

BASICS OF AUTOMATION OF PROFILING OF HIGH-EFFICIENT INSERTS OF THE TOOL FOR THREAD MACHINING

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ABSTRACT

Many modern threaded joints, especially in the oil and gas industry, must satisfy high requirements for steel mechanical properties of which they are made. To ensure efficient threading of such hard-to-machine materials (ultimate strength is more than 1250 MPa), it is necessary to use carbide cutting inserts with the negative rake angle at its corner. However, modern manufacturers of such inserts make them only with a zero value of the rake angle. This is due to the difficulty of profiling of the insert cutting edge. This article proposes the basics of such inserts automatic profiling which is based on the

algorithm developed by the authors. It includes two corrective calculations of the insert cutting edge profile, namely: the radial displacement of the corner and the tangential displacement of the area forming the crest of the thread. As a result, the computer application with the input parameter of the rake angle and output parameter of the upgraded profile of the insert cutting edge is received.

Keywords: profile of the cutting edge, negative rake angle, machining of thread

INTRODUCTION

The problem of lathe threading tool profiling at present time due to the application of a non-zero value of the back-rake angle at the tool nose of the cutter first of all refers to thread with significant requirements for the accuracy of their profile. Those types of thread are widely used in oil and gas drilling industry. For those tapered threads, the accuracy of the half profile angle is 0.5° (figure 1a).

Nowadays, there are not any tools with nonzero of the back rake at the tool nose, used for machining of the thread. It can be explained in that way: it is very difficult to calculate the profile of the cutting edge of the lathe machining tool. It means that thread profile (figure 1a) is equal to the common cutting tool profile (figure 1b). To be more successful drill string pipes must be manufactured from hard material with (ultimate strength is more than 1250 MPa). So, it needs to use for machining of their pipe thread the new tools—with modern high efficiency turning inserts. The other way of receiving of more successful drilling operation is to use the tools with nonzero back-rake angle on their

nose. But this one needs the using of the modernized turning insert profile to ensure the true accuracy of the thread profile. It is very important for this to have the negative back-rake value (Kopei, Onysko, &

Panchuk, 2019).

So, the urgent task is calculating of the tool cutting edge profile for cutters with a non-zero value of the back-rake angle and true designed other parameters.

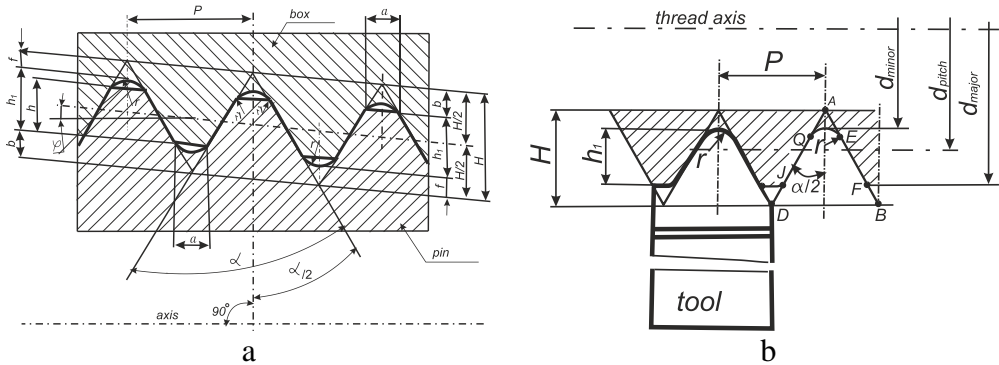


Figure 1. Sketch of Tool-Joint tapered thread according to standard API 7. Parameters of the tool joint tapered thread according to standard API 7: P – pitch, H - theoretical thread height, h_1 - work height, φ - work height, b - crest truncation, f - root truncation, h - thread height truncated, a - crest flat width, r - root flat corner radius, α - profile angle

MATERIAL AND METHODS OF WORK

For success solving of the tusk of the cutting-edge automatic profiling we must should consider the model of the manufacturing of thread using lathe machine tool. As the lathe threading tool has simple common design: with zero value

of the back rake that cone surface will be obtained. That model is demonstrated on fig. 2a. Other model is shown on figure 2b where the tool has nonzero back rake value that is the reason of receiving surface of hyperboloid of revolution (Medvid et al. (Eds.), 2019)

