Mykrolis

TO: Joseph Smith, Michael Clarke, Christopher Wargo, Jerome Couelle, Xavier Gabarre, David Stockbower, Bipin Parekh, Ross Stalker
CC: Gerry Mackay
FROM: Bill Wu
RE: Foaming effects of Levitronix's pump
DATE: April 11, 2003

Summary

The Levitronix pump generates fewer bubbles than bellows pump at the same operating condition. The 0.2um Guardian HPX filter has an excellent de-bubbled effect.

Background

There was a concern on the foaming effects of Levitronix's pump in the Bulk Chemical Delivery System (BCDS). The purpose of this test was to characterize foaming effects of Levitronix's pump in various surface tension solutions.

Experimental

Figure 1 shows a schematic of the test stand. This system re-circulated DI water through a 0.2um Guardian HPX filter with a Levitronix pump (BSM 3.1C) at various concentration of surfactant (0.001% to 0.1% of Triton-X 100). The turn over rate was 7 minutes at a flow rate of 3 GPM. The pressure of the system was measured by a pressure gages. The particle counts of the system is monitor by a PMS SO2 particle counter before and after the filter. The samples of bubble counts were taken only after at least 24 hrs running at each set of operating condition, which let the filter take out solid particles from the system.

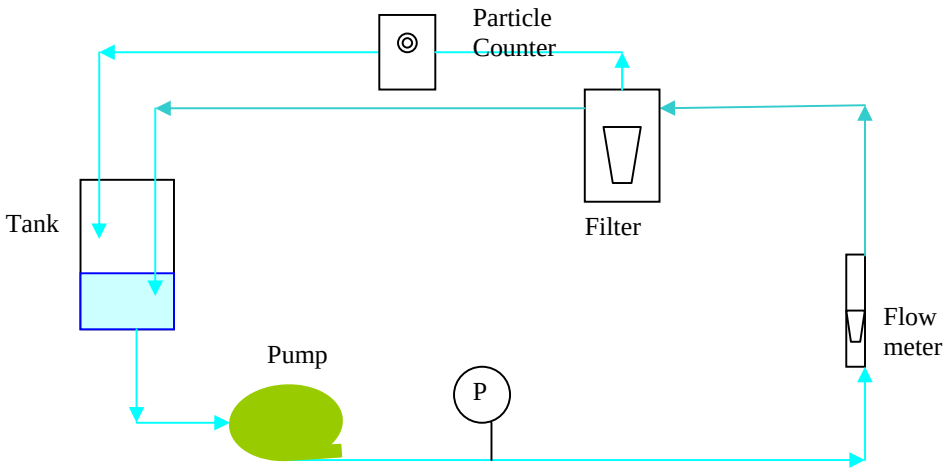
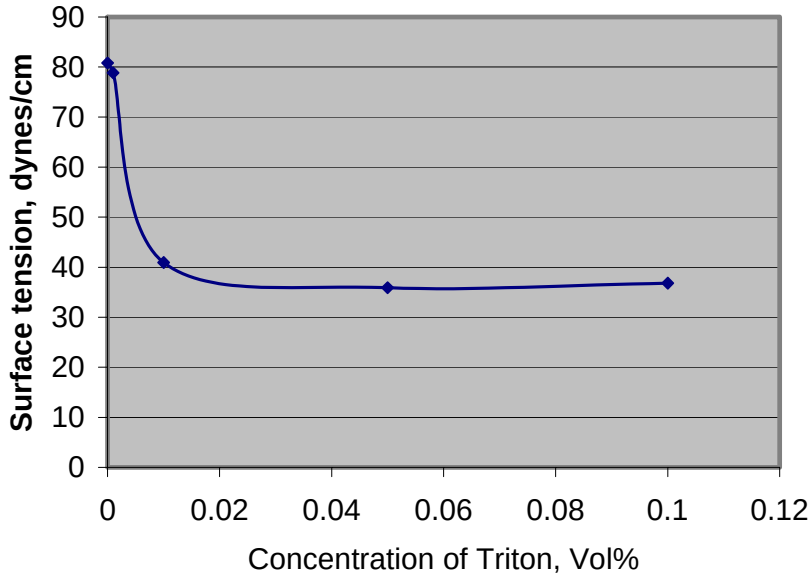


Figure 1. Schematic of the test stand

A PFI bellows pump was also installed in the test stand to compare.

Figure 2 shows the Surface tension of aqueous solution of Triton-X 100 as function of their concentration. The surface tension of solution of surfactant decrease sharply as the bulk concentration of surfactant increased. For Triton-X 100, the critical micelle concentration (CMC) was less than 0.05%, above which the surface tension remains virtually unchanged. The surface tension was measured by CSC-DuNouy Tensiometers.

