



Global Dispense Technology

Comparison of two Diaphragm Pumps for CMP Slurry Applications

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I. EXECUTIVE SUMMARY

Laboratory testing was completed by Global Dispense Technology, Inc. (GDT) to compare two different diaphragm pumps for GDT's slurry dispense systems, referred to as Pump B and Pump C in this report. The test pumps included a diaphragm pump that has been used in CMP slurry applications for several years, and a new diaphragm pump. The two pumps were of a similar size, with a maximum flow rate of approximately 13 gallons per minute (gpm).

A CMP fumed silica oxide slurry was used to test the two pumps. This slurry had been used in previous pump testing for approximately 25 hours. Samples were collected simultaneously from each pump throughout the test period. These samples were analyzed with equipment that measured the particle size distribution of the slurry particles. Slurry particle size distribution was analyzed with a Particle Sizing Systems (PSS) Accusizer 780/SPOS unit.

Increases or shifts in the particle sizes and/or distributions indicate that the pump is adversely affecting the slurry. These changes in the slurries will ultimately affect CMP polish results, and thus must be minimized by the slurry distribution system.

The results of this testing indicated that the two diaphragm pumps had very similar impacts on the slurry during the 28 hour test period. According to the manufacturer, Pump C still has some minimal design changes that will be completed prior to product release. Based on these results, GDT recommends that either pump is suitable for CMP slurry distribution systems.

II. PURPOSE

The purpose of this testing was to evaluate two different diaphragm slurry pumps in order to determine the suitability of each for GDT slurry distribution systems. The test pumps included a diaphragm pump that has been used in CMP slurry applications for several years, and a new diaphragm pump. The two pumps were of a similar size, with a maximum flow rate of approximately 13 gallons per minute (gpm).

These pumps were installed in a test bench system and operated in slurry service. The effects of the pumps on the slurries were evaluated with a PSS slurry particle size analyzer. The specific method used by the PSS unit is discussed in Section III of this report.

A fumed silica oxide slurry was used for this test.

III. TEST PROCEDURE

III.A Test Stand Setup

The pump test stand consisted of two separate pump test fixtures, such that pump testing took place concurrently. Each fixture had a slurry tank, a slurry pump, an in-line flow and pressure meter, a manual 4-port slurry sample valve, an in-line back pressure gauge, and a static back pressure regulator. The tubing size used was a combination of 3/4" and 1" diameter PFA. Each fixture has approximately 30 feet of tubing. A schematic of the pump test stand is included in Figure III.1.

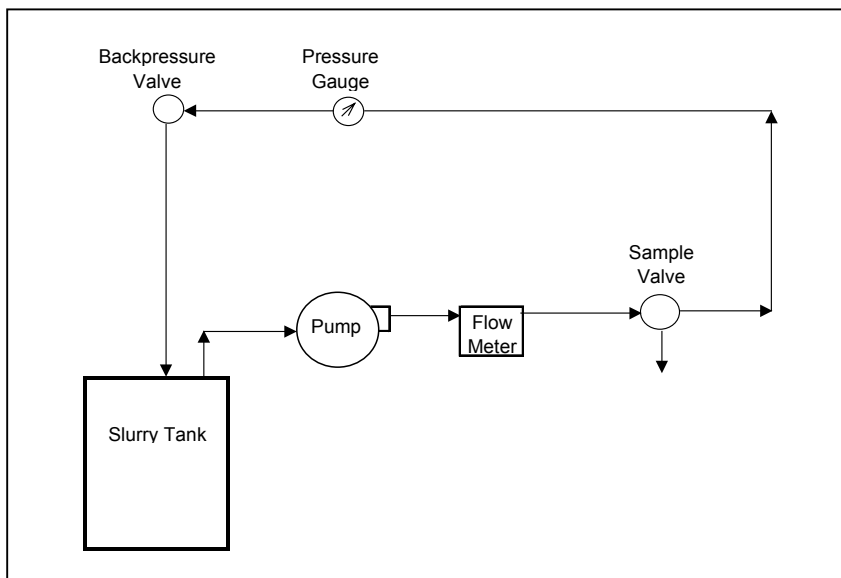


Figure III.1. Pump Test Stand Schematic

III.B Test Methodology

Prior to testing, the drum of slurry was circulated through one pump for a minimum of one hour for thorough mixing. Approximately half the slurry was then pumped into the slurry tank on the second pump test fixture. Each pump test fixture was operated in parallel for a total of approximately 28 hours. The pumps were operated one shift per day. At the end of the shift, the pumps were shut off and the slurry lines remained full of slurry overnight.

