Study on New Removal Thickness Distribution Improvement Methods for Niobium 9-cell Cavity Vertical Electropolishing with Ninja Cathode

Keisuke Nii○, Vijay Chouhan, Yoshiaki Ida, Takanori Yamaguchi
(Marui Galvanizing Co., Ltd.)
Hitoshi Hayano, Shigeki Kato, Hideaki Monjushiro, Takayuki Saeki, Motoaki Sawabe
(High Energy Accelerator Research Organization (KEK))

TUPO067

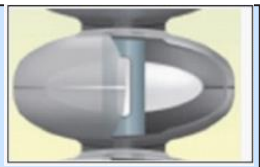
Marui Galvanizing Co., Ltd. has been developing niobium 9-cell cavity vertical electropolishing (VEP) technologies with Ninja cathode in collaboration with KEK. Conventional 9-cell cavity VEP had a serious problem, which was asymmetry of removal thickness distribution. Usually removal thickness of upper side became larger than lower side in case of both in-cell and inter-cell. So far, as one solution, we proposed "bubble diffusion prevention" method and proved it was effective for uniform removal. This time, as other new solution, we tried "cavity flip upside down" and "Ninja cathode masking" VEP methods. In this article we will report the purpose, intention and VEP experiment result of these methods.

Introduction

In 9-cell cavity VEP, removal thickness non-uniformity of internal cell and inter-cell is a big problem.

So far, we developed acid flow separate VEP system and showed removal thickness became very uniform.

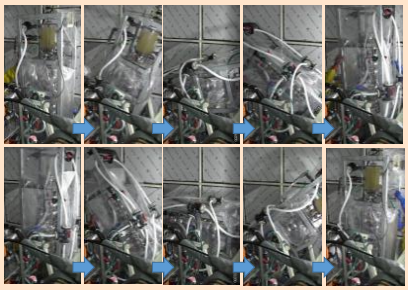
This time, we developed other new removal thickness improvement methods.
・Cavity flip upside down
・Cathode masking
We performed VEP tests using them and evaluate the results.



Ninja cathode

Cavity flip upside down

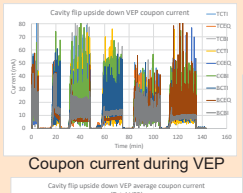
Cavity setup



Cavity flip upside down procedure

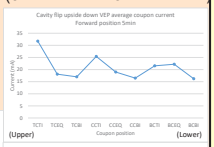
Parameters	Cavity flip upside down VEP
Voltage	~14V
Current density	20 – 30 mA/cm²
Cavity surface temperature	20–25 °C
Cathode rotation speed	20 rpm (forward position) 0rpm (reverse position)
Acid flow rate	5–10 L/min
EP time	5min (F-R)+15min (F-R)+20min (F-R)
Average removal thickness	~30um
Cathode	Ninja-v6 (With metallic wings and mesh cover)

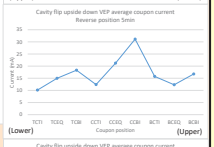
VEP condition

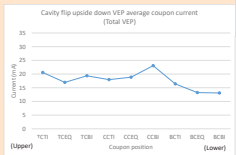


Coupon current during VEP

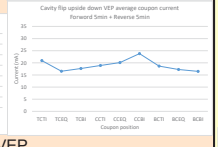
Average coupon current (5min forward -5min reverse)

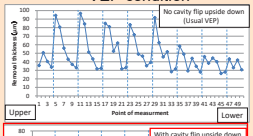


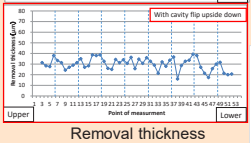




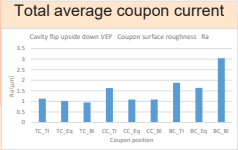
Total average coupon current



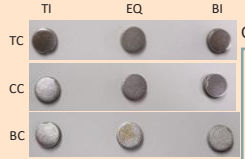




Removal thickness



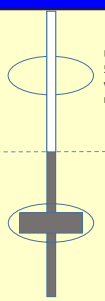
Coupon surface roughness after VEP



Coupon surface after VEP

・Average coupon current during VEP was made uniform by cavity flip upside down.
・The cavity removal thickness was made uniform as compared with the usual VEP.
・Lower cavity coupon surface became rough. It seems due to setup asymmetry.

Cathode masking

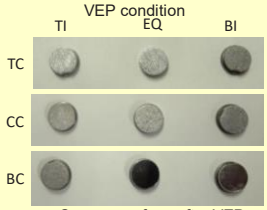


(Ninja cathode v6 with metal wings)

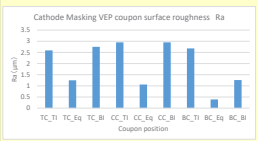
Cathode masking condition

Parameters	Cathode masking VEP
Voltage	~15V
Current density	10 – 15 mA/cm²
Cavity surface temperature	20–25 °C
Cathode rotation speed	20 rpm
Acid flow rate	5–10 L/min
EP time	~60min
Average removal thickness	~20um
Cathode	Ninja-v6 (With metallic wings and mesh cover)

VEP condition



Coupon surface after VEP

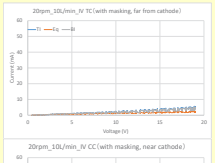


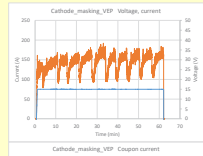
Coupon surface roughness after VEP

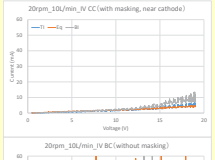
With no masking Ninja

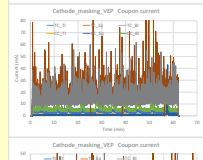
With masking Ninja

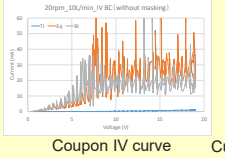
Viewport inspection(TC_TI)

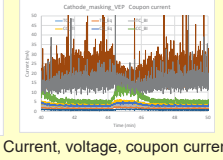






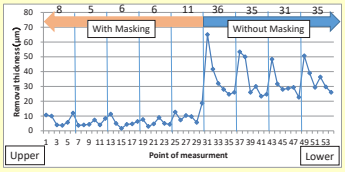






Coupon IV curve

Current, voltage, coupon current



Removal thickness

・In order to confirm the effect of masking, cathode for upper 5 cell were masked and compare with no masking parts and masking parts.
・Although the amount of polishing was greatly reduced by masking, little polishing was done (<10um).
・Rough surface was found in upper 5cell (masking parts).

Next step improvement

Cavity flip upside down VEP

・Improvement of cathode rotation part sealing
→Smooth rotation, leakage prevention, make cathode rotatable in reverse position

・Improvement of flip upside down system→Smooth and repeatable flip

・Setup symmetry improvement→Use same shape inlet and outlet parts

Masking VEP

・Optimization of masking shape→Removal uniformity and surface optimization

Summary

・To test the new removal thickness distribution improvement methods, we performed and evaluated cavity flipe upside down VEP and cathode masking VEP.

・Removal thickness uniformity was improved on cavity flip upside down VEP. Masking was somewhat effective however surface became rough.

・We will further improve the equipment and optimize the condition, and improve the surface and achieve performance of ILC specification.