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FORMING PROCESS OF SCREW SPIKE IN DOUBLE CONFIGURATION

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Summary. *In this paper technology of screw spikes manufacturing, based on the flashless forging and hot rolling in double configuration, is presented. The forging takes place in closed dies and the obtained workpiece is rolled in its middle part on cross-wedge rolling mill in order to make screw thread. As the result of this process, it is possible to eliminate disadvantages of the former technology: flash and groove on the head surface of the workpiece thread part. The new technology designing based on computer simulations and experimental research, which considerably lowered the costs of implementation. The advantages of using the new technology include: improving the finished product functional quality, increasing of productivity and obtained economic effects.*

1 INTRODUCTION

The characteristic feature of screw spikes is thread of large stroke and considerable height. The used so far technology of screw spikes manufacturing include mainly such processes: heating of round rod to the temperature of hot forming, forging of head from one side of charge, cutting of present flash, repeated heating and rolling of thread on three-wedge rolling mill with parallel axes. The disadvantage of this technology is the presence of groove on screw head surface, where conical surface is desired. Apart from that, forging with flash leads to the material waste and to the increase of process costs. Analyzing this technology and the quality of the obtained products, new conception was worked out. It is based on flashless forging of screws' heads in double configuration and forming in the middle part of thread with flat wedges of cross-wedge rolling mill, with at the same time, splitting of two products at the final stage of rolling. The working out of this new technology required dealing with three basic problems:

- working out technology of flashless double-sided forging of screw spike heads,
- designing and building of forging machine for mentioned above process realization,
- working out technology of thread forming in double configuration by means of cross-wedge rolling method.

2 NEW PROCESS DESIGNING

Designing tools for forging and rolling processes was preceded by multi variant simulation of the assumed solutions. Calculations were made mainly by means of Finite Element Method (FEM) and, additionally in the case of forging by means of Finite Volume Method (FVM). On the basis of the obtained results initial tools were designed for the first stage of experimental research, which were made with the use of lead. The experiment showed large convergence with the theoretical results and confirmed the correctness of tools design at the same time.

In Fig. 1, the comparison of head geometry made by means of flashless forging method with the results of calculations of FEM and FVM is presented. In Fig. 2 the thread rolled on the lead billet is shown. The detailed results of numerical analysis and experimental research of forging process are presented in works[1,2], however, the results of rolling process are shown in the works[3,4].

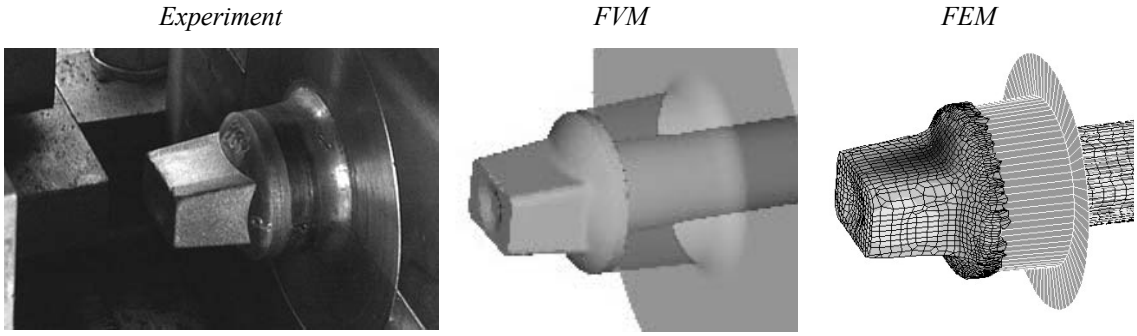

Fig. 1: The examples of the results of simulations and experimental research of flashless forging process of screw head

Fig. 2: The thread rolled on lead billet

Numerical simulations allowed also to analyze strain and force parameters in the formed material and temperature distribution in the designed process. On the basis of the obtained results, the values of temperatures of charge heating in forging and rolling processes were determined, optimal due to the process energy consumption, forming forces values and tools durability. It was assumed that the process of heads forging in double configuration would be realized in three-slide forging press. The initial parameters in this press designing were values

of forces calculated in numerical simulations. During designing the modern calculation methods were used. They allowed for analyzing dynamic and kinetic behavior of the machine and the strength FEM analysis of the particular subassemblies of the press. In Fig. 3 the built press and the examples of results of the strength analysis of the press body are presented. In Fig. 4 the forging formed in this machine is shown.

