

# Extraction of Metallic Contamination from AstiPure™ PFD3 Pumps

AstiPure™ PFD 3 pumps are the first pumps with no internal or external metal parts. Their PVDF, Teflon® and PEEK components are ideal for clean handling of ultrapure or corrosive chemicals. AstiPure PFD pumps have very low levels of extractable metals, even in aggressive 37% hydrochloric acid (HCl).

The DyconE<sup>x</sup>SM dynamic extraction procedure<sup>1</sup> was used to measure surface contamination and the rate of metal extraction from AstiPure pumps. The test, during which a pump was exposed to a continuous flow of 37% HCl for 14 days, simulates worst-case use conditions.

## Test Method

A dynamic extraction system was filled with 1.95 liters of high-purity 37% HCl and a sample was withdrawn for trace metals analysis. An AstiPure PFD3 pump was installed in the circulation loop and HCl was circulated through the system at 0.6-0.8 L/min.

An HCl sample was collected after 40 minutes to measure metal contamination removed from the surface of the pump. Additional samples, taken at 2 hrs, 8 hrs, 2 days, and 14 days, were used to determine the masses and rates of metal extraction from the bulk material of the pump over time. Samples were analyzed as a group for 37 metals by either inductively coupled plasma-mass spectroscopy (ICP-MS) or graphite furnace atomic absorption (GFAA) spectroscopy.

## Results

Table 1 shows the masses of metals removed from the surface of the pump. The primary metallic contaminant was iron. The total mass of metals removed was 9.1 ng/cm<sup>2</sup>, or 34.38 µg per pump. This is less than half of the specification, <20 ng/cm<sup>2</sup>, set by a major manufacturer of chemical delivery systems<sup>2</sup>.

Element	Surface Metallic Contaminants (µg/pump)
Fe	29.42
Ca	0.95
Cr	0.72
Na	0.64
Sn	0.45
Ni	0.38
Al	0.34
Zn	0.30
Remaining 30 Elements	≤0.20
<b>Total</b>	<b>34.38</b>

Table 1: Masses of individual metals removed from the surface of an AstiPure pump by 37% HCl

Metal extraction data were normalized to the wetted surface area of the pump. Figure 1 shows that the rate of total mass extraction decreased over time.

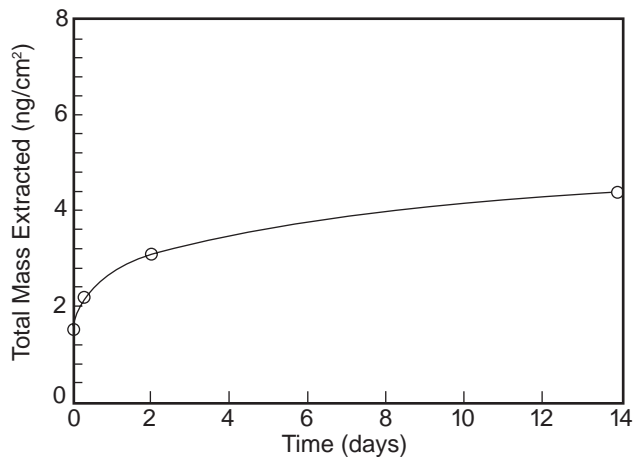


Figure 1: Cumulative total metal extraction into 37% HCl

The data in Figure 1 can be used to calculate the rate of metal extraction at any time. At 7 days, the extraction rate was 0.11 ng/cm<sup>2</sup>-day. Figure 2 compares the extraction rate for the AstiPure pump to the specification set by a major chemical distribution system manufacturer for delivery system components. Metal extraction from the AstiPure pump was well below the specification,  $\leq 0.5$  ng/cm<sup>2</sup>-day at 7 days.

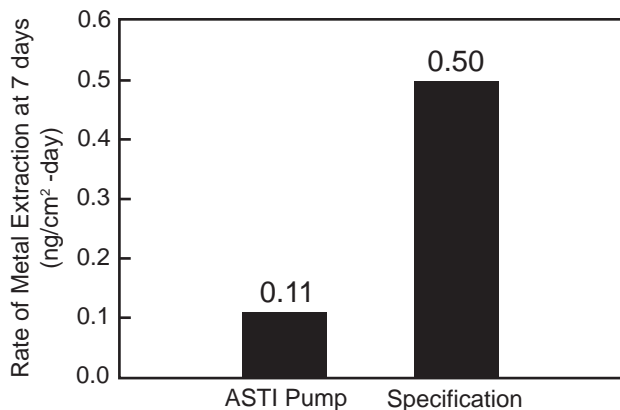


Figure 2: Comparison of the rate of metal extraction at 7 days to specification.

## Summary

The DyconEX<sup>SM</sup> dynamic extraction procedure was used to measure trace metal extraction from an AstiPure PFD 3 pump into 37% HCl. The primary metallic contaminant was iron. Surface contamination measured for 37 metals was 34.38  $\mu\text{g}$ . After 7 days of exposure to HCl, the metal extraction rate from the bulk of the pump was 0.11 ng/cm<sup>2</sup>-day. Both surface and bulk contamination were well below the specifications set by a major manufacturer of chemical distributions system for components of chemical delivery systems.

## References

1. Grant DC, T Lemke, G Duepner, D Wilkes, and N Powell, "Measurement of Inorganic Contaminant Extraction from Fluid Handling Components by Dynamic Extraction," *J of the IES*, 39(2): 29-37, 1996.
2. Grant DC, T Lemke and D Carrieri, "Specification and verification of metallic extractables in fluid handling components by dynamic extraction," in *Proceedings of the Semicon West Workshop on Contamination in Liquid Chemical Distribution Systems*, July, 1997.

The data provided here were obtained under defined test conditions. The tests were designed to mimic use or worst case conditions. However, Saint-Gobain Performance Plastics makes no specific claims about the performance of the pump in other chemicals or systems.

The DyconEX<sup>SM</sup> procedure is patented by BOC Edwards Chemical Management Division (US patent No. 5,641,895). CT Associates, Inc. has a license for commercial use of this procedure.



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