ADVANCED PRESSURE TECHNOLOGY

Product Note, PN 441
Pressure Conditioned (PC) Diaphragm Option

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Some wafer processes require improved precursor canister valve pressure drop and repeatability under vacuum at elevated temperature. AP Tech has developed a retrofittable diaphragm treatment to address this challenge.

A pressure conditioning treatment was developed for diaphragms to achieve improved pressure drop uniformity during high temperature thermal cycling under vacuum. The typical valves used are 4 series valves with 0.5 C_v such as AP 4550 and 4657 with H1 or H3 high temperature options. Each valve has two diaphragms with the non-process diaphragm vented with a hole. Please see product note #427 for a summary of valve series high temperature options.

The treatment process involves stacking and clamping the diaphragm pair in a fixture and applying five 3,000 psig (207 bar) pressure cycles to the wetted side of the diaphragm stack. Standard diaphragms are designed to be operated above this pressure. The clamping point of the diaphragm in the conditioning fixture is outside the radius used to seal when later installed in a valve, thus not compromising the sealing surface of the diaphragm. The clamping does leave a faint witness mark which helps one identify a conditioned diaphragm compared to non-conditioned. The vented diaphragm has a black colored dot for identification. The diaphragm stack does not need to remain a matched pair for use.

Validation testing was performed at ambient temperature and 150° C, with vacuum of 30 torr at outlet of valve and 700 sccm flow. Nine test valves were cycled at a time and pressure drop was recorded for each individual valve. Average pressure drop and variation for standard diaphragm with and without the pressure conditioning treatment is summarized. The matrix includes results of three sequential thermal cycles, ambient to 150° C.

		Avg. @ Ambient Temp.	Cycle #1 @150° c	Cycle #2 @ 150° c	Cycle #3 @ 150° c
Standard Diaphragm	Average, Δ Torr	3.75	11.71	11.19	15
	Std. Dev., Δ Torr	0.88	7.65	6.41	10.98
Conditioned Diaphragm	Average, Δ Torr	2.64	4.59	4.36	4.36
	Std. Dev.,Δ Torr	0.19	0.22	0.1	0.11

Thermal cycling demonstrates the improved pressure drop and reduced variability of pressure conditioned diaphragms vs. standard diaphragms without the conditioning treatment

Valve cycle testing was performed to 500,000 cycles at vacuum and 150° C with fourteen thermal cycles throughout the test to verify performance. The diaphragms passed actuator and thermal cycling without

failure and with little change in pressure drop throughout the test. Testing per above conditions, pressure treated diaphragms have stable pressure drop up to 200° C. As temperature increases above 200° C, diaphragms exhibit greater pressure drop variability.

Pressure conditioned diaphragms are now an available option. One needs to specify an A after H1 or H3 (H1A or H3A) to select pressure conditioned diaphragms in a valve or manifold. The diaphragms are also available separately: part number # 51-96003691, solid pressure conditioned diaphragm and # 51-96003692, vented pressure conditioned diaphragm.

4 series valves with pressure conditioned diaphragms achieve a 10% improvement in flow coefficient (Cv) as measured by SEMI F32 measured at ambient temperature and positive pressure.

All other H1A or H3A valve parts including the actuator, seat and body are the same as respective H1 or H3 versions.

Due to the additional process and handling, pressure conditioned diaphragms do cost more than standard.

Pressure conditioned diaphragms are not necessary for all applications, as not all processes require improved pressure drop. The standard 4 series valves continue to be successfully used for the majority of precursor delivery applications without need of enhanced performance.