Fig.2 Surface tension of aqueous solution of Triton-X 100 as function of their concentration



Results

1) **Effects of surface tension on the bubble counts**:

Figure 3 shows the effects of various concentration of Triton-X 100 on the bubble generation of both Levitronix and bellows pump. At the same operating condition, the more Triton-X 100, the more bubble counts. In fact, the surfactant, i.e. Triton-X 100, increased the bubbles forming by reducing the surface tension. The bubble counts in the figure 3 was re-plotting as function of surface tension in the figure 4. At certain range of the surface tension, the bubble counts is in proportion to the surface tension. It was apparently that the bellows pump generated more bubbles than Levitronix pump due to its violent movement at bellows where fluid is push through.

Figure 3. Comparison of bubbles generated by Levitronix (3200 rpm/3.0 gpm) and bellows pump (1.0 gpm) with various of concentration of Triton-X 100

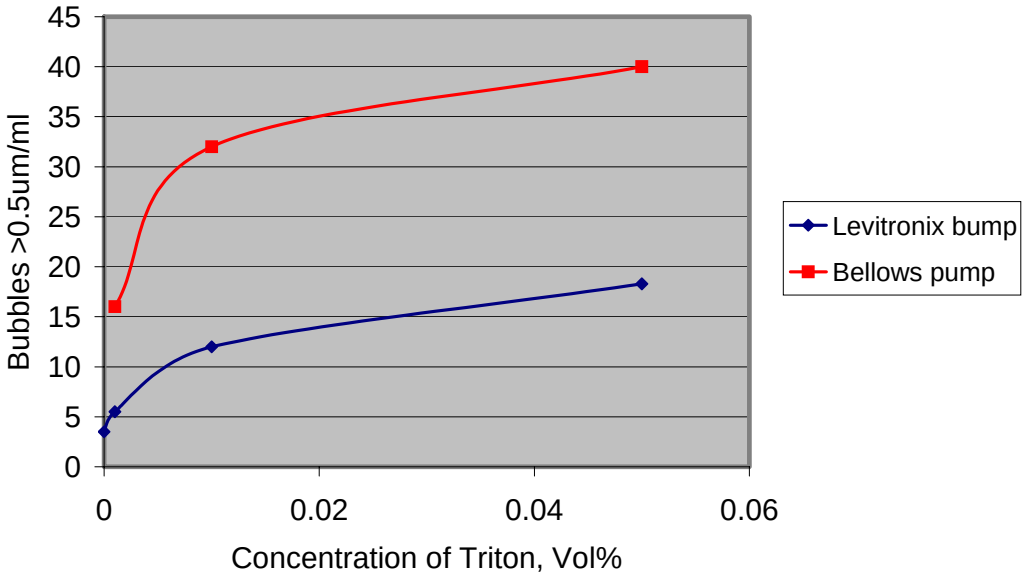
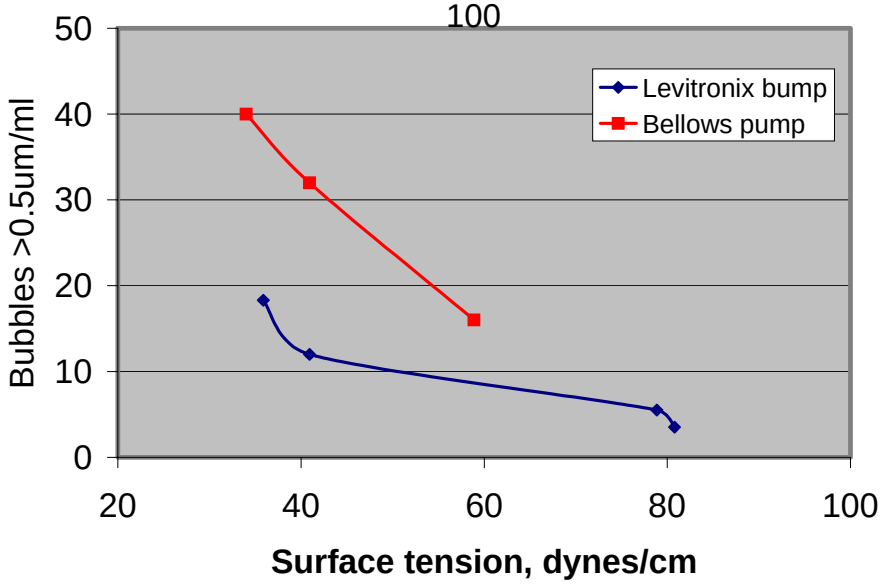


