Int J Adv Manuf Technol
DOI 10.1007/s00170-017-0762-7

ORIGINAL ARTICLE

Study on the inner surface finishing of irregular spatial elbow pipe by the centerline reconstruction

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Received: 7 March 2017 / Accepted: 28 June 2017

Abstract Due to the compact space structure of aerospace engine, the structure of the inner spatial elbow pipe of the engine exhibits irregular geometric characteristics, which makes the inner surface of the curved pipe difficult to polish, especially the bending place's surface quality cannot be ensured. It is centerline reconstruction that can be a good solution to this problem, which measures the outer surface contour line and generates the spatial point cloud of the elbow pipe and thus, the irregular geometric centerline of the spatial elbow pipe is rebuilt. Furthermore, the polishing path of the spatial elbow pipe is calculated and optimized. At the same time, using of magnetic abrasive finishing (MAF) has well in flexible machining characteristics, the outer space of the elbow pipe is loaded with rotating magnetic field, so as to get form a "magnetic abrasive brush" inside the tube, achieve the purpose of bending the inner surface finishing. Under the same processing time, compared with the pure manual measuring magnetic grain processing, the reconstruction of the center line of the magnetic processing can make the space bend surface roughness lowered to 0.11 μm, which improves the processing quality of the tube surface and the processing efficiency.

Keywords Magnetic abrasive finishing · Spatial elbow pipe · Centerline rebuild · Abrasive behavior · Surface roughness

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1 Introduction

In the aerospace, automotive, and other mechanical fields, the requirements of the engine volume are more stringent. In order to reduce unnecessary waste of space, the smaller space occupancy rate of the spatial elbow pipe is used to oil and gas transmission in the engine interior; however, due to the influence of factors such as the level of modern technology, it will cause cracks and pits and other surface defects on elbow pipe inner part in the production, especially in the bend place, when the gas or liquid flow through the pipe results in turbulence, affecting the smooth operation of the engine thus reduce the service life [1–3]. Aviation manufacturing enterprise to use the traditional method of finishing is generally to cut the pipe for grinding and then weld it; this method has low efficiency and is subject to more conditions, as after processing the stability of the pipe is poor, processing quality is difficult to guarantee, and so the traditional grinding technology is difficult to achieve processing requirements. In recent years, some researchers have found that magnetic abrasive finishing (MAF) has a significant effect on the processing of complex surfaces [4–6]. However, it is difficult to obtain the trajectory of spatial elbow pipe, so the planning of the processing track is particularly important. In the ordinary process, the center line of the elbow pipe is usually determined by manual calibration; because the method is manual, therefore, the operation is complicated, and the site is easy to be interfered, which may cause greater error, influence the machining effect, and reduce the processing efficiency. Using the method of centerline reconstruction, the machining trajectory is accurately determined for irregular spatial elbow pipe with different radius of curvature. In addition, using it is also beneficial to reduce the error caused by anthropogenic measurements, and making the processing path optimized, which results to the polishing effect becoming uniform, improving work efficiency. This method

Published online: 13 July 2017