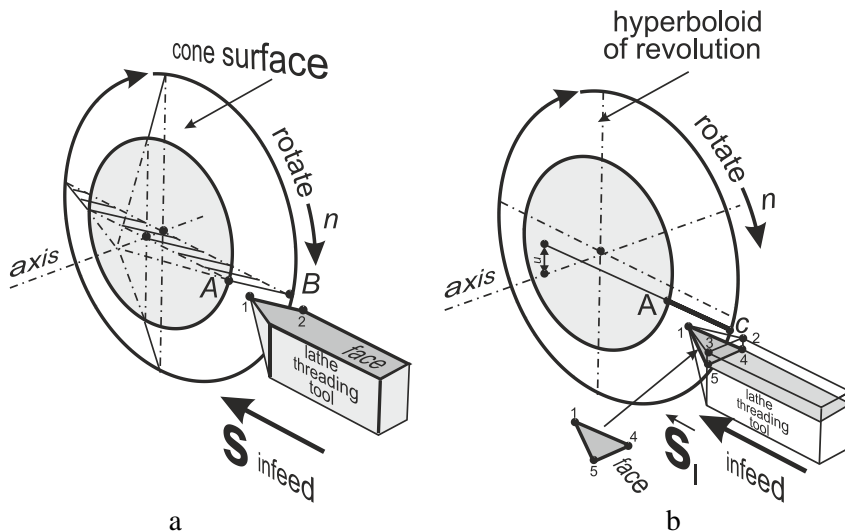


Figure 2. Schemas of threading by lathe tool with zero (a) and nonzero back rake angle (b)

So, the improving of the model *a* leads to obtain the no standard thread screw surface - the convolute helicoid (figure 3b). We must take into account that increasing of cutting ability depends on not only the material of the turning insert but on its accurate profile (figure 3a) appointed to provide the accuracy of the thread profile. As a result, the task of the cutting-edge profiling has such input parameters: the

accuracy of standard thread surface, and the value of the rake angle but there is once more needed tool geometric parameter for efficient machining of the thread – cutting edge inclination.

This parameter is necessary for providing the equality of wear resistance two sides of cutting edge: left (between points 6 and 1) and right (between points 4 and 1).

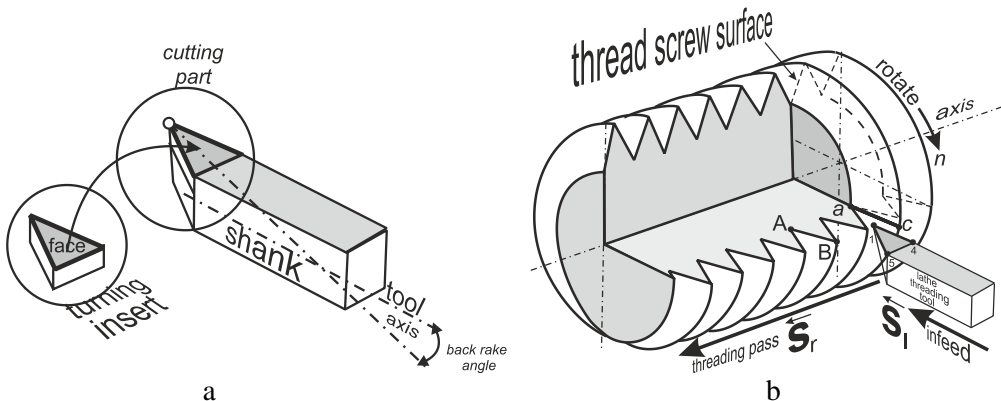


Figure 3. Schema of lathe tool with turning insert (a) and threading using it (b)