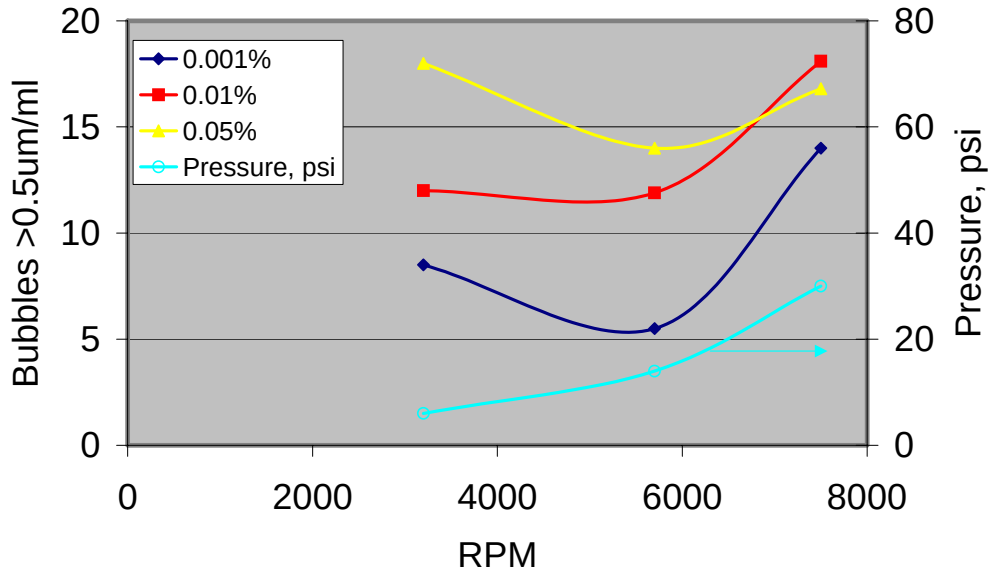
Figure 4. Comparison of bubbles generated by Levitronix (3200 rpm/3.0 gpm) and bellows pump (1.0 gpm) with various of surface tension of aqueous solution of Triton-X 100



2) Effects of RPM and pump pressure on the bubble counts

Theoretically, the higher RPM, the higher bubble counts. However, the bubble counts at 5700 RPM was relatively lower than 3200 RPM, please see figure 5. It probably was caused by the higher bump pressure at 5700 RPM, which prevent the bubble forming.

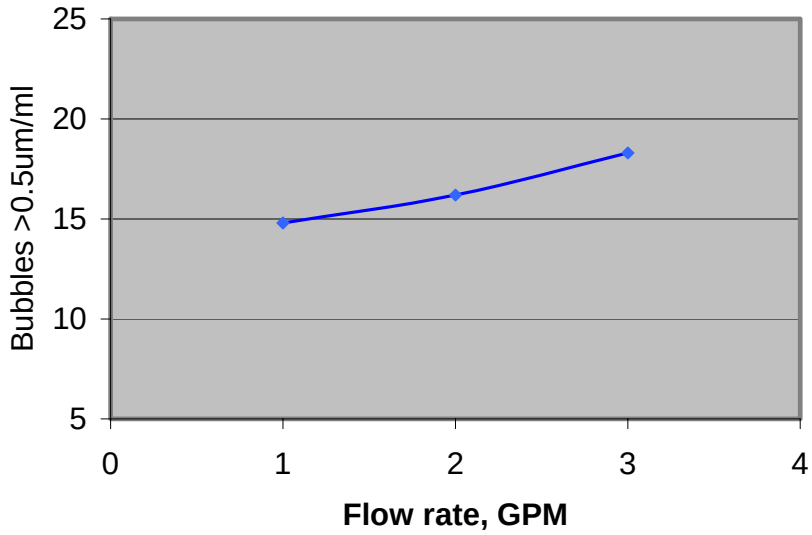
Figure 5. Effects of RPM and pump pressure on the bubbles counts with various concentration of Triton-X 100



3) Effects of flow rate on the bubble counts

As shown on the figure 6, at the same the RPM and the bump pressure, the bubble counts was slight increase as flow rate increased. The flow rate was controlled by varying the pressure load at down stream of bump. The releasing the pressure load at down stream would promote bubble growth at a relative lower pressure.

