THE EFFECT OF FLUID DYNAMICS ON PARTICLE SHEDDING FROM SEMICONDUCTOR FLUID-HANDLING COMPONENTS

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The effects of fluid flow dynamics on the rate of particle shedding from numerous types of fluid-handling components have been analyzed using an ultrapure-water rinse test. The components included valves, tubing, and other fluid-handling parts from a variety of manufacturers. The majority of the interior surfaces of the components were composed of fluoropolymers such as perfluoroalkoxy (PFA) and poly(tetrafluoro-ethylene) (PTFE).

The increase in particle concentration in the fluid passing through a component is related to the total volume of fluid that has passed through the component. The increase in particle concen-tration from a component per unit of surface area as a function of total rinse volume forms a straight line on a log-log plot. The log-log slope of the results from 50 tests ranged from -1.1 to -1.5, although the initial cleanliness of the compo-nents varied over approximately six orders of magnitude. Various liquid face velocities were used in the tests, encompassing both laminar and turbulent flow conditions.

A physical model was developed to describe this behavior. The model assumes that the rate at which particles are removed from a surface is proportional both to the number of available particles on the surface of the component and to the fluid velocity. The relationship found in this study between particle concentration and total rinse volume allows development of test methods to predict how a fluid-handling component will perform in high-purity water or chemical delivery systems.

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