SECTION 3. INDUSTRY ENGINEERING

DOI https://doi.org/10.30525/978-9934-26-519-8-6

MODERN AND PROMISING FINISHING METHODS OF AIRCRAFT ENGINE PARTS

СУЧАСНІ ТА ПЕРСПЕКТИВНІ МЕТОДИ ФІНІШНОЇ ОБРОБКИ ДЕТАЛЕЙ АВІАЦІЙНОГО ДВИГУНА

Hrebennikov M. O.
Postgraduate Student at the Department «Technologies of Mechanical Engineering»
National University "Zaporizhzhia Polytechnic";
Chief of the Bureau of Advanced Technologies
SE «Ivchenko-Progress»
Zaporizhzhia, Ukraine

Гребенніков М. О.
аспірант кафедри технології машинобудування
Національний університет «Запорізька політехніка»;
керівник бюро передових технологій
ДП «Івченко-Прогрес»
м. Запоріжжя, Україна

Honchar N. V.
Candidate of Technical Sciences, Associate Professor,
Associate Professor at the Department «Technologies of Mechanical Engineering»
National University "Zaporizhzhia Polytechnic"
Zaporizhzhia, Ukraine

Гончар Н. В.
кандидат технічних наук, доцент,
доцент кафедри технології машинобудування
Національний університет «Запорізька політехніка»
м. Запоріжжя, Україна

Increasing operational requirements for aircraft necessitates high requirements on engines that generate propulsion, their assemblies, and parts. The goal of a process engineer is to ensure precise fulfillment of all requirements, which embedded in the part design, utilizing the technologies and production experience. To improve productivity and reduce manufacturing time and production costs, the engineer must employ technologies and advanced global experience in processing similar parts that are particularly critical, highly loaded, and have complex surface geometries.

The more extreme the operating conditions of critical gas turbine engine parts among high temperatures and pressures, the more urgent the issue of improving surface profile roughness becomes. The surface roughness of rotary machine parts significantly impacts their aerodynamic and strength characteristics.

Traditional technological methods of achieving the necessary surface roughness parameters include mechanical and chemical processing. Currently, mechanical methods primarily performed using abrasive tools have found the most widespread application in enterprises.

Studying the advanced experience of aviation enterprises, it can be noted that dry electro-polishing using the DryLyte [1] technology is increasingly wider application as a finishing treatment. This is an innovative technology that is currently revolutionary in the field of metal surface polishing. The dry polishing method is based on dissolving surface material layers in a chemically active environment under the influence of electric current similar to liquid electropolishing. However, there are specific features.

Special granules saturated with electrolyte are used for processing. They serve as electrodes and create local electric fields in the contact zone with the surface roughness profile peak. When electric current is applied between the part and the granule, an electrochemical reaction occurs on the part surface, contributing to material removal. Simultaneously with the electrochemical process, the granules mechanically impact the surface, removing micro-irregularities and polishing the material.

There are advantages of this method:

– higher processing speed compared to conventional electropolishing. The combination of electrochemical and mechanical impacts enables accelerating the polishing process;

– ability to process complex profiles. Contact with the electrolyte occurs locally through granules, ensuring uniform evenly processing;

– more precise process control. By adjusting electric current parameters and electrolyte composition, one can achieve not only high-quality polishing but also specified precision.

Dry electro-polishing DryLyte is spreading quite rapidly in manufacturing parts with high requirements for precision and surface layer quality. The application of this technology in aircraft engine part production generates practical interest as an alternative method to traditional polishing techniques.

Another promising polishing method used in aviation enterprises is vibro-abrasive polishing.

One can be used both in preliminary polishing operations for removing burrs, and in final operations to improve the surface quality of parts. This method involves the use of vibrating drums or tanks filled with abrasive materials and polishing components, and has the following of advantages:

– uniform material removal;

– the ability to simultaneously process a large number of parts;

– low equipment and operating costs;

– processing a wide range of parts and materials.

A preliminary comparison and evaluation of these promising technologies for polishing a housing pair of bearings, which have high requirements for manufacturing accuracy (Fig. 1). The purpose of the comparison was to select a polishing technology that provides raceway surfaces with specified performance characteristics.