Figure 6. Effects of flow rate on the bubbles counts with Levitronix pump (3200 rpm/5.0 psi and 0.01% of of Triton-X 100)



4) De-bubble effects of hydrophilic filter

As shown in the figure 7&8, the 0.2 Guardian hydrophilic UPE filter has an excellent de-bubbled effect. There was a virtually bubble free solution obtained after the filter.

Figure 7. De-bubble Effects of 0.2um Guardian HPX with Levitronix pump at flow rate of 3.0 gpm in the 0.01% Triton

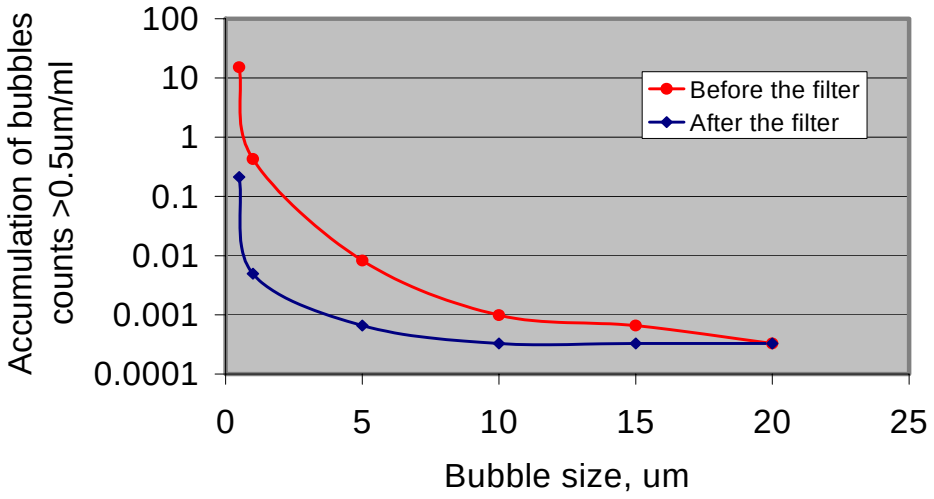
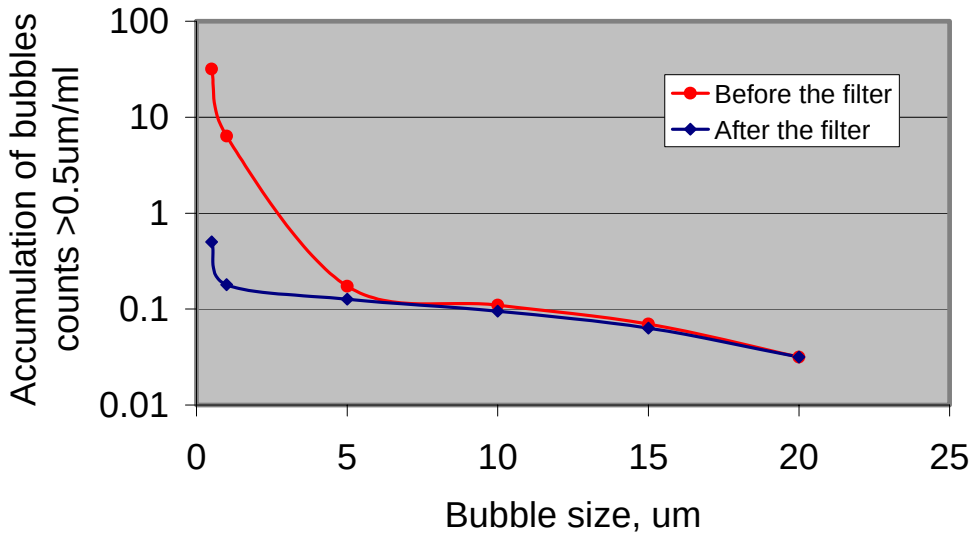


Figure 8. De-bubble Effects of 0.2um Guardian HPX with the bellows pump at flow rate of 1.0 gpm in the 0.1% Triton



Discussion

When liquid and gases are brought into contact, mass transfer between the gas and liquid phases will occur. The concentration of gases dissolved in the liquid will continue to increase until equilibrium (saturation) is reached. The concentration of gases in the saturated liquid will remain constant unless equilibrium conditions change. An increase in system pressure will cause gases to dissolve into the liquid stream. On the other hand, a decrease in system pressure will cause gases to be released from the liquid to form bubbles. The high-speed propeller in the Levitronix pump creates a low-pressure zone near the propeller, which would, creates many bubble nuclei. It was anticipated that the Levitronix bump would generated more bubbles than regular bumps. However, the relative higher bulk pressure created by the bump itself at high RPM would prevent the nuclei growth thus keep the bubble counts at a relative low level.