



## "INNOVATIVE ACHIEVEMENTS IN SCIENCE 2025"

### "OPTIMIZATION OF THE FORGING PROCESS TO REDUCE MACHINING ALLOWANCE."

Nugmanov Ikrom Nugmanovich

*Candidate of Technical Sciences: Almalyk State Technical Institute*

Abdujabborova Zilola Abduraim qizi

*Master`s student: E-mail: abdujabborovazilola520@gmail.com, tel: +998935973399*

**Abstract:** *This study focuses on optimizing the forging process to reduce machining allowance and improve material utilization in the production of aluminum alloy components. In conventional forging, large machining allowances are provided to ensure dimensional accuracy, which leads to excessive material waste and longer machining times. The research aims to develop a method that minimizes machining allowance while maintaining the required mechanical properties and geometric precision of the workpiece.*

**Keywords:** *forging, machining allowance, aluminum alloys, piston, optimization, material utilization.*

#### INTRODUCTION

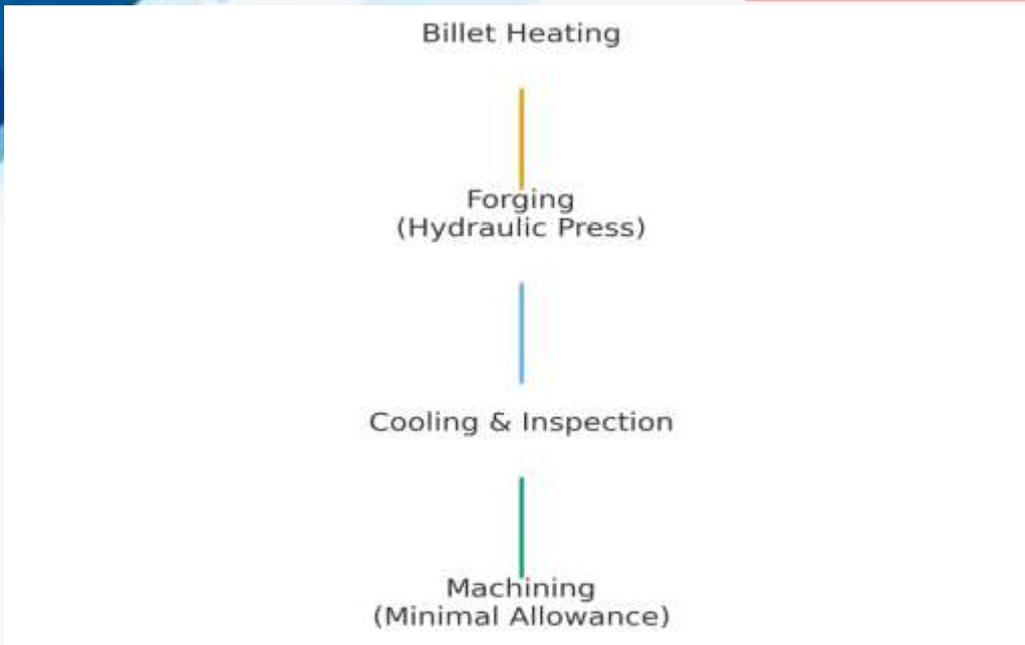
In modern mechanical engineering, minimizing material waste and improving production efficiency are major priorities. During machining operations, a machining allowance is intentionally left on forged or cast workpieces to ensure that the final part meets dimensional accuracy and surface quality requirements. However, excessive allowance leads to high material consumption, longer processing time, and increased production costs. Therefore, the development of forging technologies that produce near-net-shape workpieces with minimal machining allowance is an important direction for improving modern manufacturing efficiency.

Forging is one of the most effective methods for producing high-strength and reliable parts. The piston, a critical component of internal combustion engines, requires high precision, good mechanical strength, and excellent surface finish. Its complex geometry makes it an ideal object for studying the reduction of machining allowance through process optimization.

