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AUTOMATED COMPOSITION FOR THREADED JOINTS ON ROTARY MACHINES

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Abstract: *In this article the problem of necessity to search for other ways of improvement of accomplishment quality of the threaded joints` automated assembly, because it is necessary to prevent the process of unscrewing of a threaded joint using higher material inputs. In given article the factors influencing on deterioration of properties of thread joint are examined, also looked through the quality of its control and is specified the technique of preparation of automated assembly operations for threaded joints.*
Keywords: rotary machines, automated composition, threaded joint

1. INTRODUCTION

Threaded joints are used practically in all machine design and different constructions. 15…20% of all joints are threaded joints and they constitute 25…35% of all other assembling work intensity. In many cases threaded joints are very important elements whose resistance and longevity determines construction's work safety.

If threaded joints are not fastened it is not possible to achieve necessary unit's resistance or compaction. If threaded joints are overloaded may happen threaded joints' breakup. When such threaded joint starts working in case of continuous vibration and strokes then can happen the lost of compaction, may start the leak and the process of element displacement.

It is important to notice that automatization of technological processes has an important role in the definition of quality, maintenance characteristics and detail's lifetime. In case of complex automatization the highest technical-economic effect can be achieved on rotary machines when simultaneously are moved instruments and machining details [1].

Threaded joint's reliability is characterized by construction of joints, proper moment and force of screwed joints, the precision of realization of calculated screwing moment in the process of assembly and also by improvement of the technologic process assembly.

2. PRECONDITIONS HOW TO IMPROVE THE TECHNIQUE OF THREADED JOINT'S AUTOMATED ASSEMBLY

1. Types of threaded joints. In the industry there is used wide range of threaded joints. If the bolt is mounted with play, then it receives load perpendicularly to the axle as it is shown in the Figure 1.

Bolt's pull strength must be such which cannot displace details (Figure 1.a), it means that the force on the detail's joint must be not smaller than displacement force.

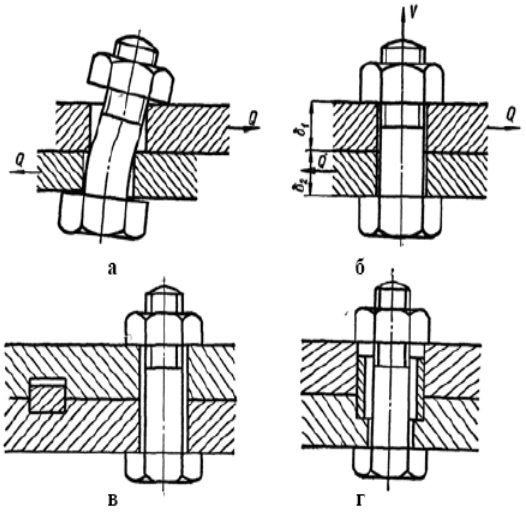

Figure 1. Threaded joint schemes which are mounted with guaranteed play; а,б-bolt-nut; в-bolt-nut with shim, г-bolt-nut with inlet

But the usage of the formulas which are taken into account when the thread is designed [2] in the process of assembly gives rather big error. That is why in order to achieve the necessary thread's quality it is necessary to realize different activities to provide the reliability of calculations which are made in the process of design.

2. Factors which can influence the loosening of threaded joints.

As the main factor for the reliability of threaded joint can be called its ability to hold big outward load and keep joint's compaction.

It is known that during the exploitation the threaded joints loose their primary traits and can be seen the loosening of threaded joints. The reasons may be such as angle inclination, inner deformations and also the influence of the temperature in which the joint is exploited. (see Figure 2)

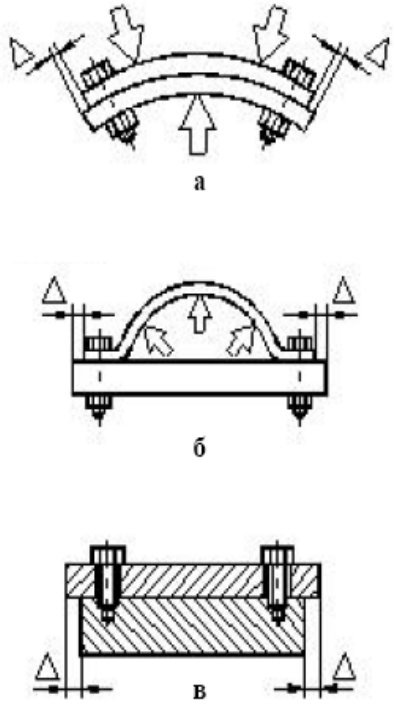

Figure 2. Factors which cause threads loosening

The main principles avoiding loosening for screwed joints are:

1) the usage of different lock devices and elements;
2) the reduce of roughness of thread and threaded details;
3) the reduce of bolt's bore diameter.

