

Application: Milk Manifold for Commercial Dairy Farms

Performance requirements: Clarity, rigidity, toughness under impact, resistance to temperature extremes and aggressive cleaners and disinfectants. Material must be FDA compliant for food contact, and capable of maintaining precise dimensions.

Materials considered: Polycarbonate (PC), Polysulfone (PSO), polyetherimide (PEI)

Overview: A milking cluster uses vacuum receivers to collect milk from each cow twice (or three times) daily. It is essential that all milk be removed from the cow in order to maintain the animal's health and optimize profit. This highly repetitive cycle requires verification of milk flow from each of four teats; therefore a transparent plastic part was developed to connect the four suction cups to the milk manifold.

End-use conditions: Parts are used in an outdoor environment (unheated barns) where ambient temperatures can range from -50F to +100F. Parts are subjected to various mechanical stresses, such as: compressive stress from being clamped to the vacuum receiver; cyclical fatigue stresses derived from the vacuum cycle, and impact from rough handling (e.g., falling off the cow or receiver to the floor; kicking or trampling by the cow). Parts are used twice daily for several hours during milking, seven days per week.

Cleaning: Immediately following the end of the morning or afternoon milking cycle, parts are subjected to CIP (clean in place) cleaning in order to comply with sanitary codes. The wash cycle to which the parts are subjected consists of an alkaline detergent at a temperature of 180F, followed by an acid rinse for disinfection. In the present case, the optimum Wash cycle temperature was 180 F; however the milking facility was unheated, so the part would be exposed to overnight temperatures as low as -50 F.

Critical Features: The part needed to have clarity to allow milk flow to be observed and high impact resistance to withstand 20-hour days in a hazardous environment (e.g. kicking cows). The part needed to attach with a quarter turn to a stainless steel component. A plastic shutoff inside the part needed to form fit (plastic against plastic) to create a water tight seal. And, of course, the part had to meet FDA requirements.

Requirements: Therefore, the application required an FDA approved material that was resistant to alkaline and acid, had a temperature range of 230 F., with a high degree of clarity, impact resistance and dimensional integrity to maintain the screw fit with the stainless steel component, as well as a plastic on plastic water tight seal.

Methodology: General technical information was available from resin manufacturers on each of the separate parameters outlined above, but how would these parameters react in combination: e.g. over time, what effect would high temperature have on chemical resistance or low temperature have on impact resistance and dimensional integrity or chemical exposure have on clarity, etc.? Resin manufacturers cannot make specific recommendations without incurring inherent liability for the success of the end use part, so it was necessary to make specific investigation into how the candidate materials might perform under simulated end-use conditions.

Laboratory Testing: To answer these questions, Plastics Technology Laboratories, Inc. was engaged to review the application and performance requirements, and create an environment that duplicated that of the actual application to which the parts would be subjected. This included accelerating the life cycle by exposing the parts to repeated immersion in chemicals, temperature changes and various impact tests to analyze the effects over time.

Analysis: Of the three materials considered for the application, one was rejected due to its inherent susceptibility to cracking after washing, and the remaining two were ranked for different balances of performance and cost. The results yielded answers that were specific to the application, rather than just a general range of independent parameters offered by the manufacturers. The parts, made from the material recommended by PTLI, have been in successful operation for over the last five years.

Summary: The Application Engineer through an exhaustive survey of the product's working environment and feature requirements was able to assemble a short list of possible materials. Then, through laboratory testing that closely replicated actual working conditions a final determination was made as to the best material. That the part would be subject to alkaline and acid during the Clean-In-Place cycle; that it would be exposed to a wide range of temperatures (180⁰ F to -50⁰ F); and that it would required impact resistance, clarity and dimensional integrity in an FDA approved material highlights the need for a top flight Applications Engineer and a sophisticated testing laboratory.