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THE ADVANCED AUTOROTATION TOOL FOR PLANING

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Abstract: *Progressive machining configurations include also the machining with rotary tools, which motion is derived from interaction forces result from machining process.*
This review introduce theoretical starting points, which is very important for derivation formulae, for work geometry of rotary plane tool.
At near derivation formulae for determination work geometry tool, is utilise method gradual project vector of motion. This derivation formulae is utilise for design of construction of plane tool. In this review is design of construction plane tool which utilise principle rotary of cutting part.
Keywords: *Autorotary tool, Tool angle, Construction of Plane Tool, Tool – in –use System, Planing*

1. Geometry of cutting part of rotary tool

Arbitrary point of cutting part tool exert this motions :

- motion of feed with speed – v_f
- cutting speed v
- motion of cutting part round axis - v_a

Basic formulae for determination work geometry tools :

$$\gamma_e = \gamma_n - \sigma$$

$$tg\alpha_e = tg(\alpha_n + \sigma).\cos\lambda_{se}$$

where:
γ_e – working orthogonal rake
γ_n – tool normal rake
σ – auxiliary angle for calculation
α_e – working orthogonal clearance
α_n – tool normal clearance
λ_{se} – working tool cutting edge inclination

Angle and too work angle of inclination cutting part - , were derivation according to of common method of determination work angles [2]. Essence of method reside in that geometry parameters we can obtain gradual project vectors of motion tool.

Object of analysis is search of course vector w which is vector of resultant speed machining process. Vector w, we can determine than resulting of components w_N and w_T. (fig. 2).

The differences are significant that is why tool angles cannot be determined for the physical processes located in machining zone and contact surfaces of tool.

Equations for working geometry of planing tool [1] were calculated by using the method of step by step projection of movement vectors.

$$tg\sigma = \frac{v.\sin\lambda_s.\sin\psi}{v.\cos\lambda_s} = tg\lambda_s.\sin\psi$$

$$tg\lambda_{se} = \frac{(\xi - \sin\lambda_s.\cos\psi).\cos\sigma}{\cos\lambda_s}$$

This calculated equations are valid too for a negative tool cutting edge inclination λ_s. If angle tool cutting edge inclination is negative thus cutting edge change course of rotary.
For angle σ are valid :

$$tg\sigma = \pm tg\lambda_s.\sin\psi$$

$$tg\lambda_{se} = \pm\frac{(\xi - \sin\lambda_s.\cos\psi).\cos\sigma}{\cos\lambda_s}$$

Negative sign is valid for negative angle cutting edge inclination λ_s.
Angle of touch – ψ (fig.1) of point cutting we can determined according to of formula:

$$\cos\psi = \frac{R_n - a_p}{R_n} = 1 - \frac{a_p}{R_n}$$

where :
$v_n = \xi.v_c$
and coefficient ξ: ξ:= $\sin\lambda_s$

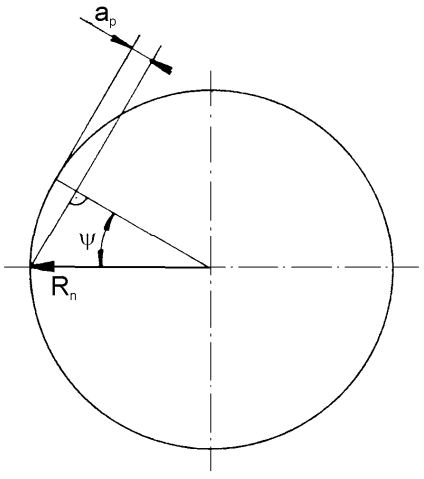

Fig.1 Scheme for calculated angle ψ

2. Analysis of geometry cutting edge of rotary planing tool which is adjust with double angle inclination cutting edge

From of theoretical analysis of work geometry tool of turning [3] result that for work of tool is good and suitable planing tool lean steel in plane perpendicular to axis of workpiece.

