The American Journal of Engineering and Technology
(ISSN – 2689-0984)
Published: February 12, 2021 | **Pages:** 22-30
Doi: https://doi.org/10.37547/tajet/Volume03Issue02-04

IMPACT FACTOR
2021: 5. 705
OCLC - 1121105677

Optimization Conditions Of Drilling Polymeric Composite Materials

Sh.N. Fayzimatov
Doctor Of Technical Sciences Fergana Polytechnic Institute Professor Of The Department" Machine-Building Technology And Automation", Fergana Polytechnic Institute, Uzbekistan

Y.Y. Xusanov
Doctor Of Philosophy In Technical Sciences (PhD), Senior Lecturer, Department Of "Machine-Building Technology And Automation", Fergana Polytechnic Institute, Uzbekistan

D.A. Valixonov
Assistant, Department Of "Drawing Geometry And Engineering Graphics", Fergana Polytechnic Institute, Uzbekistan

ABSTRACT

The article discusses the issues of improving productivity and quality when drilling non-technological holes in polymer composite materials. Systematization of non-technological holes was carried out, promising methods of drilling with varying cutting modes when inserting and entering the drill were developed and introduced into production, as well as a method of grinding outgoing chips and removing it and the cutting zone.

KEYWORDS

Speed, feed, quality, polymer, hole, drill.

INTRODUCTION

Polymer composite materials (PCMs) are the most challenging task due to the processing conditions that determine different requirements for cutting conditions and cutting tools.

In order to determine the optimal drilling conditions for polymer composite materials (PCM), the authors studied the process of drilling holes Ø10 mm deep 30 mm in parts made of carbon fiber materials.

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

THE MAIN FINDINGS AND RESULTS

We have proposed a method for drilling holes [4, 5] according to which rotation and axial movement with adjustable feed and cutting speed during plunge-cutting, hole drilling and drill exit from the cutting zone are communicated to the drill.

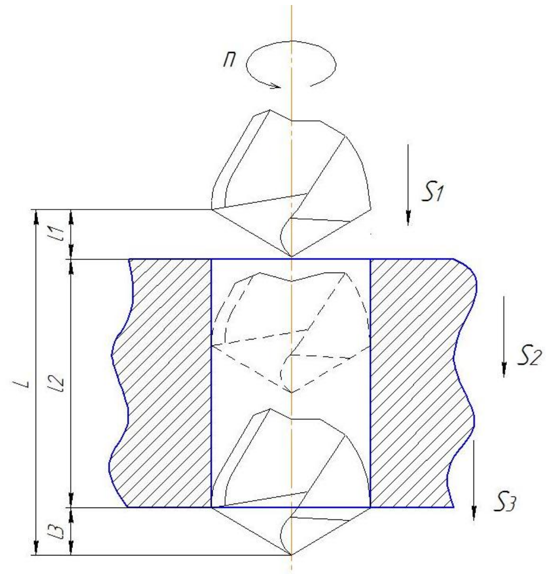


Fig. 1. Recommendations method of drilling holes with variable cutting speed and feed

The proposed method is carried out in the following sequence. The drill makes rotational and axial movement and in the process of drilling after the rapid advance of the drill during plunge-in, the cutting speed and the amount of drill feed change. After the cutting part of the drill enters the cutting zone, the feed and cutting speed is 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. (fig 1)

In order to prevent jamming of the coming and pressed chips from the cutting zone, during the drilling process, for their crushing it is proposed to periodically stop the axial feed of the drill, which will lead to separation into small parts of the chips, preventing jamming of the coming off chips between the tool and the hole, prevents pressed chips (Fig. 2) [6].

