Monitoring the Process of Gear Shaft Creating

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Abstract
The paper analyzes the features of the shaft-gear type details. A review of existing shaft types. As a result, a generalized algorithm for creating a shaft gear detail was proposed, on the basis of which the project will be created and implemented in the Scada software environment.

Keywords - *Gear shaft, process, creation, control, quality.*

I. INTRODUCTION

A high level of production organization must ensure not only production in a given quantity, but also ensure its high quality. The actual quality level of a specific product instance is established by technical control [1-3].

Technical quality control refers to the process of comparing objects indicators, tools of labour product and processes with indicators recorded in technical documentation [4].

The purpose of technical control is, first of all, to ensure the required product quality.

By product quality is meant a combination of properties that determine its suitability to meet certain needs in accordance with its purpose.

II. MATERIALS AND METHODS

A. Related Work

The process of creating the shaft gears devoted a number of works. Along with the design, choice of material and operation of numerous shaft-type details, it was and remains an important task to control and improve the quality of such details.

In [5] autoregressive model-based gear shaft fault diagnosis using the Kolmogorov–Smirnov test was described.

Lean manufacturing implementation in a gear shaft manufacturing company using value stream mapping in [6].

Modified geometry of spur gear drives for compensation of shaft deflections is investigation in [7].

In [8] the application of the local meshing plane concept is discussed and applied for detecting of tooth degradation due to fatigue, and for overall gear quality assessment.

B. Analysis of the Characteristics of the Gear Shaft

Shaft gear – combining in a single node of the mechanism and the shaft, and gear. In this case, the gear is cut in the shaft body and its diameter can be a maximum two times larger than the main shaft diameter, while the gear can be mounted on a straight shaft and can be much larger in diameter (Fig. 1).

Fig. 1 Detail of the "shaft gear" type

Detail of the "gear shaft" has a complex structure that includes the presence of a closed keyway, toothed surface. The pinion shaft is installed in the gearbox housing using two bearings.

Blanks for shafts in mass production with small differences in the diameters of the treads are produced by cutting from hot-rolled steel.

The gear shaft, which transmits torque from one shaft to another, is considered one of the most rapidly wearing parts of the mechanism, despite the fact that it was originally made much more durable and durable than conventional gears. However, the huge all-round loads experienced by the pinion shaft in the work process quickly bring it into an absolutely unsuitable condition. Thus, the need to replace this node of the mechanism requires careful observation and timely response in order to avoid loss of working time [1].

C. Overview of Existing Shafts

Consider the existing classification of the gear shaft in general.

Gear shafts are classified by purpose:

- gear shafts – bearing details of gears (gears, pulleys, etc.)
- main shafts – bearing, besides details of gears, the working parts of engines or tools machines – wheels or disks of turbines, cranks.

The shape of the geometric axis distinguishes shafts [3]:

- direct (most common);

- crankshafts – convert reciprocating motion (for example, pistons in cars) into rotational (crankshaft) or vice versa;
- flexible – with varying axis of rotation.

Also, the shafts are solid and hollow.

Hollow shafts are usually used when another piece is to be passed through. These shafts are smaller in mass than solid, but they are more difficult to manufacture.

The gear shaft is also divided by [1]:

- the shape of the initial surfaces: cylindrical, conical;
- the shape of the teeth profile: evolvent, circular (Novikov transmission), cycloidal;
- type of teeth: spur, helical, curvilinear:
- internal gearing; keyway, slotted;
- type of heat treatment: sorbitization, cementation, nitriding.

The main materials for the manufacture of shafts carbon and alloy steels.

III. THE CONTROL PROCESS OF GEAR SHAFT CREATING

A. Technological Process of "Shaft Gear" Details Creating

The development of the technological process (TP) includes:

- classification of the manufactured product based on the technological classifier;
- selection of technological bases;
- drawing up a technological route of processing;
- development of technological operations;
- rationing operations;
- determination of labor protection requirements;
- calculation of the accuracy, performance and cost-effectiveness of process options, execution of technological documents.

In instrument making 4 main methods of producing blanks are used [4]:

- casting;
- pressure treatment of materials;
- use of finished products;
- powder metallurgy.

This steel is fairly well processed blade and abrasive tools.

As a result of the analysis of shaft-gear details technological process creating, it was determined that:

- detail must be made of standard or unified blanks;
- material properties of the detail must satisfy the existing technology of manufacturing, storage and transportation;
- design of the detail must provide the possibility of applying standard, group or standard technological processes.
- design of the detail must provide the possibility of multi-site processing;
- possibility of processing the maximum number of surfaces high-performance methods and tools.

B. Development of a Generalized Algorithm for Controlling the Manufacturing Process of the Shaft-Gear Detail

The degree of accuracy in determining the quality and establishment of a marriage depends on the means used for technical control (mainly measuring instruments and devices), qualifications of the personnel performing the control, type of control.

The reduction of labour costs and funds for technical control is achieved by choosing the appropriate type, methods and technical means.

But, often, savings are achieved with the use of statistical control methods, as well as with the mechanization and automation of control operations, therefore, the following generalized algorithm is proposed for controlling the manufacturing process of a shaft-gear type detail.

Stage 1. Entering data on the process of forming the pinion shaft and directly the process of heating the die with the specified technological parameters.

Stage 2. Temperature control, namely, the condition must be met – punching temperature must be within $450^\circ < T < 550^\circ$. If the condition is satisfied, then the heating of the detail for cutting follows. Otherwise – it is necessary to repeat the cycle from the very beginning and enter other data on the stamping process.

Stage 3. Control the temperature of the blank heating in order to cut it. The temperature should be within: $850^\circ < T < 900^\circ$. Fulfilment of this condition leads to a transition to control of the cutting time, which should be 1080 seconds. If the condition is not fulfilled, then again go to the stage "Warming up of the blank for cutting", where it is necessary to adjust the parameters of the cutting process.

Stage 4. Control the heating temperature of the blank before stamping. The temperature should be within, $1150^\circ < T < 1250^\circ$, if the condition is satisfied, the heating time of the blank is checked again, which should be no more than 360 seconds, and then go to step 5. If the condition is not met, then go to stage of heating the blank before punching and correct the parameters of this process.

Stage 5. Control stamping force, it should be equal to 40MN.

Stage 6. Stamping.

Stage 7. Visual check of the received gear shaft for compliance with technical documentation. If there are no deviations from the technical documentation, then transfer the blank to the container to perform further operations. If deviations of the pinion shaft are present, then it is necessary to turn into the very beginning of the control cycle of all the main manufacturing steps and correct the technological parameters of the manufacturing process.

IV. CONCLUSIONS

The paper analyzes the features of the shaft-gear type details. A brief review of existing shaft types.

As a result, a generalized algorithm of the technological process of creating a shaft-gear wheel detail on the basis of which the project will be created and implemented in the Scada software environment is proposed. The project of a computer-integrated module for monitoring the main parameters that most affect the production of high-quality details, which will automate the process of controlling the TP of manufacturing details, thereby providing a timely and targeted impact on the quality level of the molded detail.

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