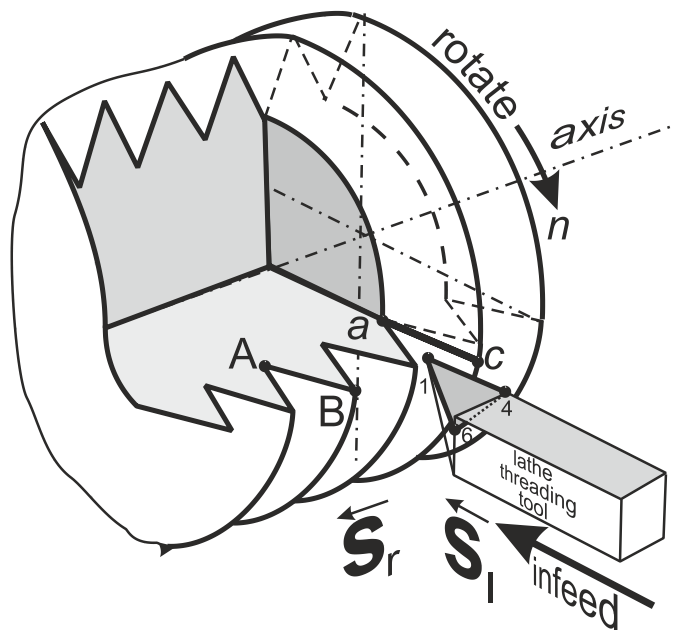


Figure 4. Schema of threading by lathe tool with nonzero cutting edge inclination.

For true complete of input parameters, it is necessary to take into account the value of the thread diameter. It is important for defining of the radial and axis deviations of tool profile relatively to thread profile. Methods of that ones are demonstrated on figure 5 (Medvid, Onysko, Pituley, Shuliar, & Havryliv, 2019).

So, the manufacturing precision of the thread profile angle depend on the two geometric parameters: back rake angle and cutting-edge inclination. But only one of them influence on the axial deviation – back rake angle. (Medvid et al., 2019). The radial deviations depend on both of them (Panchuk, Onysko, & Medvid, 2018).

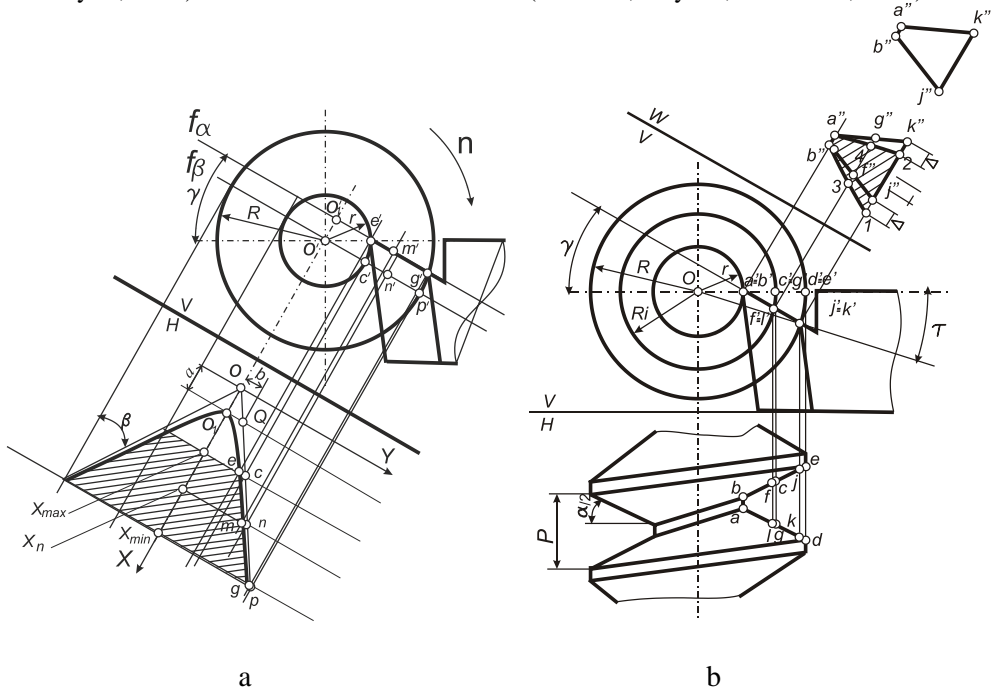


Figure 5. Schema of the defining of the radial (a) and axial (b) deviations of the tool cutting edge profile

