Computational Fluid Dynamic Simulation for Electrolyte Flow in Horizontal EP of Nb SRF Elliptical Cavities

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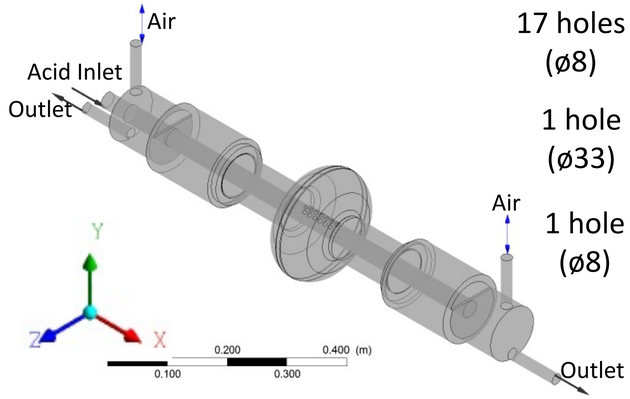
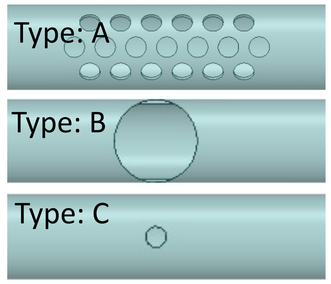
Abstract

An electrolyte flow velocity on an electropolishing surface affects a material removal rate where higher removal is observed with a higher velocity of the electrolyte. In horizontal EP (HEP) of an elliptical cavity, an electrolyte flow near the equator position might remain slow and responsible for a lower removal compared to that on the iris and beam pipe positions. In order to understand the flow dynamic on an elliptical cavity surface in the horizontal EP process, a computational fluid dynamic simulation was conducted. This study was conducted on 1.3 GHz cavity with different cathodes and acid flow rates. Final aim of the study is to improve the flow uniformity to attain uniform removal especially in multicell cavities.

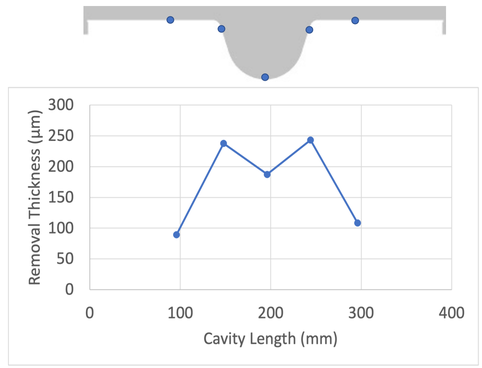
Fluid Flow with Different Cathodes and Flow Rates





Two different flow rates of 1.7 and 4.5 L/min were used.

Removal with Cathode Type-A



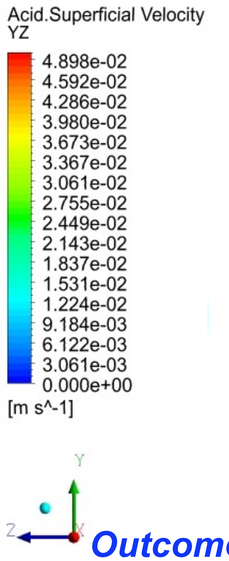
Average Removal = 160 µm

Temperature:
Equator: 32 ℃
Beam Tube: 5 ℃

Lower removal rate on the beam tube is due to intense cooling by water spray.

Acid Velocity Contours at Equator and near Iris Positions

Cathode Type	Flow Rate: 1.7 L/min			Flow Rate: 4.5 L/min		
	Left Iris	Equator	Right Iris	Left Iris	Equator	Right Iris
A [17 Holes w/ ø8]						
B [1 Hole w/ ø33]						
C [1 Hole w/ ø8]						



Velocity near Air-Acid Interface

Velocity Contour
(Top View Near Air-Acid Interface)

Cathode type: C
Flow rate: 4.5 L/min

Velocity along the Line shown in Velocity Contour

Flow is significantly higher in the right side in the case of Type-C cathode and flow rate of 4.5 L/min.

Outcomes

1. In the right side of the cavity, acid has a higher velocity near the acid-air interface. This might yield higher removal on the right iris and beam tube.
2. A cathode with multiple holes or a single large sized hole seems to be better to get lower difference in the acid velocities at the iris and equator.
3. In the case of multiple holes or single large-sized hole, a higher flow rate increases the acid velocity on the equator. However, an acid velocity also increases proportionally on the iris surface.
4. In the case of a single small-sized hole, an acid velocity increases mainly on the iris surface. This may yield a larger removal difference between iris and equator. A higher acid flow rate might further enhance the difference.

Future Tasks

1. Enhancement of the acid velocity on the equator surface to reduce the removal difference.
2. Optimization of conditions for 1300 and 650 MHz multicell cavities.

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