and cutting speed when plunging, drilling a hole and the drill exit from the cutting zone. [3]

ISSN: 2350-0328
International Journal of Advanced Research in Science, Engineering and Technology
Vol. 6, Issue 11 , November 2019

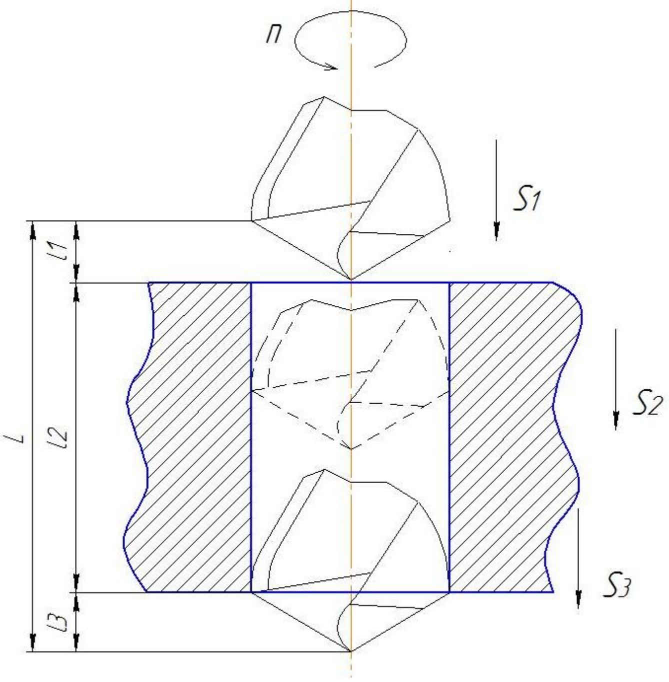


Fig. 3. Recommendations a method for drilling non-technological holes with a variable cutting speed and feed.

The proposed method is carried out in the following sequence. The drill rotates and axially moves, and during drilling, after a quick approach to the drill, the cutting speed and the feed rate of the drill change during insertion. After the cutting part of the drill enters the cutting zone, the feed and cutting speed are automatically adjusted in accordance with the recommendations for PCM drilling. Further, when the drill leaves the cutting zone, the feed rate and cutting speed are automatically adjusted again.

The effectiveness of the proposed method of drilling, in comparison with known methods is evaluated by the quality of the machined holes and the durability of the drill.

IV. EXPERIMENTAL RESULTS

The results of the studies showed that when processing non-technological holes with an adjustable feed and cutting speed, depending on the drilling process, chips and rafting are not observed, the quality of the machined holes, the drill resistance increased

Fig. 4 Sample for examining bundles and chip stacking.

As noted above, PCM drilling is the most difficult task due to the processing conditions that cause various requirements for cutting conditions and cutting tools.

The introduction of new methods for processing holes, the rational choice of cutting tools and cutting modes contribute to achieving the required quality of the holes, minimizing their cost, increasing the accuracy of the holes made of carbon fiber.

ISSN: 2350-0328
International Journal of Advanced Research in Science, Engineering and Technology
Vol. 6, Issue 11 , November 2019

Based on our theoretical and experimental studies, we have also developed a method and methodology for choosing rational cutting conditions when drilling holes in PCMs providing an increase in the quality, accuracy and productivity of the drilling process.

In order to prevent jamming of the falling and pressed chips from the cutting zone during drilling, for crushing them, we recommend periodically stopping the axial feed of the drill, which leads to separation into small parts of the chips, preventing jamming of the falling chips between the tool and the hole, and prevents chip compression.

This method of drilling polymer composite materials consists in the fact that the drill is informed of rotation and axial movement with periodic stopping of the axial movement of the drill for at least one revolution of the drill, which allows stabilizing the dynamic characteristics of the machining process and improving the quality of the holes being machined by crushing chips, elimination of compression during chip removal along the grooves of the drill, improvement of chip removal, especially when processing on automatic lines.