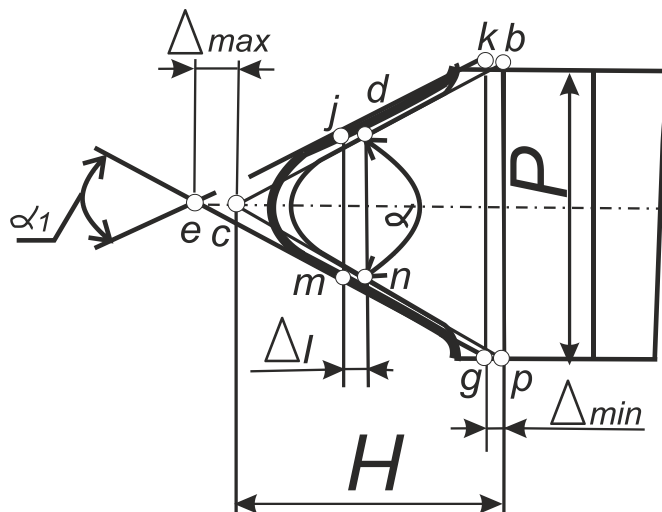


Figure 6. Schema of maximum and minimum radial deviation of the cutting edge profile

Nowadays there are tool profile research works that take to considerate only one of deviations types. A few of them deal with the radial one only (Kopei, Onysko, & Panchuk, 2018), (Kopei, et al., 2019). Axis deviation is taken ad the input parameter in one paper (Medvid, et al., 2019).

RESULTS AND DISCUSSION

The union two those programs of the cutting-edge profile calculate is the own task of modern lathe threading tool design. In the result of using of this one the program gives us the nonsymmetrical profile, because the axial deviation influence $\Delta_{\max \text{ axis}}$ is in it (figure 7a, 7b).

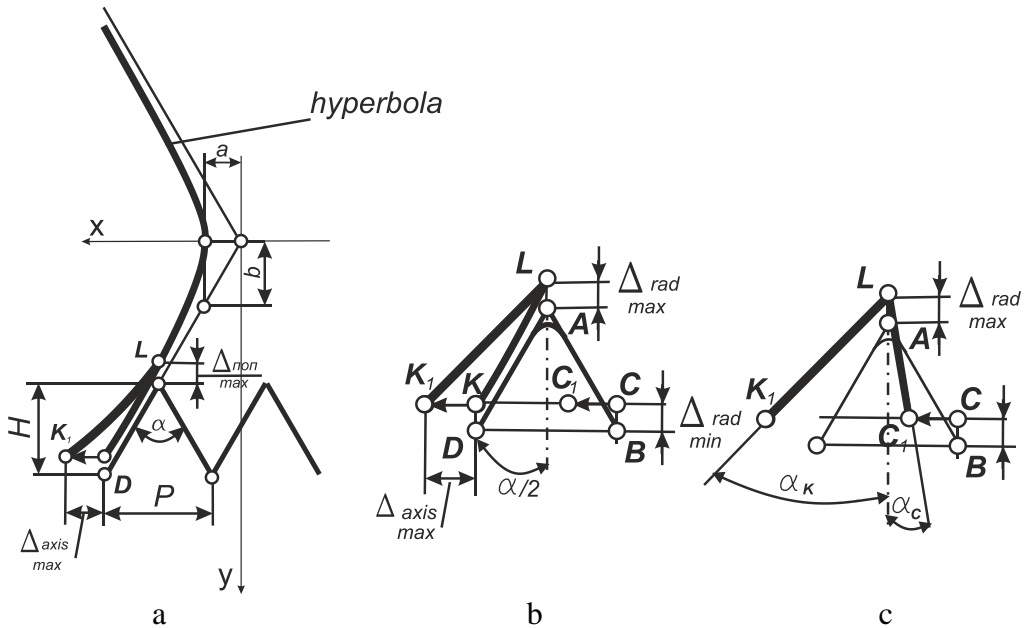


Figure 7. Schema of the obtaining of the nonsymmetrical cutting edge profile

The tool profile includes:

- maximum radial deviation (fig. 7 a,b,c);
- minimum radial deviation (fig. 7 b,c) ;
- right flank angle α_k (fig. 7,c);
- left flank angle α_c (fig. 7,c).

Last two parameters are the functionally depend on the axial and radial deviations. So, we have to build the base of input parameter and we already know about

complete output ones. Besides it, there is necessary to consider in the deviation of the tool installation. It includes:

- tangential deviation;
- radial deviation;
- axial deviation (fig.8).

So, all necessary parameters and elements are including to bases of automate profiling of the lathe threading tool (fig.8).