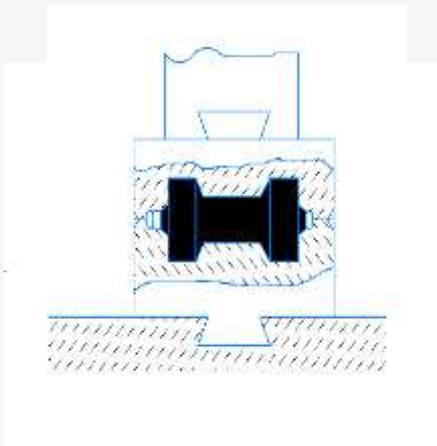
Figure 1. Forging Process Flowchart



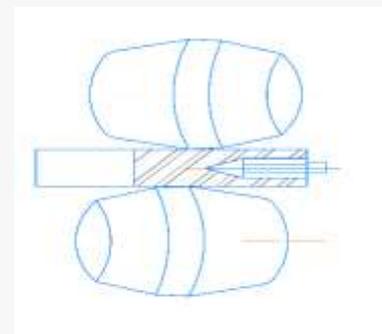
## "INNOVATIVE ACHIEVEMENTS IN SCIENCE 2025"



This study investigates the optimization of the forging process for aluminum alloys AK4 and AK8 to reduce machining allowance and improve material utilization. Aluminum alloys AK4 and AK8 were selected as the main materials due to their favorable strength, corrosion resistance, and formability. The main objective is to determine the optimal forging parameters that ensure accurate die filling, minimal material deformation defects, and high-quality near-net-shape workpieces suitable for machining with reduced allowances.



Object of Research



A piston blank was selected as the research object due to its complex geometry and the requirement for dimensional accuracy. The piston was produced by hot forging followed by machining. The study aimed to optimize the forging parameters so that the resulting blank would require minimal machining to achieve final dimensions.



## "INNOVATIVE ACHIEVEMENTS IN SCIENCE 2025"



a) before the forging process

b) after forging in a hydraulic press

The experiments were conducted using a hydraulic press with a controlled deformation rate. The billets were heated in an electric furnace with precise temperature control. Dimensional analysis was carried out using coordinate measuring equipment, and mechanical properties were evaluated through tensile and hardness tests.

In the standard process, a machining allowance of 3–5 mm is usually applied to compensate for potential inaccuracies in die filling and material shrinkage. Analysis showed that most of the excess material accumulates in the piston crown and skirt regions, resulting in significant material waste and extended machining time.

Through simulation and experimental analysis, it was found that a forging temperature of 430–470°C provides stable deformation without surface cracking. A deformation rate of 0.5–0.8 s<sup>-1</sup> ensures uniform metal flow and proper filling of the die cavity.

By redesigning the die geometry and adjusting the metal flow direction, allowance thickness was reduced to 0.8–1.2 mm, a reduction of about 75% compared to conventional processes.

The implementation of the optimized forging process resulted in a 25–30% decrease in metal waste, 20% reduction in machining time, and longer tool life. These improvements lead to significant cost savings and overall production efficiency enhancement.

Conclusion: the conducted research demonstrates that optimizing the forging process parameters can effectively reduce machining allowance while maintaining high quality and strength of aluminum workpieces. By selecting the appropriate temperature range, deformation rate, and die design, it is possible to obtain near-net-shape piston blanks with an allowance thickness reduced to 0.8–1.2 mm.

The results confirm that this approach increases material utilization, shortens machining operations, and lowers production costs. The developed method can be applied to other precision-forged components where allowance reduction is essential for economic and technological efficiency.

### REFERENCES::

[1] G. E. Dieter and H. A. Kuhn, \*Handbook of Forging Technology\*, 2nd ed. ASM International, 2014.



## **"INNOVATIVE ACHIEVEMENTS IN SCIENCE 2025"**

---

- [2] R. L. Kegg, "Forging and Forming Processes," *\*Journal of Materials Processing Technology\**, vol. 45, no. 3–4, pp. 215–223, 1994.
- [3] V. V. Pityulin, *\*Technology of Forging and Stamping\**. Moscow: Mechanical Engineering, 2008.
- [4] J. G. Lenard, *\*Metal Forming Science and Practice\**. Elsevier, 2002.
- [5] G. H. Majzoubi, "Optimization of forging parameters to improve dimensional accuracy," *\*International Journal of Machine Tools & Manufacture\**, vol. 51, pp. 150–158, 2011.