These signs are distinctive and significant, first used in drilling holes in the PCM and allow you to get a new technical result.

The effectiveness of the proposed method of drilling, in comparison with known analogues, was evaluated by the quality of the machined holes and the resistance of the drill. In addition, when processing products by known methods in the areas of exit of the drill from the work piece, chips and breaking up were visually detected.

The hole drilling operation was performed under the following processing modes: V = 7.5 m / min, S = 0.2 mm / rev; V = 7.5 m / min; S = 0.6 mm / rev; V = 12 m / min; S = 0.2 mm / rev; V = 12 m / min, S = 0.6 mm / rev. Coexistent technology provides for the modes V = 7 m / min, S = 0.1 mm / rev with a periodic output of the drill to remove chips. In the processing process, the nature of chip formation and the degree of its packaging were determined. After the drilling process was completed, using the MIM microscope, the dimensions of the bundles were determined as the maximum damaged diameter relative to the nominal diameter of the holes. The resulting defect sizes were compared with the size of the delamination's in the conventional drilling method. The surface roughness of the machined hole was determined in a similar way using. The wear of the drill was assessed after completion of processing the entire series of holes using an instrumental microscope.

According to the test results, it was established that the application of the proposed method of drilling with a periodic oston tool due to better crushing and evacuation of the chips from the cutting zone and reducing the degree of its packing allows to reduce the size of delamination to 0.3-0.6 mm against 1.05-1.3 mm with the existing drilling method. The roughness is reduced from Ra 7-8.5 microns to Ra 5.5-6.2 microns.

Thus, when processing with a periodic stop of the axial movement of the drill, these types of defects are absent, which provides an increase in the resistance of the drill and the quality of the machined holes.

Further testing consisted of sequential through hole machining.

at fixed cutting conditions v = 8.8 m / min, s = 0.050 mm / rev. Purpose

The test was a comparison of drilling methods for the durability and quality of the resulting holes.

The hole diameters were measured in one central section. The graph (Fig. 5) shows the deviations of the diameters of the holes from the diameter of the drill.

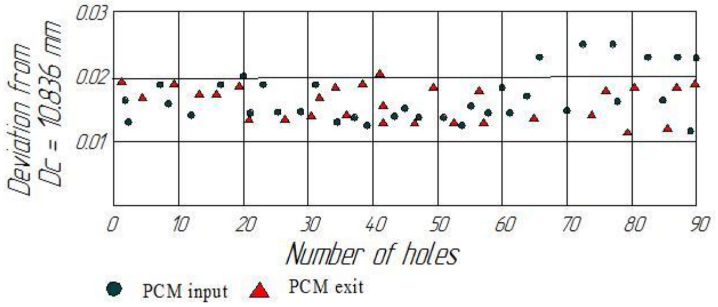


Figure 5 - Hole diameters (drill type 1, Ø13.973 mm, v = 8.8 m / min, s = 0.050 mm / rev)

The degree of conformity of the diameters of the holes to the established tolerance was estimated by comparison. The target value corresponds to a rejection probability of 0.27%. To calculate the sigma level, we used the tolerance for the manufacture of holes adjusted by the tolerance for the manufacture of the tool and its wear. The corrected tolerance T was 30 mkm.

Statistical data on the diameters of the holes obtained by different drilling methods are summarized in table 1.

ISSN: 2350-0328
International Journal of Advanced Research in Science, Engineering and Technology
Vol. 6, Issue 11 , November 2019

Table 1
Hole Diameter Statistics

Drill	Number of machined holes	The average deviation of the diameters of the holes, mm	Standard deviation δ, mm
Existing method	10	D_c+0.016	0.0035
	20	D_c+0.015	0.008
	30	D_c+0.014	0.0086
The proposed method	10	D_c+0.009	0.005
	20	D_c+0.008	0.006
	30	D_c+0.007	0.007

According to the results of experimental tests with the existing method with a resistance of 20 holes ensures the stability of the diameters of the holes at the level of marriage less than 0.27%. The range of variation in hole diameters is 26 μm, with a maximum permissible value of 30 μm, which corresponds to hole processing of the 9th accuracy class.

