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Part One: Design Impact for Fluid Components

Moore's Law in the Semiconductor Industry

The semiconductor industry has over the past decades religiously followed Moore's Law; however, it appears that we are at a point today where the industry would potentially split. On one hand those who followed Moore's Law since the early 2000's and has pushed the 300mm wafer to its limit are now heading toward the 450mm wafer to improve their profitability, although there is not a clear vision on when this move will be happening. On the other hand, those who are following More than Moore (i.e. Sensors, Biochips, Analogs / RF, etc.), are concentrating on using 200mm wafer which offers a more versatile production mode.

From a high-purity liquid perspective, the requirement pushed on flow components used in the chemical distribution or slurry distribution systems are increasingly complex on the 450mm respectively high throughput 300mm versus what was done on the 200mm. For this portion of the discussion, let us focus only on the specific point related to process integrity and cleanliness.

Design Impact for Fluid Components

Liquid transported in components such as pumps, valves, fitting, and tubing are generally answering to a combination of the following description - ultra-pure, highly corrosive, highly abrasive, and highly concentrated - thus require specific adaptation to ensure end user that these components will be working in the safest environment for both their process and their people. The semiconductor industry has elected fluoropolymer as the base material of choice. However, when high flow is required, what has become trivial nowadays with 1 inch and below component turn into another story when you reach 2 inch component due to the inherent mechanical properties of fluoropolymer. Due to this complexity in design, here are a number of points that have to be considered and how Saint-Gobain Process Systems overcame them:

Fluid envelope reinforcement - The easiest way to do this is to support the liquid flow path, generally in high-purity polymer, by a casing either made of reinforced polymer such as glass fiber PP or metal covered element for the needed support. These solutions provide the additional support that the fluid envelope need but will expose your people and your system process to potential contamination or failure, either due to permeation of chemical through the fluoropolymer envelope or by direct exposure. On our 2 inch high-purity valve Furon[®] HGV2, we used our long-term in-house industrial expertise of design on transforming injection and compression molding fluoropolymer to achieve equivalent pressure capabilities, but staying with a 100% high-purity fluoropolymer flow path and shell.

Sealing - for every fluid envelope, it will be mandatory to have on specific points a sealing technology with the large flow component. They will be combined with a source of potential contamination, not by the quality of the sealant but more specifically due to compatibility issues or with high quality universal fluoro-elastomer which will have a significant impact on the components' cost. This can be addressed through innovative technology, such as our Tongue & Groove Technology, which offers a direct fluoropolymer on fluoro-polymer sealing technology that is used on all of our designs but especially on our No O-ring union and on our valve diaphragm.

Membrane / diaphragm and components directly in the liquid flow - on the large flow application, the required deformation on valve diaphragm necessary to enable premium flow may require working with a sandwich compound - a thin PTFE layer (initial chemical resistance) backed

up by a “Viton” like elastomeric compound (flexibility & strength). This proven technology force you to bring close from your process a significant source of contaminant, especially with the harsh condition and chemistry going through the valve (or abrasive material for CMP process). To overcome this risk of having elastomeric compound close to a high-purity highly aggressive fluid, it is necessary to get further engineered solution relying on specific design combined with high flexibility fluoropolymer offering sufficient displacement related to the high flow applications. This is for that exact reason that we implemented our Rolling Diaphragm technology which allows a 100% fluoropolymer solution to achieve close to full path orifice enabling the combination of superior flow, robustness and cleanliness.

Safety and Integrity for High-purity Flow Components

As we can see on only one “parameter” described above, the impact generated on the flow component are massive, the way to address what people may consider as a simple scale up are indeed exponential in complexity.

If we consider a 300mm fab with a high wafer throughput capability or a 450mm wafer fab (if / when they will be live), they will be forced to go through the high flow solutions but will be required to maintain safety and process integrity. In which case, it will be necessary to ensure high-purity flow components are specifically designed to reflect the new challenges generated by the larger sizes.

About Saint-Gobain

Saint-Gobain designs, manufactures and distributes materials and solutions which are key ingredients in the wellbeing of each of us and the future of all. They can be found everywhere in our living places and our daily life: in buildings, transportation, infrastructure and in many industrial applications. They provide comfort, performance and safety while addressing the challenges of sustainable construction, resource efficiency and climate change. With 2015 sales of \$43.9 billion, Saint-Gobain operates in 66 countries and has more than 170,000 employees.

Saint-Gobain's Performance Plastics business is headquartered in Solon, Ohio, and employs 6,000 people in 22 countries. It is a world leader in high-performance plastics, including flexible tubing, seals, coated fabrics, foams, window film, barrier/release films, tapes, medical components, fluid handling systems and bearings.

Saint-Gobain's Process Systems business unit helps customers achieve safety, performance and brand assurance through a broad range of capabilities that rely on superior engineering and customer support. Our product applications include those in the food, beverage, habitat, aerospace, chemical and electronics sectors. We've helped customers in all of these industries achieve goals in innovation, efficiency, sustainability and product integrity through customized solutions such as flexible tubing, gaskets, seals, hoses, fittings, pumps, valves and manifolds.

