VARIOUS APPLICATIONS OF DRY-ICE CLEANING IN THE FIELD OF ACCELERATOR COMPONENTS AT DESY

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Abstract

Dry-Ice cleaning offers a dry and waterless cleaning option removing hydrocarbons and particles without residues. Complex excavations like Cu RF gun cavities and Nb multicell cavities in horizontal installation position can be cleaned in an effective way. In the recent past RF gun cathodes and cathode transport boxes could be cleaned satisfactory. A status report will be given.

INTRODUCTION

Since recent 1-cell cavity RF-Tests showed acceptable behavior such as Eacc > 35 MV/m and promising results after RF conditioning a CO_2-cleaned RF gun cavity for the photo injector at PITZ (Photo Injector Test Facility Zeuthen) could be presented, the idea is to apply this cleaning method to other RF components and multicell Cavities.

A description of the cleaning process and the experimental setup for cleaning 1-cell niobium cavities has been given in [1, 2, 3].

Basic mechanical and chemical essentials for the cleaning effect are:

- Due to shock-freezing the contaminations become brittle.
- High pressure and a high momentum of snow crystals remove the contaminations. Particles down to 100 nm can be removed.
- Hitting the surface snow particles partially melt at the point of impact. Liquid CO_2 is a good solvent for hydrocarbons and silicones.

The major advantage of this cleaning method is the absence of water or other liquids which not evaporate in short time. Figure 1 illustrates the basic design of the device.

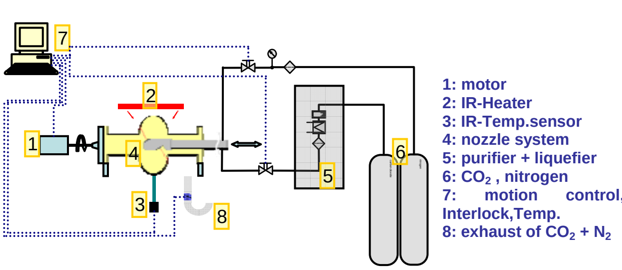

Figure 1: Basic design.

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For cleaning gun cavities a cleaning apparatus with a vertical nozzle exists. The principle setup is similar to the horizontal one shown in Figure 1.

The difference is the new rod with a gas supply and movable CO_2 nozzle, delivered from Fraunhofer Institute IPA, Stuttgart/Germany [4].

CLEANED PARTS

2-Cell Cavity 2AC1 and 3-Cell Cavity 3AC1

These two cavities were cleaned with the horizontal setup with additional heating from the IR-heater (Fig. 2).

Figure. 2: 3-cell cavity assembled to the horizontal cleaning setup with IR-heater above the cavity

The 2-cell cavity shows no field emission up to the thermal breakdown at ca. 23 MV/m (Fig. 3). The 3-cell cavity will be tested soon.

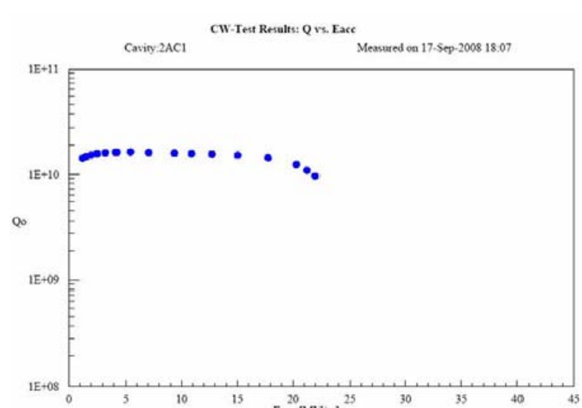

Figure 3: (Q/E)-Performance of cavity 2AC1.

RF Gun Cavity at PITZ

The $C0_2$ cleaned gun cavity showed a factor of 10 less dark-current during a RF processing at DESY/Zeuthen compared to gun cavities cleaned with conventional water cleaning procedures (Fig. 4).