The hole roughness parameter Ra was measured using a profilometer. Graphs reflecting the change in the roughness of the walls of the number of machined holes are shown in the figures.

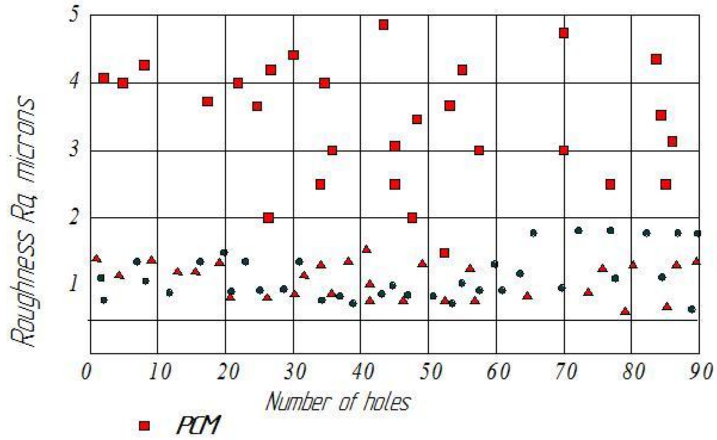


Figure 7 - Roughness of the holes (drill type 1, Ø10.973 mm, v = 8.8 m / min, s = 0.050 mm / rev)

We will evaluate the degree of conformity of the roughness to the established tolerance by comparing the average values for different tool life (10, 20, 30 holes). An additional evaluation parameter will be the maximum roughness value.

The hole roughness statistics are summarized in Table 2. The Type 1 Combined Drill provides the best roughness in a titanium alloy. After processing 30 holes, the roughness does not exceed Ra1.31, the average value is Ra0.63-0.71. The average roughness in the PCM is Ra3.64, the maximum value of Ra 4.98 among the 30 machined holes.

Table 2
Roughness Statistics

Drill	Number of machined holes	Ra, mkm	
		Medium	Maximum
Existing method	10	2,6	2,56
	20	3,1	3,38
	30	3,96	4,68
Theproposed method	10	3,05	4,05
	20	2,55	3,86
	30	2,7	2,35

The proposed drilling method provides the best roughness in PCM.

If, during processing, SOTS and air fall into the cutting zone, then when drilling in the existing way, SOTS and air fly into the surrounding space and do not fall into the cutting zone.

Successful pilot tests of the proposed method allowed to launch them in production

ISSN: 2350-0328

International Journal of Advanced Research in Science, Engineering and Technology

Vol. 6, Issue 11 , November 2019

REFERENCES

[1] Stepanov A.A. Cutting by high-strength composite polymer materials. - L.Engineering, Leningrad. Department, 1987, p. 100

[2] Dudarev A.S., Svishchev V.I. (RU) A method for drilling polymer composite materials. RF patent No. 2044170.

