ELECTRO POLISHING AT DESY, A SET UP FOR MULTI-CELL RESONATOR TREATMENT

K.Escherich, R.Bandelmann, D.Keese, M.Leenen, L.Lilje, A.Matheisen, H.Morales, P.Schmüser, E.Schulz, M.Seidel, N.Steinhau-Kühl, J.Tiessen
Deutsches Elektronen Synchrotron, DESY , Notkestraße 85, 22607 Hamburg

Abstract

Electro polishing of Niobium was invented in the 70' s by Siemens. Due to research in the last decade at KEK and CERN acceleration voltages around 40 MV/m were established in single cell treatment and first encouraging results were reached in multi-cell treatments done at KEK in collaboration with Nomura Plating company.

To study the electro polishing on multi-cell structures of TESLA a facility for electro polishing is under construction at DESY. It will be located in an annex to the existing cleanroom at DESY where the cavity treatment of the 1.3 GHz resonators for TTF takes place. The hardware is designed to handle 1.3 GHz single cells as well as multi-cell resonators up to the 2 x nine cell superstructure as described in the TESLA Design Report. We report on the infrastructure, the hardware and the general layout of the facility and the status of the activities. A flow scheme of the designed incorporation of the electro polishing into the standard handling and treatment sequence will be presented.

1 INTRODUCTION

At CERN Switzerland and KEK Japan single cell cavities were successfully electro polished. They showed an increase of performance in respect to cavities treated by Buffered Chemical Polishing (BCP) [1].

The first electro polishing (EP) of DESY nine cell cavities was made at KEK in collaboration with Nomura Plating at KEK. They showed encouraging results of more than 30 MV/m during commissioning of the system [2]. These distinguished results were so motivating that at the end of the year 2000 the decision was made to design and build an electro polishing facility at DESY. To keep the benefit of the well established handling procedures at DESY the facility will be integrated into the existing clean room facility.

Figure 1:View on the chemistry area before extension A) concrete work outside B) connection to cleanroom

This facility will be set up until the end of the year 2001.

2 GENERAL LAYOUT

The parameters developed at KEK are the basis for the lay out of EP process at DESY. To cover further developments on the EP process as well as to serve as a basic design for an industrial production the system is designed modular. With a total length of 4.5 m the EP bench can handle single- as well as multi-cell cavities up to the proposed superstructure [3,4]. The cavities will be held in the well established handling frames of the TTF preparation sequence. To these frames ring elements are connected which serve as power connectors and support between bench and cavity at the same time [5].

2.1 Lay out criteria

The total space required for the EP bench, acid storage and pipe connection as well as operators area is about 60 m². For safety reasons a separation between operators area and the EP bench is foreseen. Via a transparent and acid resistant safety wall the operators have full view on the operating process. In addition access to the cleanroom is required so that after the EP the cavities enter the cleanroom for high pressure rinsing (HPR) and assembly. One general baseline for construction of the EP is that during all installation the normal BCP cavity treatment and cleanroom processes have to go on. All components of the new infrastructure have to fulfil German safety

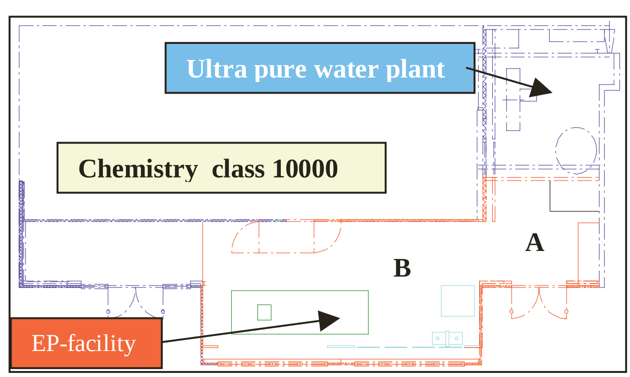

Figure 2: Ground plan of the new EP infrastructure. A= Operator area; B= process area

regulations. A complete separation of systems cleanroom, BCP treatment, and EP infrastructure is chosen. An annex to be built in front of the chemistry area of the cleanroom and a reorganization of the ultra pure water plant allow to fulfil all requirements.

2.2 Operators area

In the ultra pure water plant the reverse osmosis system, polisher and 4m³ storage tank are located. The reverse osmosis and polisher stand will be compressed to a compact system with an about 50 % reduced space requirement and shifted to the backside of the room. The ultra pure water storage tank will be shifted towards the backside of the room as well. This arrangement results in an about 16 m^2 space, that serves as operator area. The power-supply, the PLC control for the process and a PC computer based operators console will be located in this new space.

2.3 Process area

To house the EP bench and the equipment an annex just in front of the class 10000 chemistry area is under construction. It covers a space of 45 m^2. All processes in contact with the acid will be located here. In an exhaust system separated from the cleanroom and BCP area the gases of the EP process and acid will be neutralized. This central ventilation is located on top of the process area.

3 COMPONENTS

3.1 Acid storage

A 250 kg acid drum serves as storage tank for the EP process. With a Nb concentration of about 8 gr. / l acid a complete cavity treatment of 100 µm removal of acid can be done. An industrial standard drum with a PFA inliner and a PP overpack, holding the UN/DOT certification, will be filled in industry with premixed acid. When the acid is used up the drum is sent for disposal to a licensed company.

Figure 3: Acid drum with coded connection

The connecting branch is coded and coloured. To ensure that this drum is only filled with the ordered acid (H_2SO_4 96%, HF 46%, 9:1) only coded safety ball valves can be connected to the barrel for filling and emptying.
The acid drum as well as heat-exchangers, pumps, valves and pipes will be installed in one central cabinet. The central acid cabinet is connected to the EP stand via pipes, housed in a safety channel

3.2 Ventilation and gas handling

There is a permanent outgasing of the EP acid (HF and H_2SO_4) even at room temperature when the liquid is stored. During the polishing process H_2 and O_2 gases are formed and increase the natural outgasing rate [6]. In addition a continuous N_2 gas flow will overlay the acid inside the cavity to reduce the amount of H_2 down to less than 4% in volume to prevent explosive gas mixtures. To handle the gases a central ventilation is foreseen. Before ventilation a central scrubber washes out and neutralizes the HF and H_2SO_4 gases. The gas from the inside of the cavity is guided via flexible tubing to the central exhauster. The EP stand is housed in a cabinet made of acid resistant PP. Gases from the housing of the EP stand, as well as the storage cabinet and piping channel will be ventilated via a hood on top and a off-take to the central ventilation unit.

3.3 Heat exchanger:

First investigation on the parameter settings show that the

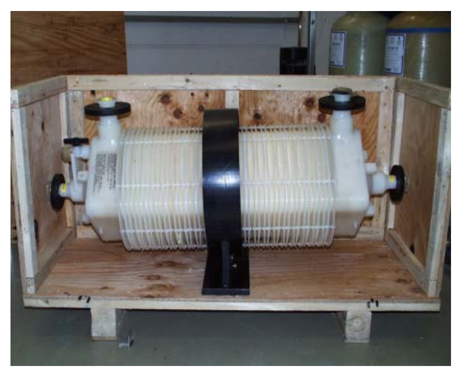

Figure 4: Heat exchanger after acceptance test

acid has to be preheated to have the starting point of polishing from the beginning on [6]. To have the capability to heat or cool the acid, two heat exchangers with a capacity 12 kW / 20°C each are foreseen. One exchanger is installed in the inlet line for preheating or cooling and one in the feed back line to the drum. The second heat exchanger allows to take away the heat of the process (chemical reaction and current flow via the acid). In case of overheating of acid the flow scheme allows to run both heaters parallel for cool down.
The acceptance test for the industrial manufactured exchangers has been made successfully. If it is necessary the efficiency of the heat exchangers can be raised by a connection to a chilled water system of the cleanroom.

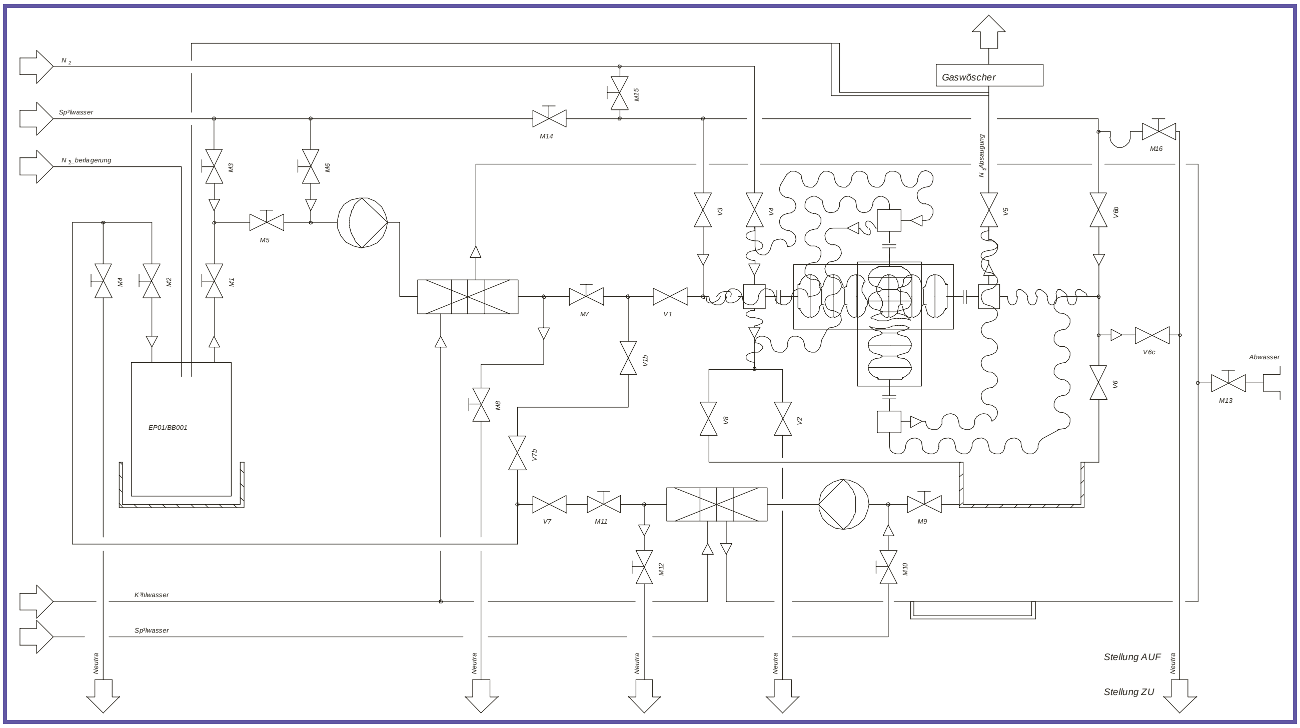

Figure5: Flow chart of the EP acid and rinsing circuit

3.4 Pumps and piping

Due to ventilation of H_2 and O_2 gas the cavity has to be at normal pressure. For this requirement a two pump version for acid circulation is designed. Pump one serves as filling pump for the cavity which is connected to the normal atmospheric pressure. Via a skimmer the acid drains from the cavity to an intermediate pressure free storage tank. Pump two refills the acid from this tank located below the EP bench to the acid drum. The pumps chosen are air powered, self priming, diaphragm pumps with a maximum capacity of 50 l/min at 6 bar made of PTFE.
The tubes, fittings and valves are industrial standard for pure fluid handling and made of PFA. To guaranty a minimum flow rate of 10 l/min this system has an inner diameter of 1”.

3.5 Rinsing water and reconditioning

A neutralization and filtration system for rinsing water is operational for the BCP process since several years now. To reduce investments it is foreseen to use this system to neutralize the rinsing water of the EP with this existing system. It had to be shown to the German administration that this system is also capable to handle the mixture of HF and H_2SO_4. A test sequence made in collaboration with an industrial company, is successfully done. Licensing procedures for this process are now going on at the approving authority.

3.6 Power supply

A water-cooled power supply of DESY standard will be used. A built-in feature is the stabilized voltage and current control by an integrated PLC. For EP on a double 9 cell structure up to 1000 A of current have to be expected. The technical data of the power supply are given in table 1.

Table 1: Technical data of the power supply

Power connection	3 x 400V	91 A
Load power	78 KVA	19 mm (0.75 in)
Output	0-30 V	0-1400 A
Cooling	Water cooling	8 l/min 20 C

4 SAFETY CRITERIA

The EP system covers 2 general safety lines. Line 1 is a general hardware safety and line 2 is the process safety. All components installed in the EP are ordered according to industrial standard and will come with license certificates. The German TÜV is a permanent partner during design phase. The EP system will hold the same high safety criteria for operator and environmental safety like the chemistry in use for the BCP treatment. An additional feature is that during the process and in case of an accident no operator has to enter the EP housing for manipulation.

4.1 Hardware safety

In case of power breakdown the whole system has to go into a secure position. Water from the municipal system as well as compressed air from a storage vessel will be available even when electrical power fails. To drain the acid out of the cavity, the EP bench can be tilted to vertical position by a manual manipulator [5]. Gravitation will force the acid to drain into the intermediate storage tank located below the stand. The pump bringing the acid back to the storage drum is driven by compressed air. It can be started manually from a safety panel. For rinsing municipal water can be connected manually as well. All valves are spring loaded and go to a defined position of normally open (NO) or normally closed (NC) when power fails. The lines for cavity ventilation and draining have NO valves integrated. To prevent a mixing of water and acid during power drop the lines are equipped with NC valves.

4.2 Process safety

For system safety the EP processes will be controlled by a PLC computer. Parameter setting is made by a PC with process visualization screen. Three levels of system safety are designed. Level one will ensure personnel safety. For this personal interlock all doors are equipped with sensors which stop all motors and pumps. In addition no process can be started if these interlocks are activated. Gas sensors measure H_2, HF and N_2 concentration continuously and will cause an acoustic signal for warning.

Level two is activated by liquid sensors which indicate a leakage of acid. The process will stop and drain the acid into a rinse water tank.

The third level will interrupt the process and restart it when the signal level is back to normal. Acid level sensors will stop the pump, hydrogen sensor and temperature sensors will shut off the power supply.

5 ACKNOWLEDGEMENT

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