Automated system of sheet-metal forming preproduction engineering control

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Abstract. This work presents expert functioning system based on statistic knowledge of engineer and control algorithms. This expert system allows operating cold sheet-metal forming processes. Thus automated control system allows getting high quality products by cold sheet-metal forming.

In the processes of cold sheet-metal stamping we often find defects repeated from time to time (cracks, folding, etc.) as a result of tool wear, insufficient plasticity of the workpiece material, technology violations, etc. Today it is important to have and apply the setting ways of technological processes control at the stage of production technological preparation, which would reduce the defect rate and production costs of the production preparation.

In the field of stamping in automatic modes there is mainly the technological route control of parts manufacturing, but at the present stage of the production, in the conditions of a large amount of the analyzed technical information it’s reasonable to develop the automated control system designing technological processes (TP), sheet stamping (SS) on the preproduction engineering (PPE) stage.

The methodology for assessing the reliability of the sheet stamping process described in [1-3], which allows identifying and correcting the critical parameters of the TP at the stage of the TPP can be taken as the basis of this system.

The essence of this method is in the automated analysis of reliability factors: the details form; material brand, the mechanical and physical requirements to it; equipment parameters, where stamping takes place; tool characteristics, etc. After that it's possible their adjustment and, consequently, the most rational values of the parameters determination for defect-free sheet-metal stamping in a particular company.

The elements of cold sheet-metal stamping system are presented in the form of so-called system of Material-Process Structure-Tooling-Equipment-Personnel (MSTEP). Parameters systematization was carried out in connection with the fact that the stamping process has a large number of factors, thus to produce one piece, it is usually possible to develop several versions of manufacturing technology, i.e. to create some sets of MSTEP. The result of MSTEP system options formation process is shown in Figure 1.
All MSTEP variants are previously assessed for reliability, i.e., on the defect-free technology. In case the value of any parameter of the system may lead to a defect, any other possible variants are considered to reduce the negative impact on the cold sheet-metal stamping.

Further, in order to obtain a rational MSTEP variant, the corrected list ranking is carried out by means of its assessment on the key performance indicators (cost of products, saving of resources, processing time, etc.), which are specific for each enterprise.

On the basis of this methodology the expert system (ES) has been developed, which operates on the basis of operator knowledge statistical accumulation (technologist) and control algorithms solutions. ES scheme is presented in Figure 2.
ES of cold sheet-metal forming process control consists of:
1) Knowledge base including a database (DB) of the material, the structure of the TP, tools, equipment, staff, rational technologies and the base of precedents (BP), technology options;
2) "Technology ranked list forming" module.

The input information for the PPE is the design documentation (DD), being developed at the stage of pre-production design (PPD). According to KD, the product manufacturability, the group of complexity (part type), the thickness and dimensions of a workpiece, the type of steel, the properties of the assortment and the requirements of dimensional accuracy and surface roughness of the parts are being determined. [4-6]

The creation of automated process control system by TP designing at the stage of the PPE will improve the quality of products manufactured by cold sheet-metal forming process, and reduce the cost of the PPE by providing defect-free TP with implementation of the economic efficiency and expediency.

References

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