So we are obtain tool with double cutting edge inclination (λ_s ; and Θ)

where:

λ_s – a tool cutting edge inclination

Θ - angle inclination of tool in back plane

From fig. 2 result :

$$tg\sigma = \frac{v_3 + v_5}{v_1}$$

$$where:$$

$$v_1 = v.\cos\theta.\cos\lambda_s$$

$$v_2 = v.\cos\theta.\sin\lambda_s$$

$$v_3 = v_2.\sin\psi = v.\cos\theta.\sin\lambda_s.\sin\psi$$

$$v_4 = v_2.\cos\psi = v.\cos\theta.\sin\lambda_s.\cos\psi$$

$$v_5 = v.\sin\theta.\cos\psi$$

$$v_6 = v.\sin\theta.\sin\psi$$

Subsequently :

$$tg\sigma = \frac{v.\cos\theta.\sin\lambda_s.\sin\psi + v.\sin\theta.\cos\psi}{v.\cos\theta.\cos\lambda_s}$$

After mathematical arrangement :

$$tg\sigma = tg\lambda_s.\sin\psi + tg\theta\frac{\cos\psi}{\cos\lambda_s}$$

Likewise we can determine work angle of cutting edge inclination λ_{se} .

where:

$$tg\lambda_{se} = \frac{w_T}{w_N}$$

$$w_T = v_n + v_6 - v_4 = \xi.v + v.\sin\theta.\sin\psi - v.\cos\theta.\sin\lambda_s.\cos\psi$$

$$w_N = \frac{v_1}{\cos\sigma} = \frac{v.\cos\theta.\cos\lambda_s}{\cos\sigma}$$

We can suppose, that at negative angle λ_s, cutting edge change course of rotary.

Afterwards common equations for determine of angles σ and λ_{se} they are:

$$tg\sigma = \pm tg\lambda_s.\sin\psi + tg\theta\frac{\cos\psi}{\cos\lambda_s}$$

$$tg\lambda_{se} = \pm\frac{\left(\xi + \sin\theta.\sin\psi - \cos\theta.\sin\lambda_s.\cos\psi\right).\cos\sigma}{\cos\theta.\cos\lambda_s}$$

where :

Sign (-) apply for negative angle cutting edge inclination λ_s. On the foundation determine of equations we can calculate values work geometry of angles. This equations we can use for arbitrary is conditions of work of tool an in arbitrary point of cutting edge determine real work geometry of angles, which are determine results work of tool.