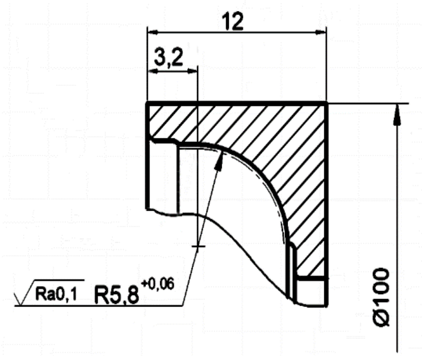


Fig. 1. Part drawing

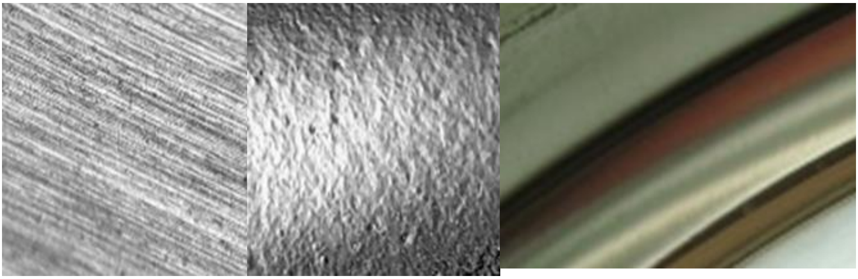
The housing surfaces that were subsequently polished were obtained by turning, with a roughness parameter of Ra 0.16…0.2.

Dry electropolishing of the housing was performed on "DLyte PRO500" equipment (current 1.5 A, voltage 20 V, duration 60 min). The housings were fixed in a special conductive fixture.

These experimental results should be considered test results and require further research.

The raceway radius of the housing after processing was 5.82 mm (initial radius R5.807), meaning the removed layer was 0.0128 mm; the roughness was Ra 0.06…0.08 μm (Fig. 2).

Comparison of housings processed using vibro-abrasive technology was performed. This processing was carried out using specialized abrasive fillers and technological liquids.



a) $25^{\times}$ b) $75^{\times}$ c) $5^{\times}$

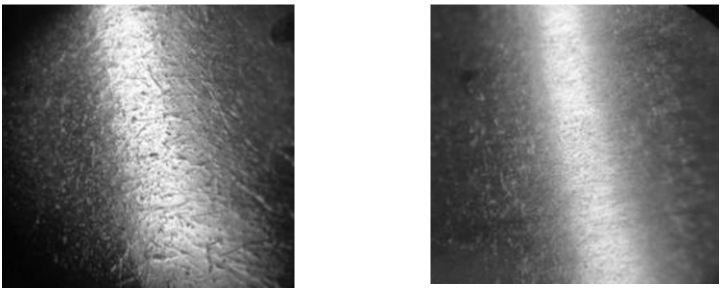
Fig. 2. Raceway surface: after turning (a); after dry electro-polishing (b, c)

Vibro-abrasive polishing of raceways was performed in several variants. The common approach of all variants was that the processing consisted of two stages:

1) preliminary processing – removal of uniformly directed micro-traces obtained during turning (Fig. 2, a);

2) final processing – fine polishing.

Duration of two processing stages was 6-8 hours (fig. 3). The roughness of the obtained surfaces was Ra 0.05…0.13 μm. Researching of variants showed that processing results similar DryLyte can be achieved by using the "ceramics-finish" polishing technology with the addition of a dry compound to the filler on the final stage vibro-abrasive processing (measurement results: Ra 0.05…0.08 μm; radius size was 5.833 mm; removable layer was 0.0138 mm).



a) $50^{\times}$ b) $50^{\times}$

Fig. 3. Raceway surface appearance after preliminary (a) and final (b) stages of vibro-abrasive polishing

After comparing raceway processing technologies, we can conclude that the results DryLyte dry electro-polishing and vibro-abrasive "ceramics-finish" technology are identical in surface quality. However, the processing time for the DryLyte technology was only 1 hour, its application can be considered preferable. Since this comparison was carry out as a test, further research and an economic comparison of finishing using these technologies are necessary to develop more specific recommendations.

Bibliography:

1. Dlyte. Dry electropolishing. URL: https://www.dlyte.com/ (application date 18.12.2024).