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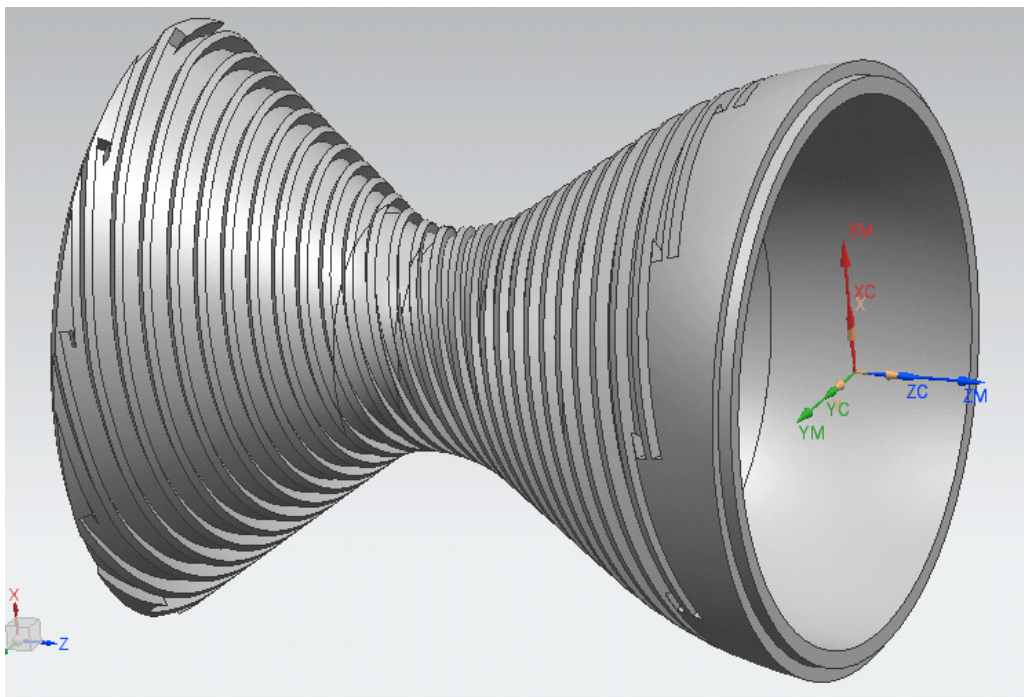
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FEATURES OF THE TECHNOLOGY FOR THE MANUFACTURE OF LIQUID ROCKET ENGINE HOUSINGS TO THE MODERN CAPABILITIES OF CAD-CAM SYSTEMS AND 5-AXIS CNC MACHINES

This article describes the following scientific results:

1. The process of planing with a special cutting tool on a 5-axis CNC machine for machining screw surfaces of liquid engine (pic.1) housings was proposed for the first time.



Picture 1 – CAD model of liquid engine shells (screw surfaces)

2. The principles of programming 5-axis CNC machines for planing using modern CAM-systems [1] have been developed for the first time.

3. A mathematical model of increasing the accuracy of the control program on a CNC machine [2] for processing the spiral surfaces of the shells of liquid rocket engines has been obtained for the first time.

4. CAM modeling of the cutting process was performed to obtain machining accuracy results.

The practical significance of the results described in the article:

1. A methodology for programming 5-axis CNC machines for machining spiral surfaces of liquid rocket engine housings by milling and planing was created and put into production.

2. The company introduced planing technology using a 5-axis CNC machine and special cutting tools.

3. A system for measuring and analyzing liquid jet engine shells was put into production.

4. A system for correcting the control program of a CNC machine was created and implemented to improve the accuracy of machining spiral surfaces of liquid rocket engine housings.

Theoretical and practical achievements of the work were implemented at the following enterprises: State Enterprise “Production Association Yuzhny Machine-Building plant named after A.M. Makarov” (YUZHMAASH), State Enterprise “Yuzhnoye State Design Office named after M.K. Yangel” (YUZHNOYE SDO).

The introduction presents scientific novelty and practical significance, reveals the relevance of the study.

The main part analyzes the problems of manufacturing liquid rocket engine cases in modern production, methods of their manufacture and control, substantiates and adapts the method of modeling the planing process for machining spiral surfaces of liquid rocket engine cases. The method of programming 5-axis CNC machines for the planing process is described. A method of accuracy control in modeling the planing process is proposed.

A mathematical model for improving the accuracy of machining the screw surfaces of liquid rocket engine covers is developed, experimental studies on full-scale samples using the mathematical model are considered, methods for modeling and programming the planing process for machining the screw surfaces of liquid rocket engine covers are developed. The results of using the above methods in production are considered.

In the general conclusions, recommendations for the practical use of the developed methods and results are proposed and the results of theoretical and experimental studies are summarized.

References

1. CAM-system
URL:<https://www.autodesk.com/products/fusion-360/blog/computer-aided-manufacturing-beginners/> (date of application 25.05.2018)
2. CNC machine
URL:<https://cncmachines.com/what-is-a-cnc-machine> (date of application 10.02.2014)
3. Liquid rocket engine
URL:<https://www.grc.nasa.gov/www/k-12/airplane/rockth.html> (date of application 13.05.2021)