That is why it must be noted that in order to guarantee the quality of threaded joint different activities to ensure it against unscrewing must be carried out.

To reduce the relief of threaded joints and to higher their efficiency different methods of occlusion are used. The efficiency of their usage may be seen looking through the information of "FHS" (Germany) on the example of thread M10. (see Figure 3)

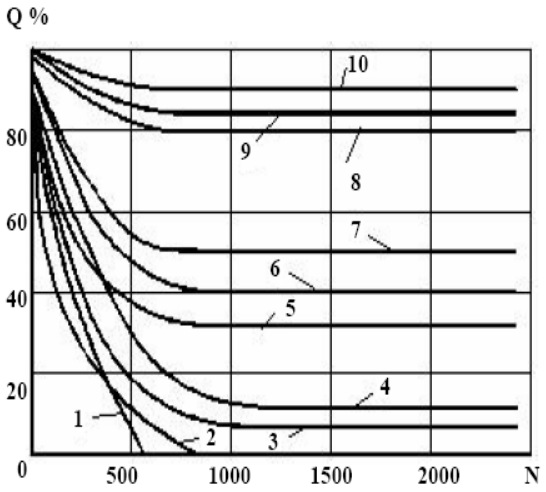

Figure 3. Thread loosening diagram in different ways of locking (Q% - drawing force, N – number of loading cycle).

Curves 1 an 2 (see Figure 3) characterizes nut without methods preventing unscrewing and nut with spring gasket (graver), 3 – nut with plastic insert on the frontal surface, 4 – nut with unbending gasket, 5 – nut with tappet, 6 – nut with lock nut, 7 – screw with plastic inserts, 8 – screw with lock cog, 9 – nut with adhesive covering, 10 – nut and screw with synthetic adhesive covering.

As we can see on the diagram the most effective methods how to ensure thread against unscrewing needs rather big financial expenses.

That is why before preparing threaded joint's assembly it is necessary to take into account the precision of fastening, the usage of lubricant, the usage of control methods, and also the improvement of threaded joint's assembly technology. As one of the way how to improve this technology is the development of methodology for technique of preparation of automated assembly operations for threaded joints. In the result with such methodology it is possible to make better the threaded joint's quality and safety.

3. METHODOLOGY OF PREPARATION OF AUTOMATED ASSEMBLY OPERATIONS FOR THREADED JOINTS

The stages of activities for providing the quality for automated assembly operations for threaded joints which were analyzed in the sources [3-7] are as following:

1) The analysis and precision for data output (nominal diameter, material, ways of overlays, precision class) must be done in the primary stage.
2) Inner fastening's control is realized which is based on the diametric sizes, step and thread's profile angle, the frontal surface deviations in compare with screw axle.
3) Necessity to pick out threaded joint's screwing method and order, based on its dimensions and constructive factors. Threaded joint's load method may be stroke-impulsive, statistical or combined. The sequence of screwing also must be chosen taking into account constructive characteristics of threaded joints.
4) Defining standards for quality. In this stage the tension state of screwing for threaded joint is chosen. The interdependence between threaded joint's tension state suspense and control parameters is defined.

$$\sigma_3 = f(M, \varphi, \Delta l) \quad (1)$$

M – torque moment; φ – screw head's turning angle; Δl – linear extension of screws head;

5) The screwdriver type's choice and specification of its technical characteristics (M, w).
6) The choice of threaded joint's screwing strength and methods of its control. In case of automated assembly of threaded

joints it is important to control the screw's tension state. Nowadays in the process of assembly operations such control methods are used:

- torque moment's control;
- screw head's turning angle and screw billet's lengthening control;
- combined control.

Torque moment's screw method includes torque moment's dependence from axial strength and geometrical dimensions of fastened element (3, 4). If the threaded joint is loaded with the forces then torque moment M_3 can be divided into two components: moment under the screw's head M_T and moment on the thread M_P. (see Figure 4)

$$M_3 = M_T + M_P \quad (2)$$

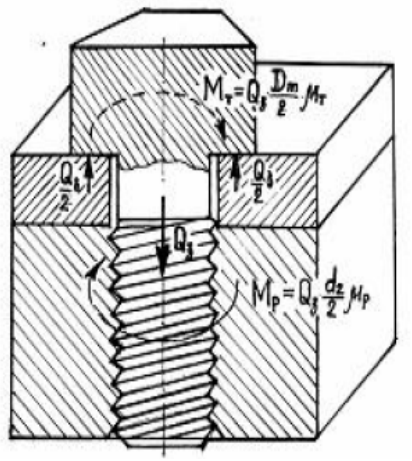

Figure 4. Schemes of moments which appears in the tightened threaded joint

$$M_T = Q_3 * D_T/2 * \mu_T \quad M_P = Q_3 * d_2 */2 * \mu_p; \quad (3)$$

$$M_3 = Q_3 * D_T/2 * \mu_T + Q_3 * d_2 */2 * \mu_p = Q_3 ((D_T/2) * \mu_T + (d_2 */2) * \mu_T) \quad (4)$$