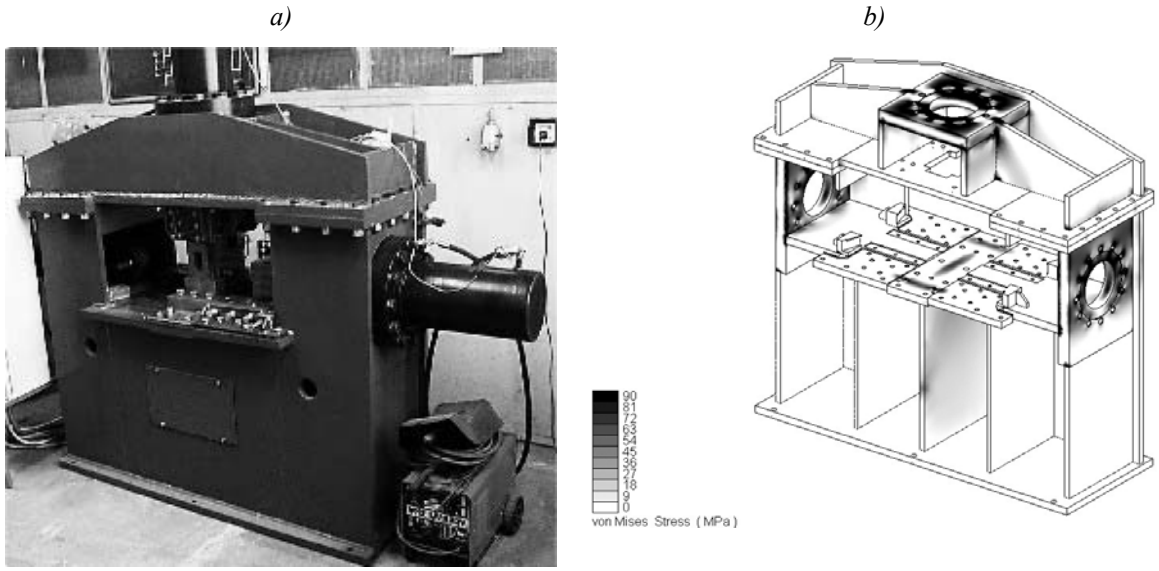

Fig. 3: Three-slide forging press (a) and the results of the strength analysis of the press body (b)

Fig. 4: The forging formed in three-slide forging press

The cross-wedge rolling of thread in double configuration with splitting of the part in the final stage of rolling was designed and realized in flat-wedge rolling mill industrially manufactured.

The industrial tests of forging and rolling confirmed the effectiveness of the new technology (Fig. 5). It should be noticed that the obtained screw spike (Fig. 5c) has conical ending of the thread part, which improves its functional qualities.

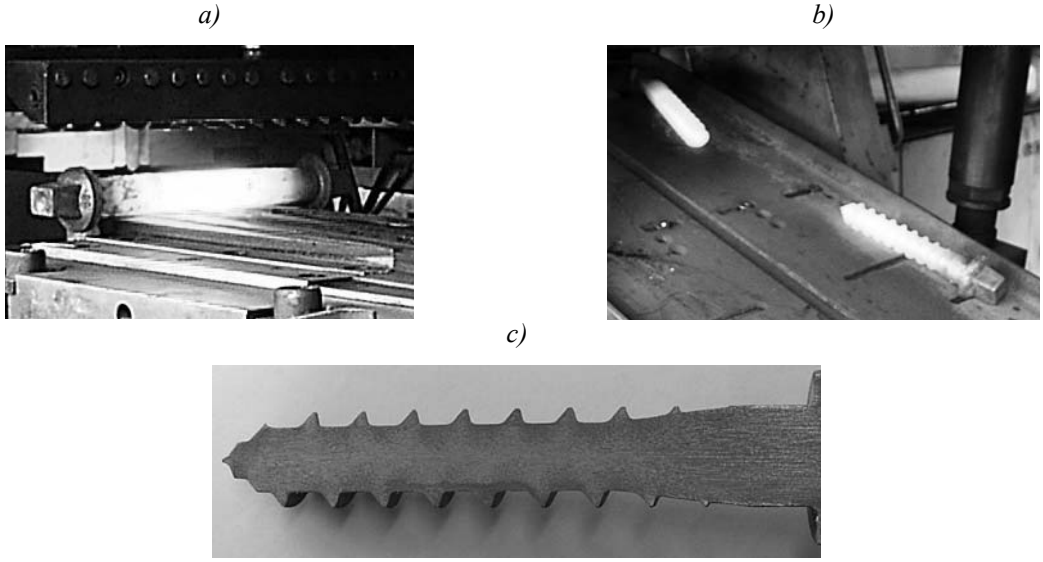

Fig. 5: The industrial tests of thread rolling in double configuration with splitting: a) forging with heated middle part put in rolling tools, b) forging falling into the container after rolling, c) section of thread part of the made screw spike

3 OBTAINED ECONOMICAL EFFECTS

The research of pre-production batch confirmed the rightness of the assumed conception of new technology of screw spikes manufacturing, which has the following advantages:

- the manufactured screw spikes meet quality and dimensional requirements,
- the functional qualities were improved due to the conical ending of thread part,
- the manufacturing of two parts from one charge increased the productivity of cutting and forming of heads and threads as well,
- the implementation of flashless forging of heads allowed to eliminate process of flash cutting and improved the index of material consumption,
- the new method is fully non-waste forming method, less time and energy consuming than the method used before.

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