IMPACT FACTOR
2021: 5. 705
OCLC - 1121105677

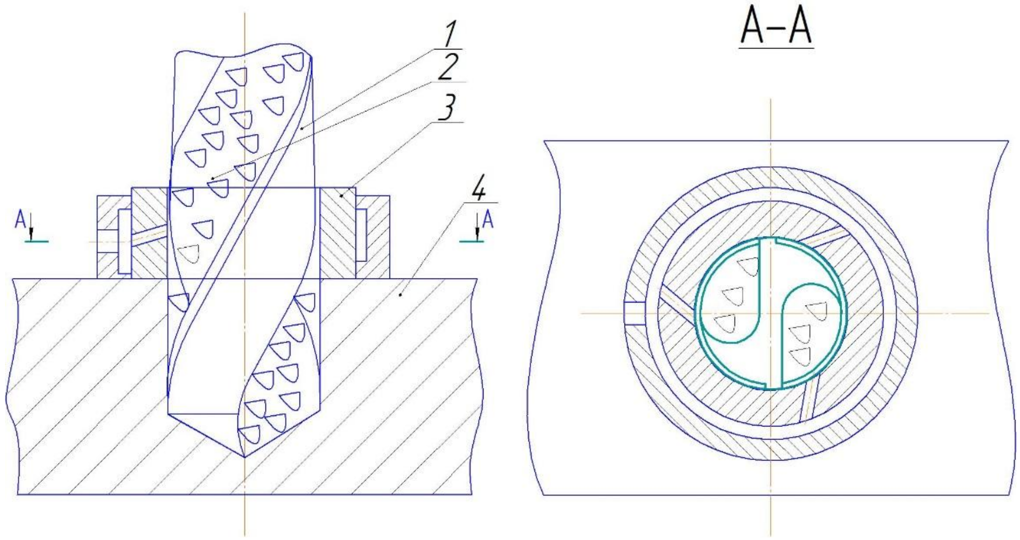


Fig. 2. The design scheme of the device aerodynamic action

1-drill, 2-shavings, 3-hole device, 4-part (PCM)

This method of drilling polymer composite materials consists in the fact that the drill is given rotation and axial movement with periodic stopping of the axial movement of the drill, at least for one revolution of the drill, which allows stabilizing the dynamic characteristics of the machining process, improving the quality of the holes being machined due to crushing chips, exceptions from pressing when removing chips along the grooves of the drill, improving the removal of chips, especially when processing on automatic lines [4,5].

The efficiency of the proposed method of drilling, in comparison with the known analogues, was assessed by the quality of the machined holes and the durability of the drill. In addition, when processing products by known methods in the zones of the drill exit from the workpiece, chips and fraying were even visually detected.

The operation of drilling holes was performed under the following processing modes: V = 7.5 m / s, S = 0.2 mm / rev; V = 7.5 m / s, S = 0.6 mm / rev; V = 12 m / s, S = 0.2 mm / rev; V = 12 m / s, S = 0.6 mm / rev.

In the process of processing, the nature of chip formation and the degree of its packing were determined. After the completion of the drilling process, using an MIM microscope, the dimensions of the delamination were determined as the maximum damaged diameter relative to the nominal diameter of the holes. The resulting defect sizes were compared with the magnitude of delamination with the traditional drilling method. The roughness of the surface of the machined hole was determined by the contact method using a profilometer. Drill wear was assessed after completing the entire series of holes using an instrumental microscope

Published: February 12, 2021 | Pages: 22-30
Doi: https://doi.org/10.37547/tajet/Volume03Issue02-04
IMPACT FACTOR
2021: 5. 705
OCLC - 1121105677

Experiment planning methods are most effective for studying complex technical systems. The main task of experiment planning is to obtain the maximum data about the system with the minimum number of experiments. The essence of experiment planning allows you to simultaneously vary all the factors affecting the process under study.

In the present study, a 3-level factorial design was used with two main factors and with the number of experiments equal to N = 9, with the number of repetitions of n = 3. (Fig. 3) The use of such a plan will reveal linear and quadratic effects for all factors, as well as the effects of interactions of the main factors. The plan was built using the software Statistica 7 [1].

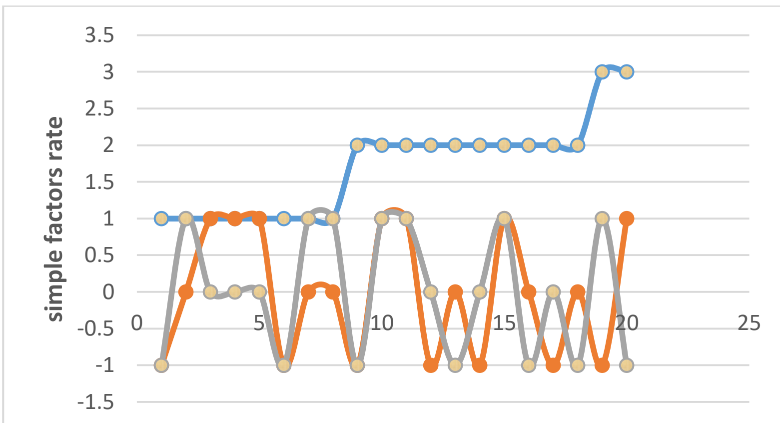


Figure 3. Factorial design matrix

Cutting speed and feed have a significant impact on the process of forming the microgeometry of the hole to be machined and on its accuracy. The depth of cut for drilling is constant.