Grab samples were collected from each pump test fixture at varying time intervals. All samples were analyzed with the PSS unit to determine the tail end particle size distribution. The distribution curves were plotted and tracked to determine if the slurry particle size distribution shifted during the test, indicating that the pump was affecting the slurry. The results from the testing are included in Section IV.

III.C Particle Sizing Systems Unit

An Accusizer 780/SPOS Single Particle Optical Sizer, from PSS was used to analyze all samples collected during this test. The method used by this instrument to measure particle size is called “single particle optical sensing” (SPOS). The SPOS technique is performed by first diluting the slurry to an acceptable level with a highly repeatable autodilution method. Then, the particles are counted and sized one at a time as they pass through the photozone of the sensor, resulting in a true particle size distribution (PSD) utilizing both light scattering and light extinction methods. The minimal particle size measured by this unit is 0.6 micron, therefore in this application the PSS unit provides only “tail end” particle distribution data.

This unit is capable of on-line analysis. For purposes of GDT’s evaluation, however, grab samples from the pump fixtures were collected in sample bottles, then injected into the PSS unit using laboratory syringes. Deionized water was not available for the unit, so distilled water was used for dilutions and rinsing.

IV. RESULTS AND DISCUSSION

For purposes of this report, the pumps are referred to as “Pump B” and “Pump C”. Pump B is a diaphragm style pump that has been used in slurry applications for several years, and Pump C is a new diaphragm pump that is close to being released.

The slurry tested was a fumed-silica oxide slurry. This slurry was used in prior pump testing for approximately 25 hours, and therefore had some initial shear. Table IV.1 below lists the operating conditions and sampling intervals for this test.

Sample Number	Air Pressure, psi/ Pump B stroke setting		Back Pressure setting, psi		Flow rate range, l/min		Total time at sample
	B	C	A	B	A	B	
1	60 psi /5	50 psi	15 psi	15 psi	15-20	15-20	1.5 hrs
2	60 psi /5	50 psi	15 psi	15 psi	15-20	15-20	4.5 hrs
3	60 psi /5	50 psi	15 psi	15 psi	15-20	15-20	7.5 hrs
4	60 psi /5	50 psi	15 psi	15 psi	15-20	15-20	11 hrs
5	60 psi /5	50 psi	15 psi	15 psi	15-20	15-20	14 hrs
6	60 psi /5	50 psi	15 psi	15 psi	15-20	15-20	15 hrs
7	60 psi /5	50 psi	15 psi	15 psi	15-20	15-20	19 hrs
8	60 psi /5	50 psi	15 psi	15 psi	15-20	15-20	22 hrs
9	60 psi /5	50 psi	15 psi	15 psi	15-20	15-20	27.5 hrs

Table IV.1. Operating conditions and sampling intervals

Figures IV.1 and IV.2 illustrate the PSS tail-end particle size distribution obtained from this test.

As observed in Figures IV.1 and IV.2, the tail-end particle size distributions for each pump were very similar over the test period of approximately 28 hours, indicating that the pumps affected the slurry by the same amount.