Q_3 – tightness strength;

d_2 – screw's average diameter;

D_T – fastened element average diameter;

μ_p – friction coefficient in the thread;

μ_T – friction coefficient under the screw's head.

When the automated screwdriver is used, the screw's tightening is controlled using built-in device. In general after turning on the screwdriver spindle appears some moment M_{Γ}, which is equal to the threaded joint's tightness moment:

$$M_{\Gamma} = M_3. \quad (5)$$

Unfortunately, the precision of evaluation of tightness strength is not higher than 25%.

For registration of parameters are used special devices with indicators or pneumatic method of measurement.

Pneumatic method is less time-consuming and is based on the following principle: after defining actual friction coefficient, the torque moment is selected from the special diagrams. (see Figure 5)

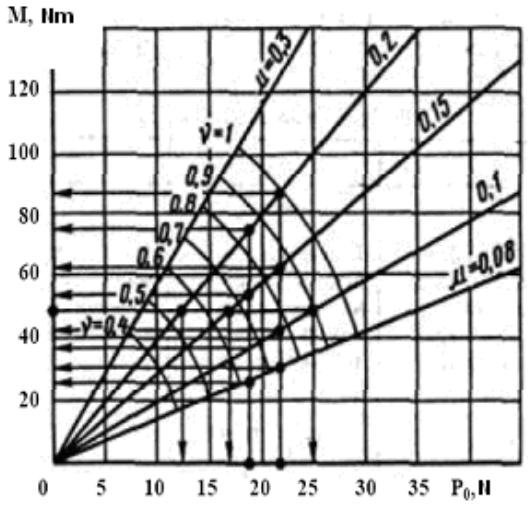

Figure 5. Diagram of tense moment for bolts with thread M12x1.25

Control method based on the billet's lengthening Δl provides the highest precision for screw's tightness measurement. This method is widely used controlling threaded joint's tension strength for very important joints. To measure

billet's lengthening it is necessary to have an access to the bolt from both sides. If the access is provided only from one side, or if the bolt is too long for measuring lengthening use indicator which is built-in in the bolt's body. (see Figure 6)

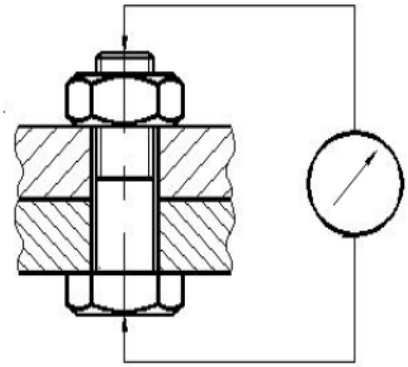

Figure 6. Scheme for measurement of screw tightness force according to lengthening Δl for threaded joint

7) Measuring main force characteristics for threaded joint (МГ, МР, φ, Δl) in order to have necessary adjusting parameters for screwdriver. For measuring torque moment's force M3, φ, Δl, imitators of threaded joint are produced, which further are mounted in the moment's division block. These imitators are made as inlets and in the same time the nut and screw are fastened together. The probative screw tightness is made using dynamometric key or screwdriver, necessary torque moment is achieved and force characteristics are measured.
8) The analysis of results and decision making.

Moments on the frontal surface M_T and in the thread are evaluated simultaneously taking into account elastic panache's curve using the pneumatic measurement scheme.

Linear lightening Δl is also controlled analyzing elastic panache's curve through the probe which is in contact with bolt's frontal surface.

4. CONCLUSION

Technical level and quality of jointed details and joints has very important meaning for providing high machine, mechanism, building construction and other product characteristics. It is known that the majority of damage in different ways is connected with joints.

Details' joint safety depends from constructions technical level on the whole, jointed details quality and mounting quality. The usage of formulas in the process of thread design and further mounting gives rather big imprecision. That is why it is necessary to improve the process of automated assembly operations for threaded joints in order to provide calculation's veracity.

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