In the classical version, the search for a multivariate analysis of variance model is carried out in two stages: the least squares method and the maximum likelihood method.

At the first stage of the search for regression equations, we use the least squares method [1].

Variable technological parameters of the experiment are cutting speed and feed, an additional parameter is the "state of the cutting tool", expressed in the influence of the cutting length. Figure 4 shows the levels of factors of the experimental design.

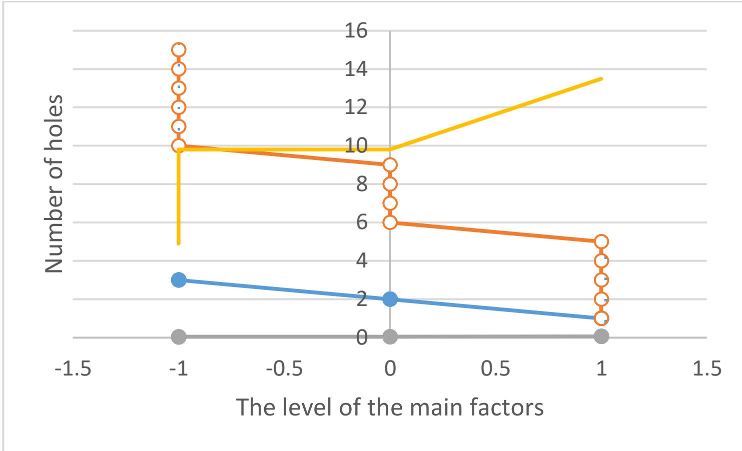


Figure 4. Levels of plan factors

Taking into account the recommendations for the appointment of cutting conditions, values of not more than 0.06 mm / rev can be considered with the range of permissible feeds. The range of feeds provided in this range includes values of 0.025; 0.03; 0.05 mm / rev, which have been validated as feed factor levels. The range of spindle speed levels is wider. For a drilling diameter of 10 mm, this row corresponds to the next row of cutting speeds. The speed of 13.2 m / min was chosen as the upper level of the factor, 4.2 m / min as the lower level, and the value closest to the average between the upper and lower levels - 10.2 m / min as the middle level.

The average value was determined from the four fixed roughness values, which was subsequently used for all calculations. The measurement of roughness in polymer composite materials (PCM) by the contact method does not allow obtaining an informative picture, since PCM surface after machining is significantly different from metal. It is a set of microexplosions of fibers, into which the stylus, even with a minimum radius, may not fall due to their depth, as well as uncut fibers, which the stylus will bend and push apart during measurement. The optical measurement method is devoid of these disadvantages шероховатости, т.к. в процессе измерения нет прямого контакта с образцом. Шероховатость в ПКМ контролировалась by optical interference microscopy on a Bruker ContourGT-K1 profilometer.

According to the test results, it was found that the use of the proposed method of drilling with periodic stopping of the tool due to better crushing and evacuation of chips from the cutting zone and a decrease in the degree of its stacking allows reducing the size of delamination to 0.3-0.6 mm versus 1.05-1.3 mm with the existing method of drilling. Roughness is reduced from Ra 7-8.5 μm to Ra 5.5-6.2 μm. [4]

There is no effect of feed on Ra, but cutting speed has a significant effect. With an increase in cutting speed, the roughness decreases, since a more dynamic cutting process promotes clean cutting of PCM fibers.

The American Journal of Engineering and Technology
(ISSN – 2689-0984)
Published: February 12, 2021 | Pages: 22-30
Doi: https://doi.org/10.37547/tajet/Volume03Issue02-04

IMPACT FACTOR
2021: 5. 705
OCLC - 1121105677

The maximum roughness value is observed at the maximum feed s = 0.055 mm / min and the minimum speed v = 6.33 m / min, as well as at the maximum speed v = 13.1 m / min and the minimum feed s = 0.031 mm / rev. The area of minimum response values lies in the area of average values of speeds, while the influence of the feed for the first layer is absent, for the second is minimal. The response surface for the deviation of the profile of the longitudinal section shows that the maximum is observed at the maximum values of the feed s = 0.055 mm / min and the cutting speed v = 13.1 m / min, the minimum corresponds to the combination of the maximum speed v = 13.1 m / min and the minimum feed s = 0.031 mm / min, which is consistent with the prevailing ideas about PCM cutting (maximum speed, minimum feed).