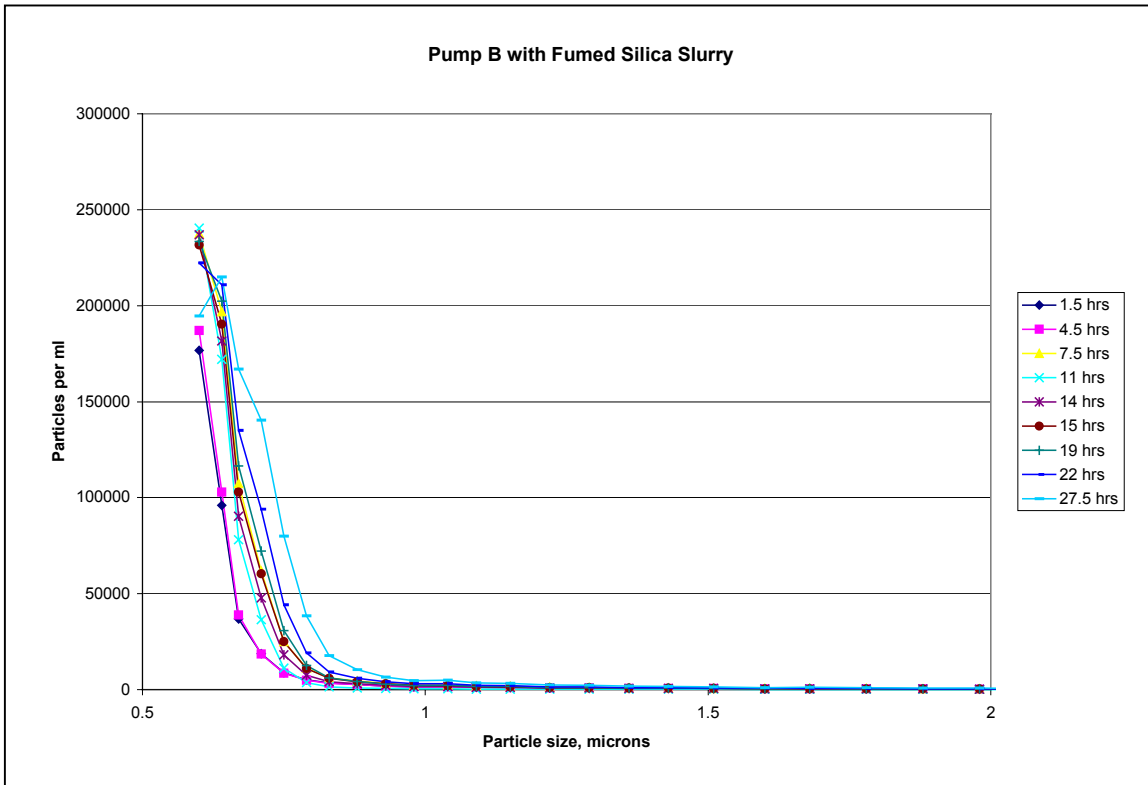


Figure IV.1. Pump B PSS Tail-end Distribution.

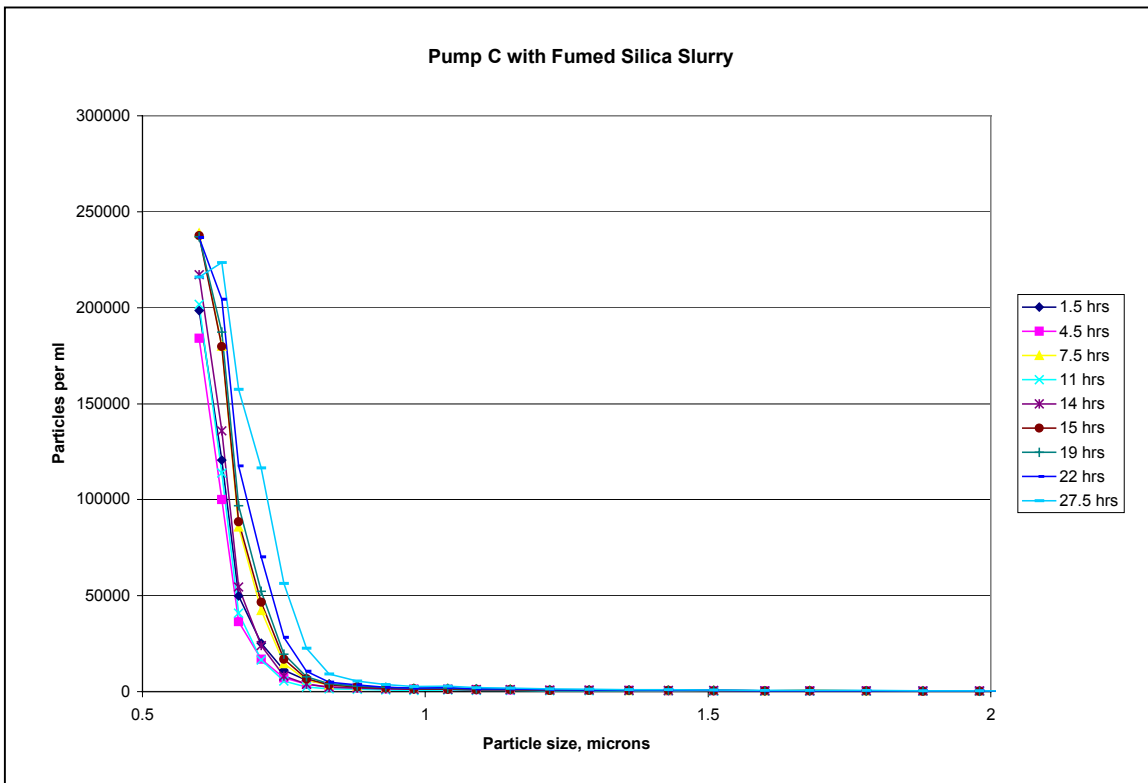


Figure IV.2. Pump C PSS Tail-end Distribution with Slurry A, Test 1.

V. CONCLUSIONS

The results of this testing indicated that the two diaphragm pumps had very similar impacts on the slurry during the 28 hour test period. According to the manufacturer, Pump C still has some minimal design changes that will be completed prior to product release. Based on these results, GDT recommends that either pump is suitable for CMP slurry distribution systems.