A.9: Development of prototype upgraded titanium sublimation pump (TSP) controller

Existing titanium sublimation pump (TSP) linear mode controllers with maximum power rating of 300 W are based on the principle of phase angle control in the primary of the main transformer with a sublimation pattern of two pulses each of one minute of 'ON' separated by a one minute of 'OFF' period for 1st pump followed by a similar pattern for 2nd pump. These controllers are designed to operate with a specific configuration ('U' hairpin) type of filaments and power sequentially two TSP pumps (filaments) with a single sublimation power set value. It was observed that, due to resistance change in one of the filaments/failure of a filament, controller used to trip as a result of overshooting of the current/voltage and was unable to sublimate the second filament leading to underutilization of sublimation pumping action for another pump.

In view of the above, one prototype microprocessor based power controller, as shown in Figure A.9.1, rated for 60 A_{max}, 10 V_{max} (variable 600 W_{max}) output was developed. This controller is capable to energize two TSP in a specific sequence of two 75 seconds (15 seconds ramp up + 60 seconds dwell period) of 'ON' period separated with one minute of 'OFF' period followed by a similar sequence to other pump with a preprogrammed idle time ranging from 1 min. to 7 days depending on the vacuum conditions.

Fig. A.9.1: Titanium sublimation pump (TSP) controller & transformer.

The main functional features of new controller are: compatibility with spiral type and 'U' hairpin type of filaments (85% Ti + 15% Mo.) with reduced cable drops, independent set power inputs, overvoltage, and overcurrent trip settings to both the filaments irrespective of their resistance variations. This feature enables us to use the filament even if the other one is open or beyond the state of use and hence, reduces the frequent need to enter into tunnel for resistance measurements. The controller programming is through soft membrane keypads visible on a bright LCD display (240 mm x 60 mm) with remote programming through Ethernet or RS485 mode through user application GUI. The controller, a half U size, derives similar features in 'Bake' mode for simultaneous parallel degassing of filaments.

The controller was subjected to exhaustive functional testing on different resistive filament load in lab and then on a UHV test setup on filament loads of 'U' hairpin type (28.74 mΩ, 34.63 mΩ, 30.66 mΩ) and spiral type (103.17 mΩ, 101.77 mΩ, 98.95 mΩ), respectively.

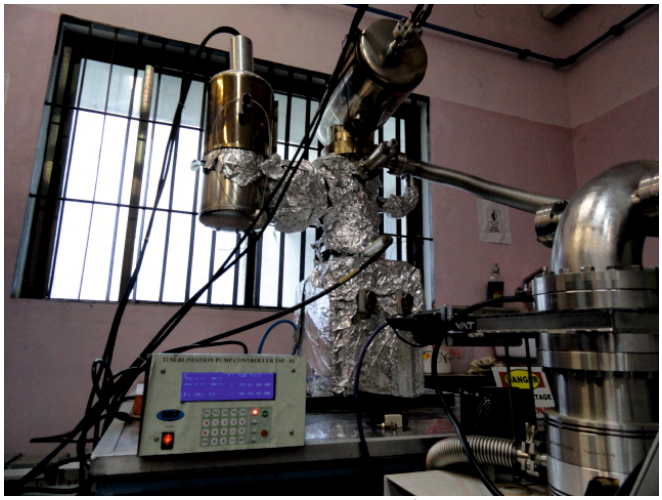

Fig. A.9.2: Testing on UHV test setup of two pumps.

The functional testing of prototype controller was carried out on UHV test setup as shown in Figure A.9.2 by subjecting filaments to three different set of nominal currents (44 A, 46 A, 48 A) with 240 minutes of delay in successive firings. The load resistance was taken after successive fixed sets (before & after) of pulsed operation. The operating parameters were acquired in the application GUI. The testing was carried for a period of three months on continuous basis.

Table A.9.1: Resistance of both type of filaments with different number of pulses of sublimation at different currents.

I =44 A	Hairpin (mΩ)			Spiral (mΩ)		
Pulses	F1	F2	F3	F1	F2	F3
	28.74	34.63	30.66	103.1	101.7	98.9
118	41.13	43.31	40.21	107.6	107.1	110.7
224	49.90	48.09	47.36	110.7	107.8	110.8
I =46 A	Only F1 of each type was sublimated					
0	49.90			110.7		
528	54.62			123.25		
I =48 A	Only F1 of each type was sublimated					
0	54.62			123.25		
528	62.67			142.90		

Table A.9.1 indicates that controller is capable to cope up with successive higher resistances with incremental upward settings of current values for the optimal sublimation performance. The controller after testing in UHV test setup has been installed in Indus machine vacuum segment-4 along with other existing controllers for observing its field performance.

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