Further tests consisted of sequential processing of through holes at fixed cutting conditions v = 8.8 m / min, s = 0.050 mm / rev. The purpose of the tests was to compare drilling methods in terms of durability and quality of the holes obtained [11].

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

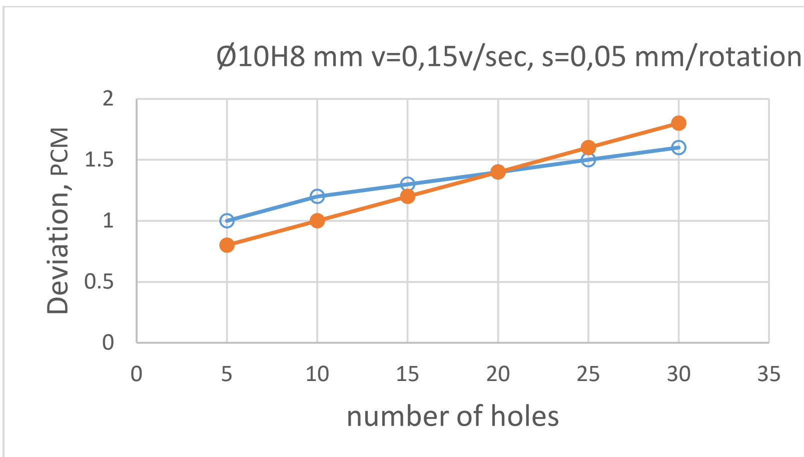
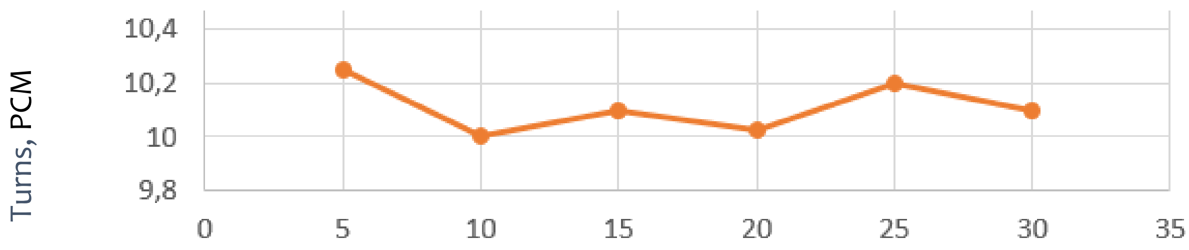


Figure 5-Influence of the number of drilled holes on the amount of deviations

According to the results of pilot tests, when drilling, the stability of hole diameters at a level of less than 0.27% is ensured. The range of variation of hole diameters is 26 microns, with a maximum allowable value of 30 microns, which corresponds to the processing of holes of the 9th grade of accuracy.

The proposed drilling method provides the best roughness in PCM.

Deviations of cylindricity from the factors of cutting speed, feed, drilling length could not be found. The intervals of variation of deviations from the roundness of the hole in are shown in Figure 6.



Number of holes, pcs

Figure 6 - deviation of hole diameters from the diameter of the drill

Correspondence of hole surface roughness to tolerances is one of the main criteria for their quality. Roughness affects the durability, fatigue strength and corrosion resistance of mating parts. The microrelief of holes in a PCM is difficult to study and predict.

The coefficients of determination for RaPKM are 0.95, respectively; 0.43; 0.78. The PCM cutting mechanism is less predictable than the metal cutting mechanism. This is due to the structural features of the composite material and the anisotropy of its properties. Roughness parameters Ra are presented in figures 7, respectively.

