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Fuel Filter Filling Analysis

Keywords - Moldflow, Nylon, Knit line, Weld line, Air trapping

What Went Wrong?

The fuel filter in a gasoline engine application was leaking while in service. Failure was occurring near a welded joint in the part.

Evaluation

Pressure testing of the fuel filter revealed failure occurred near the housing shoulder weld. Visual and microscopic examination of the fuel filter revealed no evidence of cracking or deformation at the failure location. A leakage flow path was apparent near the housing-to-cap weld. This leak path occurred coincident with a knit line and air trapping in the housing weld shoulder. The leakage path appears to be the result of a no-fill condition from molding. Fourier transform infrared spectroscopy (FTIR) was used to identify the filter housing material and injection molding simulation (Moldflow®) was performed to replicate knit line and air trap formation. FTIR analysis identified the material as nylon. The transparent material property indicates that the nylon structure was amorphous.

Moldflow® simulation of the fuel filter showed a racetrack effect in the housing weld shoulder. The racetrack effect occurs when plastic flows into thick regions of a cavity more easily than thin regions. In the fuel filter, the racetrack effect leads to a knit line and air trapping tendencies in the weld shoulder. Proper venting at the knit line location and localized thickness changes could reduce the racetrack effect and improve knit line strength. Additional Moldflow® simulation was performed to reduce the racetrack effect, eliminate the knit line, and reduce air trapping in the housing.

Conclusion

It was the conclusion of the evaluation that leakage occurred from air trapping at a knit line in the housing weld shoulder. Proper venting and localized thickness changes could alleviate these issues in the molding process. The use of injection molding simulation software suggested ways to improve the fill pattern by eliminating knit line formation and reduce air trapping.

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Figure 1: Pressure testing revealing the leak location and view of the failure location.

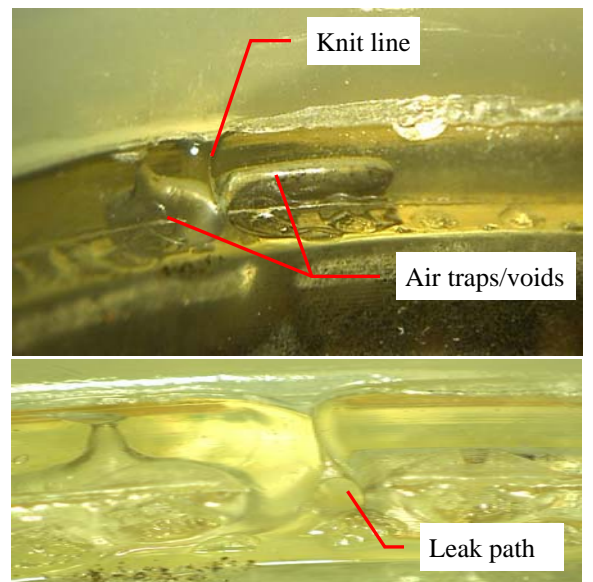


Figure 2: Micrographs of the leak location showing air traps/voids and a leak path at the cap-to-housing welded joint.

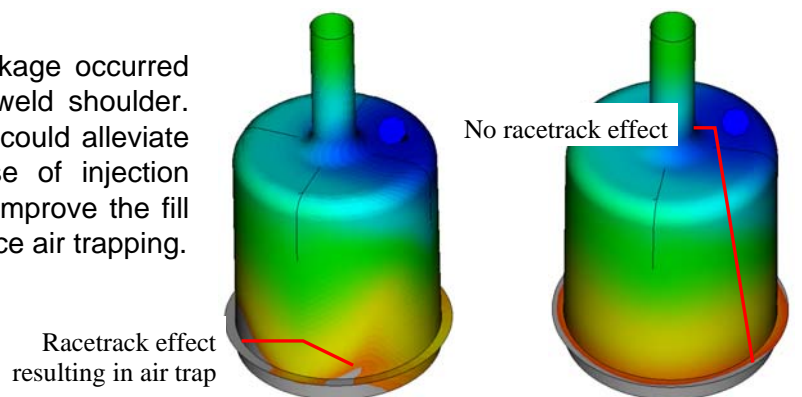


Figure 3: Moldflow® fill pattern plots showing the racetrack and air trapping issues (left) and an optimized fill process that eliminates racetracking and minimizes air trapping (right).