Design of Half-Reentrant SRF Cavities

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OBJECTIVE

- Achieve higher accelerating gradients by lowering B_{peak}/E_{acc}
- Ensure multi-cell can be easily cleaned

INTRODUCTION

There are two approaches to achieving higher accelerating gradients:

1. Increase the theoretical maximum accelerating gradient by using a material with a higher RF H_{crit} than Nb
2. Improve the cell shape to lower B_{peak}/E_{acc}

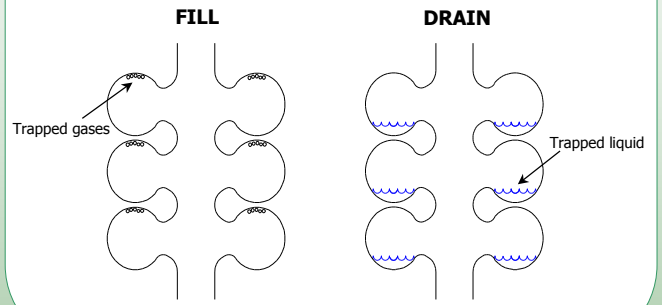
This can be done by making a cavity reentrant, at the expense of E_{pk}/E_{acc}.

By using a reentrant cell shape, Cornell lowered B_{pk}/E_{acc} 10% below a TESLA cell. However, a multi-cell reentrant cavity may be difficult to clean.

By using a half-reentrant cell shape with a k_{cc} of 1.5%, B_{pk}/E_{acc} could be lowered 15.5% below a TESLA cell.

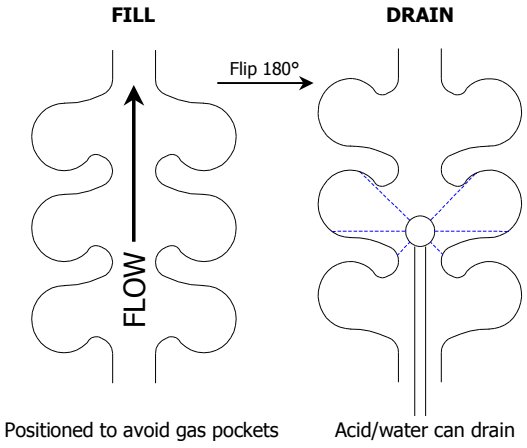
PROBLEM

A reentrant cell shape traps gases and liquids during chemical treatment.



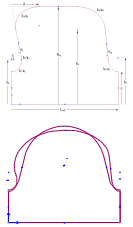
SOLUTION

By making the cell reentrant on only one side, gas pockets are avoided and liquids can drain from the cavity – all while using current cleaning techniques.



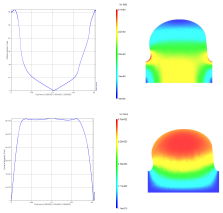
SIMULATIONS

Analyst was used to calculate the cavity parameters. There are twelve geometrical variables.



Further Improvements

- Possibly reduce wall angle to < 6°
- Use a series of arcs instead of ellipses to define geometry
- Flatten electric and magnetic surface field profiles



RESULTS

		TESLA	Cornell Reentrant	CEBAF Low-Loss	High-k Half Reentrant	Low-k Half Reentrant
Frequency	[MHz]	1,300	1,300	1,500	**1,300**	**1,300**
E_{peak}/E_{acc}	[-]	2.00	2.40	2.17	**2.40**	**2.38**
B_{peak}/E_{acc}	$[\frac{mT}{MV/m}]$	4.26	3.78	3.74	**3.78**	**3.60**
R/Q	[Ω]	115	121	129	**123**	**135**
G	[Ω]	270	280	280	**283**	**283**
(R/Q)·G	[Ω²]	31,050	33,768	36,103	**34,673**	**38,021**
k_{cc}	[%]	1.87	2.38	1.49	**2.09**	**1.51**
R_{iris}	[cm]	3.5	3.5	2.65	**3.34**	**2.97**

CONCLUSION

Two new half-reentrant shapes have been developed. Simulations show that all electromagnetic parameters are comparable to a fully reentrant shape, except for a lower k_{cc}. The truly desirable property of a multi-cell half-reentrant cavity is that it can be cleaned with current technology.

For the proposed low-k half-reentrant shape, with a B_{peak} of 185mT, an accelerating gradient of 51 MV/m is foreseeable.

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