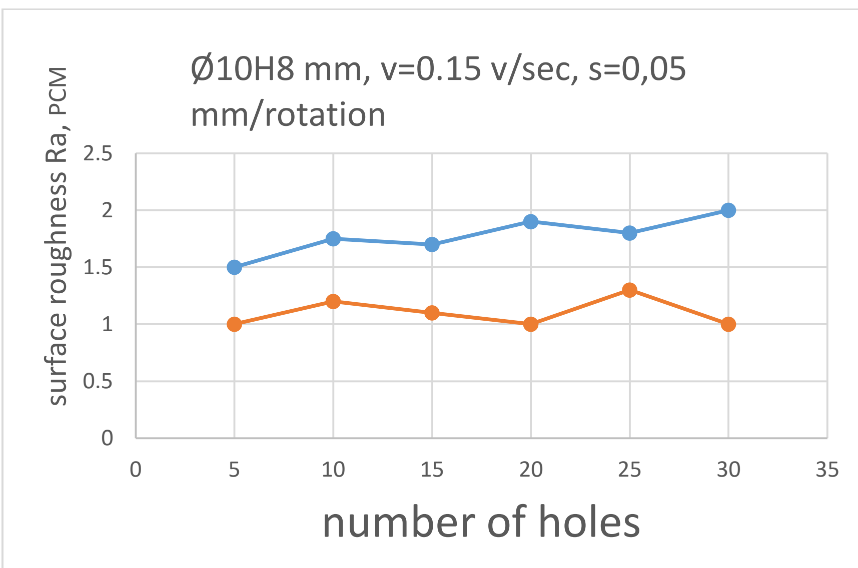


Figure 7 – Rougness change in PCM Ra

CONCLUSION

1. The minimum deviation of the profile of the longitudinal section corresponds to

   the feed s = 0.023 mm / rev and the cutting speed v = 10.18 m / min. If it is necessary to increase productivity with minimal impact on profile deviation, an increase in feed should be considered.
2. The diameter of the longitudinal section of the PCM hole practically does not change, but in the sections close to the drill exit, a slight increase in the diameter is observed.
3. No deviations from the roundness of the cutting speed, feed and drill length were found.
4. The most significant factors affecting hole accuracy parameters are speed and feed. The dominant factor affecting the surface quality in PCM holes is the cutting speed, an increase in which is accompanied by a decrease in roughness.
5. The method of adjusting the feed at the entry and exit of the drill from the cutting zone improves the quality of the hole in the parts made of polymer composite materials.
6. The method of obtaining chips with a predetermined length, which is achieved by communicating the rotation with periodically stopping the axial movement of the drill during one revolution, makes it possible to increase productivity by 1.4 times, and improve the drilling surface roughness by 20%

REFERENCES

1. Draper N.R. Applied regression analysis / N.R. Draper, G. Smith. M .: Williams, 2007.912 p.
2. Sheffe G. Analysis of variance / per. from English. Moscow: Fizmattiz, 1980.628 p.
3. Fayzimatov B.N. Fayzimatov Sh.N., Khusanov Yu.Yu. Ulukhozhaev R.S. Shokirov A.Kh. “The software product of the method for regulating the feed at the entry and exit of the drill from the cutting zone, which allows to improve the quality of the hole in parts made of polymer composite materials” // Certificate of official registration of the program for electronic computers No. DGU 06970, 30.09.2019
4. Fayzimatov B.N. Fayzimatov Sh.N., Khusanov Yu.Yu. Shokirov A.Kh. “Software product of the method of obtaining chips with a predetermined length during drilling for machine tools by program control” // Certificate of official registration of the program for electronic computers No. DGU 07520, 20.01.2020
5. Fayzimatov Sh.N., Fayzimatov B.N., Khusanov Yu.Yu. “Perspective drilling methods, non-technological holees in polymeric composite materials” // International Journal of Emerging Technology and Advanced Engineering Volume 6, Issue 11, November 2019, – P. 11681-11689. (05.00.00; №9)
6. B.N.Fayzimatov, Sh.N.Fayzimatov, Yu.Yu.Husanov. International Journal of Engineering Research and Technology. ISSN 0974-3154, Volume 13, Number 12 (2020), pp. 4823-4831 © International Research Publication House. http://www.irphouse.com
7. Усманов Джасур Аминджанович, Холмурзаев Абдирасул Абдулахатович, Умарова Мунаввар Омонбековна, & Валихонов Достонбек Аъзим Угли (2019). Исследование формы

Published: February 12, 2021 | **Pages:** 22-30
Doi: https://doi.org/10.37547/tajet/Volume03Issue02-04

IMPACT FACTOR
2021: 5. 705
OCLC - 1121105677

сороудалительной сетки колково-барабанного очистителя хлопка-сырца. Проблемы современной науки и образования, (12-1 (145)), 35-37.

8. ACADEMICIA: An International Multidisciplinary Research Journal. 2020,10,5.(95-99).Online ISSN : 2249-7137.DOI : 10.5958/2249-7137.2020.00225.6.Using gaming technologies in engineering graphics lessons. Dostonbek Valikhonov, Saydullo Arziev. Department of Descriptive Geometry and Engineering Graphics, Fergana Polytechnic Institute, Fergana, Uzbekistan