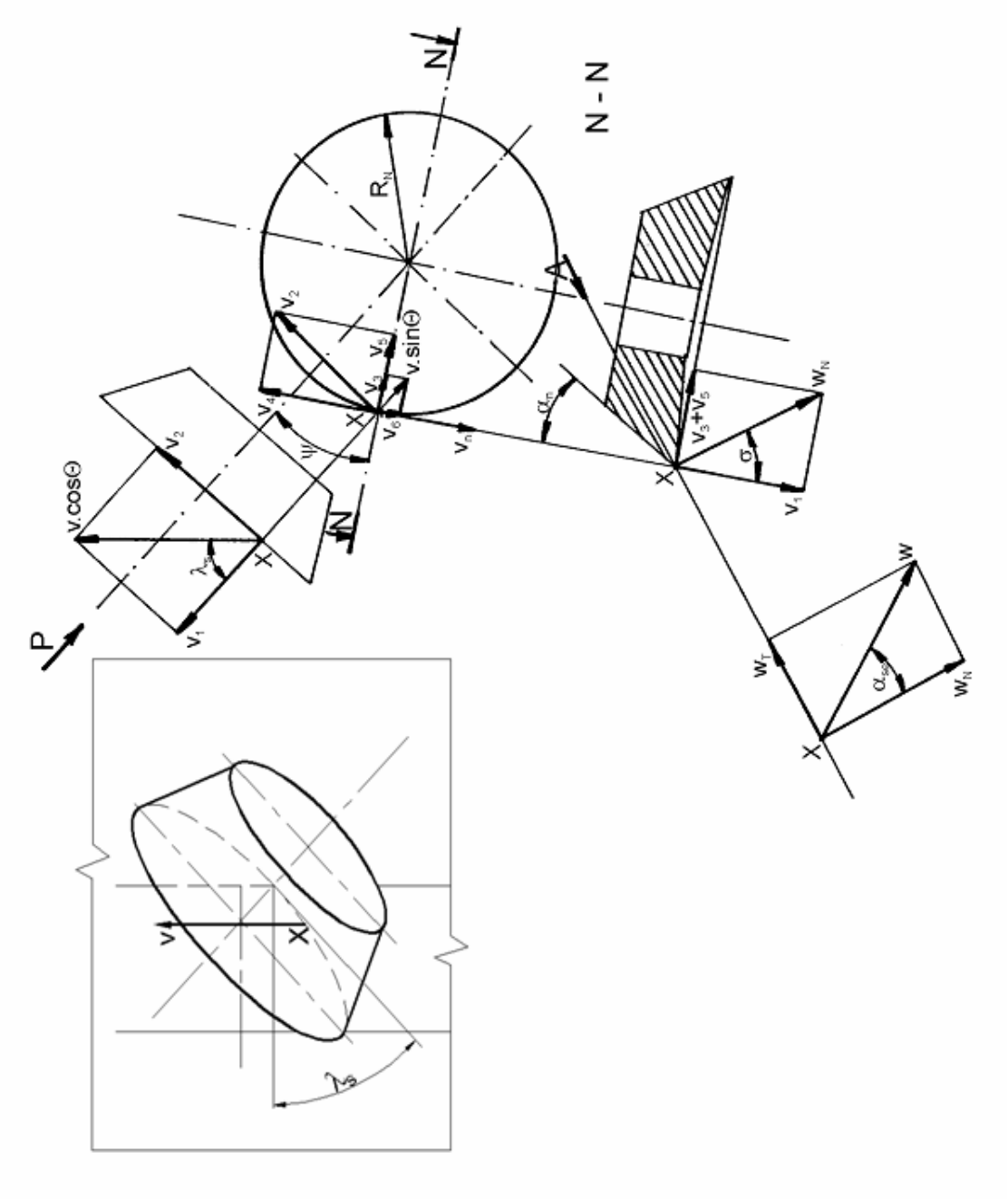

Fig. 2 Work angles of planing tool with double angle cutting edge inclination.

3. Construction of planing tool

Construction of planing tool enable change tool cutting edge inclination - . At project of construction autorotary tools is necessary go out from requirement:

- high of tough construction tool,

- high of precision motion tool (radial – circular runout and action)
- high reliability motion of tool, which we secure suitable construction of tool.

In works of authors we can acquaint with construction of lathe, milling and planing tools. Generally we can affirm, that suitable are tools, which has of rotary part fit in sliding bearings. Fit in antifriction bearings is not suitable.

The formulae were utilise at project of planing tools. Possibility of minimum radial clearance setting, and easy way of sliding surfaces lubrication. Experiments tacked place mostly in real production conditions. This new planing tool design has several advantages for many groups of machined materials. Working rages of tool were confirmed experimentally, in agreement with theoretical conclusions.

From results of theoretical analysis of work geometry follow, that is suitable this planing tool adjust with double angle cutting edge inclination (λ_s ; Θ) where angle λ_s is altering. The angle you can recommend constant ($\Theta = 5^o$).

Very important characteristic of tool is due to friction of chip and face tool and workpiece – flank tool. In body of planing tool (fig.3) is conical case Cu Sn8 (1), in case is rotary cutting part of planing tool (2). Minimum radial clearance we can adjust auxiliary of screw (3) and ball ϕ 6mm (4) Screw (5) insure of screw against rotary. Screw spleen on the rotary part of tool serve for forced of ointment.

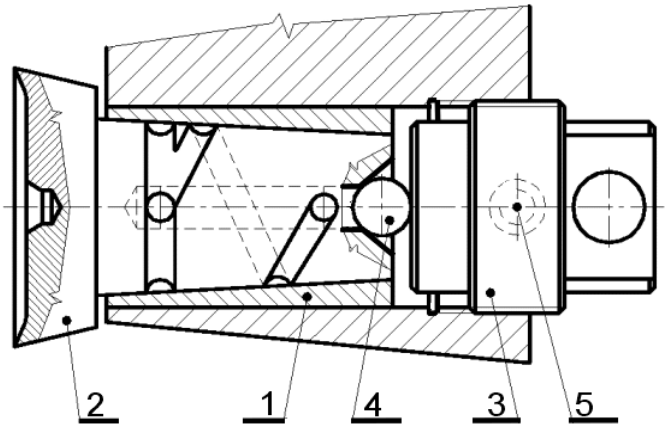

Fig. 3 Scheme of minimum radial clearance setting and sliding surfaces of rotary cutting part planing tool.

4. Conclusion

On the rudiment of theoretical analysis of work geometry rotary tool, he was constructed this planing tool and was performed experiments.

From the results we can recommended:

- For the reliable rotary movement of cutting part of planing tool is most important right define minimum radial clearance and sliding surfaces lubrication.
- Experiments tacked place mostly in real production condition this new planing tool design has several advantages for many groups of machined materials.
- Using of tools with circular cutting edges those can swing with autorotation is perspective namely for machining of extremely hard materials to remove heat from plastic deformed zone.
- Rotary of tool determine mainly cutting v and tool cutting edge inclination λ_s.
- A tool cutting edge inclination λ_s we can recommended in extent λ_s= 45- 60^o.
- Cutting speeds for this tools we can recommended important higher, than at classical planing tools.

- A tool wear be situated only on the flank of tool.
- The planing tool have extremely high tool life.

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