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# Calculation-experimental method of determining the propensity for warping non-rigid disks of hydraulic machine

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**Abstract**

In work is considered a way of forecasting of axial displacement of a surface of a nonrigid disk during its processing due to modelling real conditions. Except for an opportunity of forecasting the given way allows to spend not destroying control of disks over propensity to deformations not only at its processing, but also during operation. Application of the presented way allows to lower quantity of technological losses by manufacture of nonrigid expensive disks of axial compressor

*Keywords: deformation, a nonrigid disk, accuracy, defect, the driving wheel, the compressor*

## 1. Main text

**Nomenclature**

ω – size of a deflection of a surface of a disk;
P – force of cutting;
v – speeds of cutting;
t – depths of cutting;
s – submissions;
$h_з$ – size of deterioration of the tool on a back surface;
$\omega_0$ – a deflection on internal radius of a surface;
$M_{r0}$ – the moments, acting internal radius in radial directions;
$M_{\theta 0}$ – the moments, acting internal radius in tangential directions;
r – current radius on which the deflection pays off;

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$\psi_{\omega r}$, $\psi_{\omega\theta}$, $\psi_{\omega P}$ – accompanying functions [3];
D – cylindrical rigidity;
E – the module of elasticity;
$\mu$ – factor of Poisson;
h – thickness of a surface of a disk;
$P_y$ – an axial component of force of cutting;
$P_{3o}$ – the force of fastening operating in an axial direction;
$P_{3p}$ – the force of fastening operating in a radial direction;
$P_Э$ – axial (equivalent) force;
$P_{3r}$ – radial efforts of fastening of a processable disk;
$P_{3\theta}$ – tangential efforts of fastening of a processable disk;
$r_н$ – external radiuses of a surface of a disk;
$r_в$ – internal radiuses of a surface of a disk.

By manufacture of thin-walled disks of axial compressor in diameter 500 – 1000 mm having a rim and a nave, from corrosion-proof materials characteristic and difficultly cleaned defect are loss of accuracy as a result deformation details. Deformation it is shown in axial displacement of a surface of a disk concerning its rim or a nave therefore the surface accepts the dome-shaped form with the arrow of the deflection exceeding sometimes the set error of manufacturing in 2 – 5 times. The preparations of disks received by punching in a temperature interval of processing by pressure with cooling on air, pass a number of technological operations, including turning processing on removal of an allowance from a rim, a surface and a nave. Deformation details occurs at removal of an allowance from both parties of a surface at processing on a lathe on turning and a roundabout machine tools. Deformation leads to losses of expensive details besides the specified defect complicates application of preparations of disks with the reduced allowances on machining, and also automation of process of processing.

The lead researches establish the reasons of occurrence deformation, and also kinds of their possible display:
1. Residual axial displacement of a surface of a disk concerning a rim or naves leading loss of geometrical accuracy of a detail. Such phenomenon results from action of the residual technological pressure exceeding critical values, in a superficial layer of a surface of a disk, and also in a rim and a nave of a disk [1]. The specified pressure have been divided into two kinds according to the mechanism of their occurrence.
1.1. The compressing hereditary residual technological pressure generated at a fabrication stage of preparation and acting on a surface of a disk in a radial direction from a rim.
1.2. To bring the residual technological pressure brought in a superficial layer of preparation during machining.
2. Restored displacement of a surface of a disk during processing concerning a rim or a nave leading loss of geometrical accuracy of a detail, and also to loss of dimensional accuracy of a detail. The specified display arises because of joint action of forces in technological system, residual technological pressure which size does not surpass critical values, and technological conditions of processing [2].

At research of an error of processing resulting axial displacement of a surface of a disk concerning a rim under action of forces in technological system and residual technological pressure, has been developed the method of an estimation of size of axial displacement of a surface of a disk concerning a rim based on positions of the theory of elasticity.

As is known, on a deformation surface of a disk the strongest influence is rendered with force of cutting, namely its component directed in an axial direction to a surface of a disk. Action of this making force can be estimated as qualitatively, and quantitatively, using approaches and methods of the theory of elasticity. At an estimation of action of force of cutting also it is necessary to consider, that its size is a variable depending on modes of processing, sizes of deterioration of the tool on a back surface.
Whereas supposed errors on manufacturing of a surface of a disk in an axial direction make 0,01 – 0,05 mm, the mathematical model based on the equations of a method of initial parameters has been developed for an estimation of action of force of cutting on a surface of a processable disk. Equation for calculation will look as follows:

$$\omega = (D\omega_0 - r^2 M_{r0}\psi_{\omega r} - r^2 M_{\theta 0}\psi_{\omega q} - P_y r^2 \psi_{\omega p}) / D, \quad (1)$$

Cylindrical rigidity, D, is defined from the equation: