A NEW HIGH PRESSURE RINSING SYSTEM ESTABLISHED AT DESY

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Abstract

In 2007 a new High Pressure Rinsing (HPR) system was developed at DESY and is operational since 2008. Beside implementations of improvements on high pressure rinsing systems lay out, one goal of the design is to set up a prototype high pressure rinsing stand applicable in industry and in an industrial production line. After commissioning, the new high pressure rinsing stand became a standard hardware in use for the cavity preparation processes at DESY. We report on design specialities and experiences gained so far in more than 300 rinsing processes of about 2 hours length.

INTRODUCTION

World wide several high pressure rinsing systems (HPR) are operating successfully. They are in use for single and multi cell cavities and differ in the individual design. All systems share mostly the general common lay out, consisting of a ultra pure (UP) water plant supplying the HPR water, a compressor to pressurize the ultra pure water, a filter unit to hold back particulates, a cane holding the spraying nozzle and the motion system to guide the water jets from the nozzles towards all parts of the resonator surface. Most commonly piston based pumps are in use to set up the water pressure. These pumps are oil lubricated and compress the water via a diaphragm. This design bears the risk that there is a direct pass of oil to the UP water in case of failures of the diaphragm or seals. In addition the non linear movement of the pistons introduces pulsation to the water jet and can lead to vibrations of the spraying cane. For vibration reduction damping elements are introduced into the high pressure feed line to the cane.

At DESY a new HPR system had to be set up to increase the turn around time of cavities in the on going cavity preparation and to have a back up system in case one HPR stand fails. In this new HPR system the experiences of the last years and improvements in the vision of an industrialization of the HPR process had to be included.

HPR SYSTEM

The new HPR system at DESY had to be added to the existing clean room and infrastructure. A clean room cabinet with ISO 4 air quality (Fig. 1) and a buffering UPW are added as annexes to the DESY clean room. The new HPR stand is accessible from the ISO 4 assembly area of the existing clean room. To prevent strong variations of the UP water system a buffer tank of 500 l capacity with an independent UP water system (Fig. 2) for stand by operation is integrated in the DESY UP water loop.

Figure 1: View on the new HPR cabinet.

GENERAL PARAMETERS

Table 1: Overview on Hardware Installed in the New DESY HPR

HPR pump	
HPR pump type	Turbine Type Sunflo® P3000
Pressure	30-100 bar
UP water volume @100bar	1,2- 6 m3 /h
UP water temperature:	20-80 C by pre setting on program start
Spray head	Standard DESY spray head 8 nozzles
Turbine bearings	Whole metal bearing lubricated by UPW
Turbine material	Stainless Steel
Surface quality of turbine	polished Ra 0,2 µm
Motion system	
Vertical motion drive	Stepping motor + spindles drive
Bearings for vertical motion	Linear bearing hidden behind separating
Rotation drive	Stepping motor + Teflon®[3] timing belt
Rotational drive bearing	Ceramic Stainless non lubricated central bearing
HPR Cabinet	
Cabinet air quality	ISO 4 and better
Air speed control.	0,15-0,60 m/sec variable
Air distribution	3 filter fan units automatic pressure drop control
Cabinet material	Stainless steel

HPR PUMP

For pressurizing the UP water a commercial turbine Type Sunflo 3 ®[1] is installed. The turbine with a rotation speed of 19000 turns per minute shows maximum pressure variations of <= 1 bar at 100 bar system pressure and a capacity of up to 6 m^3/hour (@100bar). This design allows supplying up to 5 HPR stands with DESY nozzle head installed.

Gearbox and turbine are separated by a control space. The turbine and turbine body are electro polished and lubrication free. The turbine is equipped with whole metal bearing, lubricated and controlled by permanent water flush. Drain water from the turbine as well as abrasives form the bearing exit on a flush port installed. This port is usable for quality control of the bearing and leakage if the gearbox seals.

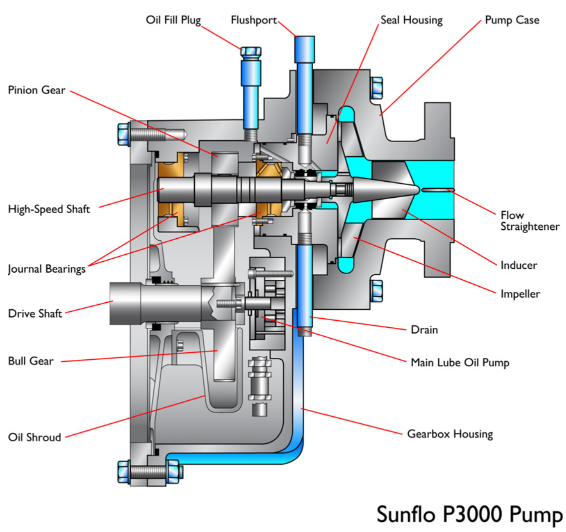

Figure 2: Cross section of the HPR pump.

The water pressure can be regulated from 30 to 100 bar (maximum) by a frequency driver with a setting precision of 1 bar.

MOTION UNIT

HPR Systems, in use at DESY since 1993, is based on the motion of the cane from an underneath installed motion unit. This design bears the risk that particulates and abrasives from seals of the drain system enter the motion system and could be guided into the cavity interior. The new HPR design fixes the position of the spraying cane while the cavity performs the three dimensional motion.

General Lay Out

A central post, housed in a separate part of the cabinet, ventilated by the exhausting air of the HPR cabinet, takes all forces coming from motors, motion systems and the load by a cavity. Its deformation under the full load capacity of 150 kg is measured to be less than 0,2mm in respect to the parallel resonator axis. For vertical motion a stepping motor with gearbox and spindle drive is installed. The rotation of the resonators, hanging on the central bearing [®2] (Fig.3), is realized by a timing belt drive made from Teflon. The timing belt is driven by a stepping motor connected to the central post.

Ball Bearing of the Central Cavity Fixture

The central part of the cavity fixture, a lever arm motion unit, holding the resonator during rinsing. The lever arm is located on top of the cavity. During design phase a 1:1 plastic model was fabricated to study the influence of the fixture to the laminar flow. A ball bearing made of ceramic balls and stainless bearing housing (Fig.4) is installed in the centre of the lever arm. The cavity adapter, as well as the rotational driving unit is connected to this central ball bearing.

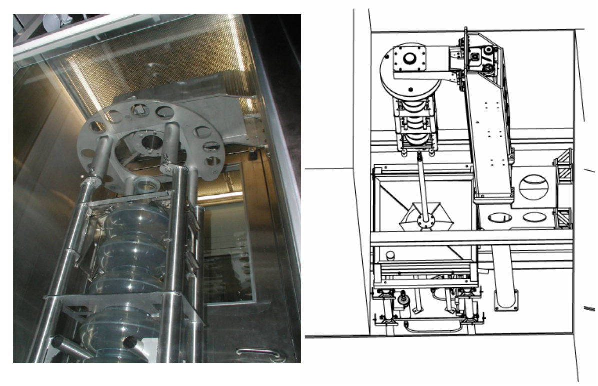

Figure 3: Left: View on the cavity adapter lever arm. Right: Schematic of the HPR system with lever arm motion unit and cavity installed.

To prevent abrasives form the timing belt or ball bearing entering the ISO 4 area, the rotating parts are sealed by a rotational shaft seals made from Teflon.

UP Water Supply

The New HPR pump is capable to feed up to 5 HPR stands in parallel. A minimum water flow of 6m3/h is required by the turbine in order not to go into cavitations,

Figure 4: Left: View on the ceramic central ball bearing Right: 1/1 plastic model of the cavity adapter lever arm.

even if the actual set up at DESY only consumes 1to 1.5 m^3 /h. The DESY UP water plant allows feeding up to a maximum of 20 l / minute of UPW. To suppress strong flow variations in the existing UPR plant at start up of the new HPR a separate UPW supply is installed. It is feed continuously from the main UPW plant. The HPR UPW system buffers the turbine water supply in a tank of 500 l storage volume, levelling the non linear water consumption during start up and shut down of the turbine. In addition it allows to circulate the UPW continuously threw all piping and valves of the HPR system during stand -by operation. The water quality is controlled by on line TOC, resistance and temperature control sensors.

Computer Control and Visualisation

The HPR stand is controlled and steered by a Siemens S7 PLC. For communication, display of parameters and manual operation the PLC can be remotely controlled by a PC. All system parameters as well as the actual position of the cavity (rotation and vertical position) are displayed and stored on disk.

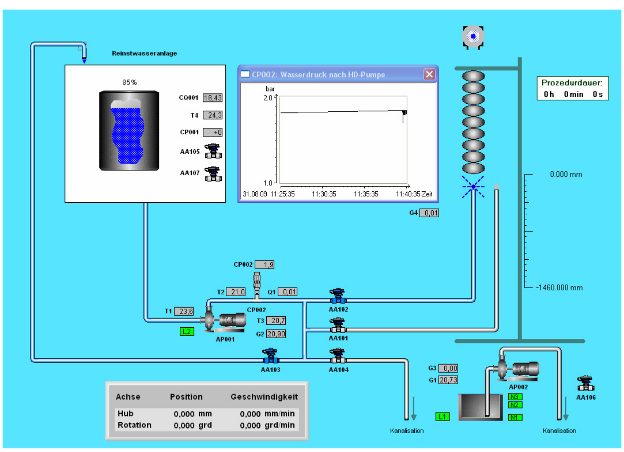

Figure 5: View on the control and steering panel.

DATA

In HP rinse treatments redone after RF measurements of cavities with the new HPR stand, improvements on field emission limits were seen (Fig. 6). The statistics of cavity treatments exclusively performed with the new HPR system since 2008, show average acceleration gradient of 31,8 MV/m and applicable gradients in respect to the maximum allowed gradient for FLASH ($1*E^{-2}$ mGy/min) of 27,5 MV/m.

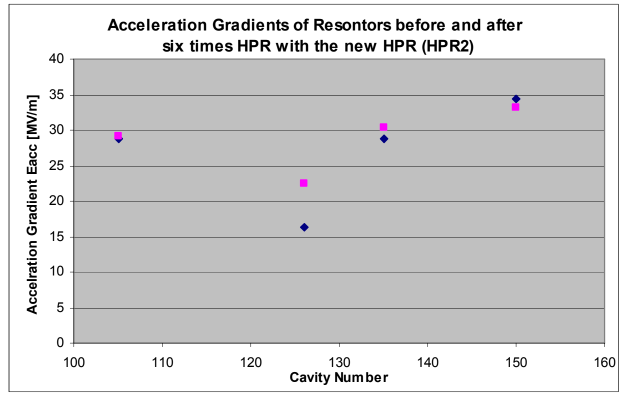

Figure 6: RF test results of nine cell cavities re treated with the new HPR system [**Red**= Eacc after re treatment; **Blue**=Eacc before treatment].

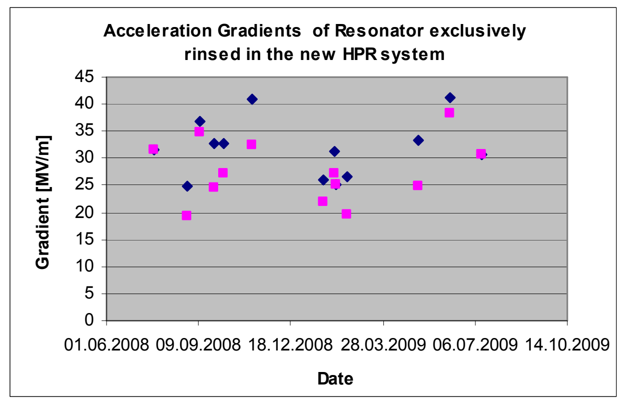

Figure 7: RF test results of nine cell cavities exclusively HP rinsed in the new HPR system [**Blue**=Maximum acceleration gradient; **Red**: radiation acceptance limit Eacc for FLASH [0.01mGy/min].

CONCLUSION

At DESY a new high pressure rinsing system was developed and is operational now. It is shown that the general design of central ceramic ball, motion units, lever arm and cavity adapter are applicable in class ISO 4 conditions are not origin of particulates. A turbine in use as HPR pressure rings pump leads to a vibration free feeding of the spraying cane. In more than 300 HPR preparation cycles of 2 hours length the new HPR showed a robust and reproducible behavior. Applicable acceleration gradients [Eacc @$1*E^{-2}$ mGy/min] of up to 41 MV/m are reached. The new HPR system is qualified and became a part for the on going cavity preparation at DESY.

REFERENCES

[1] Sunflo SPX Process Equipment Bran+Luebbe GmbH Operation Werkstrasse 4, D-22844 Norderstedt Germany
[2] Ball bearing by E & K Wälzlager GmbH Max Plank Strasse D -52499 Baesweiler, Germany.
[3] Timing belt by Wilhelm Herm. Müller GmbH & Co.KG Postkamp 14 D 30159 Hannover Germany