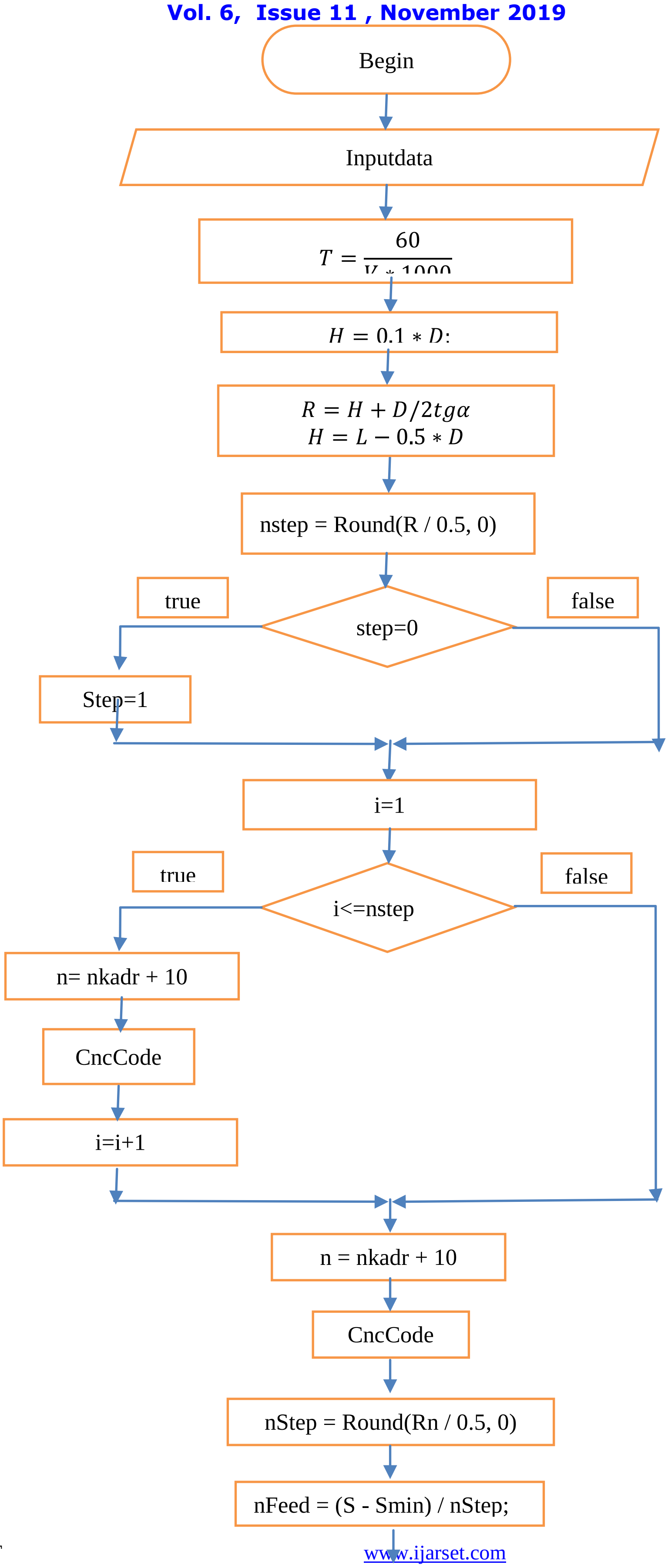
[3] Fayzimatov BN, KhusanovYu.Yu., FayzimatovSh.N. The software product of the method of regulating the feed at the entrance and exit of the drill from the cutting zone, which allows improving the quality of the holes in parts made of polymer composite materials // State Patent Office of the Republic of Uzbekistan. Certificate No. DGU 0887. 07/27/2019

[4] KhusanovYu.Yu. Ways to increase the efficiency of plastics and the quality of products. Scientific and Technical Journal, Fergana Polytechnic Institute. Fergana, 2019, Volume 23 №1

AUTHOR'S BIOGRAPHY

Yunusali Khusanov

Teacher; Mechanical Engineering and Automation Department, Ferghana Polytechnic Institute, 86, Ferghana street, Ferghana city, Uzbekistan.


Begin
Inputdata
T = 60
H = 0.1 * D:
R = H + D/2tgα
H = L − 0.5 * D
nstep = Round(R / 0.5, 0)
true
step=0
false
Step=1
i=1
true
i<=nstep
false
n= nkadr + 10
CncCode
i=i+1
n = nkadr + 10
CncCode
nStep = Round(Rn / 0.5, 0)
nFeed = (S - Smin) / nStep;

ISSN: 2350-0328
International Journal of Advanced Research in Science, Engineering and Technology
Vol. 6, Issue 11 , November 2019