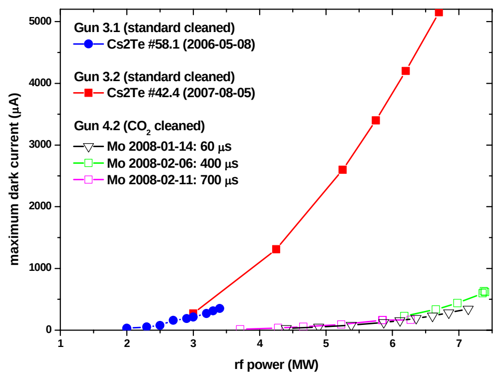

Figure 4: Comparison of dark-current for different cleaning methods. Different cathodes were used during these tests.

Figure 5 shows the gun cavity mounted to the vertical cleaning device. In order to avoid contaminations due to abrasion, the crossbar holding the cavity, moves up and down and turns the cavity along the way. The nozzle support does not move at all. Because of the complex outer surface of the gun cavity, we decided not to heat the cavity.

Figure 5: A gun cavity assembled to CO_2 cleaning device.

RF Gun Cathodes and Transport Frame

Some cathodes and related components have been cleaned manually. Here the CO_2 nozzle from the horizontal setup was used (Fig. 6). An adequate cleaning was controlled by a particle counter. The counting decreased during the cleaning process. RF measurements are outstanding. However, the technical procedure is well-known. Figure 7 shows a cathode mounted to a transport frame.

Figure 6: CO_2 cathode cleaning by hand.

Figure 7: Cathodes in a transport frame.

Waveguide Connector

A waveguide connector of the PITZ gun system was cleaned lately. In the near future RF tests will start at DESY/Zeuthen (Fig. 8 and Fig. 9).

Figure 8: Waveguide assembled to the vertical cleaning setup.

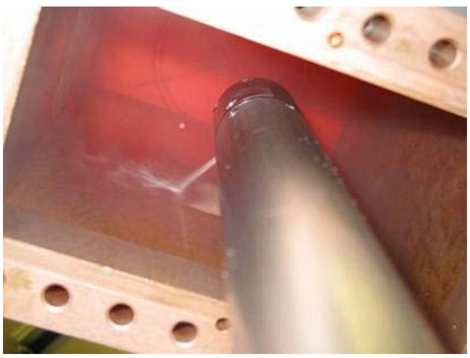

Figure 9: Nozzle and CO_2 - jet inside waveguide.

Input Coupler for Photo Injector

First cleaning tests are done. Cleaned components will be mounted to the other photo injector parts and tested in the near future at DESY/Zeuthen (Fig. 10).

Figure 10: Input coupler in vertical device.

SUMMARY

We could show that dry ice cleaning of complex structures is possible as a matter of principle. A movable gas nozzle helps to clean areas with limited accessibility. During the cleaning process of the RF gun no additional external heating was applied. The promising dark current measurements give an indication to omit the IR-heater in future. 2-cell and 3-cell cavities could be cleaned. Adjacent RF tests will follow in the near future.

ACKNOWLEDGEMENT

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REFERENCES

[1] D. Reschke et al.; "First experience with dry-ice cleaning on srf cavities", Proc. Lin. Acc. Conf. LINAC2004, THP71, Luebeck, Germany (2004)

[2] D. Proch, D. Reschke, B. Günther, G. Müller, D. Werner, "Dry-ice cleaning for SRF applications", Proc. 10th Workshop on RF Superconductivity, Tsukuba, Japan, p. 463 (2001)

[3] A. Brinkmann et al., "Dry-ice cleaning on SRF cavities", Proc. of the Europ. Acc. Conf.; Edinburgh, Great Britain (2006)

[4] D.Reschke, A. Brinkmann, K.Floettmann, D.Klinke, J.Ziegler, D.Werner, A.Grimme, Ch.Zorn, "Dry-ice cleaning: The most effective cleaning process for SRF Cavities ?" Proc. 13th International Workshop on RF Superconductivity,Beijing,China (2007).