Magnetic Abrasive Finishing of Internal Surface of Aluminum Pipe using Magnetic Machining Jig

Muhamad Mohd Ridha¹,a and Yanhua Zou²,b

¹Graduate School of Engineering, Utsunomiya University, Yoto 7-1-2, Utsunomiya, Tochigi 321-8585, JAPAN
²Graduate School of Engineering, Utsunomiya University, Yoto 7-1-2, Utsunomiya, Tochigi 321-8585, JAPAN
ᵃdt127175@cc.utsunomiya-u.ac.jp, ᵇyanhua@cc.utsunomiya-u.ac.jp

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Abstract. Magnetic abrasive finishing technology has been known very well in finishing of stainless steel SUS304 pipes to mirror finish standard. However, the applications in softer metal such as aluminum A2017 were difficult due to soft metal characteristic itself. In 2002, Zou and Shinmura had developed a new method of magnetic field assisted machining process using magnetic machining jig for SUS304 pipe [1]. The development has since then expanded in many research. This research finds the optimum finishing condition for mirror finish standard in internal surface of aluminum A2017 pipe. We use a 100% polyester fabric that does not cause scratch on the material and found that the optimum pole-pipe gap to be 13mm to achieve the best surface roughness $R_s$ of 0.020µm after finishing, from surface roughness $R_s$ of 0.195µm before finishing.

Introduction

In recent years, high level of clean energy has been in great demand especially in the field of semiconductor, aerospace, nuclear and chemical. It is very important for highly pure liquid in these fields to be stored in tanks and transfer using highly clean internal surface parts because it should not be contaminated by any foreign particles. Where the internal part of surface is rough enough that it may accumulate foreign particles in the gap or small hole, corrosions may occur. In more severe cases, it may even cause cracks, leaks and finally burst in pipes and tanks. In critical places such as in nuclear plants, the result would be inevitable as there are possibilities of radiation exposure. Therefore, internal surface of tanks and pipes that related to these industries are required to be free from any foreign particles, requiring it to be polished to mirror surface finish. Magnetic abrasive machining of stainless steel pipes SUS304 has been known very well in finishing to mirror finish standard [2]. However, its applications in softer metal such as aluminum A2017 were difficult due to soft metal characteristic itself. This research finds the optimum finishing condition for mirror finish standard internal finishing for aluminum A2017 pipe. The aluminum A2017 has a hardness of 130HV compared to SUS304 that has 200HV.

Processing Principle

Fig. 1 shows the machining principle of internal pipe in 3D model. The workpiece is fixed to a chuck where two permanents magnet rotating at the external, which connected to each other with a yoke. The construction of machining apparatus consists in total of four magnets, which located in pair at both external and internal of the workpiece. Method using a magnetic machining jig requires strong magnetic force to enable the jig to move synchronously with the external magnets when it is rotated. A linear vibration movement is applied at the pipe length direction to promote even mixing of the abrasive particles during the process. The movement of magnetic machining jig rubbing internal pipe resulting a finishing effects to the surface. For smaller diameter workpiece magnetic abrasive method is recommended due to space constraint for magnetic machining jig [3].