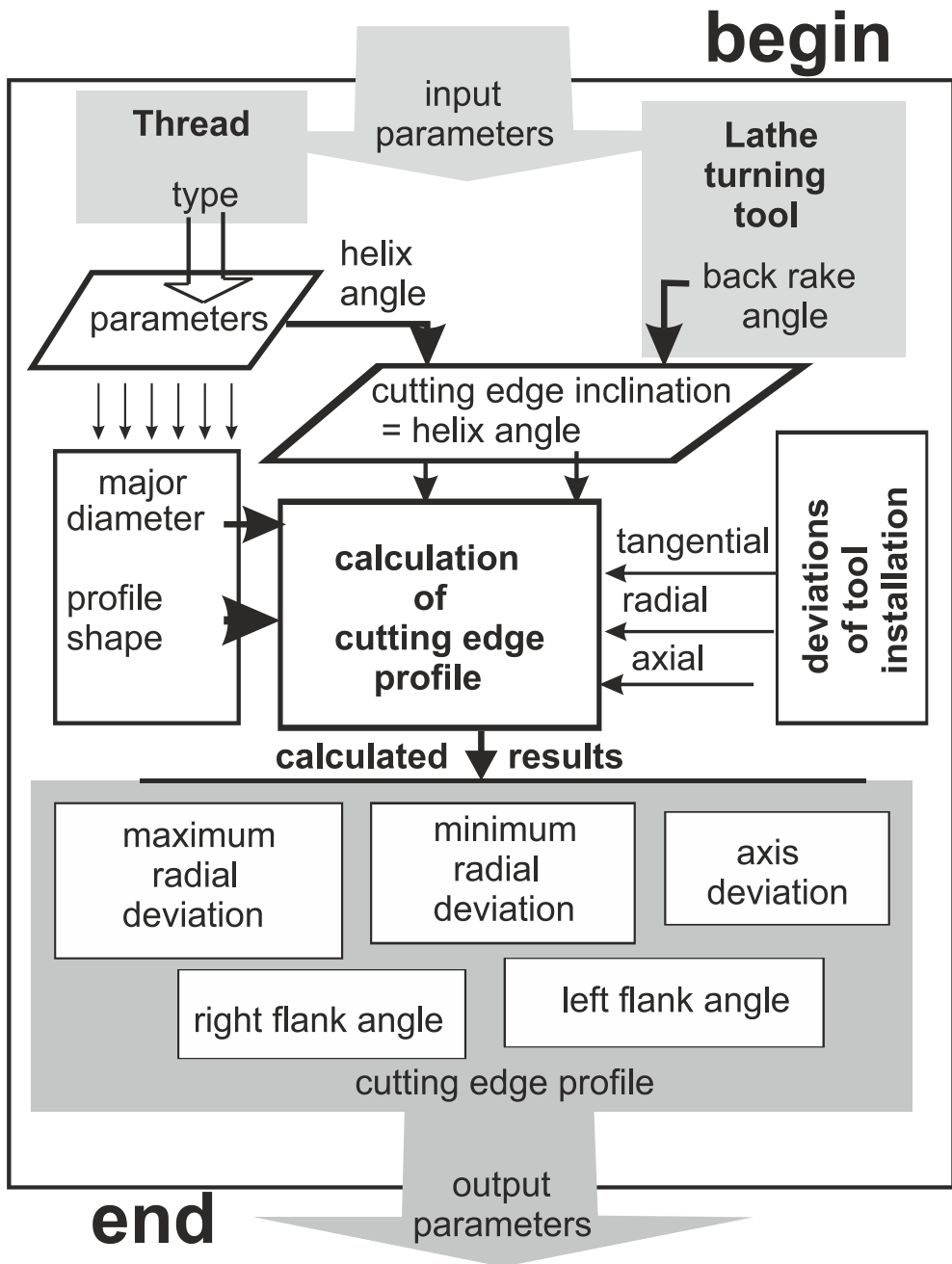


Figure 8. Schema of the own necessary elements for automation of the cutting edge profiling of the lathe threading tool

CONCLUSIONS

In the article the basics of automation of profiling of high-efficient inserts of the tool for thread machining are considered. Input automation program parameters

include main thread parameters and lathe turning tool parameters. The deviations of the tool installation are included to the program too.

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